NASA Pioneering Space Innocentive Challenge Results

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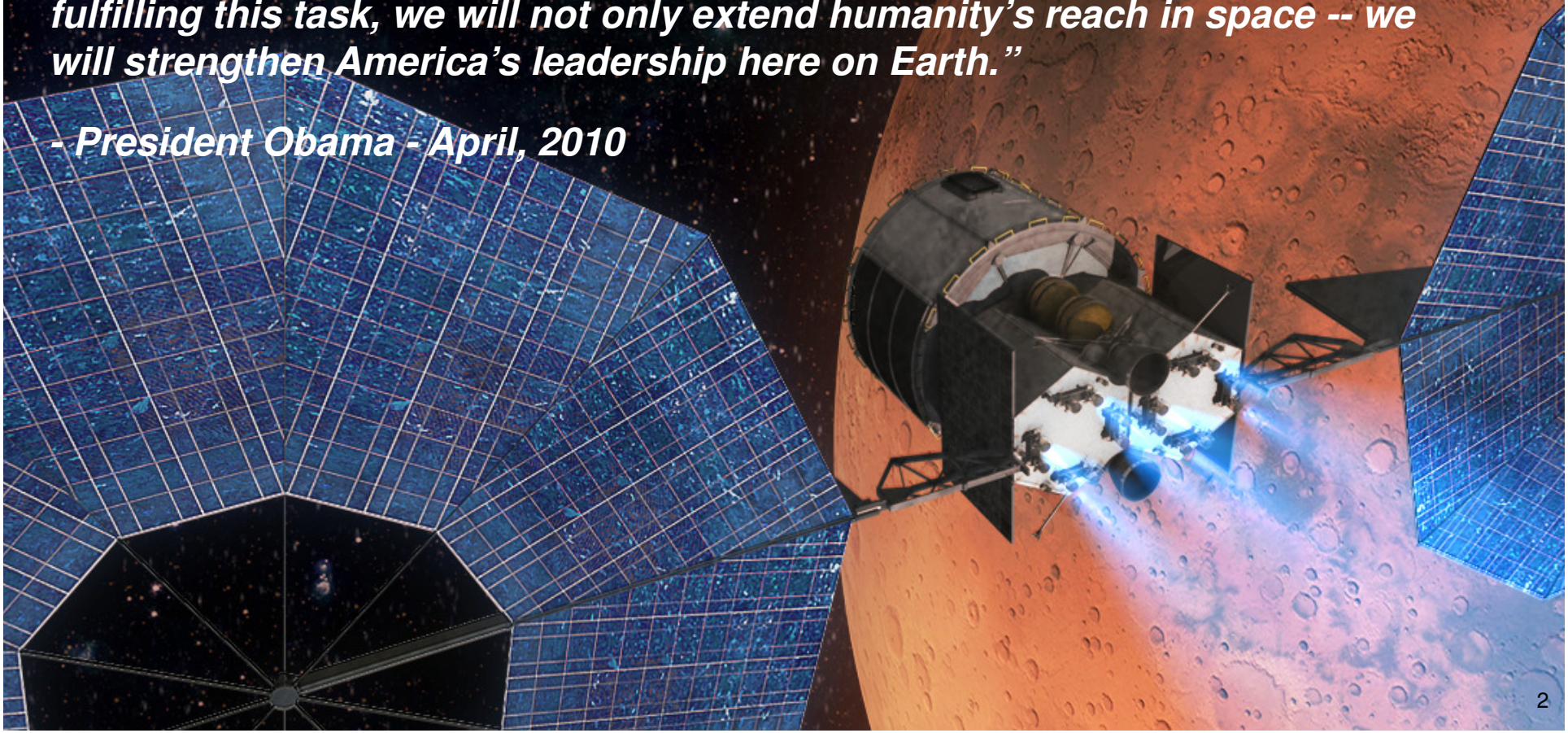
Pioneering Space - Goals

"Fifty years after the creation of NASA, our goal is no longer just a destination to reach. ***Our goal is the capacity for people to work and learn and operate and live safely beyond the Earth for extended periods of time, ultimately in ways that are more sustainable and even indefinite.*** *And in fulfilling this task, we will not only extend humanity's reach in space -- we will strengthen America's leadership here on Earth."*

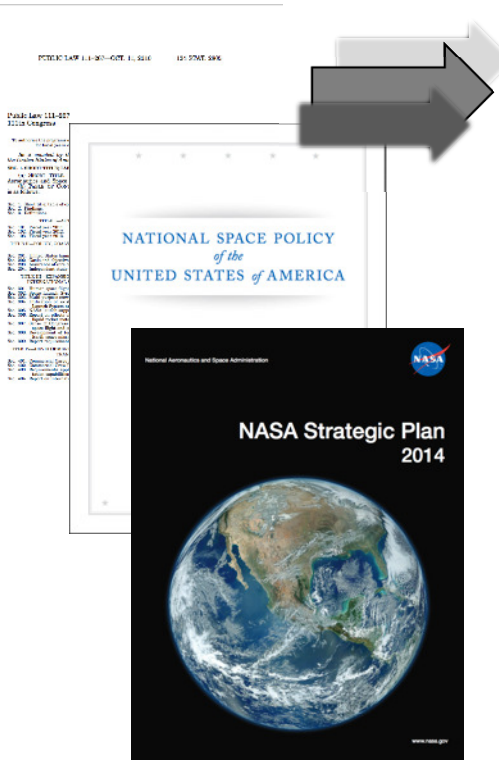
- President Obama - April, 2010



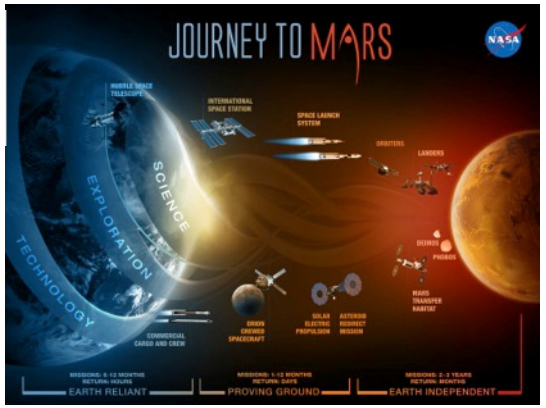
Evolvable Mars Campaign – Study Activity

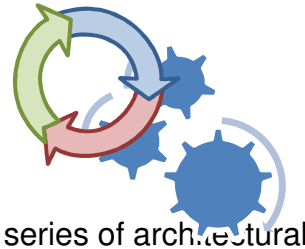
Body of Previous Architectures, Design Reference Missions, Emerging Studies and New Discoveries	2010 Authorization Act, National Space Policy, NASA Strategic Plan	Evolvable Mars Campaign

- Internal NASA and other Government
- International Partners
- Commercial and Industrial
- Academic
- Technology developments
- Science discoveries



- Establish capacity for people to live and work in space indefinitely
- Expand human presence into the solar system and to the surface of Mars





- An ongoing series of architectural trade analyses, guided by Strategic Principles, to define the capabilities and elements needed for a sustainable human presence on Mars
- Builds off of previous studies and ongoing assessments
- Provides clear linkage of current investments (SLS, Orion, etc.) to future capability needs

- ***How do we pioneer an extended human presence on Mars that is Earth independent?***

- **Need to agree on a common understanding of the three phrases in this question to provide guidance for Mars surface systems and ConOps planning**
  - **What is meant by "pioneer"?**
  - **How long is "an extended human presence"?**
  - **What is meant by "Earth independent"?**

NASA Challenge:

Space Pioneering – Achieving Earth Independence

was posted to the InnoCentive challenge center May 5, 2015 and closed July 6, 2015

NASA Challenge: Space Pioneering – Achieving Earth Independence

TAGS: Physical Sciences, NASA, Engineering/Design, Food/Agriculture, Life Sciences, Chemistry, Theoretical-licensing

AWARD: **$15,000 USD** | STATUS: **Under Eval** | ACTIVE SOLVERS: 4812 | POSTED: 5/05/15

NASA is embarking on a long-term effort of "pioneering space" for this and future generations. In this context, "pioneering space" is defined as the ability for humans to go further and stay longer in space with an ever decreasing need to be reliant on Earth, approaching "Earth independence".

For this specific Challenge, the Solver is asked to focus on particular elements of "pioneering space," namely those elements needed to establish a continuous human presence on Mars.

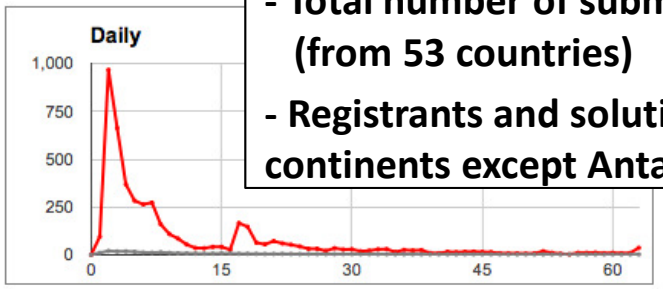
Source: InnoCentive **Challenge ID:** 9933746

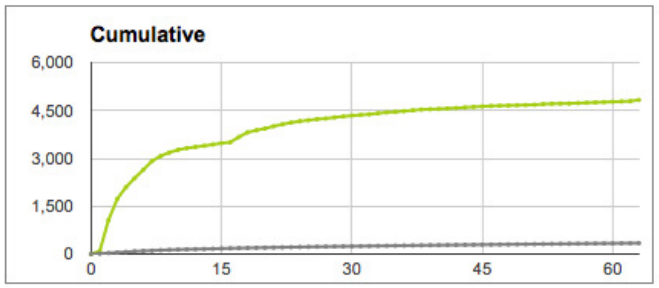
Challenge Overview

InnoCentive Pioneering Challenge Final Stats

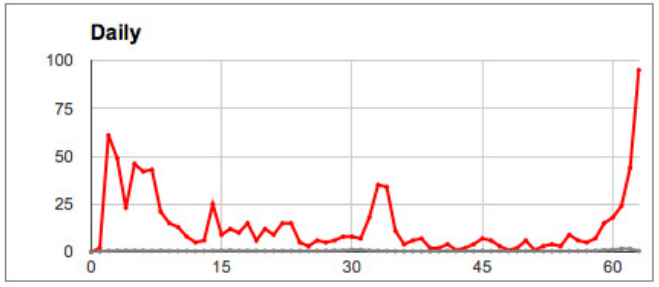
- **Total number of project rooms: 4812 (from 110 countries)**
- **Total number of submissions: 771 (from 53 countries)**
- **Registrants and solutions from all of the continents except Antarctica**

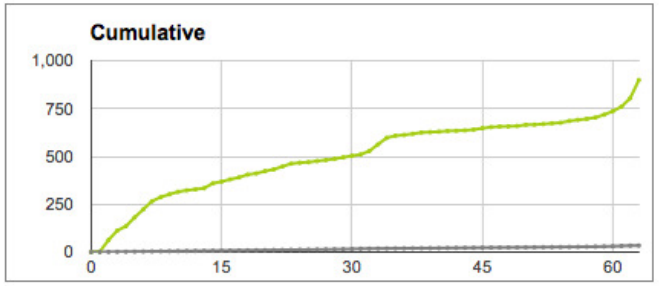
Solvers





Solutions





Observations of Submittals Received

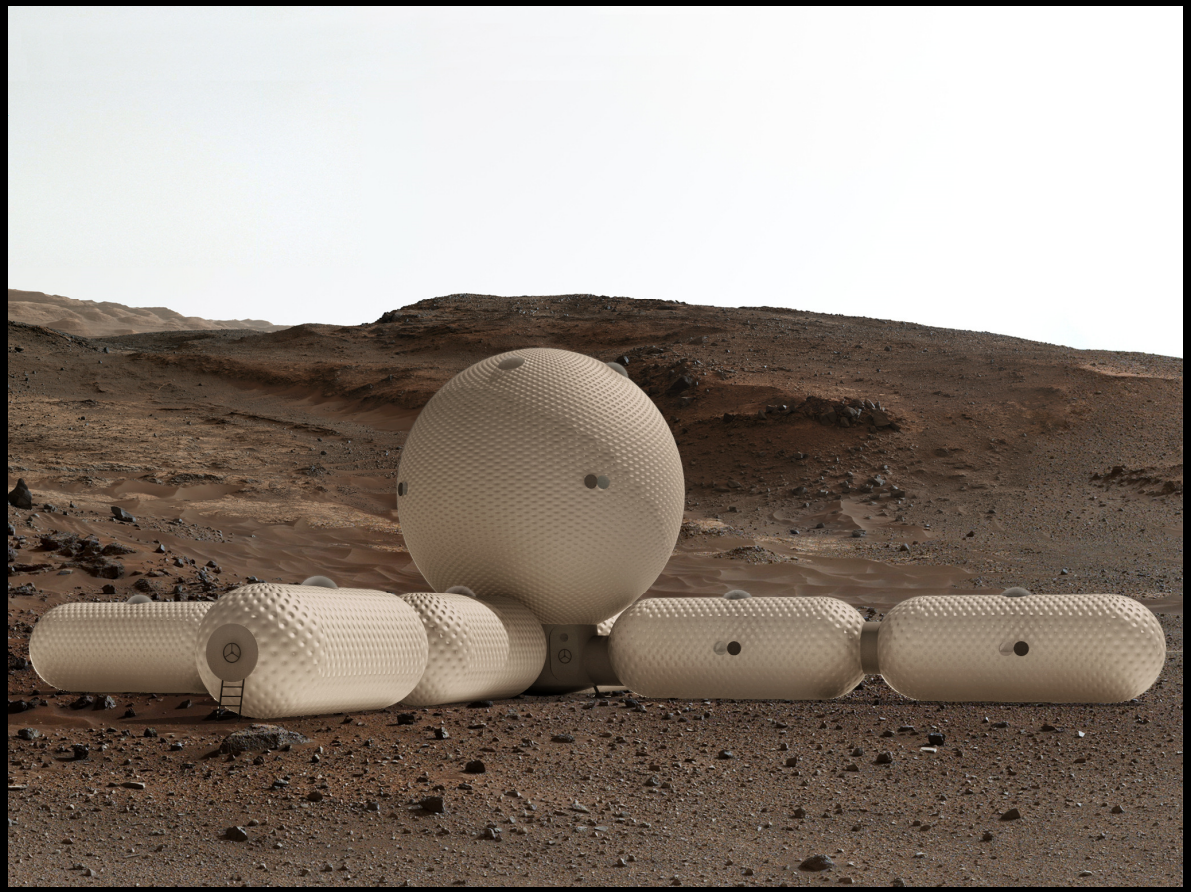
- Wide range of responses: from very little detail to moderate level of technical detail; from single surface system focus to broad range of (integrated) systems.
- Some concepts applied with a new twist in response to the challenge statement; some concepts introduced with reference to recent research drawn from other applications
- Several submittals collectively addressed some of the primary issues associated with “pioneering Mars” and gave HAT some specific concepts that we should evaluate in conjunction with other concepts during our FY16 Mars Surface Proving Ground studies.

Winner

Arthur Ruff, from Toronto, Canada, for his entry:

Mars Igloo: An ISRU Habitat

The Martian Igloo uses ISRU to build habitats with minimal additional mission complexity. Water and regolith are mixed and poured into a form made from Mylar. The mixture freezes into reinforced ice, which provides the structural strength and radiation shielding for the habitat.



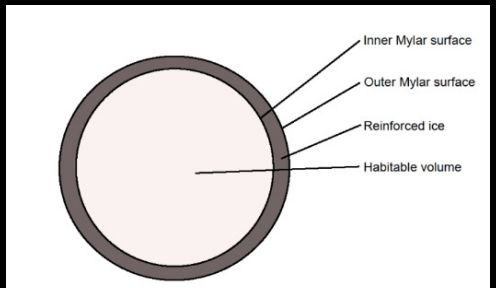


Figure 1 – Cross section of spherical Igloo Habitat

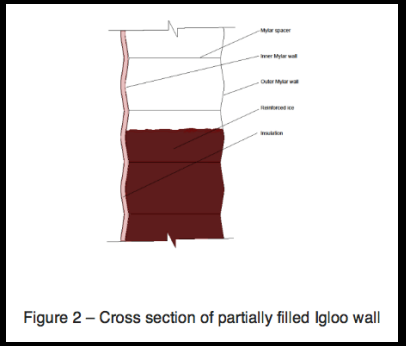


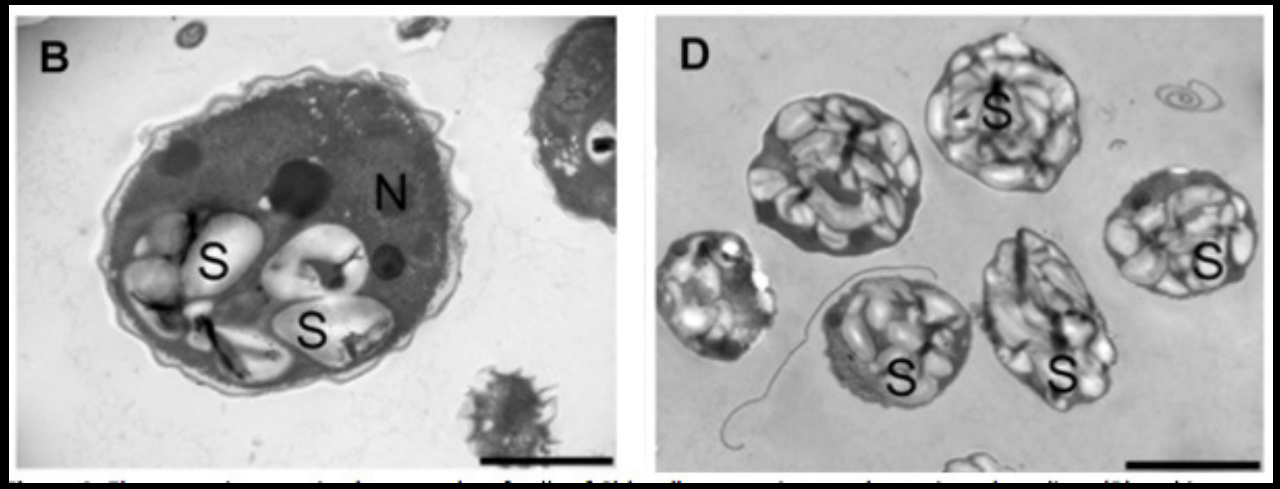
Figure 2 – Cross section of partially filled Igloo wall

Winner

Pierre Blosse, from Urbandale, Iowa, for his entry:

Starch from the Micro-Algae Chlorella as the Main Food Source for a Self-Sustaining Martian Colony

This proposal describes a system to grow starch from the microalgae Chlorella as the main food source for colonists on Mars. It is based on three discoveries made in recent years by biofuels researchers.



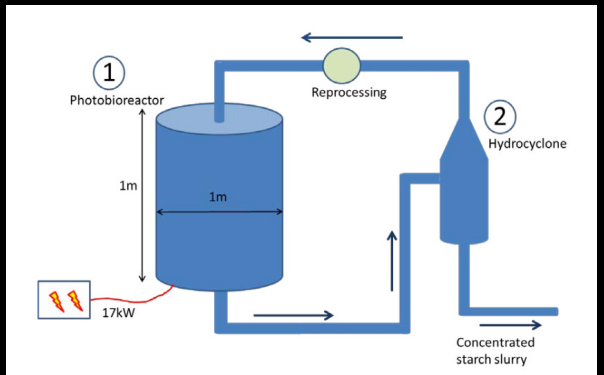


Figure 2. Schematic of the proposed system.

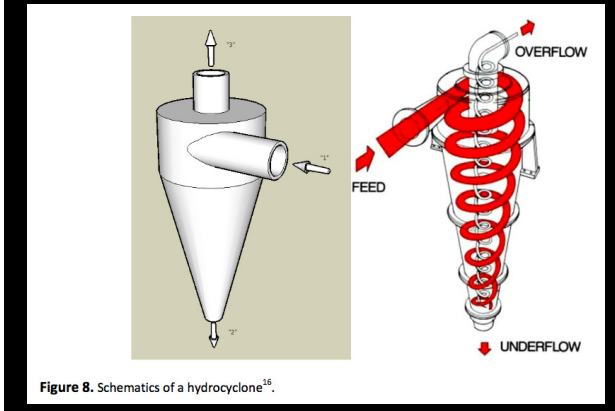


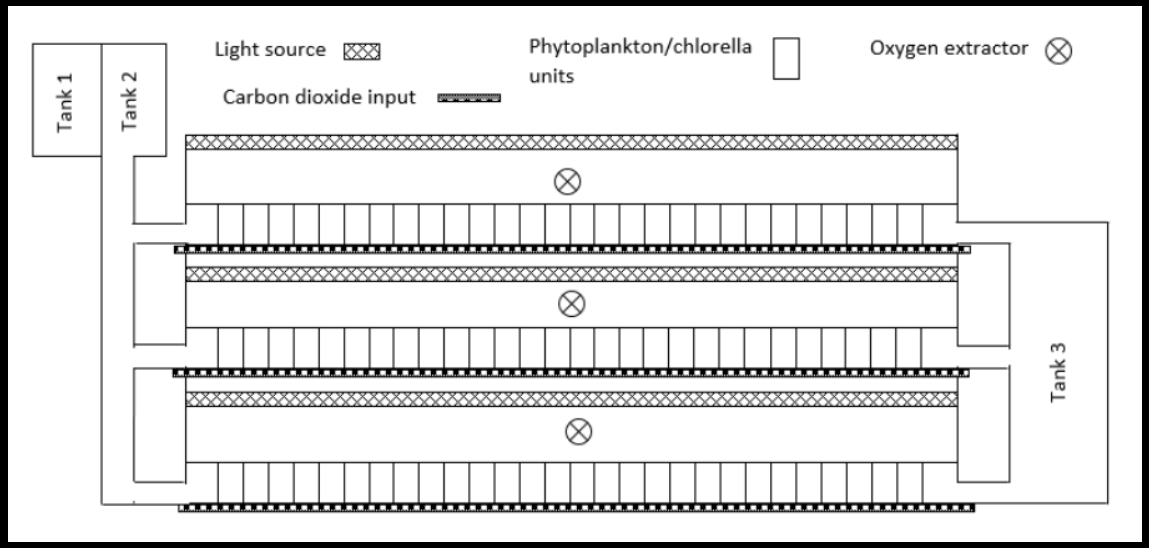
Figure 8. Schematics of a hydrocyclone[16].

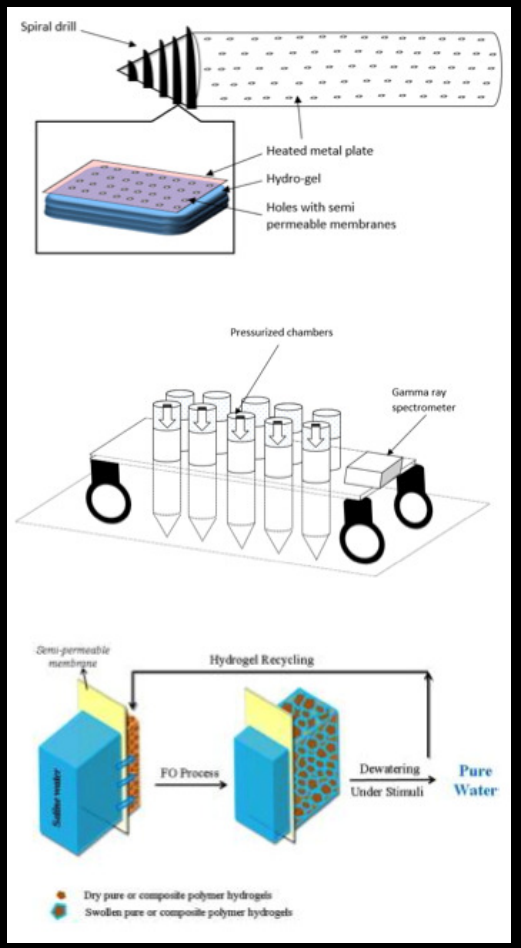
Winner

Aaron Aliaga from Menifee, California and Maleen Kidiwela from Irving, Texas, for their entry:

Mars Settlement Concepts

Proposes Hellas Basin human base, and looks at the integration of life support and habitat systems. Includes the design for oxygen production photo bioreactor unit and using Chlorella and Phytoplankton as a food source.





Rationale for three winning submittals

- **"Mars Igloo"**
  - Proposal to use water ice and local Mars regolith as "Mars concrete"
    - At "typical" surface temperatures water ice is very rigid
  - Use of Mylar (or a similar light-weight and flexible material) as a structural form and containment solves several issues

- **"Hellas Basin human base"**
  - Proposal for an integrated solution addressing three major issues associated with "pioneering" and "Earth independence"
    - (1) Long term radiation protection
    - (2) Supplemental food growth integrated with (3) bioregenerative life support
  - Illustrates an integrated solution (although with less detail) that incorporates the detailed solutions from the other two winners

- **"Starch from Micro-algae Chlorella …"**
  - A detailed proposal for a solution addressing supplemental food growth integrated with bioregenerative life support
  - Proposal based in part on recent research for biofuels that take advantage of Chlorella growth properties – research not available for previous studies of algae growth used in bioregenerative ECLSS

Summary

- **Successful “outreach” to external public community**
- **Magnitude of response to challenge**
  - Validated many of the approaches we have considered within the Evolvable Mars Campaign
  - Identified potential areas to reconsider based on recent technology and operational maturity

Pioneering Next Steps in Space Exploration

15-206

NASA Releases Plan Outlining Next Steps in the Journey to Mars

NASA is leading our nation and the world on a journey to Mars, and Thursday the agency released a detailed outline of that plan in its report, "NASA's Journey to Mars: Pioneering Next Steps in Space Exploration."

"NASA is closer to sending American astronauts to Mars than at any point in our history," said NASA Administrator Charles Bolden. "Today, we are publishing additional details about our journey to Mars plan and how we are aligning all of our work in support of this goal. In the coming weeks, I look forward to continuing to discuss the details of our plan with members of Congress, as well as our commercial and our international and partners, many of whom will be attending the International Astronautical Congress next week."

The plan can be read online at:

http://go.nasa.gov/1VHDXxg

The journey to Mars crosses three thresholds, each with increasing challenges as humans move farther from Earth. NASA is managing these challenges by developing and demonstrating capabilities in incremental steps:

Earth Reliant exploration is focused on research aboard the International Space Station. From this world-class microgravity laboratory, we are testing technologies and advancing human health and performance research that will enable deep space, long duration missions.

In the **Proving Ground**, NASA will learn to conduct complex operations in a deep space environment that allows crews to return to Earth in a matter of days. Primarily operating in cislunar space—the volume of space around the moon featuring multiple possible stable staging orbits for future deep space missions—NASA will advance and validate capabilities required for humans to live and work at

http://www.nasa.gov/press-release/nasa-releases-plan-outlining-next-steps-in-the-journey-to-mars