Summary of the Workshop on
Human / Robotic Exploration of the Solar System

Sponsored by: Revolutionary Aerospace Systems Concepts
NASA Langley Research Center
**Human & Robotics Exploration Mission Objective**

- Identify key revolutionary technologies for Human and Robotics systems which have the potential, when synergistically combined, to reduce the time, distance and safety barriers associated with scientific exploration beyond Low Earth Orbit (LEO).

**Universities Space Research Association (USRA) Task Mission Objectives**

- Use a collaborative effort of academic, industrial and government experts to identify potential revolutionary aerospace systems concepts for scientific exploration beyond LEO with both Humans and Robots.
- Gain an initial understanding of the revolutionary technologies associated with these Human and Robotic systems concepts which, if developed, would maximize the probability of meeting NASA’s Exploration Grand Challenges.
- Attempt to engage a broad audience for solicitation of creative, revolutionary ideas.
USRA Task Approach

- Conduct a NASA-style Request for Information (RFI) through the NASA Institute for Advanced Concepts (NIAC) in order to solicit ideas from academic, industrial and government experts.

- Use ongoing NASA activities associated with Human and Robotic exploration beyond LEO to establish initial mission requirements associated with planetary and in-space platform science scenarios.

- NIAC evaluation and compilation of RFI responses.

- Conduct a RASC focused Human & Robotics exploration workshop to integrate expert ideas with the results of the RFI activity.
ICASE/NASA LaRC Workshop on Revolutionary Aerospace Systems Concepts for Human Robotic Exploration of the Solar System was held on November 6-8, 2001 at NASA LaRC.

- Primary workshop objectives were to:
  - Present key results from the USRA RFI
  - Capture an overview of current scientific exploration goals, objectives, and top level requirements
  - Provide a forum for the free exchange of ideas dealing with revolutionary systems concepts and technologies associated with Human and Robotic exploration beyond LEO

- Workshop announcement placed on ICASE website on July 25, 2001
  http://www.icase.edu/workshops/hress01.html

- Attendance: More than 100
Human / Robotic Exploration of the Solar System

Workshop Presentations

http://www.icase.edu/workshops/hress01/responses.html
http://www.icase.edu/workshops/hress01/presentations.html
**Sensitive Skin Concept for Spacecraft/Aircraft**

- Structural elements using nanocomposites
- Sensitive skin cover with multiple sensing capabilities including detection of hazardous agents
- Actuation arrays for shape/surface control
- Self-healing, self-cleaning capabilities

**Hormones for Caterpillar Move**

- A simple, one-pass hormone from head to tail
- Controls and synchronizes all motor actions
- Independent from the length of the snake
Akin, David
Cooperative Human-Robotic Roles in EVA Work Sites
Bartlett, Paul
Human Exploration Enabling Robotic Systems and Technologies
Boston, Penelope
The Robot-Human Continuum: Concepts, Evolution, and Applications For Space Exploration
Bushnell, Dennis
Frontiers of Space Access / Utilization / Exploration Technologies
Campbell, Mark
Human Centered Control of Complex Automa-Teams
Carr, Christopher
Distributed Architectures and Traverse Planning for Mars Exploration
Cassanova, Robert
NASA Institute for Advanced Concepts RFI Summary Results
Chun, Wendell
Long-Lasting Colonies
Cirillo, William
Revolutionary Aerospace Systems Concepts (RASC)
<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clark, Benton</td>
<td>From Robotic Missions to Free Moving Robots</td>
</tr>
<tr>
<td>Cooke, Doug</td>
<td>Human Exploration Architectures and Perspectives</td>
</tr>
<tr>
<td>Cybenko, George</td>
<td>A Novel Information Management Architecture for Maintaining Long Duration Space Crews</td>
</tr>
<tr>
<td>Dickerson, Pat</td>
<td>Catapults and Platforms for Planetary Surface Exploration: Geology, Biomedicine and Astrobiology</td>
</tr>
<tr>
<td>Dicus, Dennis</td>
<td>Advanced Materials to Enable Future NASA Missions</td>
</tr>
<tr>
<td>Dubowsky, Steven</td>
<td>Concepts for Future Space Robots</td>
</tr>
<tr>
<td>Duke, Michael</td>
<td>Human-Enabled Science</td>
</tr>
<tr>
<td>Frassanito, John</td>
<td>Strategic Visualization: The Animation of John Frassanito &amp; Associates For NASA</td>
</tr>
<tr>
<td>Fullerton, Rick</td>
<td>The Future of EVA Technologies</td>
</tr>
<tr>
<td>Author</td>
<td>Title</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Funaro, James</td>
<td>The Difficult Sciences</td>
</tr>
<tr>
<td>Hansen, Jack</td>
<td>A Human-Centered Computing View of Planetary Exploration</td>
</tr>
<tr>
<td>Hecht, Heiko</td>
<td>The Science Fiction of Artificial Gravity</td>
</tr>
<tr>
<td>Hodgson, Edward</td>
<td>Preparing for Life in the Convergence Zone</td>
</tr>
<tr>
<td>Hur, Michael</td>
<td>Sensitive Skin for Biologically-Inspired Aerospace Materials and</td>
</tr>
<tr>
<td></td>
<td>Structural Elements Based on Nanotechnology</td>
</tr>
<tr>
<td>Kammash, Terry</td>
<td>Space Power and Propulsion</td>
</tr>
<tr>
<td>Landis, Geoffrey</td>
<td>Human Robotic Cooperation using Humans and Robots Synergistically</td>
</tr>
<tr>
<td></td>
<td>To Explore the Solar System - Scenarios</td>
</tr>
<tr>
<td>Leitch, Jim</td>
<td>Formation Flying for Assembly of Deep Space Interferometers</td>
</tr>
<tr>
<td>Lipson, Hod</td>
<td>Autonomous Design and Fabrication for Long Term Space Exploration</td>
</tr>
<tr>
<td>Lumelsky, Vladimir</td>
<td>Human-Robot Exploration - Missing Ingredients</td>
</tr>
</tbody>
</table>
Mankins, John
Human Exploration

Marzwell, Neville
Innovative Concept in Brain-Machine Seamless Interface for Human-Robotics Space Development Capabilities

Mavroidis, Constantinos
Haptic Interfaces using Electro-Rheological Fluids

Mayer, Theresa
Molecular Electronics and Directed Self-Assembly: Ultra-Small Computers That Build Themselves

McKay, David
Planetary Surface Scenario

Michelson, Robert
Intelligent Planetary Biomimetic Robotic Agents

Montemagno, Carlo
Artificial Life and Nanobiotechnology: Foundations for Autonomous Robotic Systems

O’Donnell, John
Robotic Versus Human Resources - Worktask Selection Criteria For Exploratory Space Missions
**Human/Robotic Exploration of the Solar System**

**Workshop Presentations**

**Ohi, Seigo**
*Human/Robotic Hematopoietic Stem Cell Therapy and Gene Therapy for Exploration of the Solar System*

**Pedersen, Liam & Kortenkamp, David**
*Space Robotic Capabilities*

**Rose, John**
*Achieving Comprehensive Mission Robustness*

**Shen, Wei-Min**
*Self-Reconfigurable Robots & Digital Hormones*

**Siegel, Richard**
*Nanostructured Materials*

**Siegfried, William**
*Technologies That Will Change Space Exploration in the Next 40 Years*

**Sullivan, Thomas**
*Human Health and Performance Aspects of a Mars Mission*

**Whittaker, William**
*Projected Existence for Human-Robotic Cooperation*
<table>
<thead>
<tr>
<th>Visionary Challenges Listed in CP 01-02</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fulfill the human desire to understand our place in the universe.</td>
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<tr>
<td>• Seek knowledge to understand how we evolved and what is our destiny.</td>
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<tr>
<td>• Search for life in the universe and understand cosmological phenomena.</td>
</tr>
</tbody>
</table>

| • Pursue the fascination of space and satisfy the human drive for exploration of the vastness of space, often at great risk. |
| • Make possible the safe, affordable and effective exploration, development and self-reliant habitation of our solar system – and eventually space beyond our solar system by humans and their agents. |
| • Mediate the effects of the space environment, such as microgravity and radiation, on humans and other living things, |

| • Provide seamlessly integrated, safe, reliable, fast and efficient transportation network from the Earth’s surface to distant locations in space as well as portal to portal on the Earth’s surface. |

| • Understand the influence on the Earth system of the actions of mankind, the natural cyclic phenomena in the Earth’s system and the interaction of the Sun-Earth system. |
| • Create tools and techniques to access, visualize and interpret data and model findings. |
| • Predict the future evolution of the Earth system and its relationship to natural phenomena and human activity, and validate this predictive capability. |
Planetary Exploration Using Biomimetrics

Anthony Colozza, Ohio Aerospace Institute

Phase II Performance Period: March 31, 2001 to August 31, 2002

- Gas used to drive wings can be reused to create ultrasonic ranging signals.
- FMCW waveform allows Doppler insensitive range measurements.
- Wing and fuselage motions provide scanning mechanism for ultrasonic beam.
It is at its frontiers that a species experiences the most perturbing stress. The urge to explore, the quest of the part for the whole, has been the primary force in evolution since the first water creatures began to reconnoiter the land. We humans see this impulse as the drive to self-transcendence, the unfolding of self-awareness...

Living systems cannot remain static; they evolve or decline. They explore or expire. The inner experience of this imperative is curiosity and awe. The sense of wonder—the need to find our place in the whole—is not only the genesis of personal growth but the very mechanism of evolution, driving us to become more than we are. Exploration, evolution, and self-transcendence are but different perspectives on the same process.
Wyn Wachhorst, The Dream of Spaceflight

The frontier, like the world of the child, is a place of wonder explored in the act of play. Work is self-maintenance; play is self-transcendence, probing the larger context, seeking the higher order...

Joseph Campbell has observed that in countless myths from all parts of the world the quest for fire occurred not because anyone knew what the practical uses of fire would be, but because it was fascinating. Those same myths credit the capture of fire with setting man apart from the beasts, for it was the earliest sign of that willingness to pursue fascination at great risk that has been the signature of our species. Man requires these fascinations, said the poet Robinson Jeffers, as “visions that fool him out of his limits.”

Like the capture of fire, the longing for space-flight is rooted less in means than in meaning itself.