Use of Earth-based Analogs for Long-duration Space Missions

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RYMDSTYRELSEN
Swedish National Space Board

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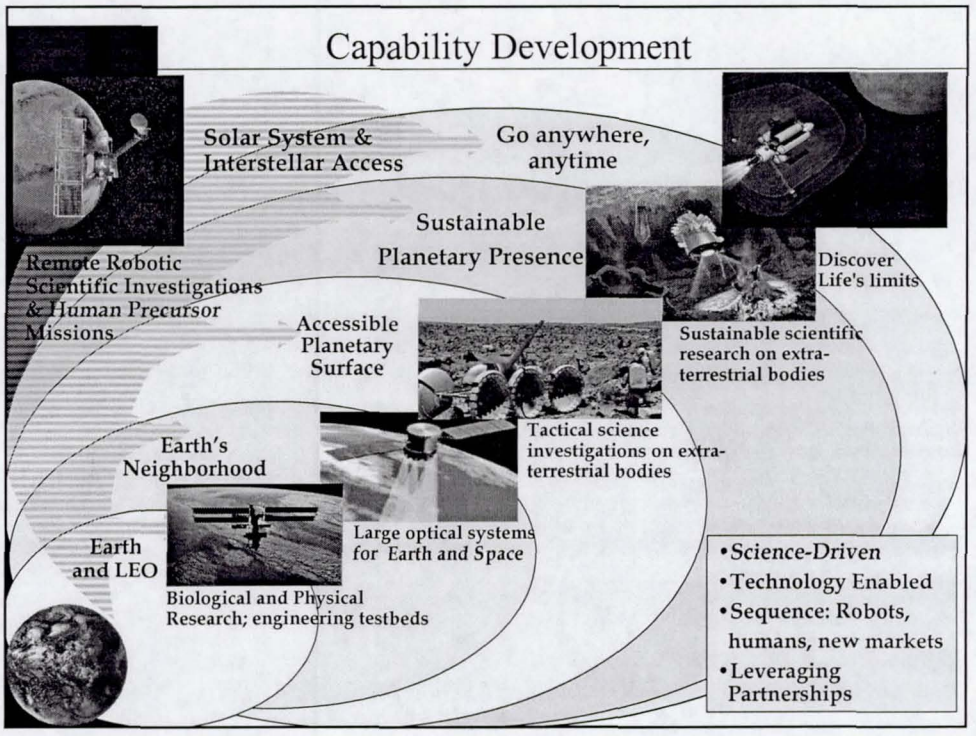
Swedish Polar Research Secretariat

Donald L. Henninger, PhD, Manager
INTEGRITY* Office
NASA – Johnson Space Center
Mail Code EC
Houston, TX 77059
DONALD.L.HENNINGER@nasa.gov
281-483-5034

* *Integr*ated Human Exploration Mission Simulation Facil*ity*



- *Analogue*
- *Simulator*
- *Prototype*
- *Substitute*
- *Test Bed*
- *Laboratory*
-
-
-

Human Exploration Missions Beyond Low Earth Orbit

General Attributes

- **Far from Earth**
  - **Mars is 1.5 AU's**
  - **Nominal Mars mission 1000 days**
- **Abort scenarios unsympathetic**
- **Very different from any past human space missions**
- **Risks are extremely high**

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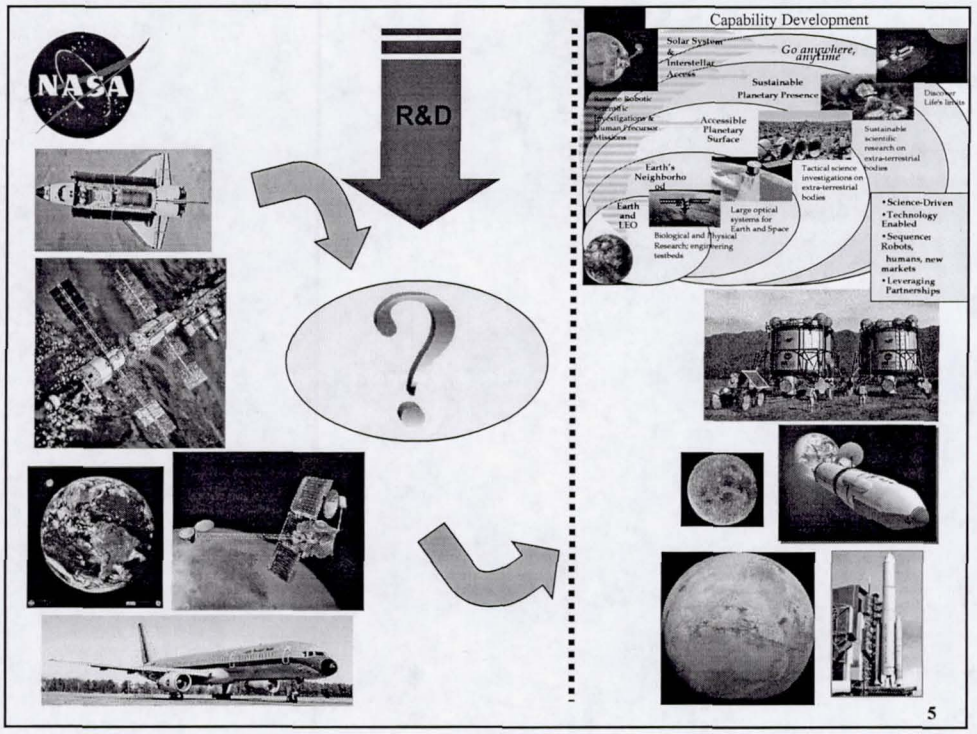

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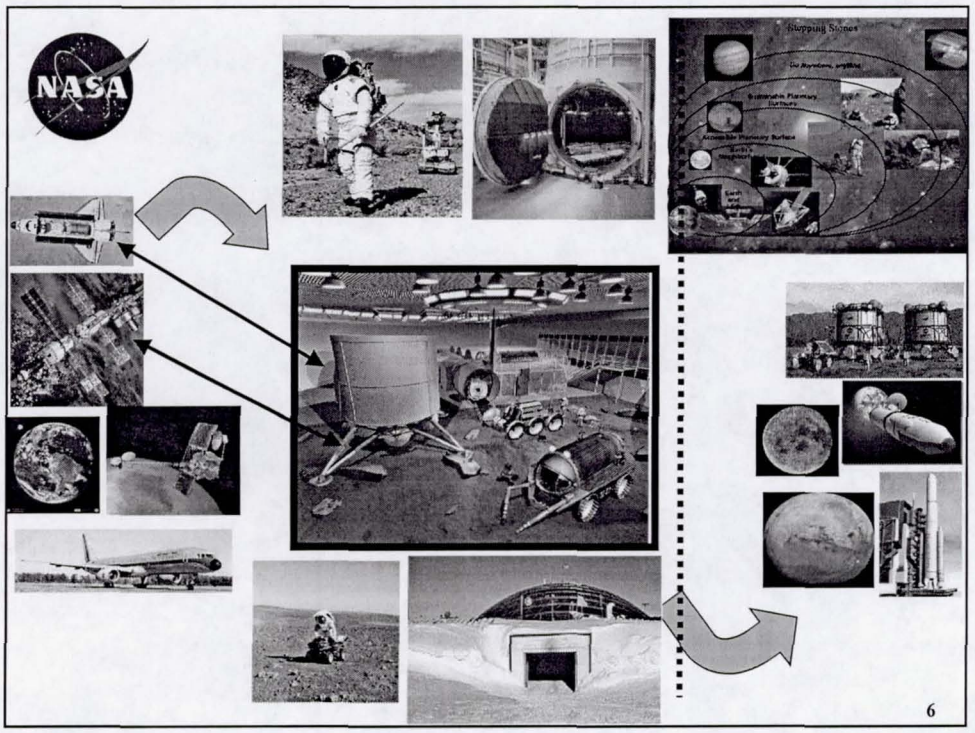

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OBJECTIVE

- *Design and build a ground test bed capable of accurately simulating all elements of a series of long-duration human planetary exploration missions*
- *Operate it as an actual set of long-duration human planetary missions*
- *Involve all elements of a mission*

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Is a human exploration mission in every respect – it just doesn't leave the Earth

- Establish a set of missions)

  "Fly the Mission on the Ground" concept
- Establish "baseline technologies" for the missions (tests) and conduct on-board "flight" experiments during the missions (tests)
- Missions are selected/defined; real requirements are generated; real milestones are established (focus for R&D)

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All elements associated with a long-duration human planetary exploration mission

- Mission operations, medical, psychological, crew accommodations, crew selection, vehicle & habitat design, human factors, power systems, life support, communications, planetary exploration, in-situ resource utilization, planetary protection, EVA, robotics, rovers, science operations ...

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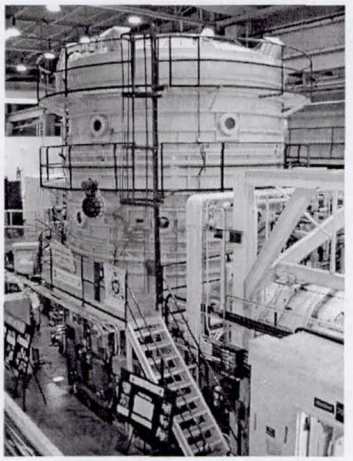
Allows NASA to develop and validate enabling technologies

- Integrated testing is a necessary step
- Unless integrated ground and flight testing is carried out, risks will go unidentified and unmitigated



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Costs & Risks

- Costs & risks are likely to be low
  - Costs would be low relative to an actual flight mission
  - Risks are minimal -- just stop, fix the problem, & restart; or correct the problem while continuing

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Allows NASA to address new management techniques needed for large complex missions of the future

- Develop more effective management techniques
  - embed metrics to continuously evaluate effectiveness
- Develop & evaluate more effective cost and risk estimation techniques

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Education – Outreach

- Classroom links, visits, student experiments, etc.
- Teaching tool for science, engineering, business management, computer science, public affairs, marketing, communications, arts, ...
- Develop improved techniques with embedded metrics

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Public Affairs

- Need to "re-engage" the public in a well-thought out, methodical, sustained way
- Develop new paradigms with embedded metrics for public interaction – the internet, …

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- *International partnering*
- *Commercial partnering*
- *Academic partnering*

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Candidate Partnering
NASA
National Academy of Sciences
National Academy of Engineering
Institute of Medicine
National Research Council
THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine
UNIVERSITY of GUELPH
Defense Advanced Research Projects Agency
DARPA
THE UNIVERSITY OF TEXAS AT AUSTIN
LUNDS UNIVERSITET
energy.gov
U.S. DEPARTMENT OF ENERGY
USDA
NATIONAL SCIENCE FOUNDATION
NSF
THE PENTAGON
RICE UNIVERSITY
PENNSTATE
RYMDSTYRELSEN
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CORNELL
Purdue University
THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS
NASDA
DLR
Microsoft
HITACHI
Inspire the Next
MIT
Stanford University
ИКИ
CBA ABC
Panasonic USA
Carrier
Cole Farmer
SONY
JOHN DEERE
AGCO
ADM
Betty Crocker
IKEA
OSRAM SYLVANIA
LOCKHEED MARTIN
ILC DOVER
Nautilus
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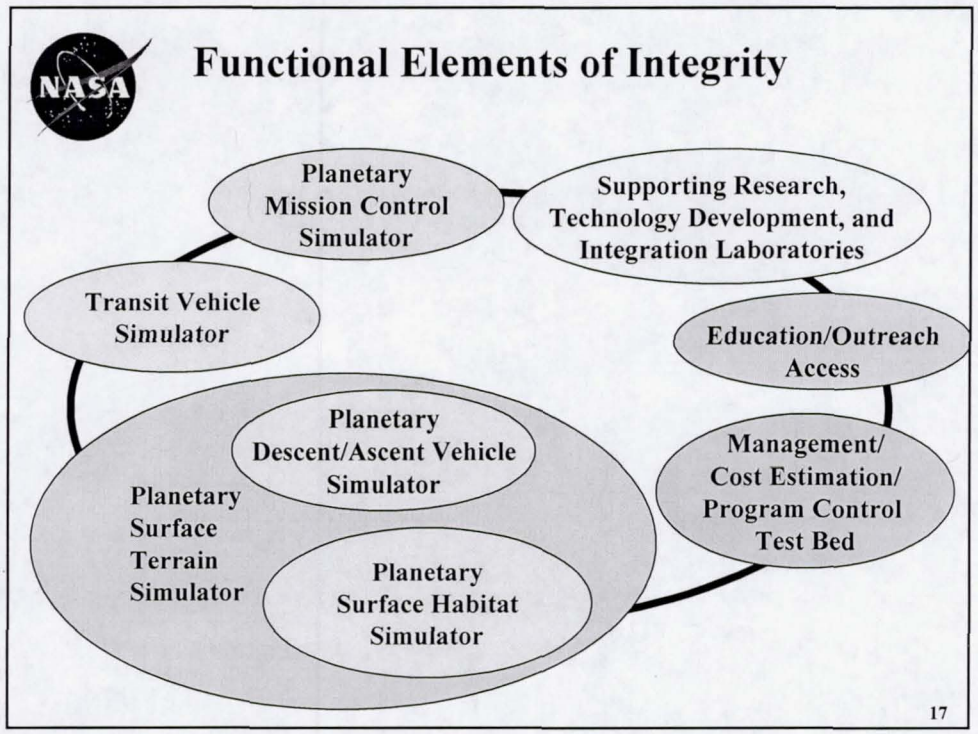
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Functional Elements of Integrity
Planetary Mission Control Simulator
Supporting Research, Technology Development, and Integration Laboratories
Transit Vehicle Simulator
Education/Outreach Access
Planetary Descent/Ascent Vehicle Simulator
Planetary Surface Terrain Simulator
Management/ Cost Estimation/ Program Control Test Bed
Planetary Surface Habitat Simulator
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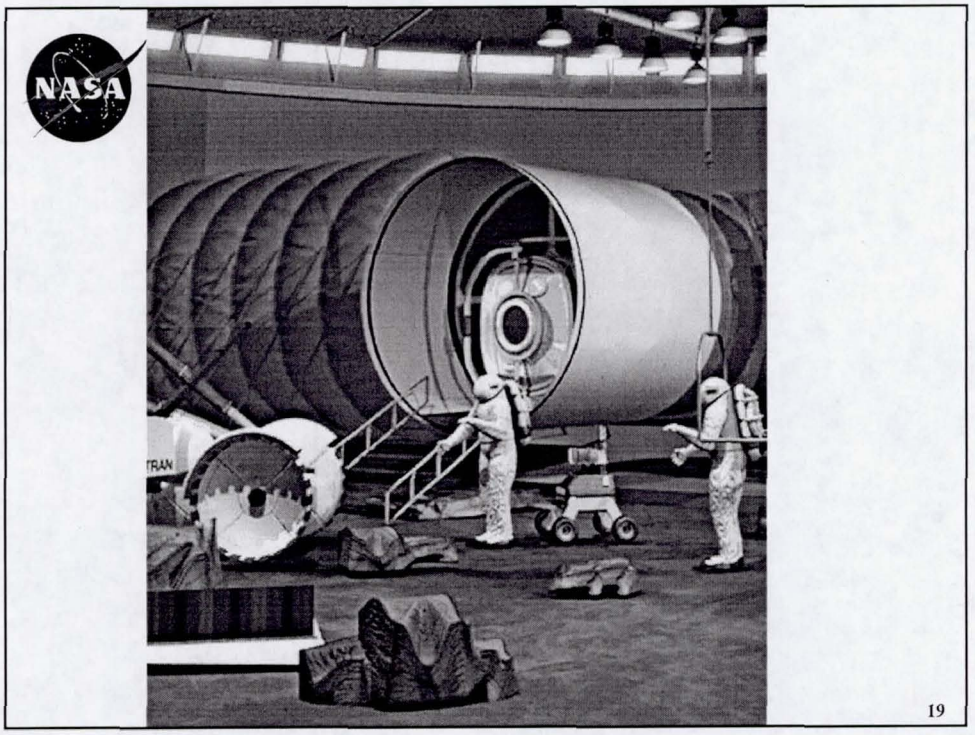

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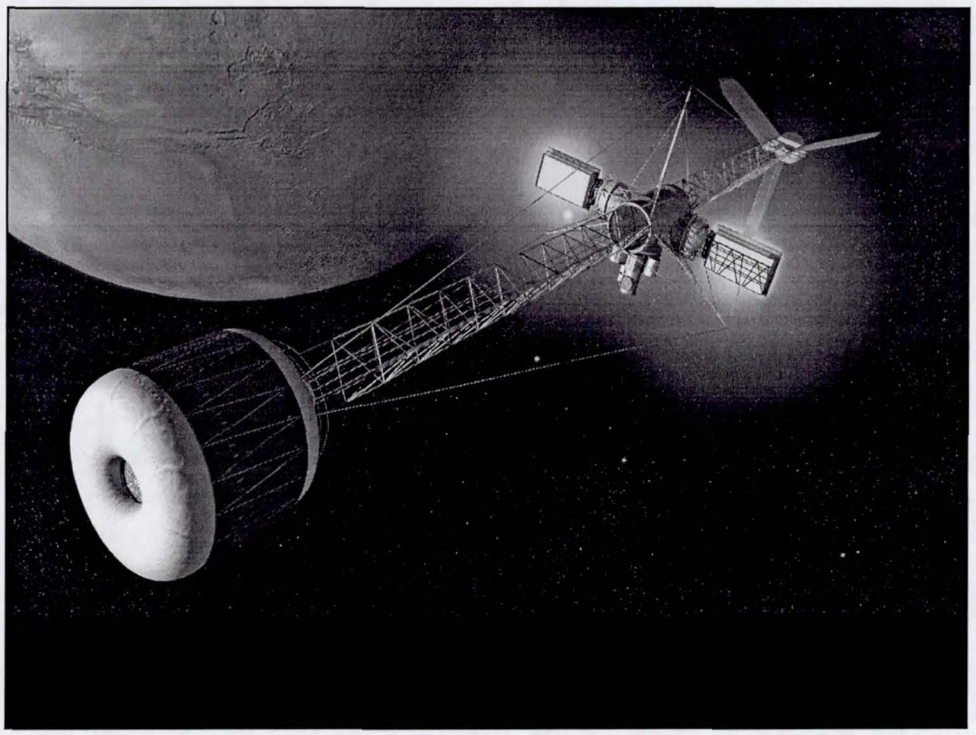

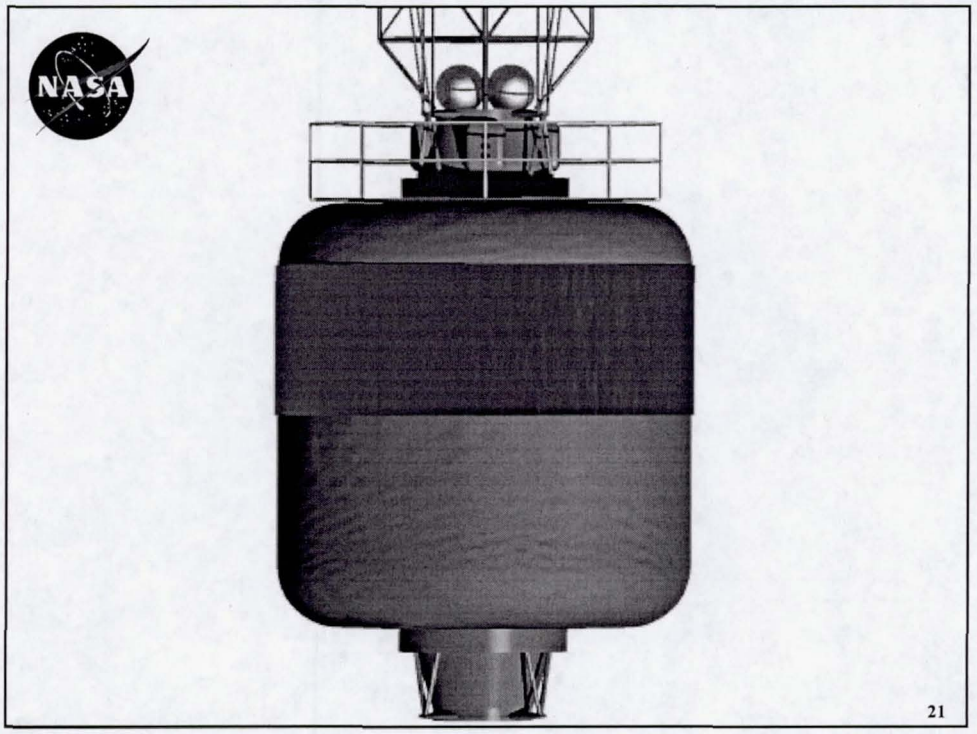
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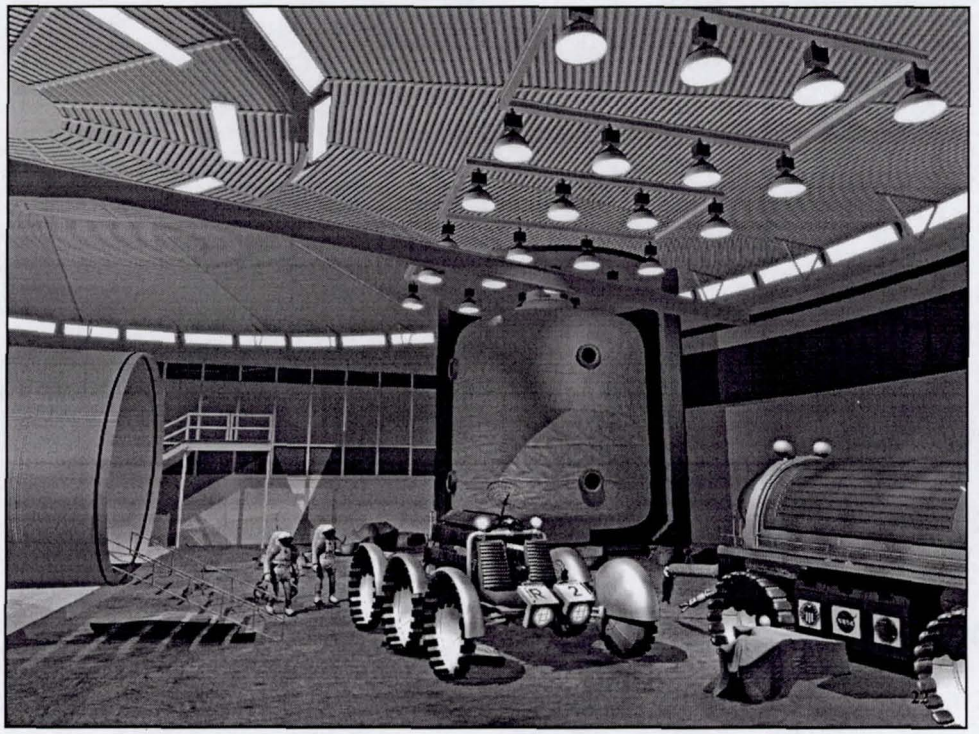

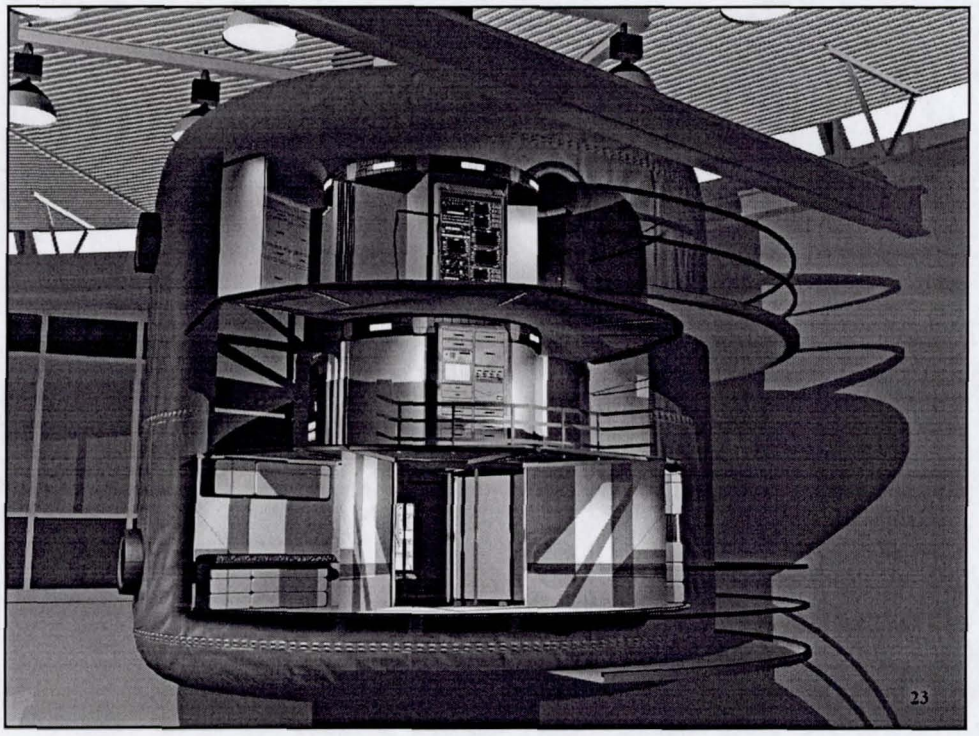
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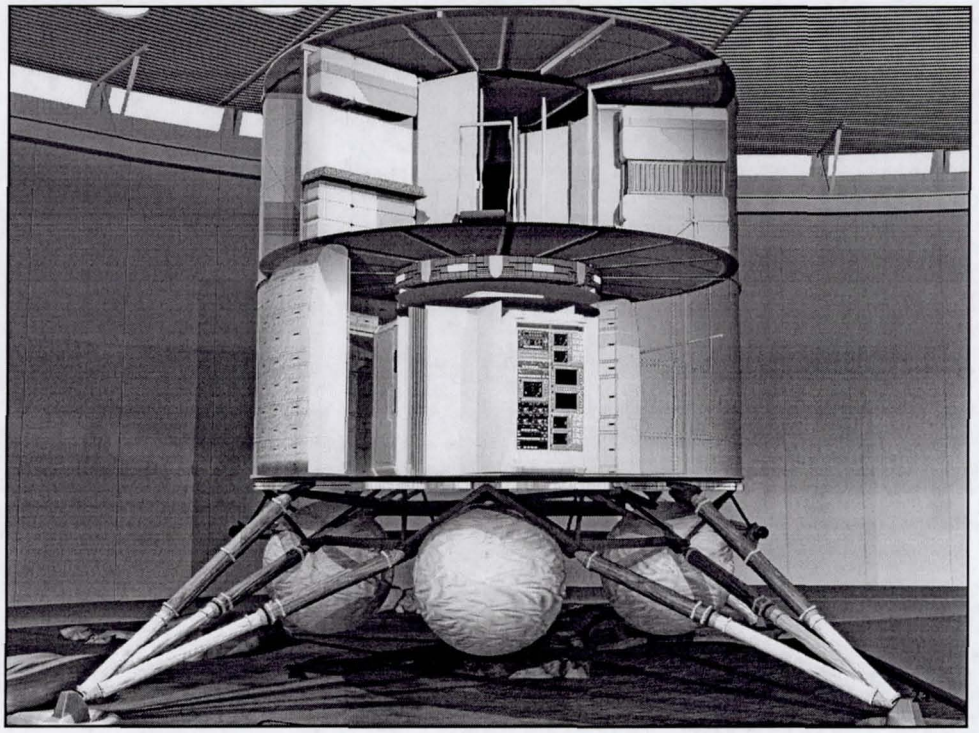

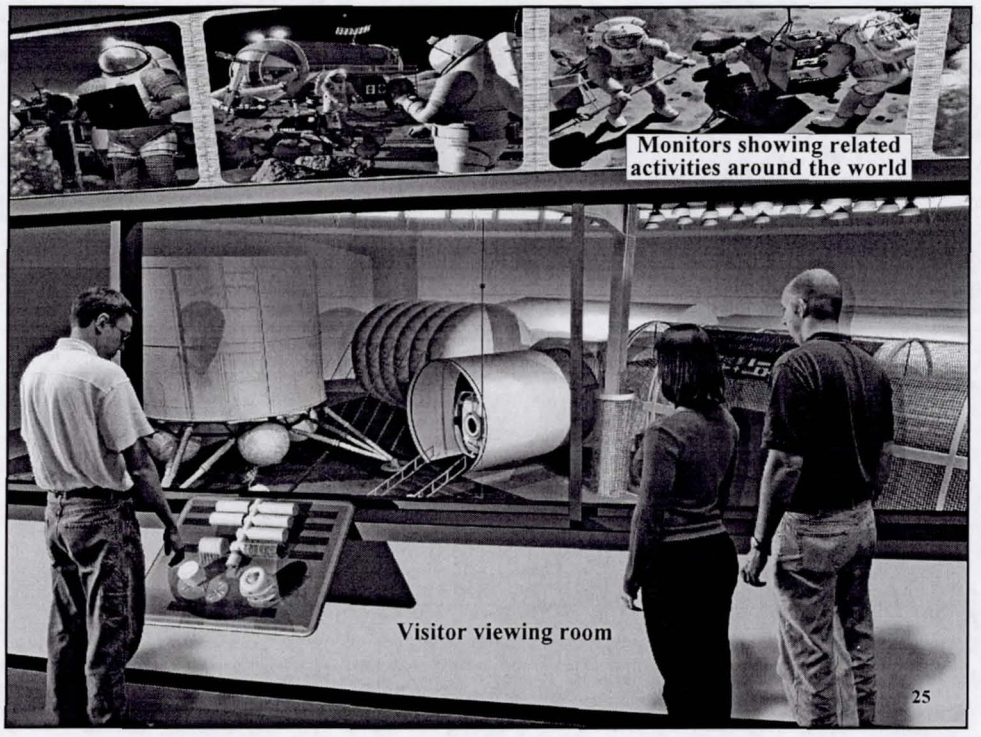
Monitors showing related activities around the world
Visitor viewing room
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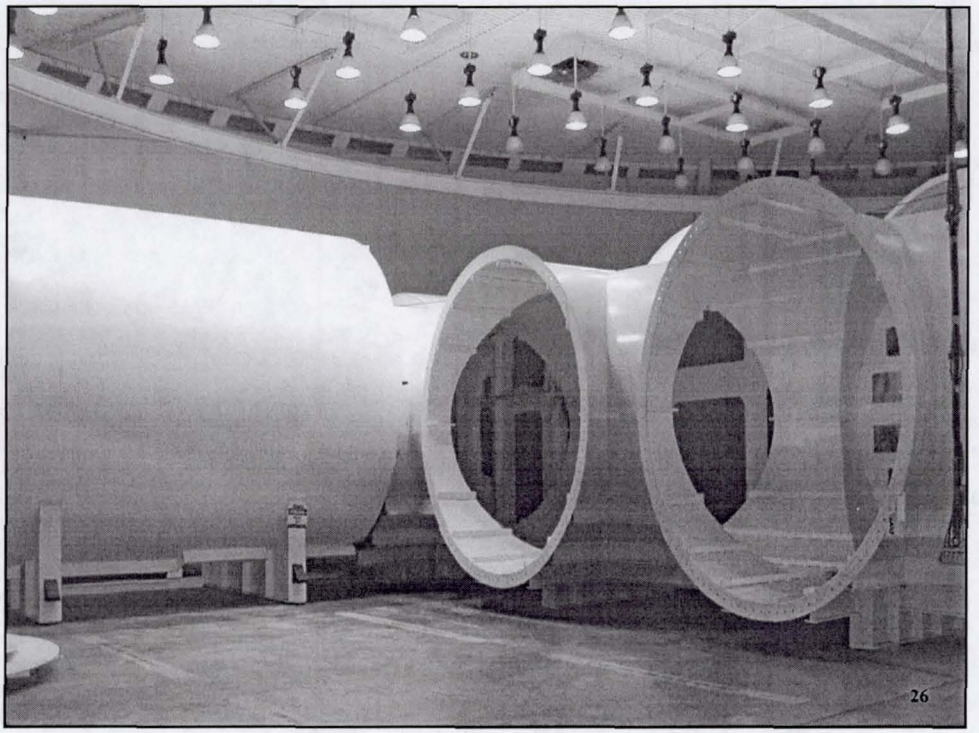

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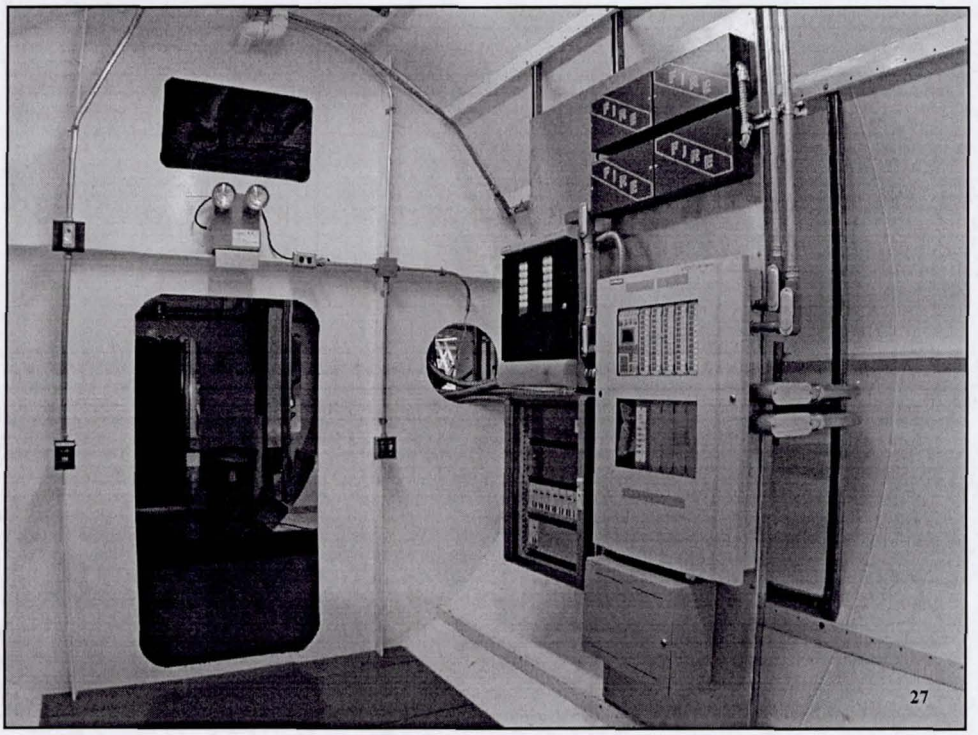

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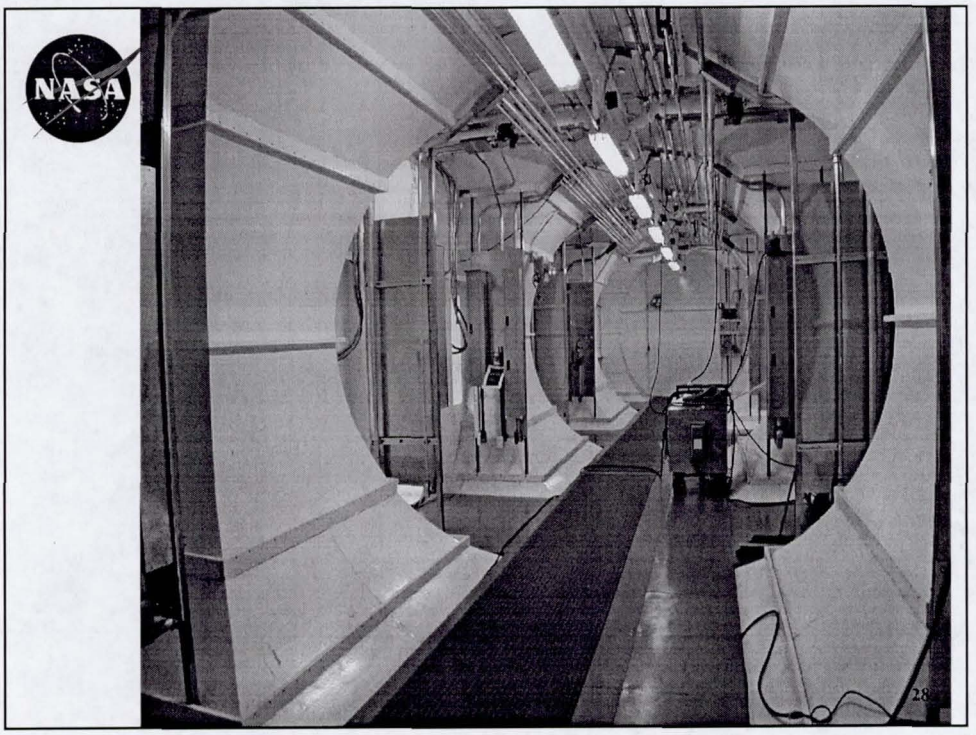
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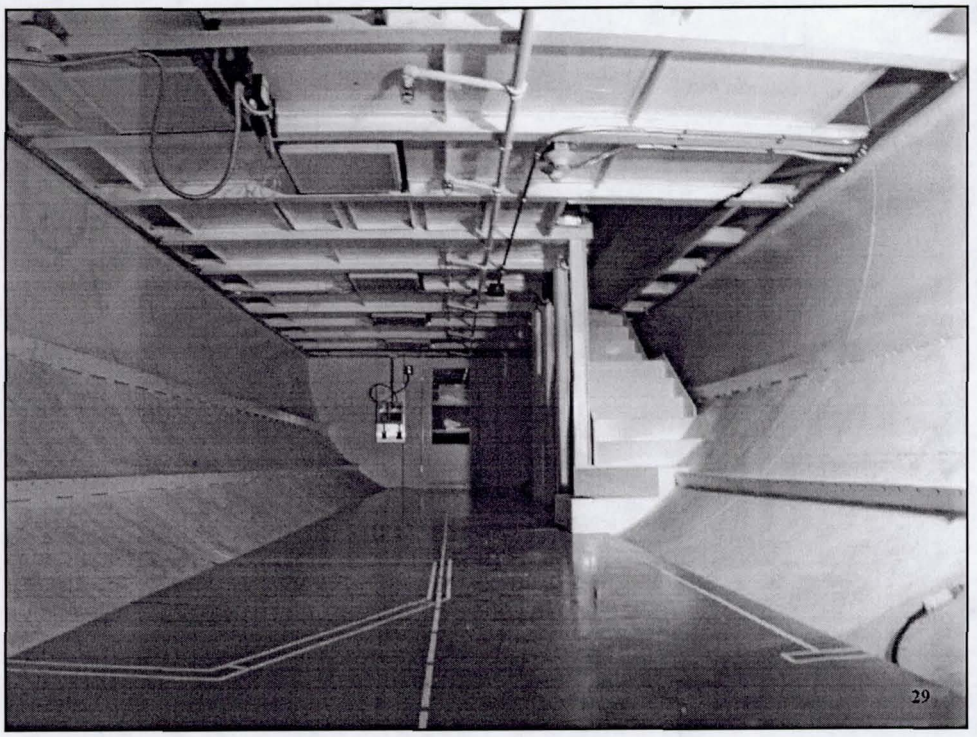
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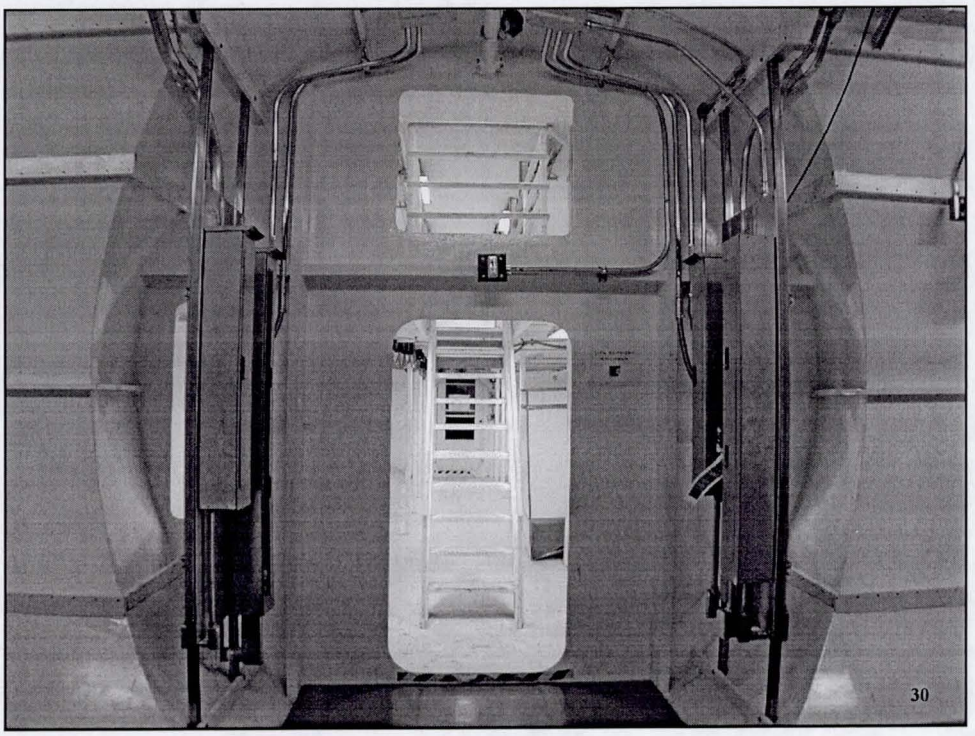
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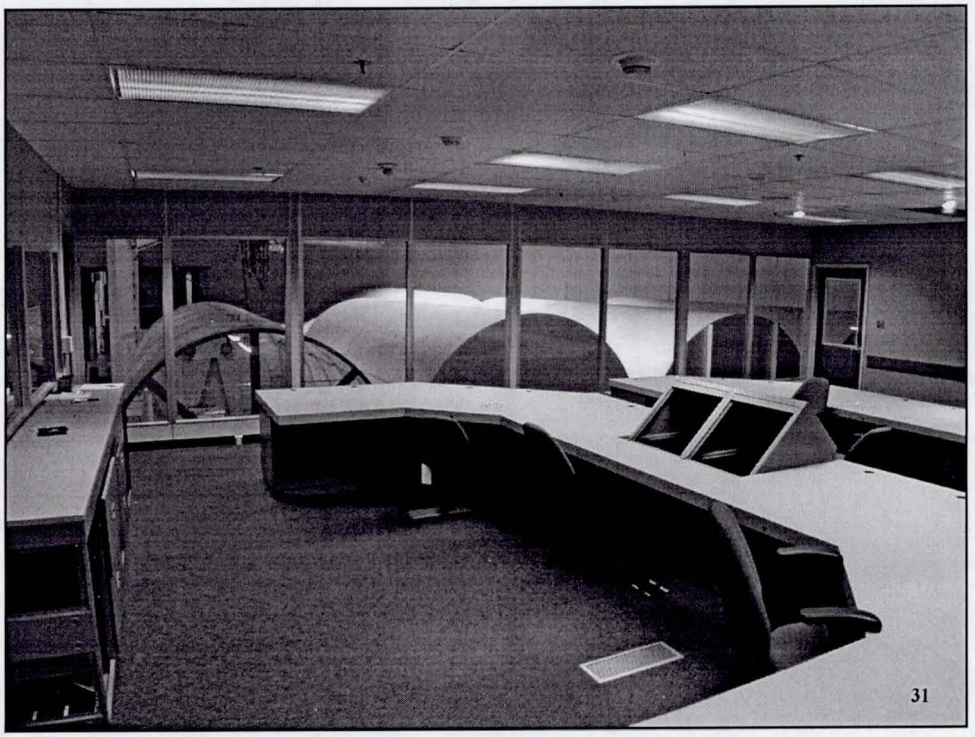
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SUMMARY

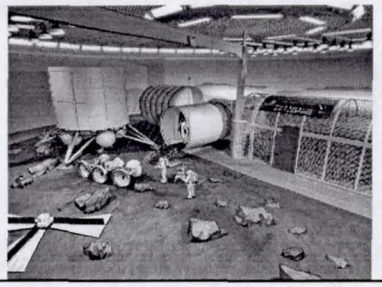
Human exploration missions are very complex and risky – duration and distance from Earth

Integration issues are difficult to identify

Individual technologies & systems have inherent risk

Integration of all systems & procedures on the ground will allow risk to be managed

Integrated procedures can be developed and validated

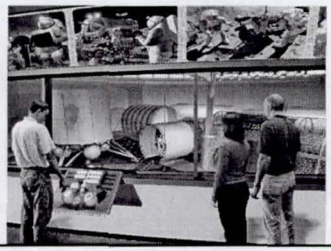


Definition of "missions" provides focus

INTEGRITY is likely a cost-effective way to prepare for any of the future human exploration missions

INTEGRITY will facilitate:

- Development of improved management techniques, including cost & risk estimation
- International, Commercial, Academic partnering
- Public involvement



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