NASA
Advanced Exploration Systems (AES)
Habitation Systems Project
Deep Space Habitat (DSH)
X-Hab Academic Innovation Challenge
for 2013

Tracy Gill
NASA/KSC
FY10

First Year of Habitat Demonstration Unit (HDU) as Pressurized Excursion Module Configuration
From PowerPoint to Demo Unit

Habitat Demonstration Unit – Pressurized Excursion Module

June 2009

April 2010
HDU1-PEM Field Configuration

- Heat Pump
- Diesel Generator
- HUB
- Hard-line Data Connection
- Command Bus Communications

Sections:
- Section A
- Section B
- Section C
- Section D
- Section E
- Section F
- Section G
- PORCH
- RAMP
- AIRLOCK
- GEO.LAB
- MED OPS
- SUIT MAINT.
- GENERAL MAINT.
- VEGGIE UNIT
- WINDOW Section D
Habitat Demonstration Unit (HDU) D-RATS 2010

A. Scott Howe, JPL
FY11

First Year of Deep Space Habitat Configuration
Vision:
• Develop fully autonomous habitation systems that enable human exploration of space.
• Develop, integrate, test, and evaluate Habitation Systems that will be utilized as technology pull / testbed and to advance NASA's understanding of alternative mission architectures, requirements, and operations concepts definition and validation.

Mission:
• The Habitat Demonstration Unit – Deep Space Habitat Configuration - ready for remote testing in Aug 2011.

Top-Level Milestones
2010: 1st HDU Pressurized Excursion Module Demo
• 8/2010 – 9/2010 Desert RATS Field Analog Test
2011: 1st Gen HDU Deep Space Hab (DSH) Module Demo
• 8/2011 – 9/2011 Desert RATS Field Analog Test
2012: 1st Gen HDU DSH Demos
• 3/2012 Systems Test
• 9/2012 Analog Test
2013: 2nd Gen HDU DSH Demos
• 3/2013 Systems Test
• 9/2013 Analog Test
From PowerPoint to Demo Unit

Pressurized Excursion Module

June 2009

Deep Space Habitat

September 2010

August 2010

~ August 2011
1. Inflatable Loft (X-Hab Competition)
2. Logistics-to-Living
3. Autonomous Ops: “Intelligent” Habitat System Management Software
4. iHab Digital Double (D^2)
5. Power Generation & PM&D Systems
6. Environmental Protection Technologies
   A. Dust Mitigation Technologies
      a. Electrodynamic Dust Screen to repel dust from surfaces
      b. Lotus Coating
      c. Vent Hood at the General Maintenance Workstation
      d. Operational Concept for End-to-End Dust Contamination Management
      e. Vacuum Cleaner
   B. Micrometeoroid Mitigation Technologies
      a. Micrometeoroid Detection
   C. Radiation
      a. Operational Demonstration of Cargo Transfer Bags to deployable blankets for Radiation Protection and ECLS water purification demo
7. HDU Core Computing, Wireless Communication and RFID
9. Flat Surface Damage Detection system
10. MMOD Hab impact monitoring system
12. Telerobotic Workstation
13. General Maintenance/EVA Workstation
14. Medical Ops/Life Science Workstation
15. Geo-Science Lab Glovebox/Workstation
16. Material Handling
17. Food Production: Atrium concept
18. LED Lighting
19. 3-D Layered Damage Detection System for Surfaces
20. Habitability / Habitation
21. Hygiene Module
X-Hab Challenge 2011

**Project Review Milestones**
- Sept 30 – Concept and System Definition Review
- Oct 30 – Preliminary Design Review
- Nov/Dec – Critical Design Review
- Feb 14 – Progress Checkpoint Review #1
- April 1 – Progress Checkpoint Review #2

**Deliverables:**
- X-Hab University Proposal
- X-Hab University Work Plan and Implementation Schedule
- Milestone Progress Reviews (WebEx & Telecon)
- X-Hab University Inflatable Loft Prototype Demonstration Unit
- X-Hab University Inflatable Loft Technical Final Report

CONGRATULATIONS to the 2011 X-Hab Academic Innovation Challenge Winners -
University of Wisconsin – June 20-24, 2011

Oklahoma State University – June 6-10, 2011

University of Maryland – June 13-17, 2011
HDU-DSH 1st Level Plan View

Modified FY10 porch extension

Docked Rover faces this way

Docked Rover faces this way

Hygiene Module

1

GeoLab

A

B

Tele-operations

S/GMWS

C

D

LS/MOWS

F

E

H

G

4

3

2

Dust Mitigation Module
DRaTS HDU-DSH Configuration

Hab Functions:
- Univ of Wisconsin’s Inflatable Loft
- Ruggedized A/C Unit (not shown)
- Power Interface Cart (not shown)

Deployable Porch and Ramp

Dust Mitigation Module (FY10)

Hygiene Function / Module
- Toilet
- Hand Wash
- Whole Body Wash

Lab Functions
- GeoLab, Telerobotics W/S, Med Ops, EVA/Gen Maint. W/S

NASA built, assembled, and outfitted a 4-port 1-story vertical Lab in FY10

http://www.spacegrant.org/xhab/
FY12

The Deep Space Habitat concept matures under Advanced Exploration System Program
AES HSF-Works Habitation: Deep Space Habitat Definition & Subsystem Maturation

**Description:** The Habitation Systems Project-2 will focus on Deep Space Habitat capabilities and performance definition, perform trade studies pertaining to a DSH for multiple destinations and capabilities utilized in the capability driven framework of long-duration Human Exploration Missions. This project will also focus on maturation of habitat subsystems via gen-2 and gen-3 progressive development leveraging from the other AES projects, OCT, IR&D and collaborations with industry and academia as appropriate.

**DHS Definition**
- DSH Configuration & Subsystem Definition
- Volumetric Mockups, & Evaluations

**HDU Gen-2 Subsystems Maturation** *(Leveraging)*
- Integrated Test in HDU Gen-1 Operational demo Unit

**DSH Gen-3 Subsystems Maturation** *(Leveraging)*
- Integrated Test in 20 ft Chamber

**X-Hab Academic Challenge**
- Participatory Exploration of DSH systems and innovation demos

**Relevance to HSF:**
1. DSH Definition & Configuration for Multiple Destinations
2. Validate HSF-AT mission architectures & Concept of Operations.
3. DSH Performance & Derived Requirements
4. Perform Risk Mitigation & Maturation of Deep Space Habitat
5. Early Investments on DSH Capabilities, Focused Hab-related Technology
   Infusion, Integrated Testing, Demonstration, & Maturation
6. Multi-Center DSH Team & SME, Retooling & Motivate Engineers
7. Inter-Agency Collaborations & International Collaborations
8. STEM - Education Outreach & Public Engagement

**Teaming:**
- Lead Center: JSC
- Project Lead: Alvin Drew, Kriss J. Kennedy, P.I. Jonathan Dory
- Partnering Centers: ARC, GRC, GSFC, JPL, JSC, KSC, LaRC, MSFC
- Partnerships: US Army Natick, Navy

**Resources Required:**

<table>
<thead>
<tr>
<th>Resources Required</th>
<th>FY12</th>
<th>FY13</th>
<th>FY14</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Procurements $M</strong></td>
<td>$2.91</td>
<td>$2.94</td>
<td>$2.95</td>
<td>$8.80</td>
</tr>
<tr>
<td><strong>FTE</strong></td>
<td>64.5</td>
<td>58.1</td>
<td>56.9</td>
<td>179.5</td>
</tr>
</tbody>
</table>
ISS-derived Deep Space Habitat

- The team will continue to mature the HDU at JSC.
- Adding a new prototype DSH based on ISS elements being developed by our multi-center team at MSFC
X-Hab 2012

• X-Hab 2012 Challenge
  – reviewed 9 proposals and selected 4 unique projects (not a competition):

• Four Projects Awarded
  – DSH-Lite: University of Maryland
    • Vertical Axis Cylinder Configuration
  – DSH-Lite: Oklahoma State University
    • Horizontal Axis Cylinder Configuration
  – An Efficient Plant Production System for eXploration HDU: Ohio State University
  – Geo-Lab reduced gravity sample holders/manipulator tools: University of Bridgeport, Connecticut
Key Links for AES Habitation Systems and X-Hab 2013 Information

- Current Project web page
  - [http://www.nasa.gov/exploration/analogs/hdu_project.html](http://www.nasa.gov/exploration/analogs/hdu_project.html)

- Our page that talks about X-Hab. It includes pictures and some video from our first year. Our second year is underway so no pictures yet.
  - [http://www.nasa.gov/exploration/analogs/hdu_project.html](http://www.nasa.gov/exploration/analogs/hdu_project.html)

- NASA Edge podcast during this year’s competition

- A video tour of one of the HDU prototype

- The page at the NSGF that hosts the X-Hab 2013 solicitation and receives the responses. It contains the past two solicitations and FAQs that answer most questions.
  - [http://www.spacegrant.org/xhab/](http://www.spacegrant.org/xhab/)
X-Hab 2013 Solicitation

- Will be similar to X-Hab 2012 Academic Innovation Challenge because we have picked a suite of potential projects and will select unique contributions that we rate as the best value and total up to our budget allocation for this effort.
- We encourage teaming with other schools and leveraging contributions from academic, industry, or commercial partners.
- We have made suggested funding levels ranging from $10k-$50k for each project.
- Projects may be related to the ISS-derived DSH or the HDU-DSH or they may be stand-alone depending on the description.
Important Dates

Solicitation Phase
• 7 Mar 2012  Date of Announcement / Release of RFP
• 4 Apr 2012  Notice of Intent Due
• 7 Apr 2012  Questions for online TIM Due
• 11 Apr 2012 Online Technical Interchange Meeting
• 2 May 2012  Proposal Due Date
• 30 May 2012 Award Announcements

Summer - Fall 2012 Design Phase
• 19 Sep 2012 Requirements and Systems Definition Review
• 24 Oct 2012 Preliminary Design Review
• 5 Dec 2012 Critical Design Review
• Spring 2013 Manufacturing, Assembly, and Testing Phase
• 13 Feb 2013 Progress Checkpoint Review #1
• 3 Apr 2013 Progress Checkpoint Review #2
• 15 May 2013 Project / Product Delivery to JSC (or as appropriate)
• May - June 2013 Integration with HDU at NASA/JSC
• July - Aug 2013 Integrated Testing & Dry Runs with HDU-DSH
• Aug - Sept 2013 Testing
Backup
HDU DSH in the News
(since May 2011)

- MIT Tech Review
  - [http://www.technologyreview.com/computing/38733/?mod=chfeatured](http://www.technologyreview.com/computing/38733/?mod=chfeatured)
- Article about Habitat Impact Monitoring Systems (HIMS)
- OSU X-Hab Article
- NASA Press Release on X-Hab 2011 competition
- Projects inside JSC Building 220 including Morpheus and Habitat Demonstration Unit
- University of Wisconsin release on X-Hab selection
  - [http://www.news.wisc.edu/19535](http://www.news.wisc.edu/19535)
- PR Newswire article on X-Hab competition
- University of Wisconsin X-Hab team page
  - [http://homepages.caewisc.edu/~elder/xhab/index.html](http://homepages.caewisc.edu/~elder/xhab/index.html)
- NASA Press Release
- AP Article in the Chicago Tribune
- Textile World article about University of Wisconsin
- Desert RaTS Overview with featured information and a cut-out of DSH.
- HDU Public Home Page Updates on nasa.gov with X-Hab and Desert RaTS 2011 Preview
  - [http://www.nasa.gov/exploration/analogss/hdu_project.html](http://www.nasa.gov/exploration/analogss/hdu_project.html)
<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Conference/Publication</th>
<th>Conference/Publication Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Scott Howe, Todd Hong, Bob Hunkins, D. Scott Hafermalz, Kriss Kennedy, Larry Toups</td>
<td>Mobile Field Analog for Lunar Habitat Integrated System Monitoring</td>
<td>ASCE Earth and Space 2010, Honolulu, HI, March 14-17, 2010</td>
<td><a href="http://content.asce.org/conferences/earthspace2010/">http://content.asce.org/conferences/earthspace2010/</a></td>
</tr>
<tr>
<td>Kristina Roudsari, Kriss Kennedy, Hester Yim, Raymond S. Wagner, Todd Hong, George Studor, Paul Delaune</td>
<td>A Modular Instrumentation System for NASA’s Habitat Demonstration Unit</td>
<td>NAA Space 2010, Anaheim, CA, August 20-September 2, 2010</td>
<td><a href="http://www.aiaa.org/content.cfm?pageid=230&amp;lumeetingid=2387">http://www.aiaa.org/content.cfm?pageid=230&amp;lumeetingid=2387</a></td>
</tr>
<tr>
<td>Tracy Gill, Jerad Merbitz, Kriss Kennedy, Terry Tri, Scott Howe</td>
<td>Integration Process for the Habitat Demonstration Unit</td>
<td>NAA Space 2010, Anaheim, CA, August 20-September 2, 2010</td>
<td><a href="http://www.aiaa.org/content.cfm?pageid=230&amp;lumeetingid=2387">http://www.aiaa.org/content.cfm?pageid=230&amp;lumeetingid=2387</a></td>
</tr>
<tr>
<td>J.-C. Liou, Opiela, Corsaro, Giovane, Anz-Meador</td>
<td>Demonstration of a Particle Impact Monitoring System for Crewed Space Exploration Modules</td>
<td>2nd International Astronautical Congress (IAC) to be held in Cape Town, South Africa from 3 - 7 October 2011</td>
<td><a href="http://iac2011.com/">http://iac2011.com/</a></td>
</tr>
</tbody>
</table>