FABRICS IN SPACE ARCHITECTURE

History and examples of textile architecture for advanced space habitats

2012 USC – School of Architecture
“Space Architecture is the theory and practice of designing and building inhabited environments in outer space”

Millenium Charter, Tx USA, 2002

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Textile architecture for advance space habitats

CONTENT

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3 MAPPING WITH FABRICS: NASA HDU Hygiene Module (Master Thesis)
4 LUNAR HABITAT USING FABRICS: First stage design (Master study)
5 CONCLUSION
Mechanikoi, a constructive degree (Eastern Roman Empire):

- They mastered both construction science and technology as well mathematics and astronomy
- Key architects: Isidore of Miletus (H.Sofia), Heron of Alexandria (Robotics)
- *HAGIA SOFIA (Holy Wisdom, Istanbul, 537 A.C.):* Mathematics and science to study the cosmos allowed a better and impressive structural design… (Earthquakes)
FIRST PROJECTS OF SPACE STATIONS

Konstantin Tsiolkovsky, Concepts (1897)

Herman Potočnik Concept, 1929

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Konstantin Tsiolkovsky, Concepts (1897)
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FABRICS IN SPACE ARCHITECTURE: Exterior

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Images courtesy of NASA
FABRICS IN SPACE ARCHITECTURE: Inflatable
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FABRICS IN SPACE ARCHITECTURE

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Image courtesy of NASA
FABRICS IN SPACE ARCHITECTURE: **SUIT**

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Image courtesy of NASA
Cargo Transfer Bags (CTB):
• Current logistics elements
• Could be used as waterwalls (waste & water treatment)
• Deep Space Mission: 200-500 CTBs
• Made of polymer (high H content)
• Radiation shielding capabilities
• Flexible
FABRICS IN SPACE ARCHITECTURE: DSH Logistics-2-Sgileding

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HDU Micro-Hab Hygiene Module

Images courtesy of NASA

Façade Tectonics Workshop

Model: Scott Howe, JPL NASA/Clatech

USC School of Architecture - Sep 25th, 2012 - © Raul Polit-Casillas
Number of bags by layer: 18
Separation: 840 mm (33 in)
Angle (with respect to axe): 41°

Alignment of bags: One direction
Drawbacks: Different directions / curvatures
Benefits:
• Supporting points are better distributed
• It uses a fewer or equal number of bags
• % Ae in second layer is lower
• Better resistance against physical impacts
• Areas near airlocks are better covered
COMPONENTS
1. Flexible elements (CTBs)
2. Supporting Surface (Force Net)
3. Discrete Elements (Micro-harpoons)
4. Automatic Tool: CTBs Mapper

Fabric architecture for advance space habitats
FABRICS IN SPACE ARCHITECTURE: CTB Mapper

Textile architecture for advanced space habitats
Mission and launcher

- **Mission Elements**: Launcher system (2 Ariane V ES), habitat module, propulsion unit and moon lander
- **Launch vehicle**: Ariane V up to 21 tons of payload
- **Crew**: 6 astronauts
- **Duration**: 180 days or more
- **Location**: It should be able to adapt to any landing site. It is assumed a sensible flat surface would be chosen.
- **Operations**: Tele-operated from Earth. The system should not require any previous human presence or activity.
- **Logistics**: Fully autonomous but not fully equipped. Consumables and equipment would be shipped later.
- **Analogs**: Both technology and concept should be able to be tested on Earth previously (with gravity present)
- **Technology**: Any system should use a technology with enough TRL.
Reducing mass, volume and energy budgets using fabrics

- **In situ resources Utilization (ISRU):** Using regolith as construction element
- **Radiation protection:** ESA 1992 – shielding of 400 g/cm² recommended during solar flares
  - 2 - 3 meters would suffice, while 4 to 5 meters will protect even during solar flares
- **Volume:** It has to fit in an Ariane V fairing. Adaptable architecture
- **Mass:** Reduce mass budget to the maximum. Increase multipurpose elements
- **Terrain:** Flat or flatten terrain, however the system has to be adaptable
- **Human Factors:** Respect to basic habitability measurement
- **Simulation and testing:** Feasible testing methods should be available
Self deployable habitat for a crew of 6. Fitting within the 4.5 m diameter of an Ariane V launcher fairing volume, mass and energy budgets should be reduced to maximum.
Adaptability = Expandable + Foldable (Fabrics) + Inflatable
FABRICS IN SPACE ARCHITECTURE: Design
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Lower deck

Programme Distribution

- A MAIN ACCESS: 12 m²
- B SECONDARY ACCESS: 12 m²
- DUST CONTROL: 3.2 m²
- ACCESS OPERATIONS/STORAGE: 14 m²
- LIVING AREA/KITCHEN: 18 m²
- SCIENCE AREA: 18 m²
- GREEN HOUSE: 10 m²
- COMMON AREAS/BATHROOM: 4.8 m²
- TOTAL: 92 m²
FABRICS IN SPACE ARCHITECTURE: Design

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Upper deck
FABRICS IN SPACE ARCHITECTURE: Design
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FABRICS IN SPACE ARCHITECTURE: Construction

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THANK YOU...