SATC

Space Architecture Technical Committee

Construction of the International Space Station. Courtesy of NASA

2ND EDITION

HOW TO BECOME A SPACE ARCHITECT

SO YOU WANT TO BE A SPACE ARCHITECT?

SATC
Space Architecture Technical Committee

Officers of American Institute of Aeronautcs and Astronautics (AIAA)
Space Architecture Technical Committee (SATC)

- **Chair**: Ondřej Doule
- **Vice-Chair**: David Wong
- **Secretary**: *Open position*
- **Treasurer**: Shahzad Khaligh

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Construction Subcommittee
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- Payam Brahami
- Annette Barnes
- Silvano Colombano
- John Gulliford
- Patrick Harkness
- A. Scott Howe
- Shahzad Khaligh
- Sungwoo Lim
- Georgi Petrov
- Brian Pitchford

Education Subcommittee
- Chair: **Olga Bannova**
- Maria João Durão
- François Lévy
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Habitability & Human Factors Subcommittee
- Chair: **Sandra Häuplik-Meusburger**
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- Donald Barker
- Ogbonnaya Iheukwumere
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- Abhishek Jain
- Regina Peldszus
- Jackelynne Silva-Martinez

Subcommittee name change as of May 2014 (original name: Human Factors & Design SC)

Outreach Subcommittee
- Chair: **David Wong**
- Michael Fox
- David Nixon
- Tomáš Rousek

Subcommittee name change as of May 2014 (original name: Media SC)

Awards Subcommittee
- Chair: **Renée L. Matossian**
- Mark Kerr
- Emanuel Pimenta
- Brent Sherwood

New Subcommittee

Membership Subcommittee
- Chair: **Marc Cohen**

Subcommittee name and strategy change as of May 2014 (original name: Professional & Liason SC)

Terrestrial Applications Subcommittee
- Chair: **Shai Gerner**
- Anton Andonov
- Christian Carpenter
- Kürsad Özdemir

New Subcommittee

Space Architecture Committee on Standards (SACS)

- **Chair:**
- **Frederic Slane**

Donald Barker | Ondřej Doule | Paivi Jukola | Ronald Kohl | Satoshi Nagano

This flyer has been prepared for people wanting to learn more about the field of space architecture and to inform about first steps towards this field.

The flyer has been prepared by the Space Architecture Technical Committee (SATC) of the American Institute of Aeronautics and Astronautics (AIAA). The SATC is the first formal organization of aerospace architects and industrial designers in the world and is recognized and supported by the AIAA, the world's leading professional aerospace institute.

What we do:
- organize aerospace architecture paper sessions at international space conferences;
- advise on the skills required to work in the aerospace architecture field;
- promote research on aerospace architecture topics;
- assist students with space architecture projects;
- provide liaison between aerospace engineering, architecture and industrial design disciplines.
- organize space architecture outreach events

For more information about SATC please visit our websites:
http://www.spacearchitect.org
https://info.aiaa.org/tac/SMG/SATC/default.aspx

THE FIELD OF SPACE ARCHITECTURE

What is the scope of Space Architecture?

Who are Space Architects and what do they do?

Who can become a Space Architect?

How is the field of space architecture related to terrestrial architecture and to design for extreme environments?

Can Space Architecture contribute to sustainable development?

The active participation of architects and industrial designers in the aerospace industry began in the 1960s. In the USSR, the studio of Vladimir Chelomei designed the Salyut 1 space station, which launched in 1971. In the USA in 1968, industrial designer Raymond Loewy persuaded NASA to include a window in the Skylab space station so that astronauts could see out and observe the Earth; Skylab launched in 1973.

The beginning of human space flight was dominated by engineers proving out the necessary transportation and life support systems, but it did not take long for architects to envision their role in designing space stations and planetary bases. NASA relied on their crew systems division for capsule design and in the early 1970s, a few architecture students expanded the scope defending graduate theses on space station concepts. Toward the end of the decade, NASA's interest in building a space station exposed the need for architectural-level thinking. This cracked the door for aerospace support contractors to consider hiring an architect. Later, the Space Station Freedom Program further opened the door including architects within NASA, the broader contractor community, and academia working together in the emerging field called Space Architecture.

SALYUT 7
(with docked Progres spacecraft)

SKYLAB

Today, a growing international community of architects and industrial designers is at work across the space field. They are involved in all areas of space projects and mission development including robotic rover and probe design, lunar and Mars base design, launch facilities planning and construction, mission payload definition and management, underwater and simulated microgravity testing, systems engineering, space mission control support, and extreme Earth environment habitat design and construction.
Fundamentally, space architecture is an extension of Earth architecture. Earth is a celestial body in space; so is Mars; so is the Moon. Space architecture beyond Earth distinguishes from terrestrial architecture by extreme environmental conditions: high radiation, low (or no) atmospheric pressure, low (or no) apparent gravity, and large temperature variations, to name just a few. Nevertheless,

Can Space Architecture contribute to sustainable development?

the goal is still the same: to provide a shelter that protects and supports good quality of life for the inhabitants. With the attitude of an architect, the task is to learn everything you can about the environment you're designing for – whether on or off the Earth – and learn the techniques for dealing with the extremes.

One of the biggest challenges that space architecture faces is lack of established infrastructure such as: power and water supply, sewage and waste recycling and transportation support. Once you learn how to design structures for harsh and unforgiving environments of space you will become aware of possibilities that Space Architecture offers for Earth applications and how it can contribute to sustainable developments right now...

A new Space Architecture subcommittee (Terrestrial Applications) was formed in 2014 to explore and promote terrestrial applications of space architecture with particular focus on sustainable development.

So don't miss this opportunity to become a part of the space architecture community to improve living on "Spaceship Earth".

Example of terrestrial application of space architecture - Self-deployable Habitat for Extreme Environments used in area damaged by earthquake
Image credit: SHEE Consortium 2014, image by Space Innovations

SPACE ARCHITECTURE PUBLICATIONS

Where can I find publications about Space Architecture?

Our website features several books and a bibliography of over 600 technical publications on the field of Space Architecture:

http://www.spacearchitect.org/

Click "**resources**" or "**bibliography**" in the top menu and follow the links from there. You can find books and **publications** related to Space Architecture on the website. *Aliter** public outreach events started in 2010 and a Facebook outreach site started in 2012.

Conferences and events where space architects present their work

AIAA - AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS
SPACE CONFERENCE

ICES - INTERNATIONAL CONFERENCE ON ENVIRONMENTAL SYSTEMS

INTERNATIONAL ASTRONAUTICAL FEDERATION
IAC - INTERNATIONAL ASTRONAUTICAL CONGRESS

THEORBIT
the Space Architecture community newsletter

SPACE ARCHITECTURE PUBLIC OUTREACH

Where should I start?

What background can help in pursuing a Space Architecture career?

What about future employment?

Space Architecture is still an emerging discipline. Employment opportunities depend on governmental support of space exploration programs and commercial initiatives in the field that are still limited. The best attitude is to prepare yourself technically, and follow the news and developments to seize opportunities when and where they arise.

Some traditional architecture, engineering, and construction (AEC) firms have developed concept art for large-scale space development. Their dreams may still be decades away from realization. You can find the list of potential employment opportunities **here**.

Currently, most space architecture is conducted by governmental space agencies and major aerospace contractors. The "New Space" economy is bringing opportunities to more aerospace startups. All of these are dominated by aerospace engineers. A space architect must be prepared to speak their language and demonstrate an ability to contribute to a technical design team.

In addition to a professional education in terrestrial architecture, a space architect must develop an understanding of the space environment and its impact on human health and environmental design. The architect must be able to extrapolate technical design knowledge from typical terrestrial conditions to the extreme environments of space. Additional knowledge in engineering, or in architectural research devoted to the space environment, will help to open doors to employment.

Photograph credits: Ondrej Doule (2012)

Vehicle Assembly Building and launchpad #39 *(top)*

Orion re-entry vehicle engineering model *(middle)*

Space Shuttle Endeavour cockpit interior *(bottom)*

SPACE ARCHITECTURE EDUCATION

What education is needed to become a Space Architect?

Where can I go to study?

Do I have to have a professional degree in architecture or aerospace engineering?

Which post-graduate programs are available?

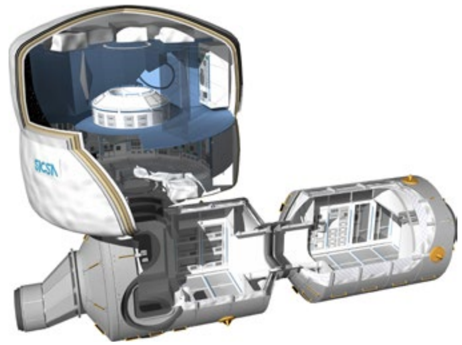
Space Architecture is an emerging discipline. For most of the current practitioners it is a self-made, self-directed career path. You must be well motivated and find a tutor or a team that suits you and your interests.

Among the members of SpaceArchitect.org, most have “regular” professional degrees in architecture (B.Arch or M.Arch.) or industrial design. Beyond that, a Space Architect needs to become familiar with all topics related to human space exploration.

People have taken different paths to that knowledge. Some of us have gone on to pursue doctoral degrees in architecture focusing on certain aspects of space design and construction. Others have gone for dual professional degrees in architecture and aerospace engineering. Others have managed to get involved in space architecture projects as traditional architects and have learned what they needed to know about space architecture through teamwork and immersion in the process.

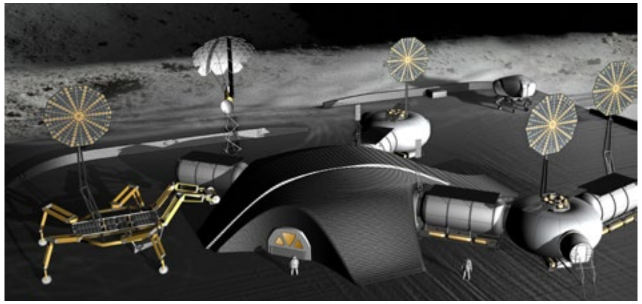
At ***SpaceArchitect.org*** *you can read a short biography for each member, including his or her education and work experience.*

A list of institutions can be also found on our website: ***SpaceArchitect.org***.



Transhabitat for Mission to Mars
Image credit: SICSA, Boeing, ILC Dover for NASA, 2008-2009
SICSA, University Houston

Destination Moon Studio, Project Cyclops Hub: Benesch, Galonja, Milchram, Rossetti, 2012. Image credit: VUT Vienna, HB2-Emerging Fields



SinterHab (initiated at International Space University, Strasbourg), 2010, Image credit: Rousek, Eriksson, Doule

SPACE ARCHITECTURE COMMUNITY

How can I become a member of the SATC?

How can I become a member of SpaceArchitect.org?

The Space Architecture Technical Committee (SATC) is one of about 70 Technical Committees (TC)s in the American Institute of Aeronautics and Astronautics (AIAA). The AIAA accepts TC member nominations on an annual basis and forwards them to the TCs in November each year. Membership in the AIAA is a prerequisite for membership in the SATC. AIAA members may nominate themselves for membership in any of the TCs. AIAA sets limits on the size of TCs to promote their function as committees in which each member takes an active role.

We have several space-architect colleagues who are not current members of the AIAA or SATC. Some are alumni; others have tended to be more involved in other professional societies. For example, several of them are regulars at the Earth & Space conference organized by the American Society of Civil Engineers.

For this reason, we established SpaceArchitect.org as an independent organization to include space architects from various professional associations. Membership in SpaceArchitect.org is open to individuals who are professionally involved in the design of human habitats or space exploration systems, as evidenced by:

- membership in a professional design society;
- or, demonstrated professional design practice;
- or, enrollment in a design degree program.

By joining our group you will be connected to the international community of space architects and will have opportunities to learn and get involved in space architecture activities. You will get a chance to talk to the most experienced space architects on Earth and get feedback for your work, studies, research or ideas and activities.

AIAA - SATC

TO

SPACEARCHITECT.ORG

Dr. Theodore W. Hall

Chairman 2010-2014

Analysis of artificial gravity

"If our designs for private houses are to be correct, we must at the outset take note of the countries and climates in which they are built."

— *Vitruvius*

"It seemed necessary to make this point to enable me to deal with the objection that people of this kind would never be found on the Earth but only in the mind of a moon-struck individual, one-third mentally deranged by fantasies of space travel and two-thirds lost to realities in a maze of mathematics."

— *Hermann Oberth*

"Such things do not exist and cannot exist and never have existed ... Yet when people see these frauds, they find no fault with them but on the contrary are delighted, and do not care whether any of them can exist or not."

— *Vitruvius*

"I am not in favor of compact designs which give an impression of solidity and recall heavy earthly buildings. Other laws prevail in space and there is no reason why the old architectural rules should be followed."

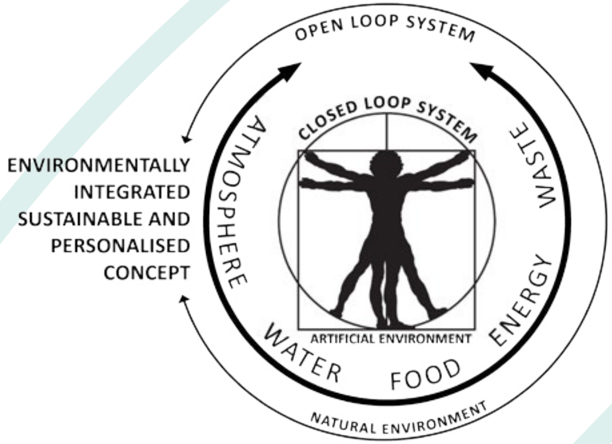
— *Hermann Oberth*

These are some of the quotes that I co-opted as tag lines for chapters of my dissertatation. I especially enjoy the juxtaposition of Vitruvious and Oberth. Vitruvious wrote The Ten Books on Architecture in the First Century BC. Oberth wrote about space habitation 20 Centuries later. Sometimes they seem to agree; sometimes they seem to disagree; they're both usually right. This is the adventure of Space Architecture: bringing timeless design prinicples to bear on futuristic scenarios. Our designs must account for the climates in which they are to be built, or people will die. Those climates may be radically different than any we've designed for previously, and old architectural rules of thumb need to be reexamined and possibly discarded.

Space Acrhitecture is not for the technically timid. To play this game, one needs to educate oneself about the harsh realities of life beyond Earth, and the science and technology for fashioning habitable bubbles in deadly environments. Only then is one prepared to stand toe-to-toe with the engineers and strive for architectural aesthetics that treat the human as more than a deterministic biochemical subsystem of a soulless machine.

Game on!

Dr. Ondřej Doule
Chairman 2014-2015



The field of Space Architecture has identified principles and complexities of the human being to its limits. Space Architecture addresses not only human technological adaptations required for activities in a variety of nominal and extreme environments, but most importantly it identifies the main requirements enabling human existence in general – i.e., the main architectural design and ordering principles that could not be found without knowledge derived from human spaceflight.

These Space Architecture design drivers, when applied on Earth, guide terrestrial architects in directions off the path of mannerist or artistic expressionism but rather in the direction of fully sustainable dwellings, enabling maximum harmony with their environments and becoming expressions not only of form and function but also of environmental adaptation, resource provision, and intelligent or adaptive personalised human-system integration.

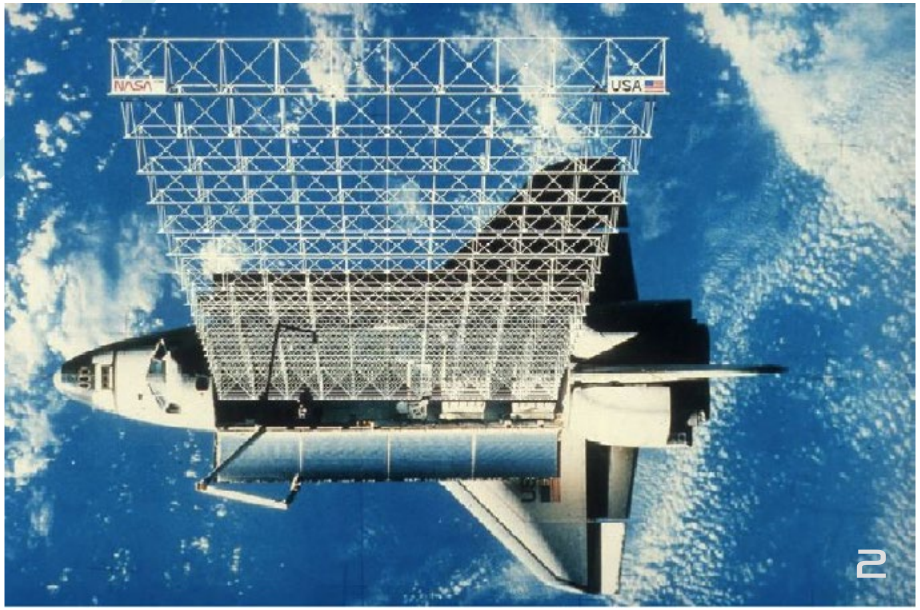
Ecological principles have been often pronounced by space architects in the past. Nonetheless the 21st Century shows that architects' human-centred thinking has to better integrate economic aspects of their concepts to be able to compete with current mainstream, purely economic strategies. Too many space architecture concepts are considered visionary, utopian, or unrealistic due to their high initial cost. The concept of dwelling in extreme environments has to include all aspects in a meaningful strategy that justifies the initial development investment. Extreme environments often require processes for pre-integrated construction within the habitat elements. In most places on Earth, architecture benefits from well-developed construction infrastructure; hence pre-integrated technology is not strictly required. But still, terrestrial architecture would benefit from many space architecture design strategies.

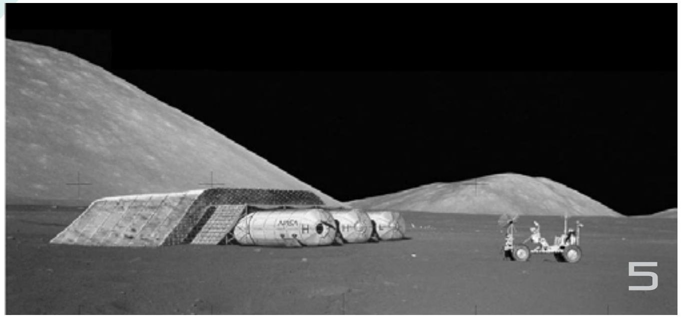
The future of space architecture lies in its full integration with the terrestrial architecture and civil engineering domains while being tightened much closer with humanities in terms of personalised design approaches. In addition, the complexity of human living, as understood by space architects, unveils an important need for architectural integration of expert disciplines that are currently broken into pieces that struggle to communicate with each other.

The space architecture field will have a global impact on living on Earth. It will soon guide the development of human settlements in the universe due to its position on the leading edge of discovery and understanding of human existence in the universe in general.

HOW TO BECOME A SPACE ARCHITECT

Samples of space architects' work





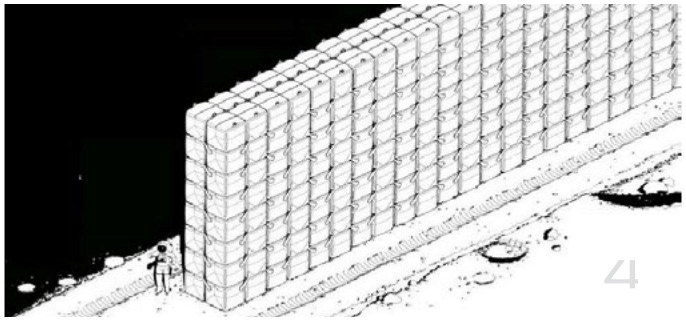


Image credits:

1 | Portable-Wearable Workstation, Project for SpaceHab Inc, David Nixon, Joe Kennedy, Southern California Institute of Architecture, 1987

2 | Fold-out Structural Platform, Technical proposal for NASA, David Nixon, Jan Kaplicky, 1984

3 | Space Station Wardroom Table, Project for NASA ARC, David Nixon, OveArup & Partners, NASA ARC, 1988-89

4 | Moon Wall, David Nixon, Jane Wernick, 1991

5 | Lunar Base Radiation Shield Canopy, David Nixon, Jan Kaplicky, 1985

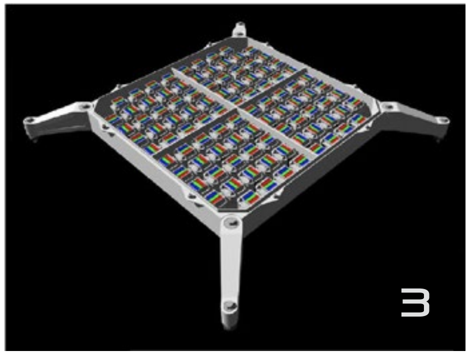


Image credits:

1 | European Space Station, Propposal for European Space Agency, David Nixon, Nick Larter, Robin Huttenbach, 1987-88

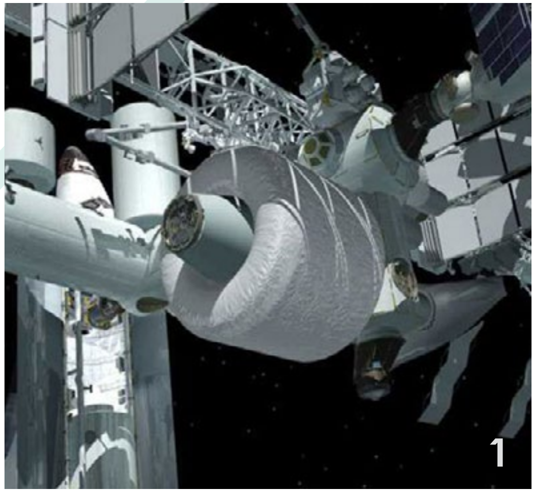
2 | Space Station Wardroom Full-Scale Prototype, Project for NASA ARC, JSC, David Nixon, Southern California Institute of Architecture, 1987-88

3 | Small Science Experiment Carrier, Project for Astrocourier Ltd., David Nixon, Nick Larter, 2000-02

Image credits:

1 | ISS TransHab, NASA, Kriss Kennedy, Constance Adams, 1999-2000

2 | TransHab, TransHab vertical interior cut away view, NASA-JSC, Frassanito and Associates (graphics image), Kriss Kennedy, Constance Adams, et al., 1999-2000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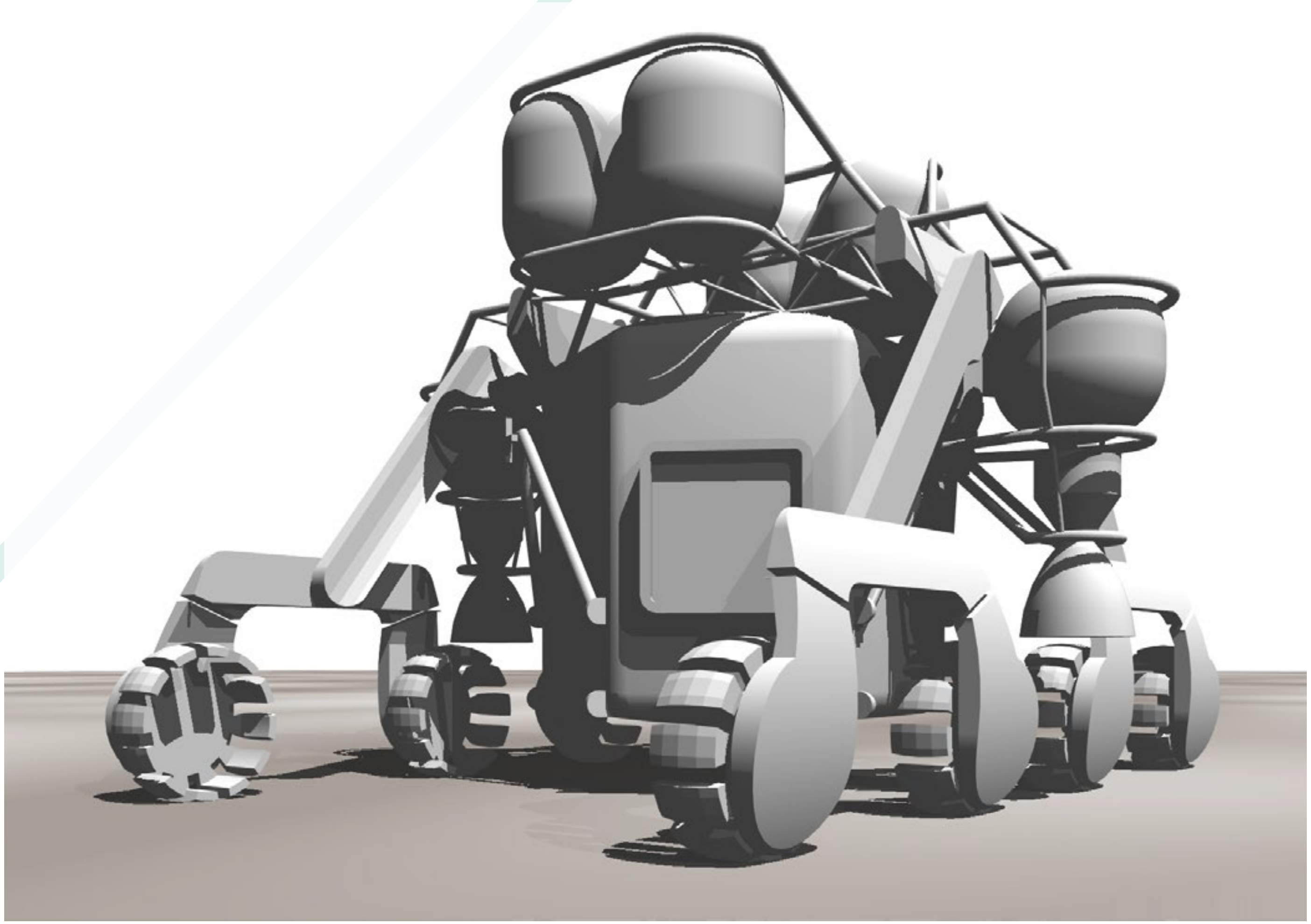

Image credit:

Mobitat project (Mobitat on surface with mobility system deployed), Plug-in Creations, A. Scott Howe, 2005

Image credits:

1 | Transformable Robotic Infrastructure-Generating Object Network TRIGON system (TRIGON-derived mobile habitats in docking mode), Plug-in Creations, A. Scott Howe, 2009

2 | Transformable Robotic Infrastructure-Generating Object Network TRIGON system (TRIGON-derived small pressurized rover), Plug-in Creations, A Scott Howe, 2009

3 | Transformable Robotic Infrastructure-Generating Object Network TRIGON system (TRIGON-derived small pressurized rover on Mars surface), Plug-in Creations, A. Scott Howe; Image by Chris Howe Design, 2009


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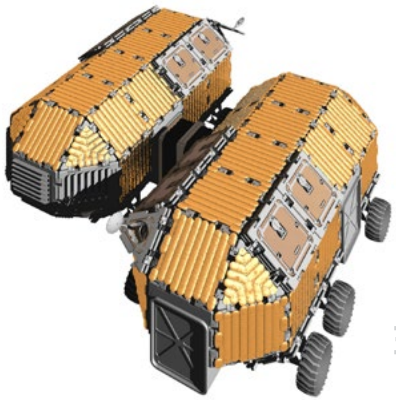
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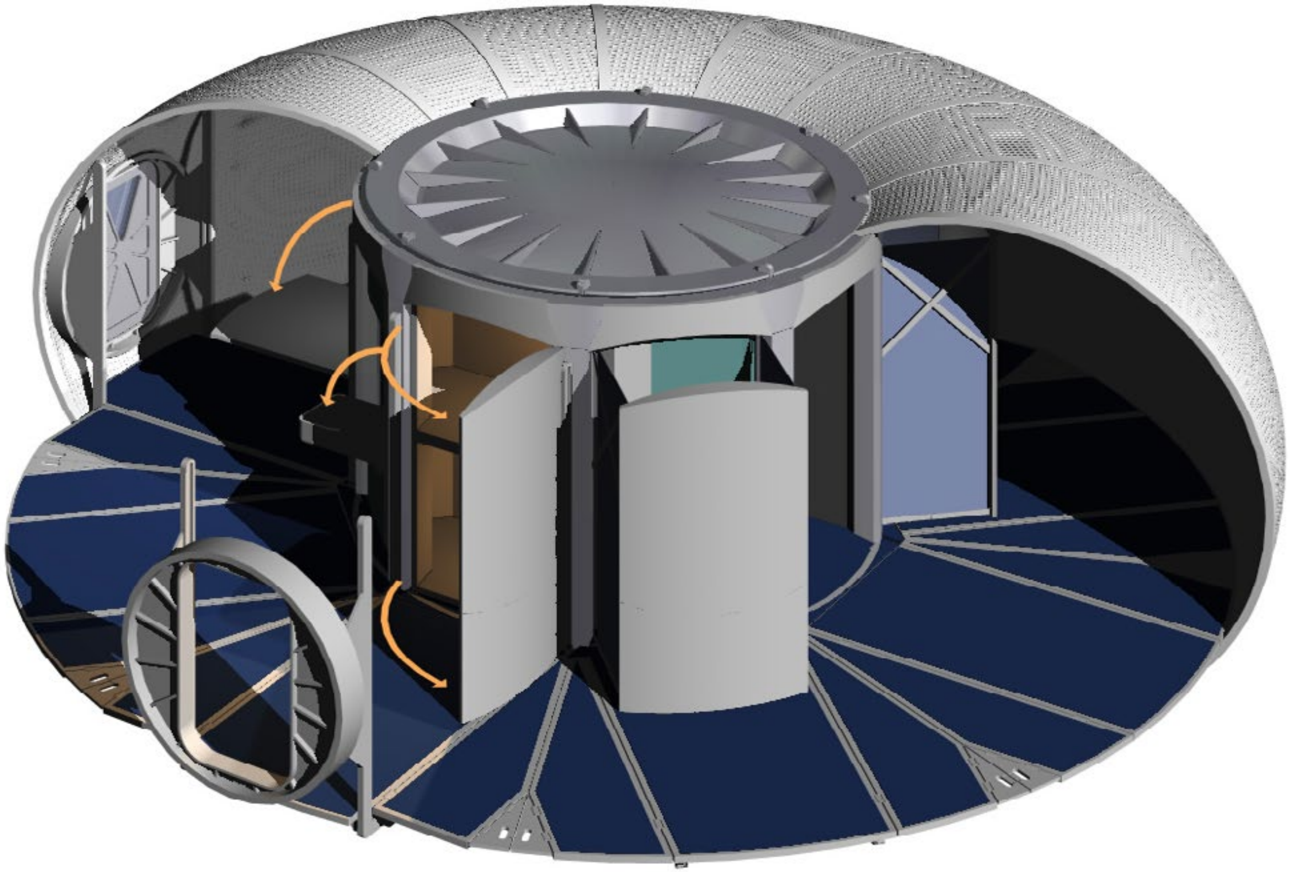
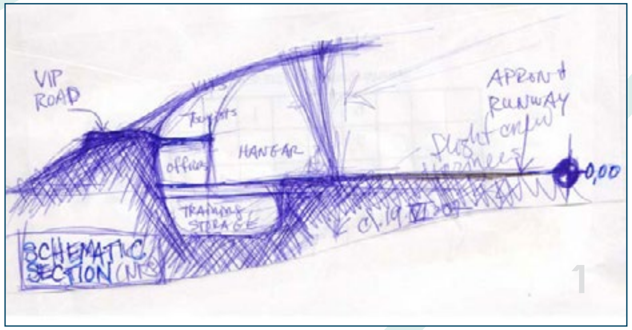
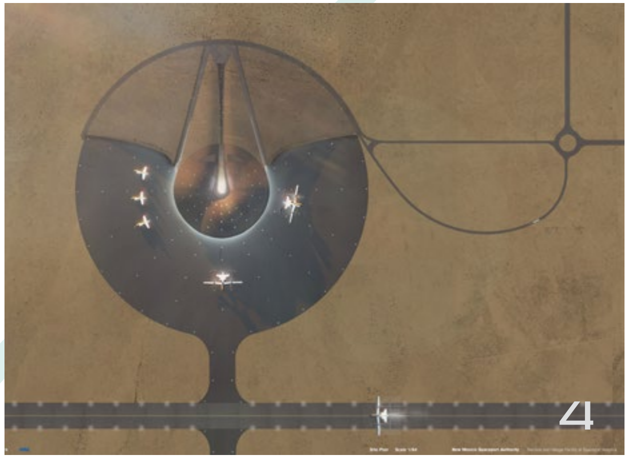


Image credit:

Lunar Architecture Team studies, Hybrid Inflatable Habitat isometric internal view, NASA, Scott Howe, Larry Toups, Kriss Kennedy, et al., 2008-09

Samples of space architects' work





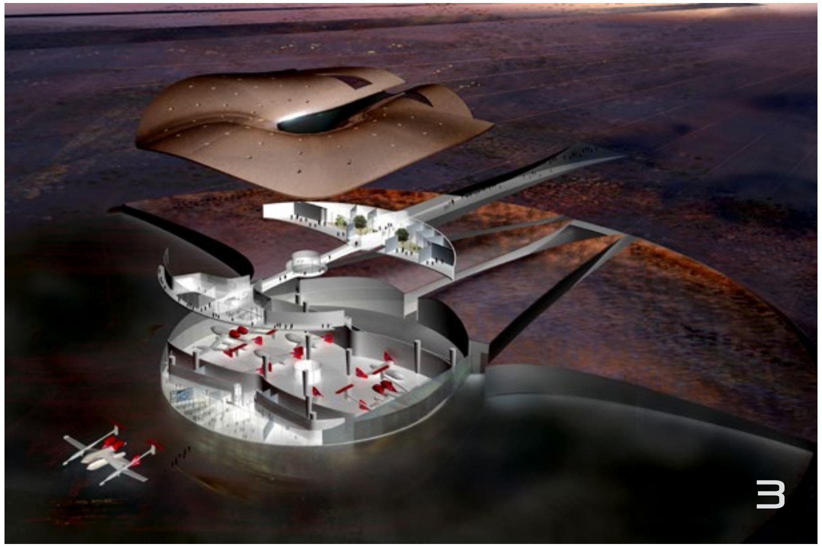


Image credits:

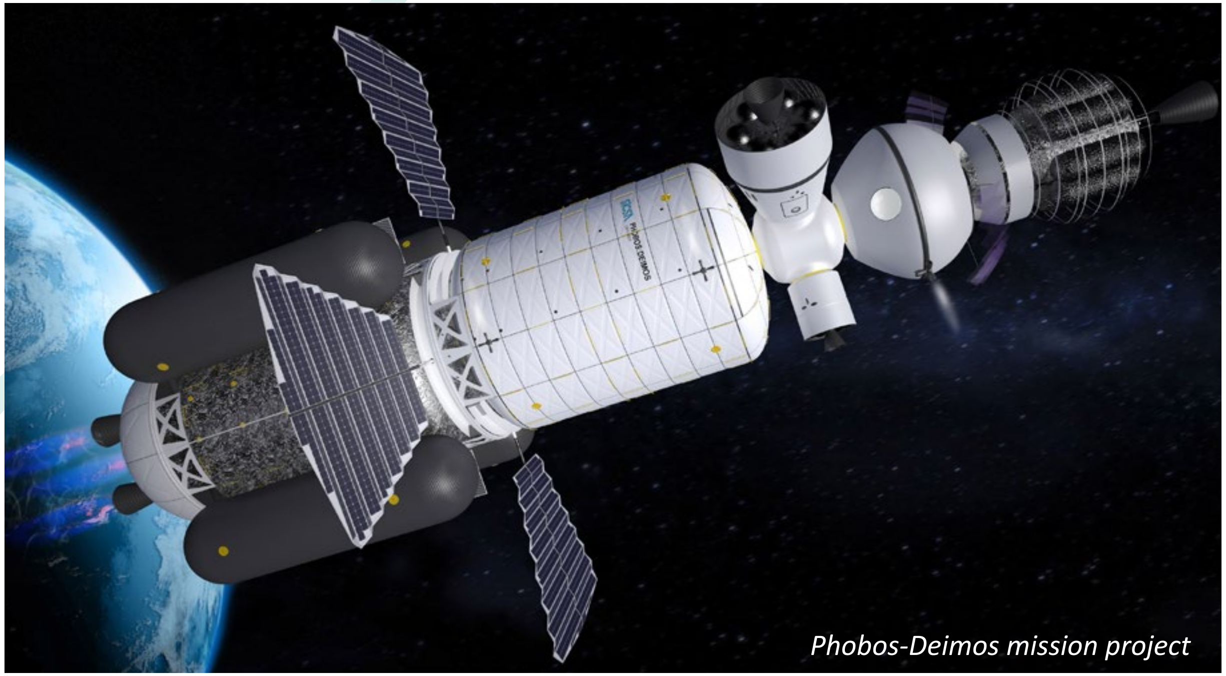
1 | Conceptual design for the SpacePort America Terminal and Hangar Facility Synthesis int'l, Constance Adams, 2007

2 | Schematic design drawing for the SpacePort America Terminal and Hangar Facility [1], Synthesis int'l and Foster+Partners, 2007

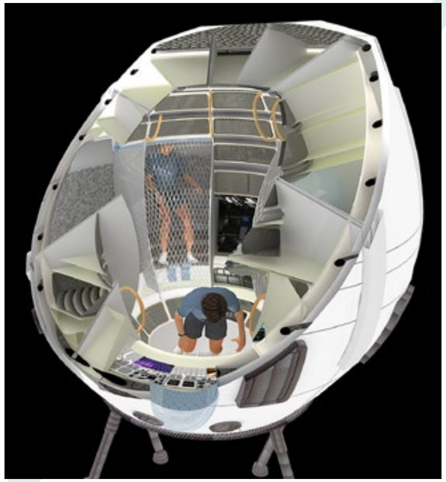
3 | Schematic design drawing for the SpacePort America Terminal and Hangar Facility [2], Synthesis int'l and Foster+Partners, 2007

4 | Schematic design drawing for the SpacePort America Terminal and Hangar Facility [3], Synthesis int'l and Foster+Partners, 2007

Samples of space architects' work



Phobos-Deimos mission project



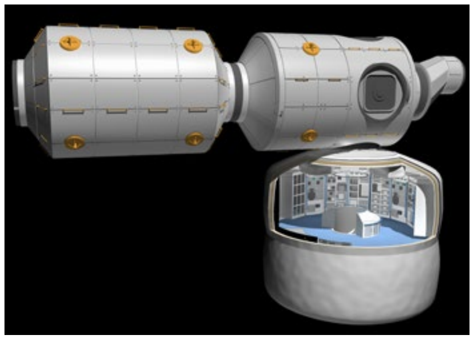
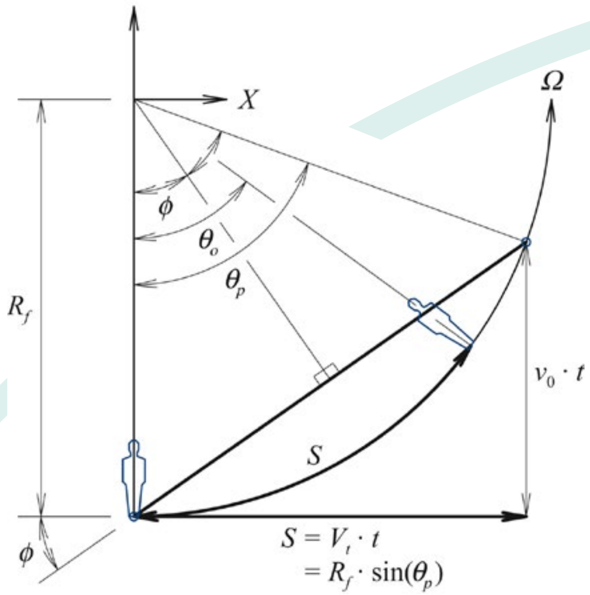
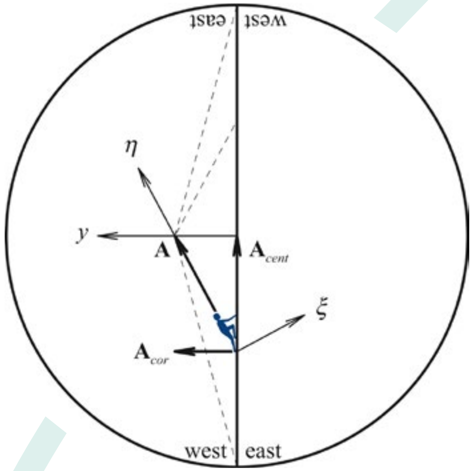


Image credits: Sasakawa International Center for Space Architecture, 2013

Samples of space architects' work





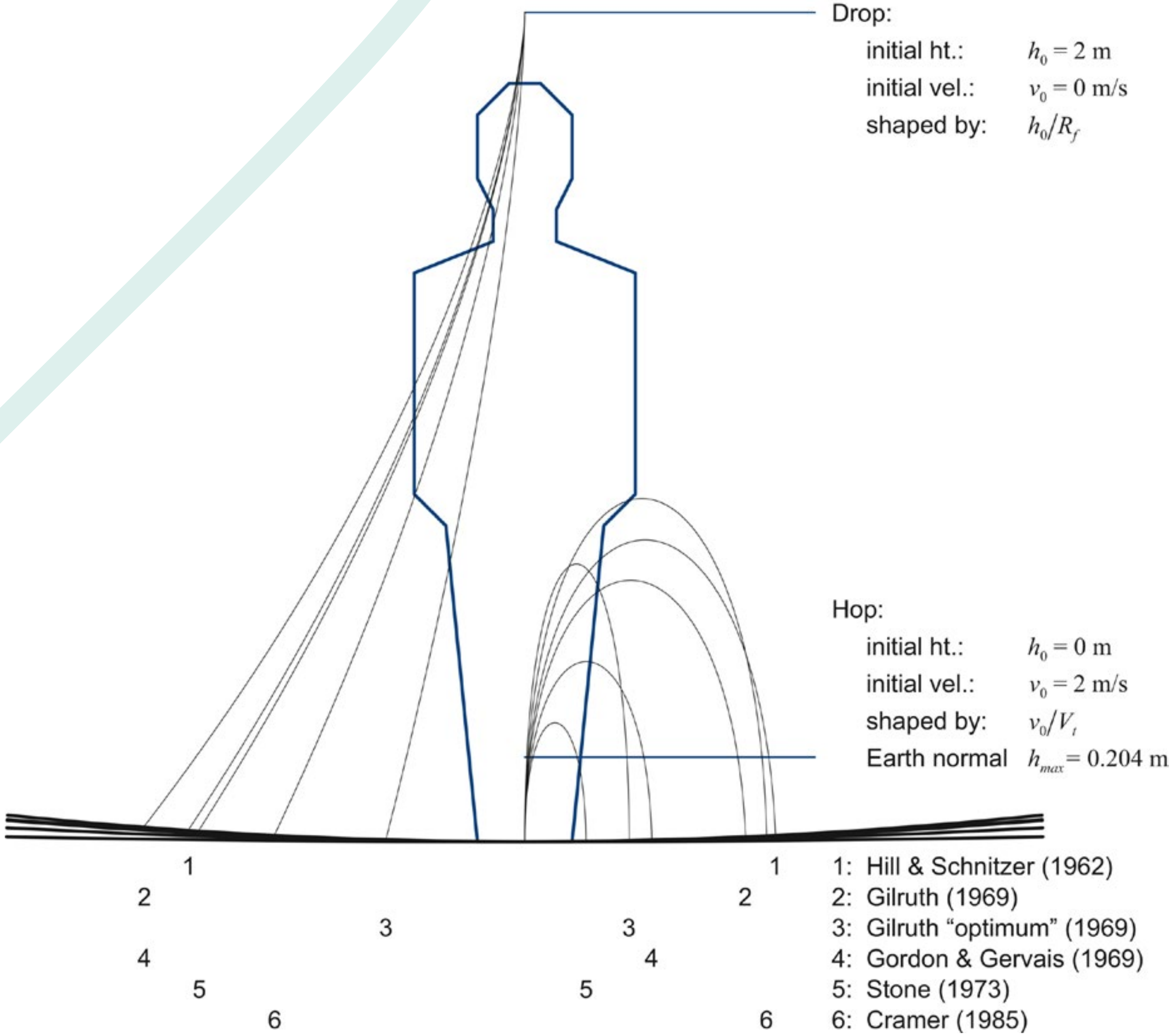


Image credits:
Theodore W. Hall, Artificial Gravity Environment, 2013

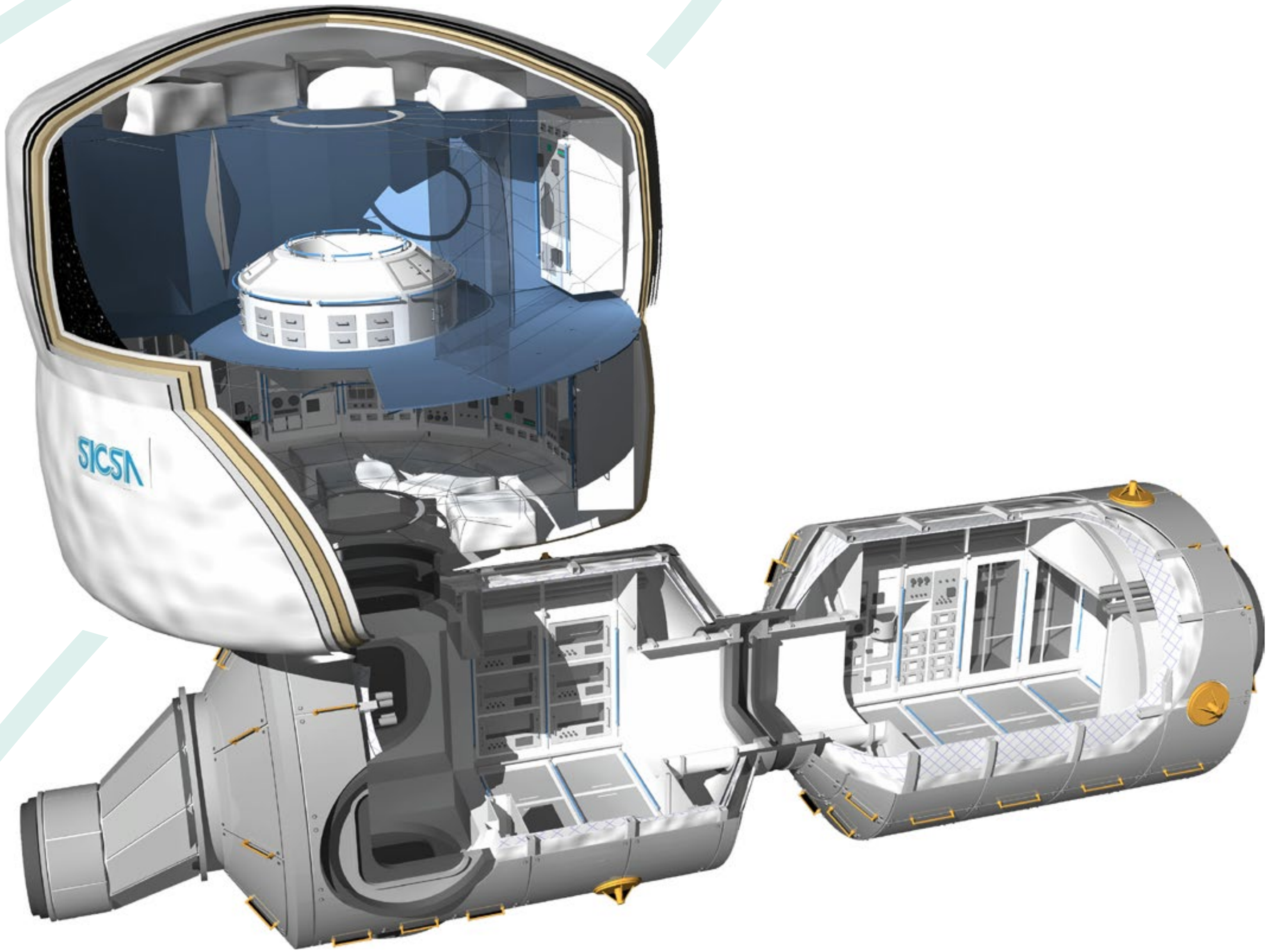


Image credits: Sasakawa International Center for Space Architecture, 2013

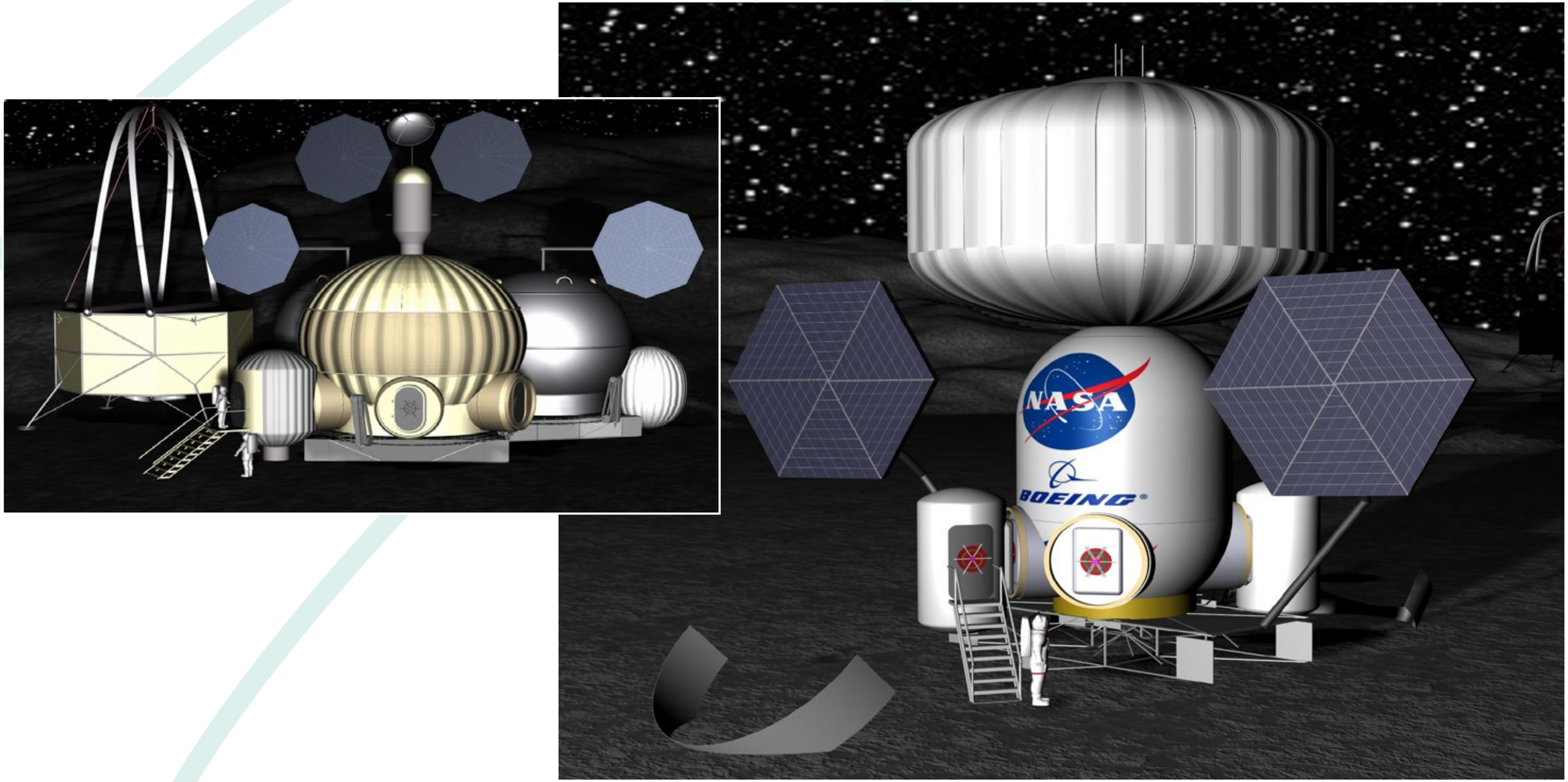


Image credits: Minimum Functionality Habitation Element, Sasakawa International Center for Space Architecture, 2013

Samples of space architects' work

1

2

Image credits:

1 | RAMA - Rover for Advanced Mission Application, LIQUIFER Systems Group, rendering René Waclavicek, 2009

2 | MEDUSA from subsea to Mars, COMEX Fr, LIQUIFER Systems Group, A. Vermeulen, rendering LIQUIFER Systems Group [René Waclavicek], 2012

3, 4 | RAMA - Rover for Advanced Mission Application, Fairing, vertical, horizontal section, LIQUIFER Systems Group, rendering René Waclavicek, 2009

5 | ISS-SLEEP-KIT, astronaut sleeping bag 3D-rendering, LIQUIFER Systems Group, rendering Kjell Herrmann, 2011

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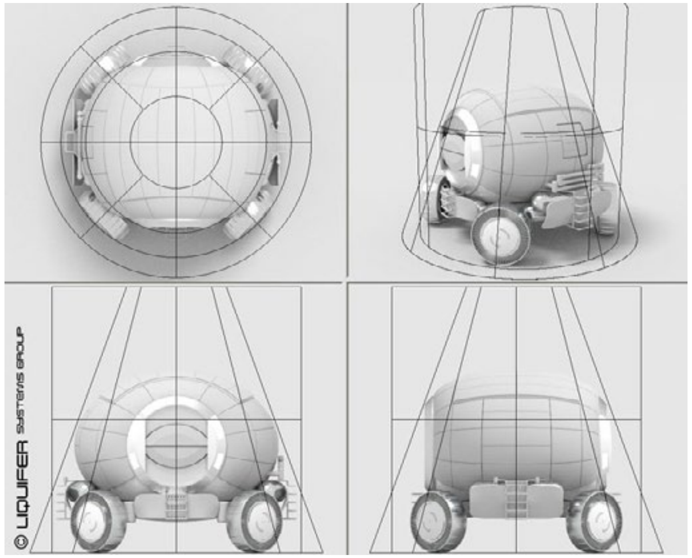

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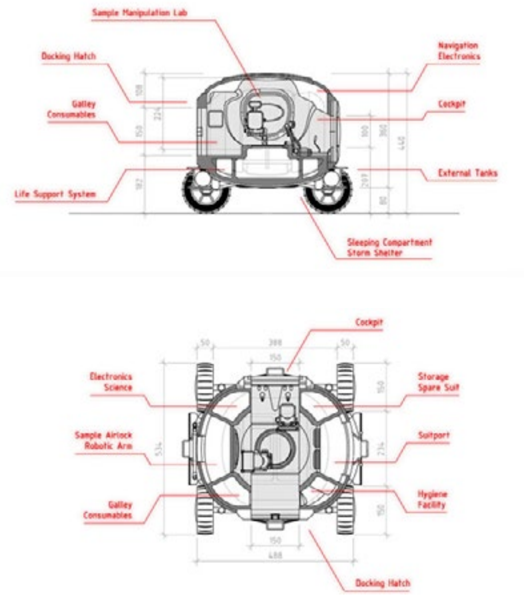

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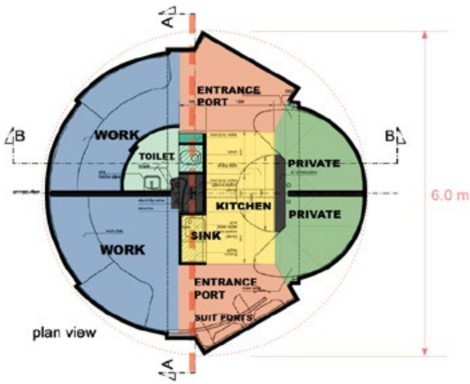
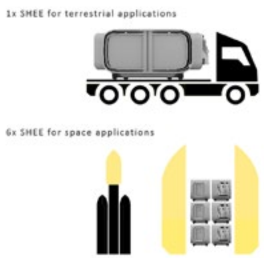
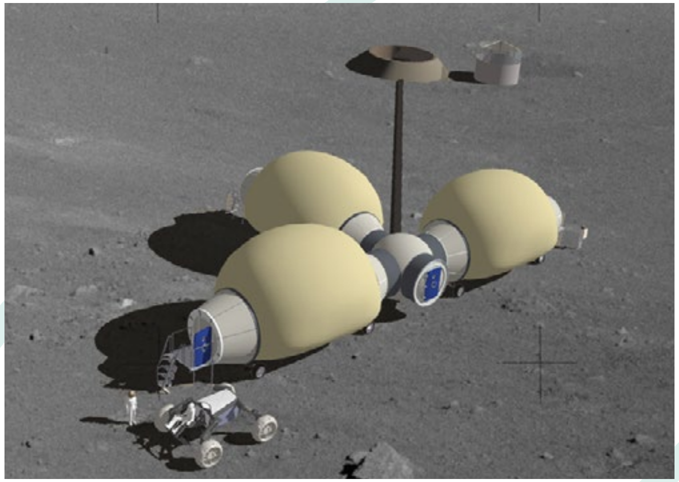
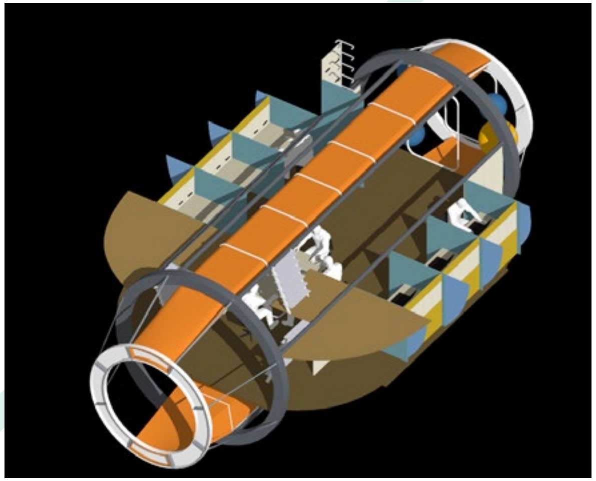


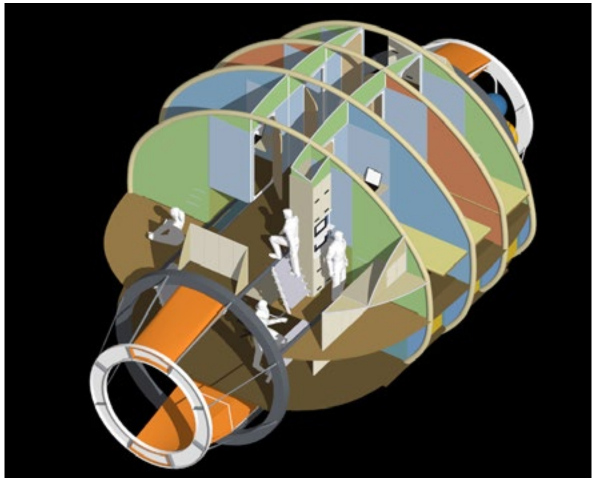
Images credits:

Self-deployable Habitat for Extreme Evnironments, SHEE Consortium 2014, Space Innovations, 2014









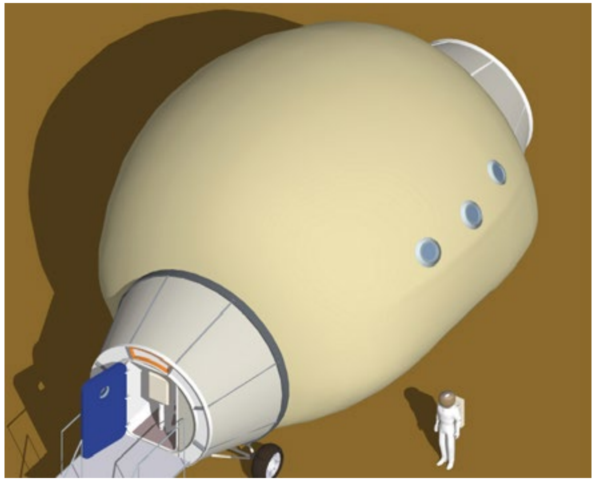
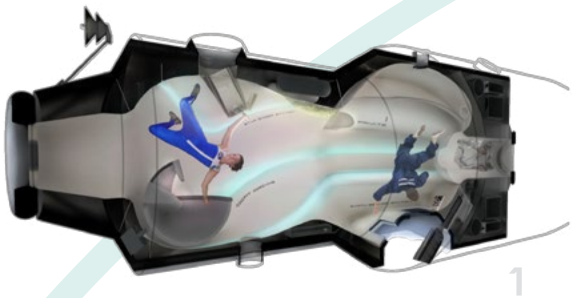


Image credits:

Surface Endoskeletal Inflatable Module, Synthesis Int'l, Georgi Petrov, Constance Adams, 2010

Samples of space architects' work



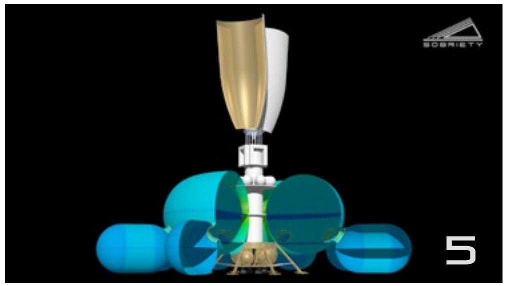


Image credits:

1 | Omicron orbital hotel - dev. stage III, Space Innovations, 2014

2 | Silverbird, suborbital rocketplane interior concept design, Space Innovations, 2008

3 | Mars Base 10, Mars base concept design for crew of ten, Space Innovations, (visualization) A-ETC, 2009

4 | Lunar Base 10, Lunar base concept design for crew of ten, Space Innovations, 2010

5 | Lunar Base 10 deployable structure, Space Innovations, vizualisation and FEM by Sobriety, 2011

6 | Silverbird, suborbital rocketplane concept design, Ondrej Doule, Martin Kubicek, Space Innovations, 2010

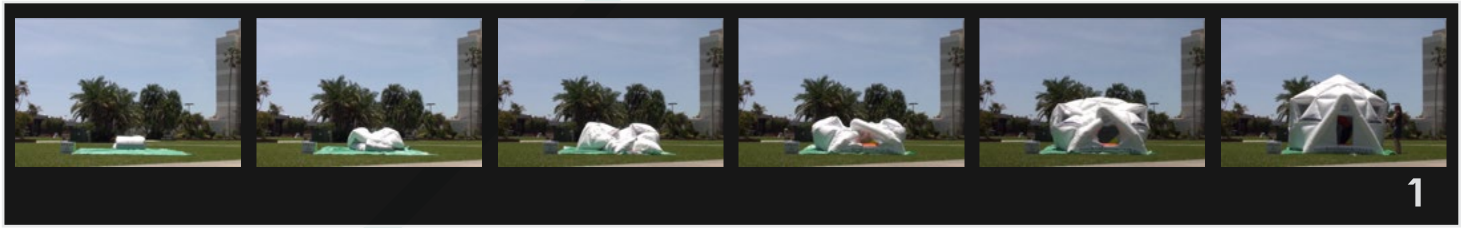
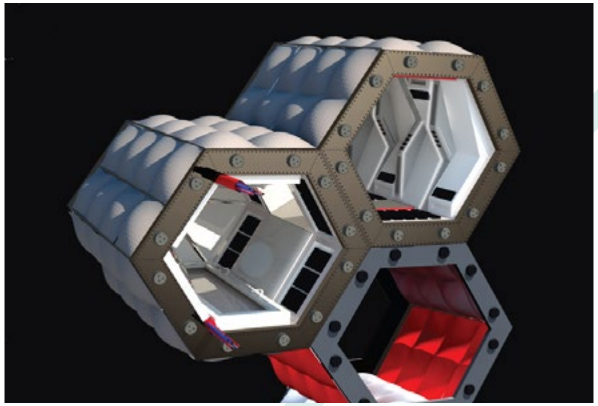
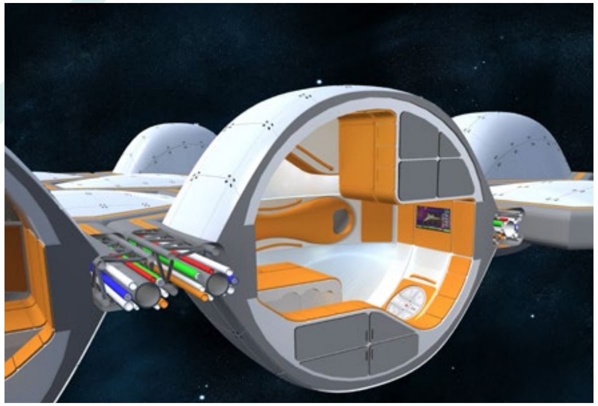


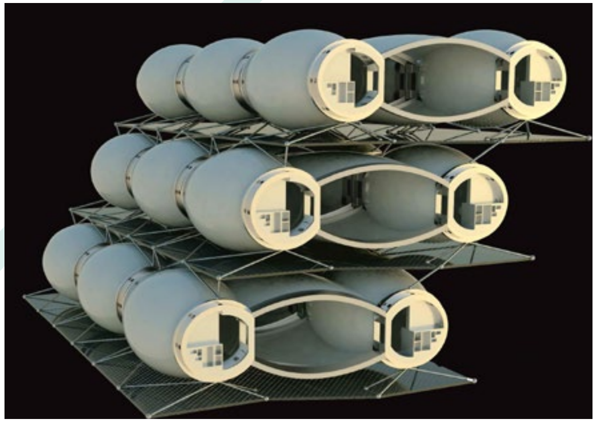
Image credits:

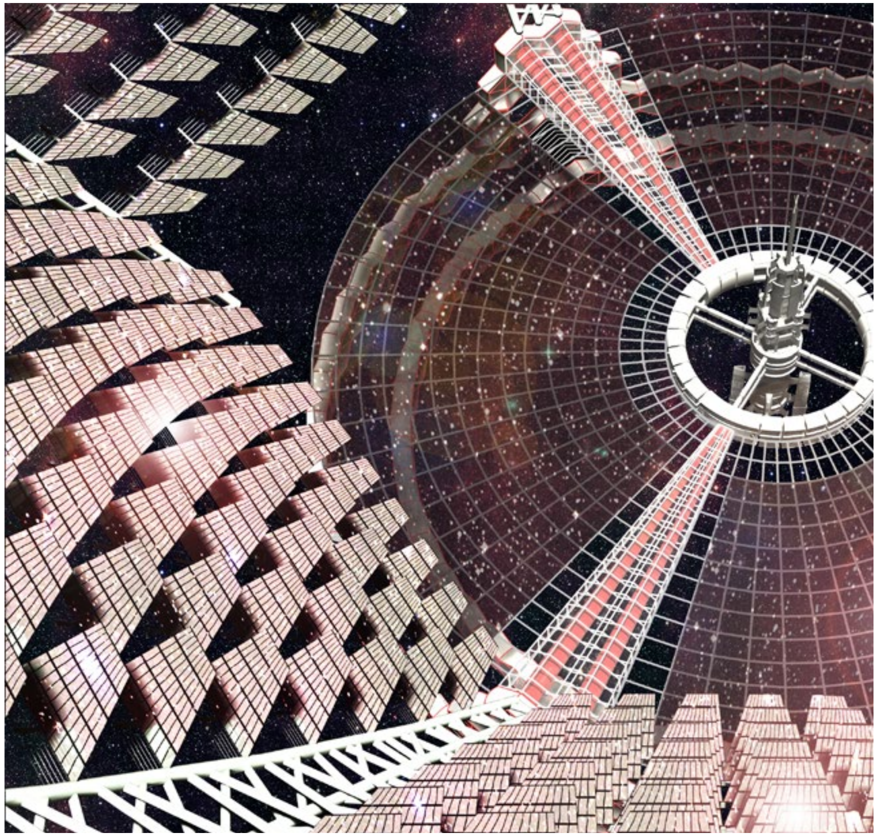
1 | Crystal - rapidly self-deployable habitat demonstrator 1 minute deployment sequence, Sobriety, Space Innovations, 2012

2 | Crystal - rapidly self-deployable habitat demonstrator, Sobriety, Space Innovations, International Space University, Florida Institute of Technology, 2012









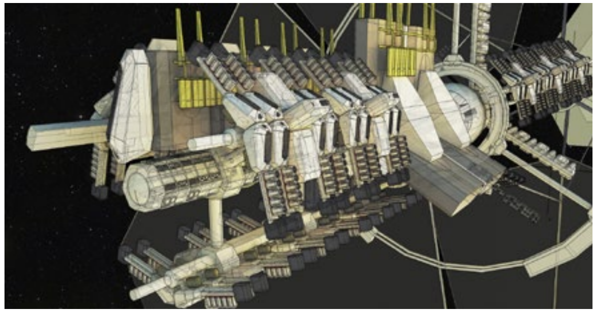


Image credits:

SBSP: Space Based Solar Power, Professor Michael Fox Design Studio at Cal Poly Pomona (selected works), 2010.

Students:
Cooper Ballantine
Andrew Lords
Mason McCarthy
Jonathan Rolf
Yasser Mohamed
Ramin Tasbihchi
Krzysztof Pyter
Jade Manabat
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Melissa Martinez
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Raul Martin Saet
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Image credits:
Vertical Habitability Layout and Fabrication Studies - Project for NASA, Professor Michael Fox Design Studio at Cal Poly Pomona, 2012

Students:
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Lina Chan
Veronica Hernandez
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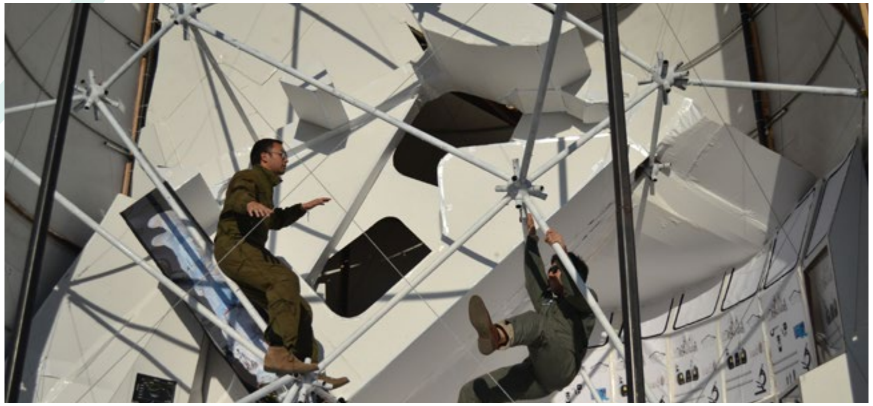
Patrick Kornman
Andrew Cartwright
Abdelsayed Marc
Brianna Wiley
Garrett Sanne
James Colton
Brandon Cruz
Bryan Wolfe
MichaelCharette
Khoe Huynh
Ken Yim
Jorge Bernardino
Cameron Jacobson
Jason Friedrich
Drew Rhee
Rick Sanchez
Keyur Anushri
Tiffany Davis
Jena Cardenas
Aaron Gomez
Ken Lee



Samples of space architects' work

Image credits:
EVSS: Economically Viable Space Station, Professor Michael Fox Design Studio at Cal Poly Pomona (selected works), 2011

Students:
Luis Gil
Milagro J. Carpio
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Albert Escobar
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