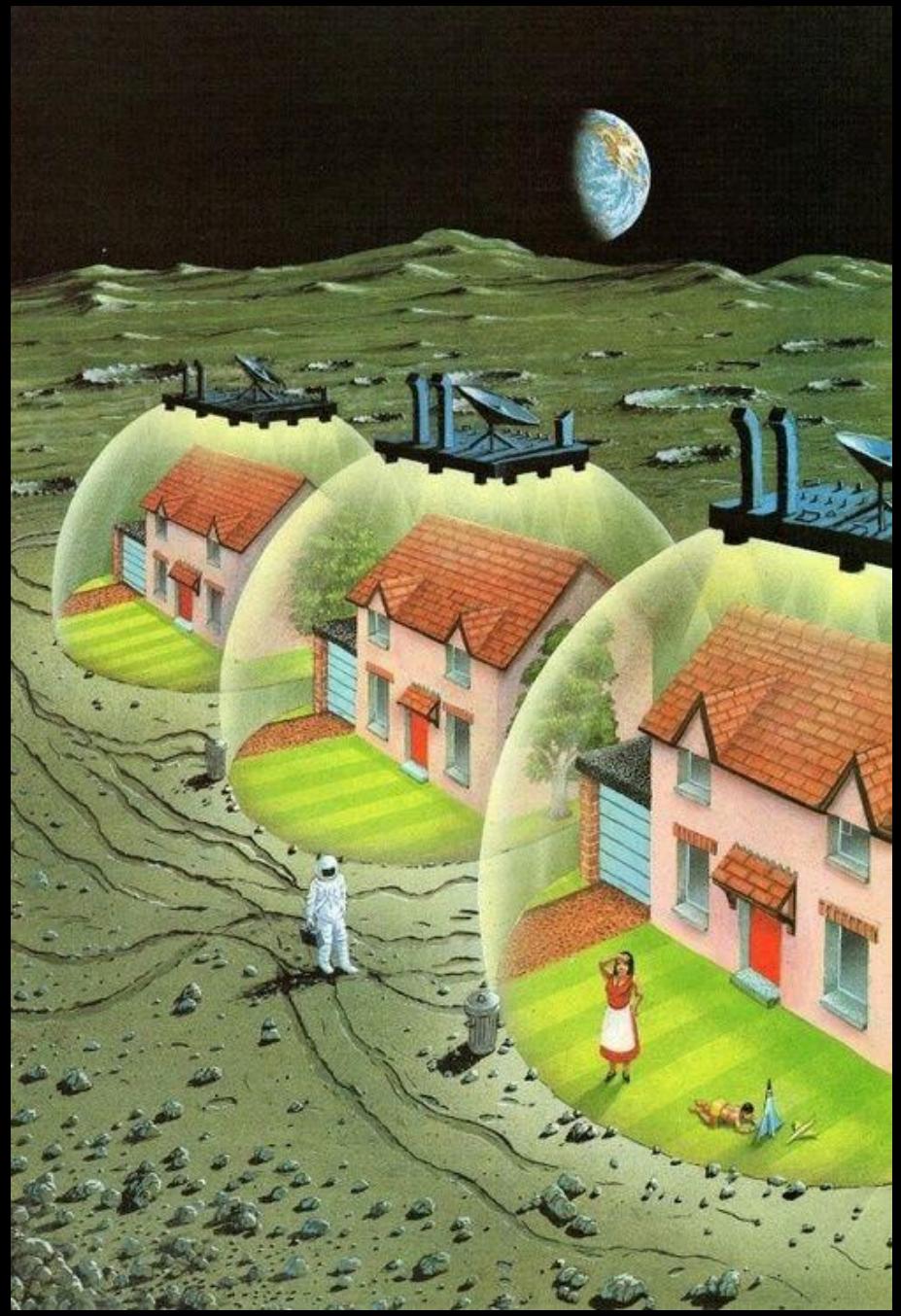
MOON-VILLAGE LIVING LAB
SUR LA SURFACE LUNAIRE

(Research of the Regeneration energy system and LSS integrated façade for Lunar surface habitat)

**LSS : Life support system*

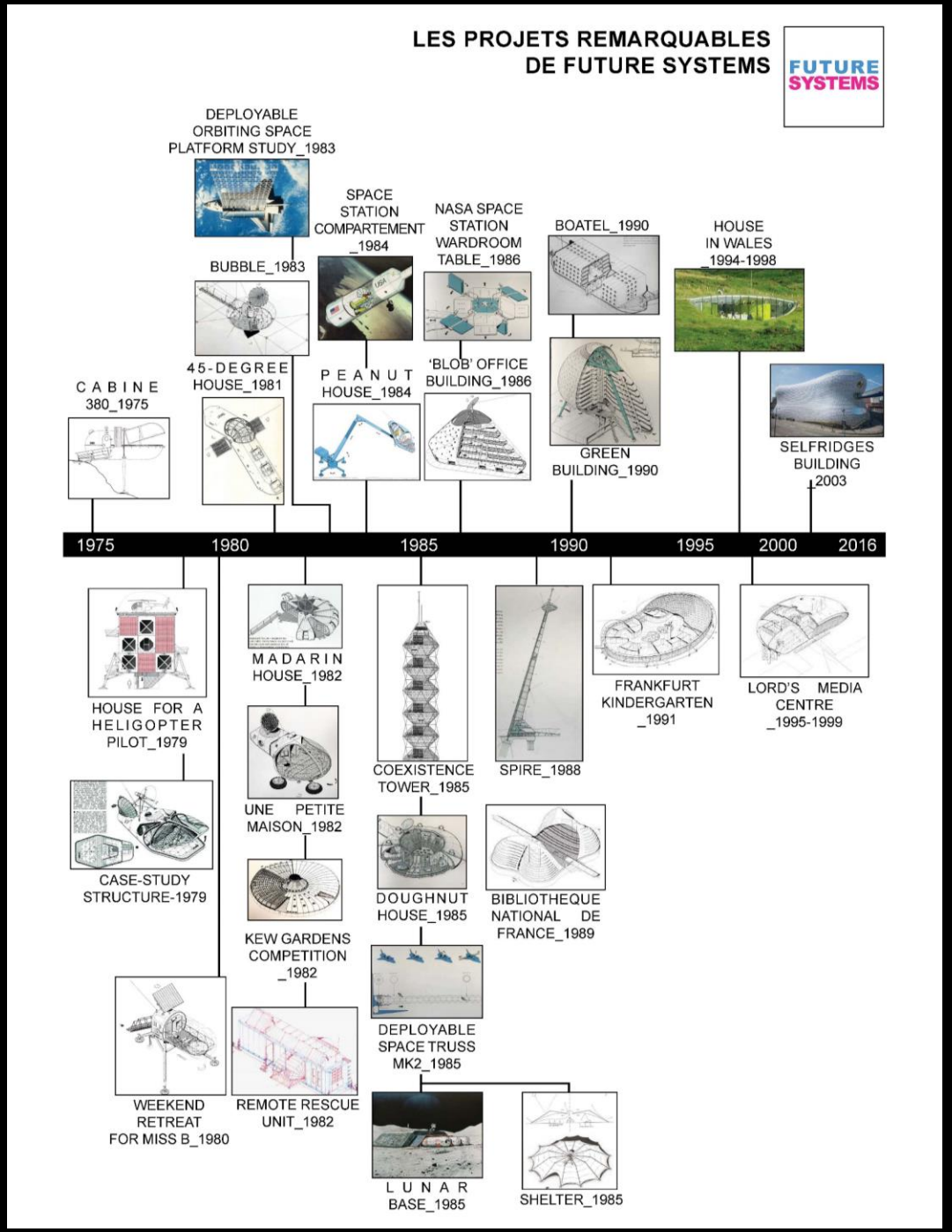
PFE 10 _ Kim kyunghwan

POURQUOI un projet à la Lune???!



Architecture Terrestre et Extraterrestre

1. Nouvelle inspiration



Architecture Terrestre et Extraterrestre

1. Nouvelle inspiration

“Oase No. 7” (“Oasis Number 7”)
(1972, Documenta @ Museum Fridericianums)

Le module Beam gonflé pour la
première fois par la NASA, le 28 mai 2016

Architecture Terrestre et Extraterrestre

2. Nouvelle technologie/technique pour l'architecture terrestre

Dymaxion_House,1933_Buckminster Fuller

1er Tentation avec la construction aéronautique pour une bâtiment autonome

Panneau Solaire

Architecture Terrestre et Extraterrestre

3. Architecture Autonome : Prolonger l'habitabilité sur l'environnement non-favorisé,
OU Construire une architecture autonome dans une ville polluée

***Objective** :*

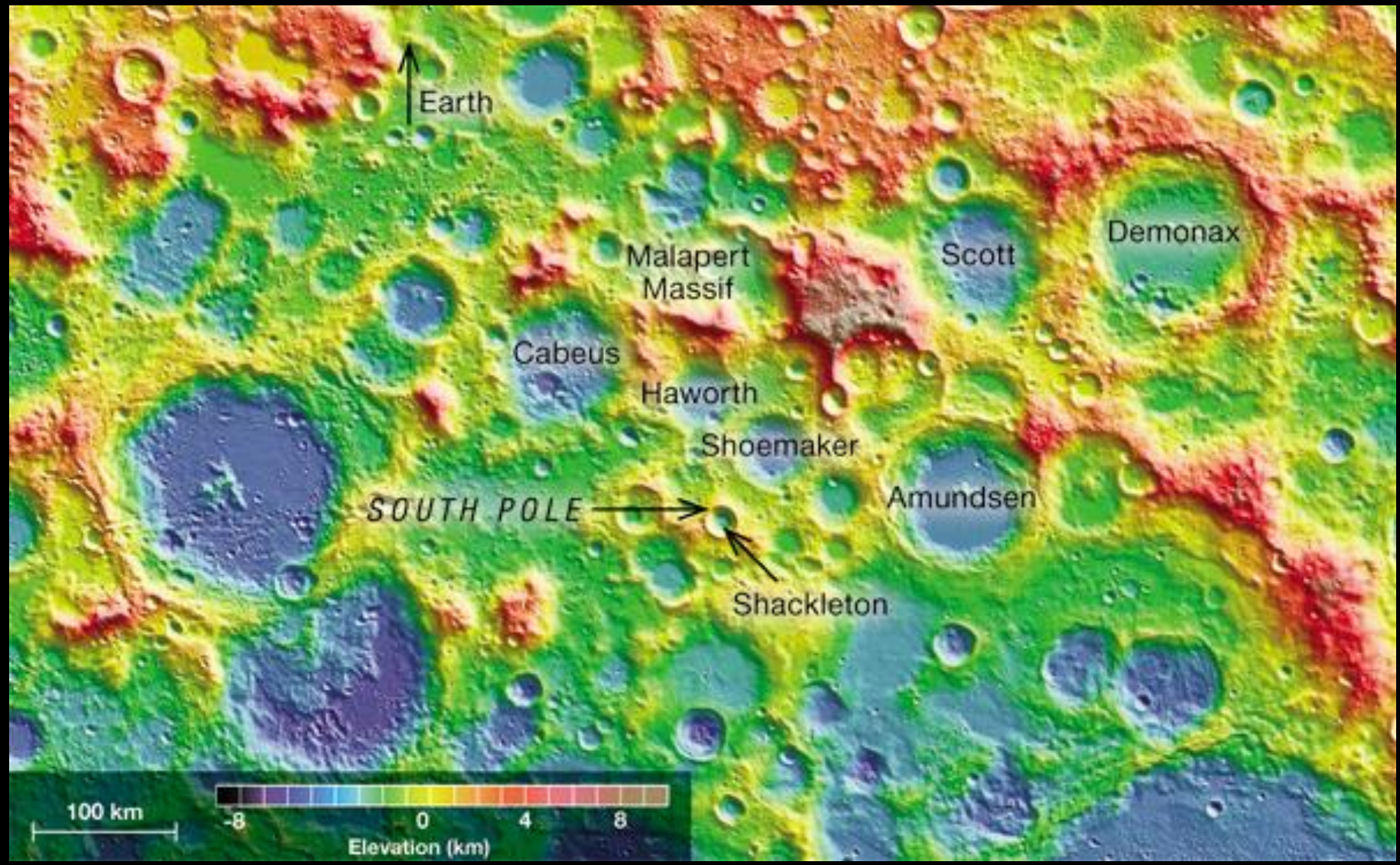
- Recherche de prototype d'une façade hybride intégrant un system qui régénère de l'énergie et le soutien à la vie (LSS)

- Intensifier l'habitabilité dans un contexte confiné

**LSS : Life support system*

Problématique *:Comment la technique de construction , la représentation sociale et l'habitude culturelle de la Terre vont-elles transférer dans un contexte lunaire?*

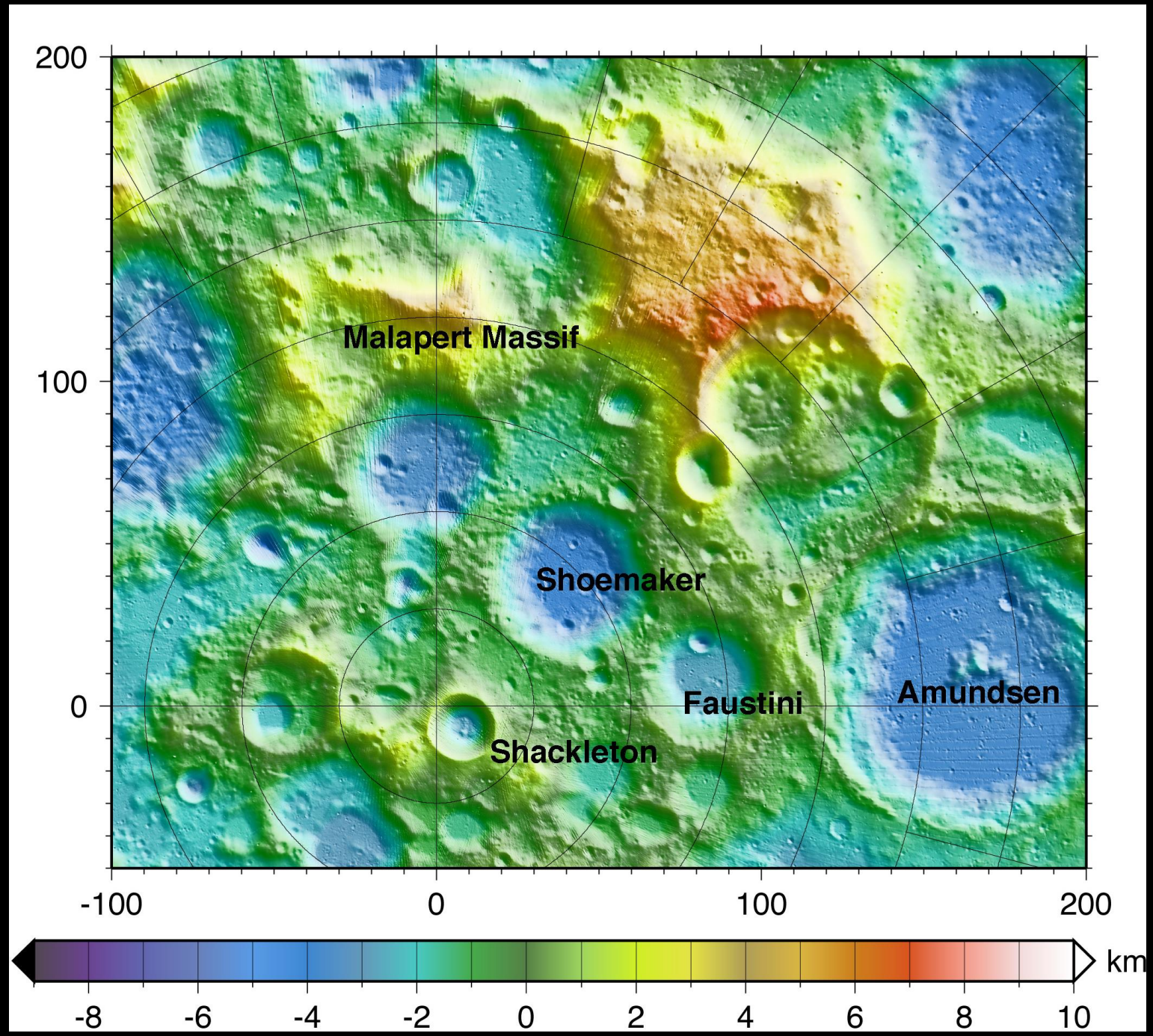
S I T E : Pôle–sud, Lune



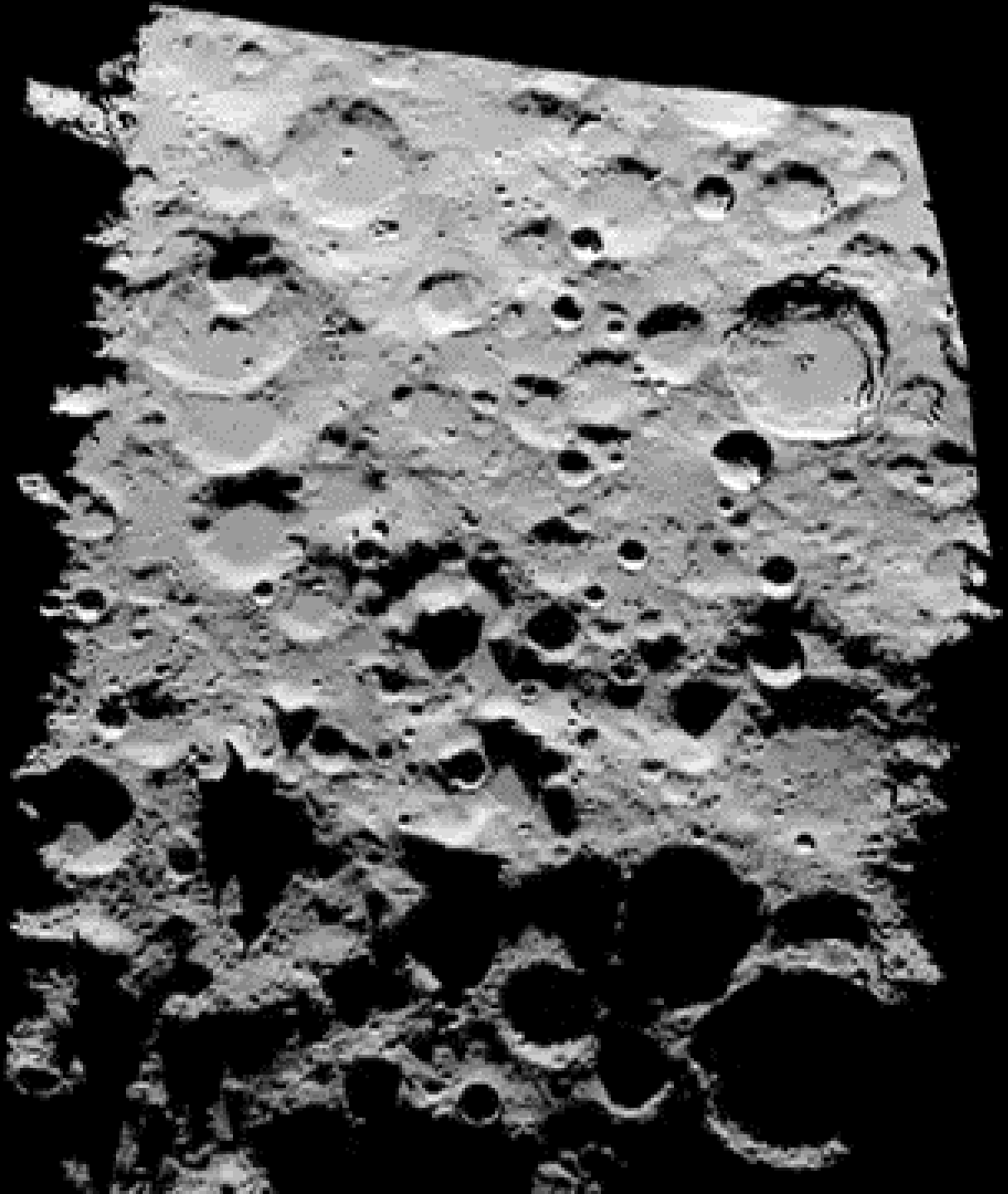
REGION MALAPERT

Situé près du pôle Sud lunaire
(85.99 S, 357.07 E)

Le sommet du ‘Massif de Malapert’ a un fort éclairage. ‘Malapert Massif’ bénéficie également d'une visibilité exceptionnelle de la Terre et d'un excellent potentiel de communication (et d'un potentiel scientifique intéressant!)

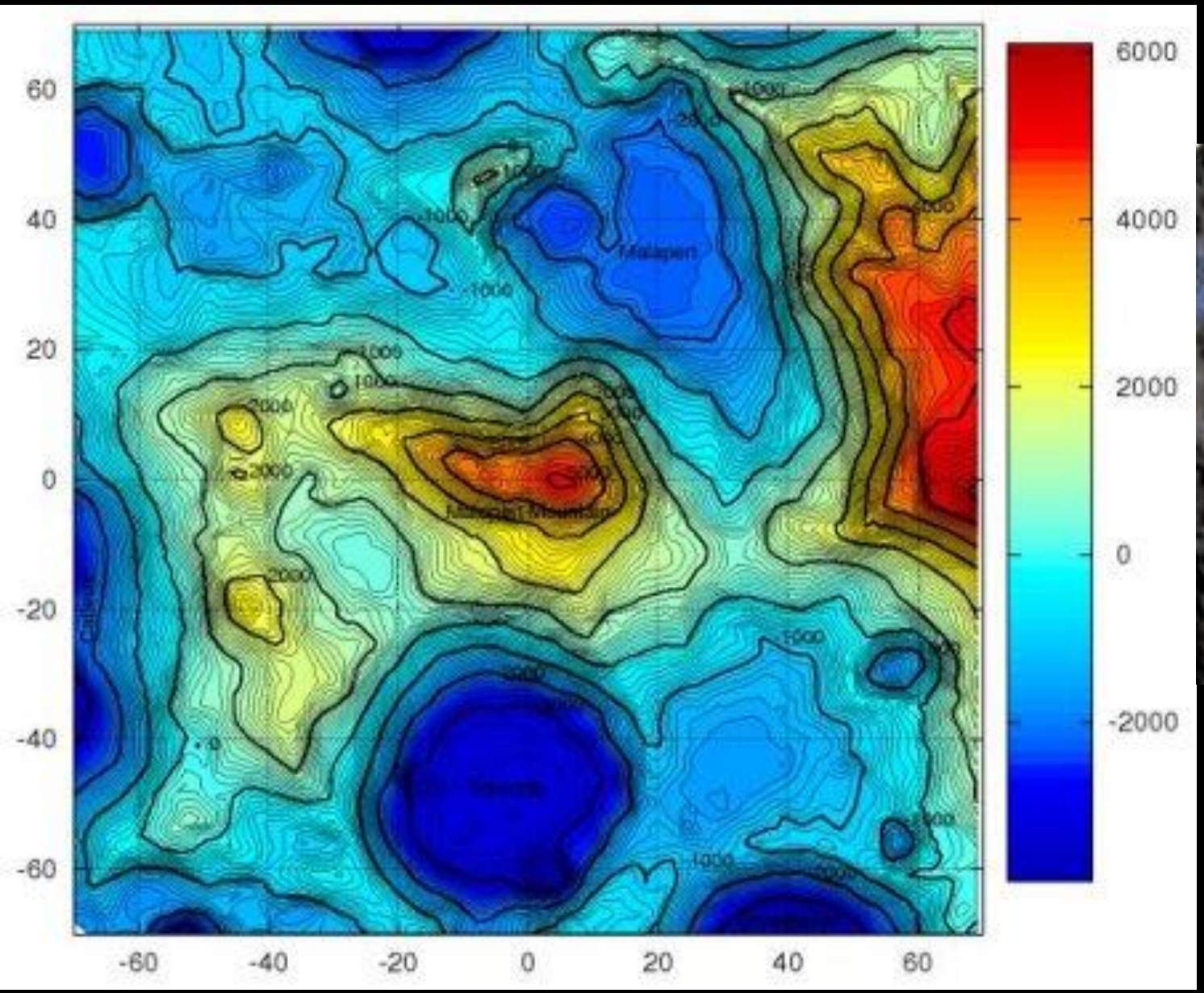


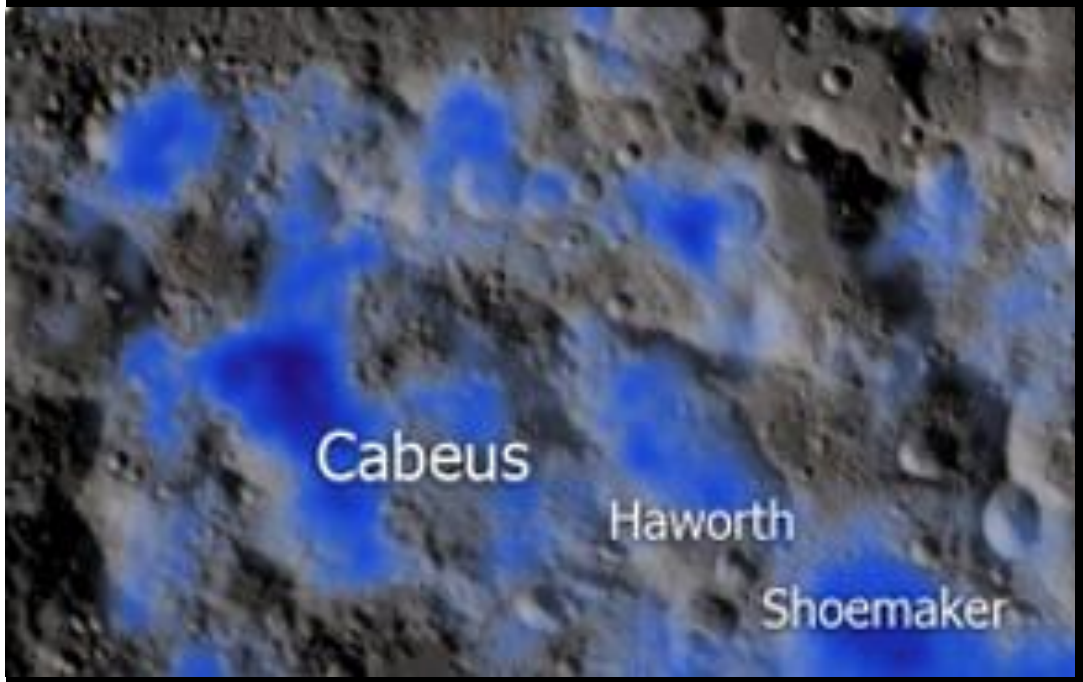
Illumination of the Moon's south pole Over one day



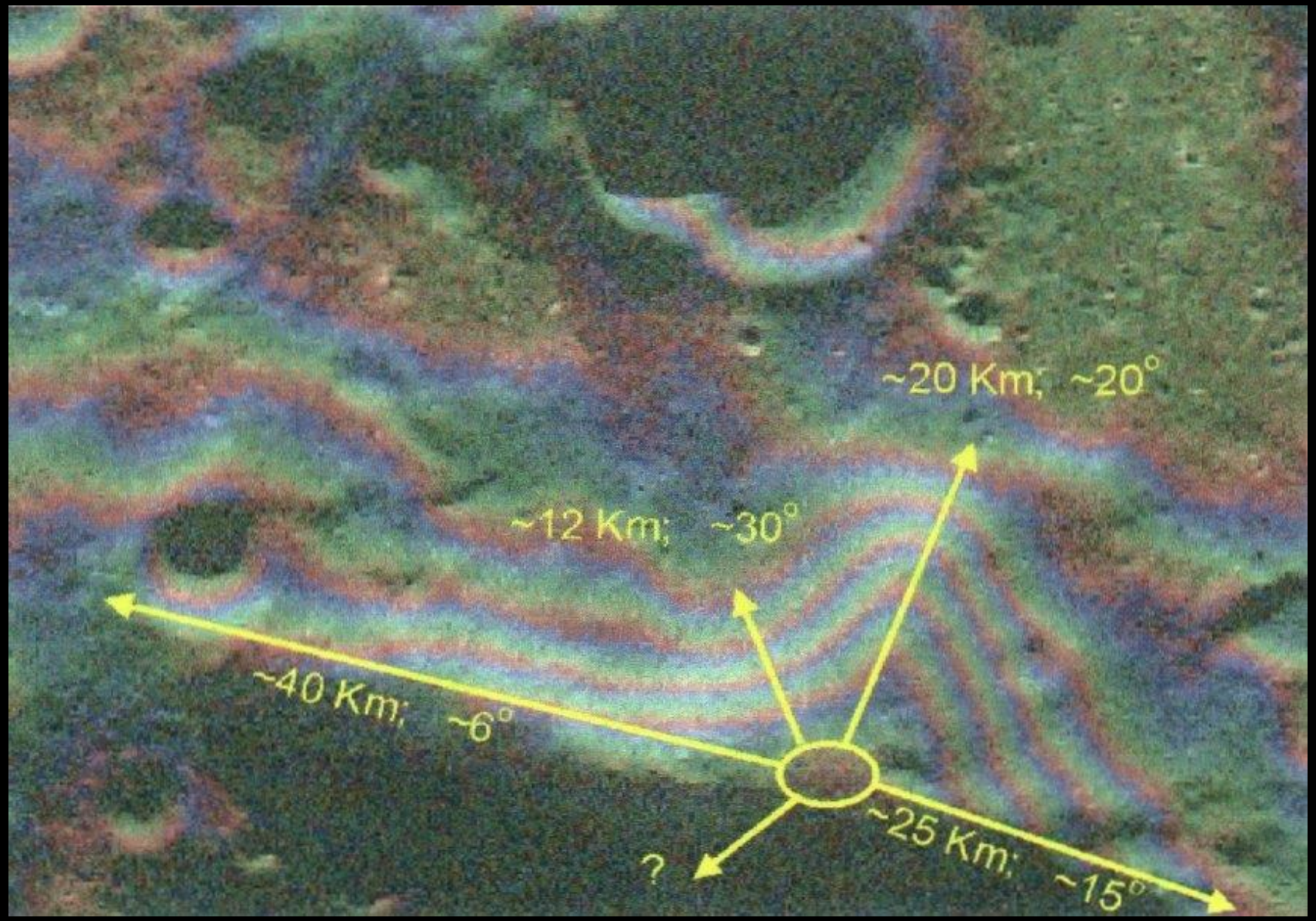
VUE DU POLE SUD A LA TERRE

S I T E : Pôle–sud, Lune


60
40
20
0
-20
-40
-60
-60
-40
-20
0
20
40
60
6000
4000
2000
0
-2000

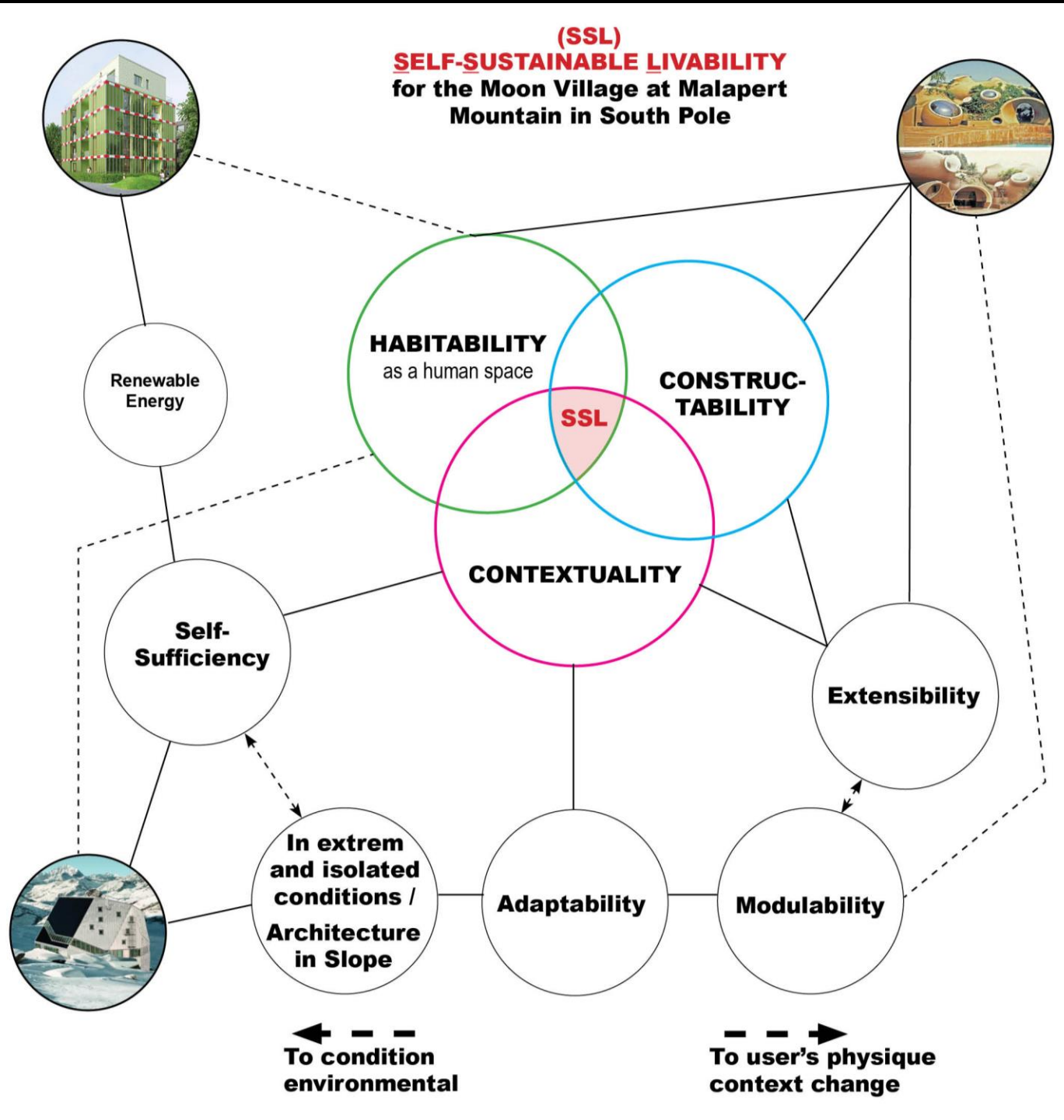

Cabeus
Haworth
Shoemaker

MT. MALAPERT

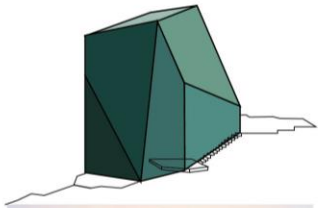



6395.99
17879.51

PROJET AUJOURD'HUI : Foster + Partners, ESA (European Space Agency)

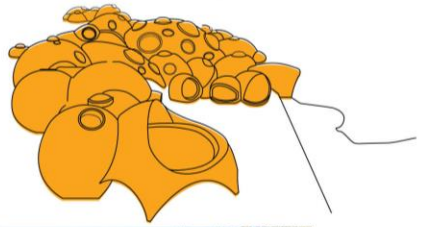

(SSL)
SELF-SUSTAINABLE LIVABILITY
for the Moon Village at Malapert Mountain in South Pole
Renewable Energy
HABITABILITY
as a human space
CONSTRUC-TABILITY
SSL
CONTEXTUALITY
Self-Sufficiency
Extensibility
In extrem and isolated conditions / Architecture in Slope
Adaptability
Modulability
To condition environmental
To user's physique context change

NEW MONTE ROSA HUT SAC , 2008



Architect
Bearth & Deplazes Architekten AG, Daniel Ladner
Location
Western Europe - Switzerland - Zermatt, canton Valais
Story
5 Stories
Climate Zone
Cold, mountains
Date of completion
2008
Type / Purpose
Gastronomy / Research Station (future)
Sustainability Features
Solar heating, energy recuperation, energy storage

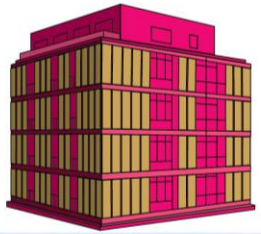
LES MAISON BULLE, 1968-1996



Palais Bulle (Espace Cardin), Théoule-sur-Mer, 1975-1989
Maison Bulle Antoine Gaudet, 1968-1996
Maison Yvonne Murard, 1972-1974
Astronomical Observatory, Côte d'Azur, 1974/197

Architect
Antti Lovag
Location
South France
Story
1 story or 2 stories.
Climate Zone
Temperate
Date of completion
1989 (Palais Bulle)
Type / Purpose
Residential / Observatory (Côte d'Azur, France)
Sustainability Features
Easy Construction, extensible modules, human centred design.

BIQ-THE ALGAE HOUSE , 2013



Architect / Project Partner
Splitterwerk, Arup GmbH, B+G Engineers /
Otto Wulff Bauunternehmung
Location
BIQ Das Algenhaus, Am Inselpark 17, 21109
Hamburg, Allemagne
Story
5 Stories
Climate Zone
Temperate
Date of completion
2013
Type / Purpose
Residential / Exposition
Sustainability Features
High efficient façade
Biomass heating systems
Ground Source Heat Pump

COMPARATIVE ANALYSE 1 _ CONTEXTUALITY

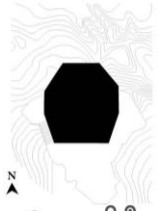
	AREA/VOLUME	ENERGY ASPECT	CONTEXT	PARTI

NEW MONTE ROSA Hut SAC,2009

Area
255.0 m²
Gross Volume (GV) (m³)
3699
Building Costs
6500000 CHF

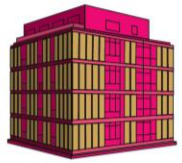
Self-Sufficency
High

Heating Energy (kWh/m²a)
17500
Use of renewable ressources - low tech
natural cross ventilation, others
Use of renewable ressources - high tech
solar heating, photovoltaics, energy pile systems, energy recuperation, energy storage, other



Facade produce energy
Solar panel Intergrated facade
Considering forme against wind
Wood Material inside
High performance of energy

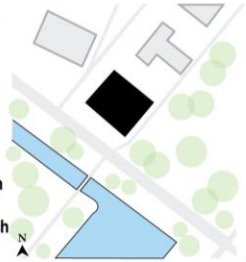
BIQ-The Algae house,2013



Area
1850 m²
Gross Volume (GV) (m³)
-
Building Costs
3.4M Euro

Self-Sufficency
High

Biomass Energy (kWh//m²/year)
4500 (30kWh/m2/y)
Heating Energy
32 MW heat/year (150 kWh/m2/y)
Use of renewable ressources - low tech
Sun shading
Use of renewable ressources - high tech
High efficient façade
Biomass heating systems
Ground Source Heat Pump
Aximolendus. Sequias perorion raecae aut vendi nimilit quae et optae la volo



Facade produce energy
High performance of energy
Algae powred house
adjustable structure

	DAYLIGHT	FENESTRATION	SPACE COMPOSITION	ACCESSIBILITY

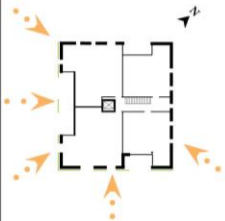
NEW MONTE ROSA Hut SAC,2009

(http://www.dnarbarte.com/)

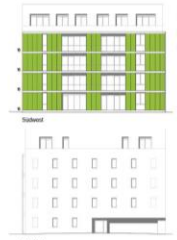
Window to wall ratio
Low

TO THE SITE
HARD

BIQ-The Algae house,2013



(http://www.sprenger-vonderlippe.de/)



Window to wall ratio
High

TO THE SITE
EASY

COMPARATIVE ANALYSE 2 _ HABITABILITY & CONSTRUCTABILITY

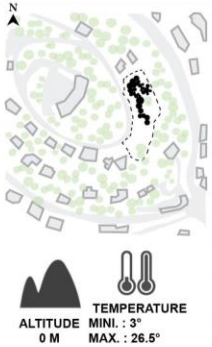
	AREA/VOLUME	ENERGY ASPECT	CONTEXT	PARTI

MAISON BULLE_ Palais Bulle (Espace Cardin),1987

Area
1200m²
Gross Volume (GV) (m³)
-
Building Costs
350M Euros
Building Costs / m³ GV

Self-Sufficency
Low

Heating Energy (kWh/m²a)
-
Use of renewable ressources - low tech
no
Use of renewable ressources - high tech
no

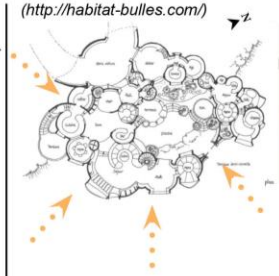


Adapted house
Reflect on user's way of living
Optimized space
Respect for the site
Continuity between inside and outside
Function of the furniture
Easy /auto construction

	DAYLIGHT	FENESTRATION	SPACE COMPOSITION	ACCESSIBILITY

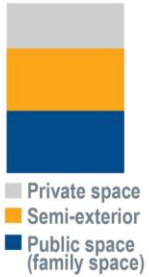
NEW MONTE ROSA Hut SAC,2009

(http://habitat-bulles.com/)



(http://www.frac-centre.fr/)

Average
Window to wall ratio



TO THE SITE
EASY

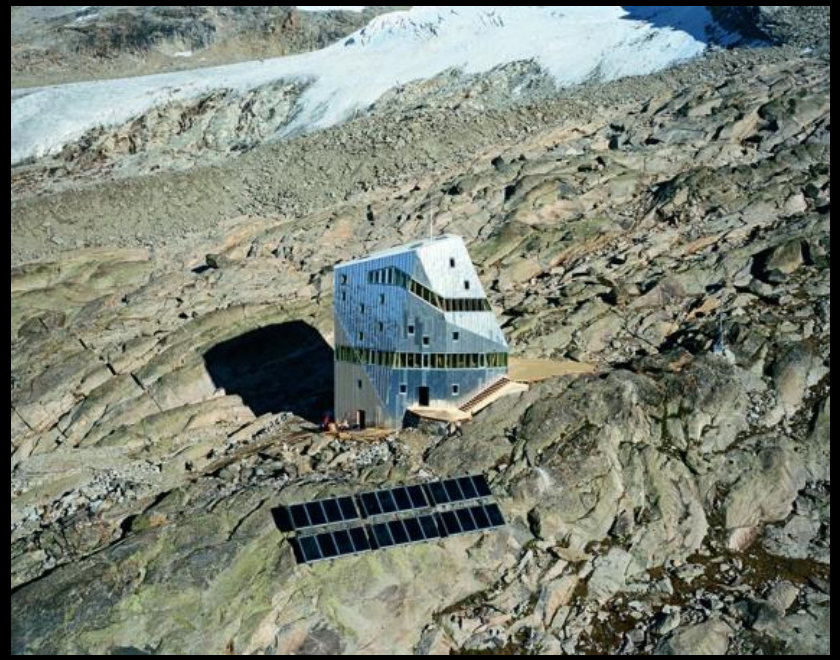
Architecture autonome durable sur les Alpes

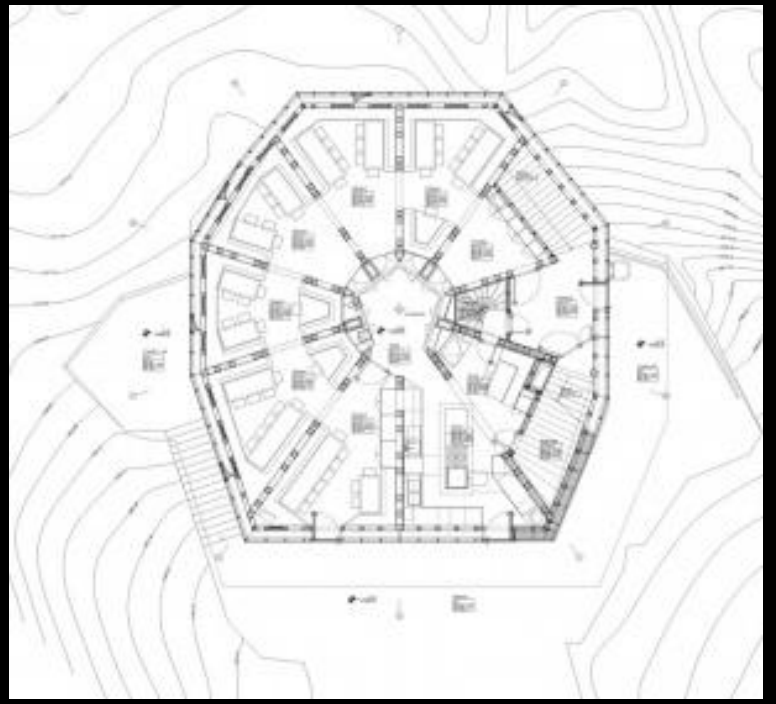
Refuge du Goûter, 2013_ DécaLaage Architecture

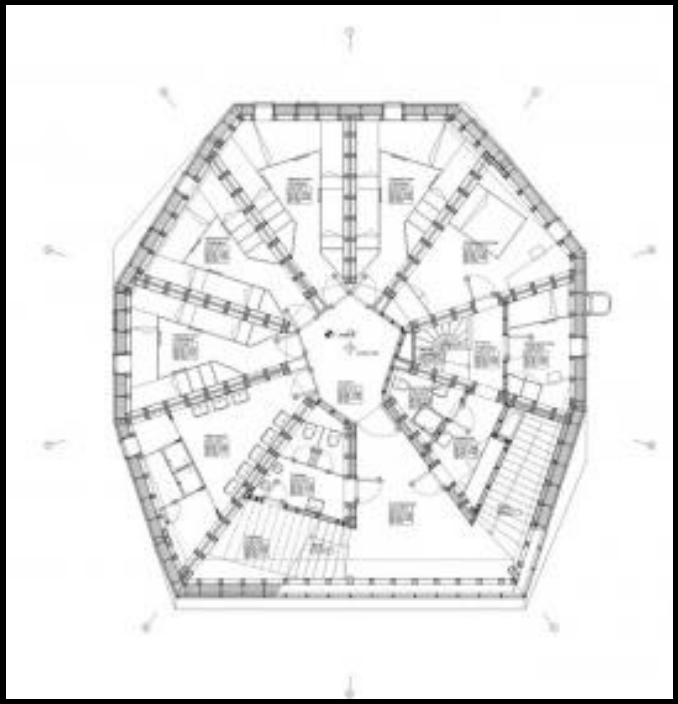
Monte Rosa Hut. 2008_ Bearth & Deplazes Architekten AG, Daniel ladner

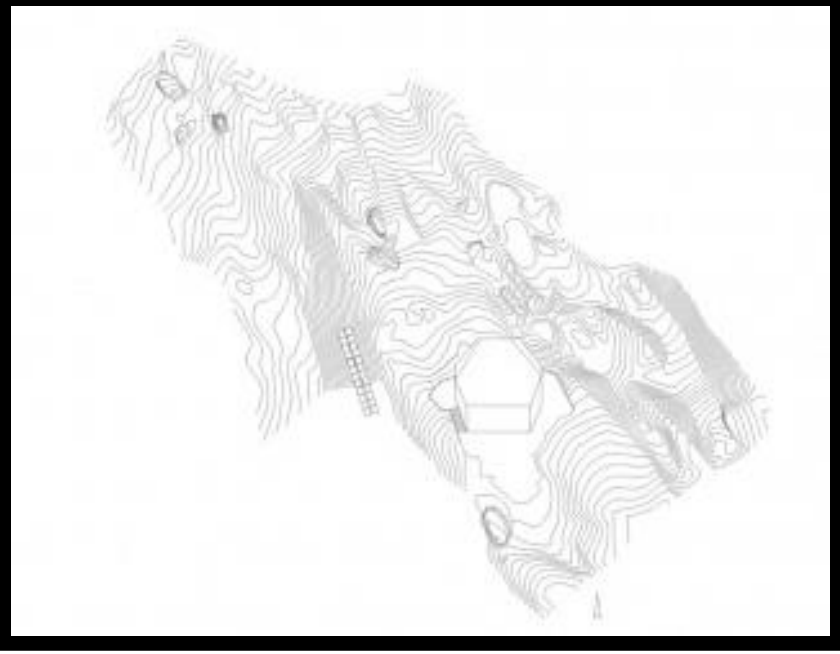
*An **autonomous building** is a building designed to be operated independently from infrastructural support services such as the electric power grid, gas grid, municipal water systems, sewage treatment systems, storm drains, communication services, and in some cases, public roads.

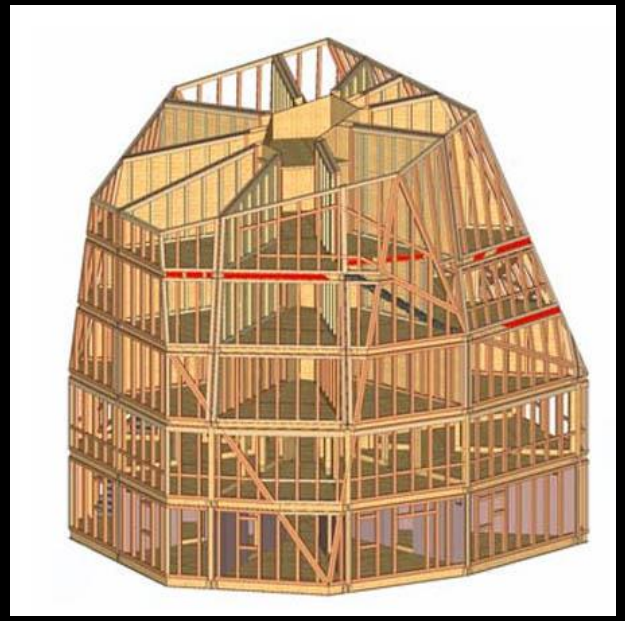
Monte Rosa Hut

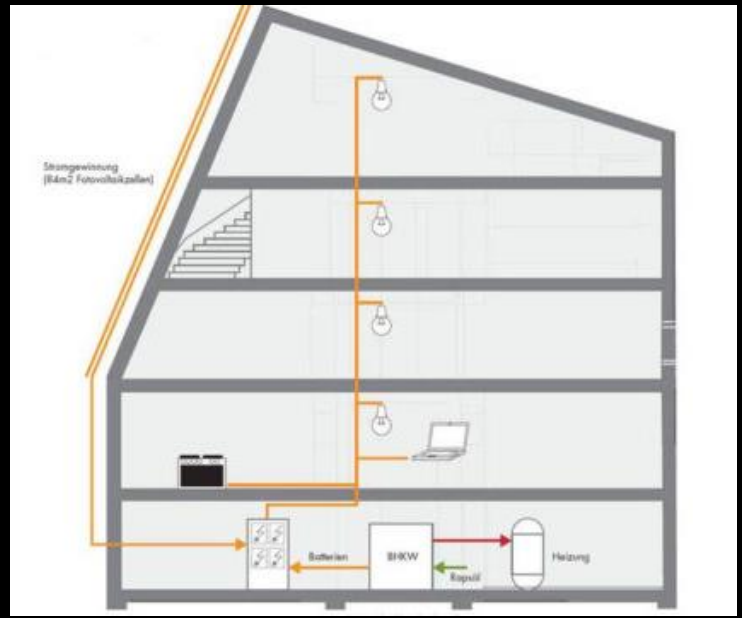












BIQ_The Algae house

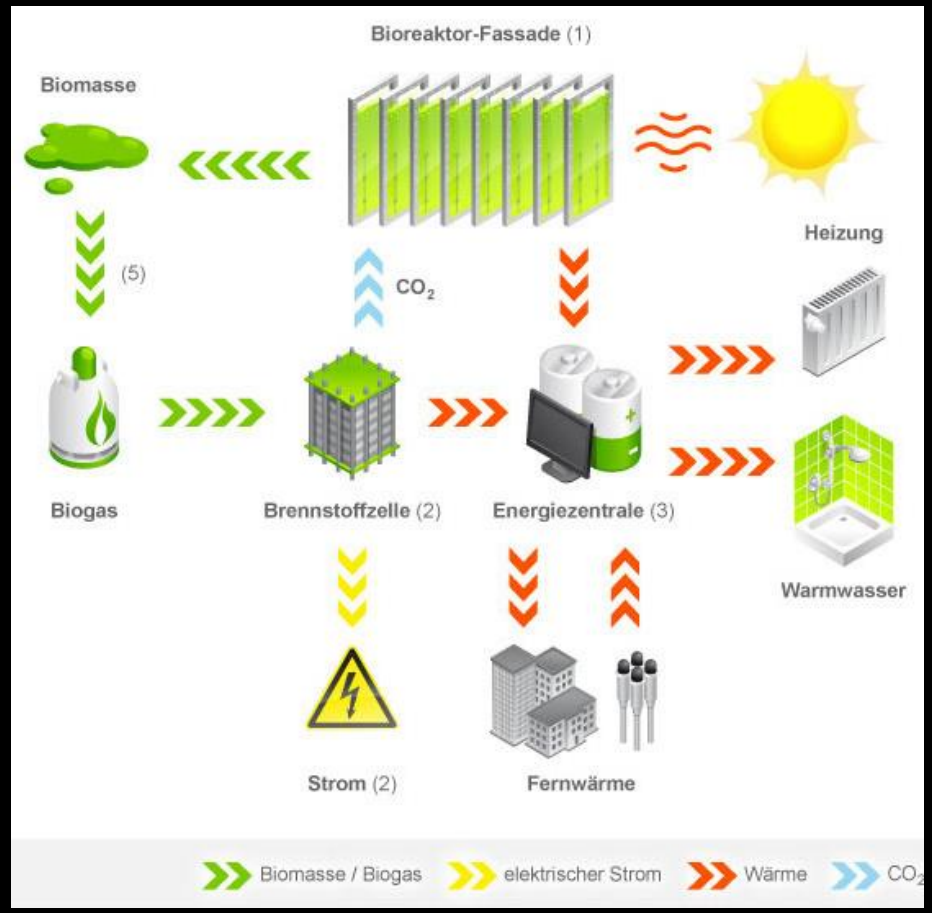
whg 10
2 zi-whg
63.8 m² wf

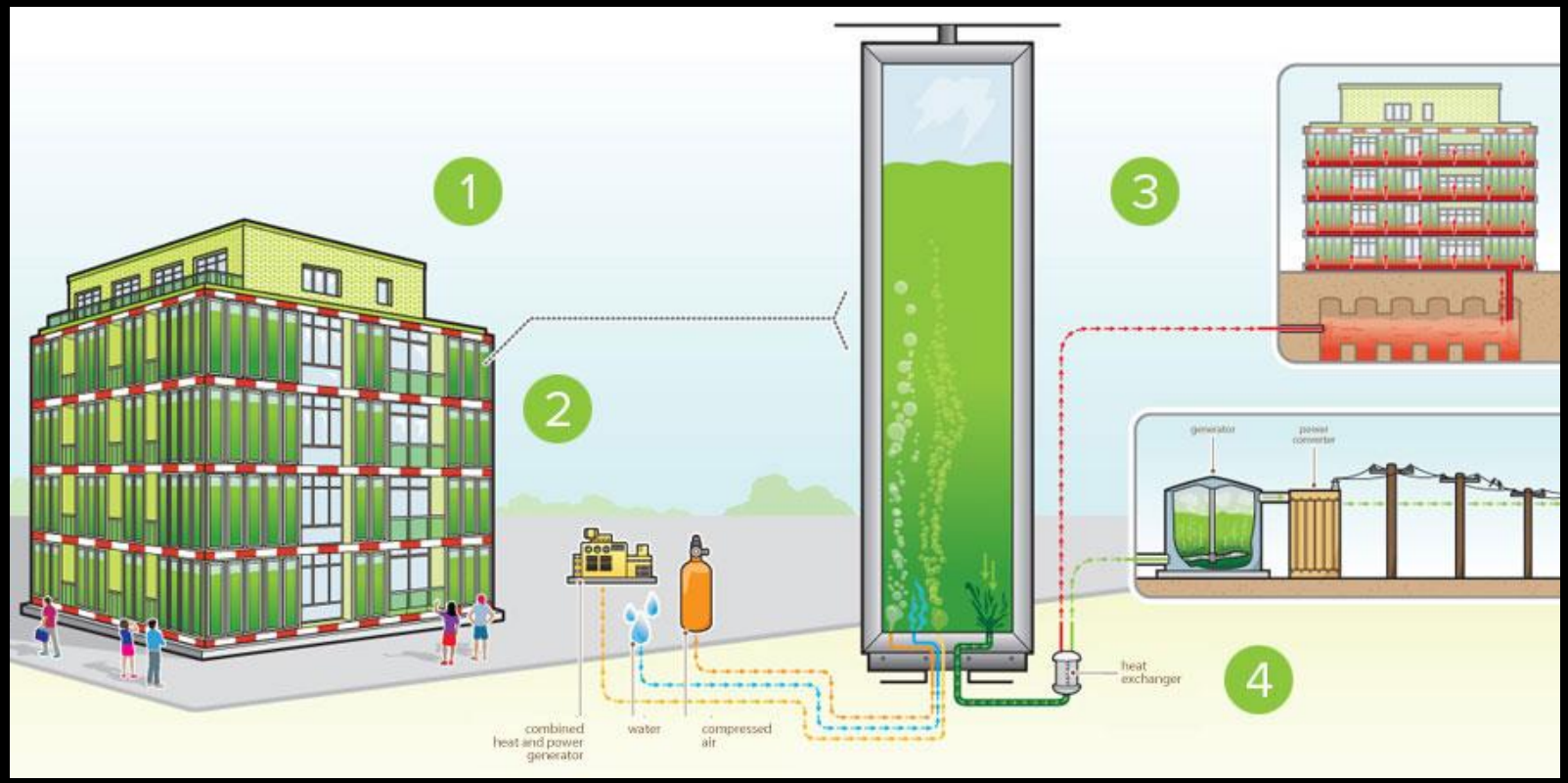
whg 7
3.5 zi-whg
maisonette
59.5 m² wf 2.og
117.6 m² wf gesamt

whg 9
3 zi-whg
88.6 m² wf

whg 8
3 zi-whg
86.8 m² wf

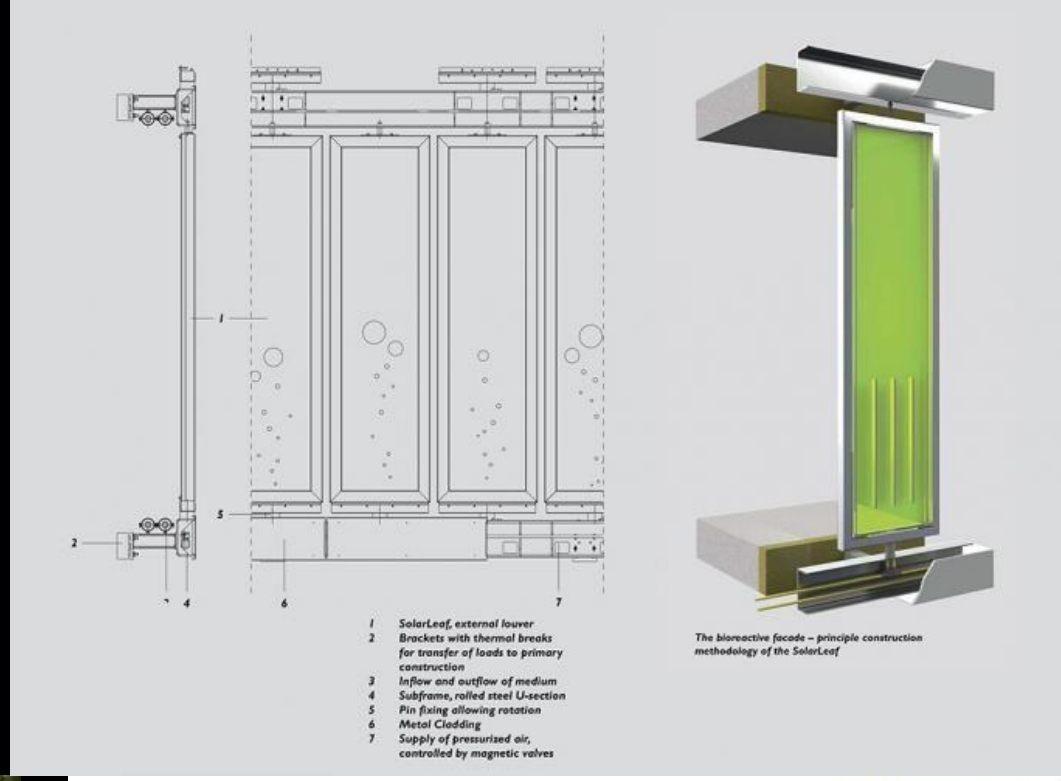
BIQ_The Algae house

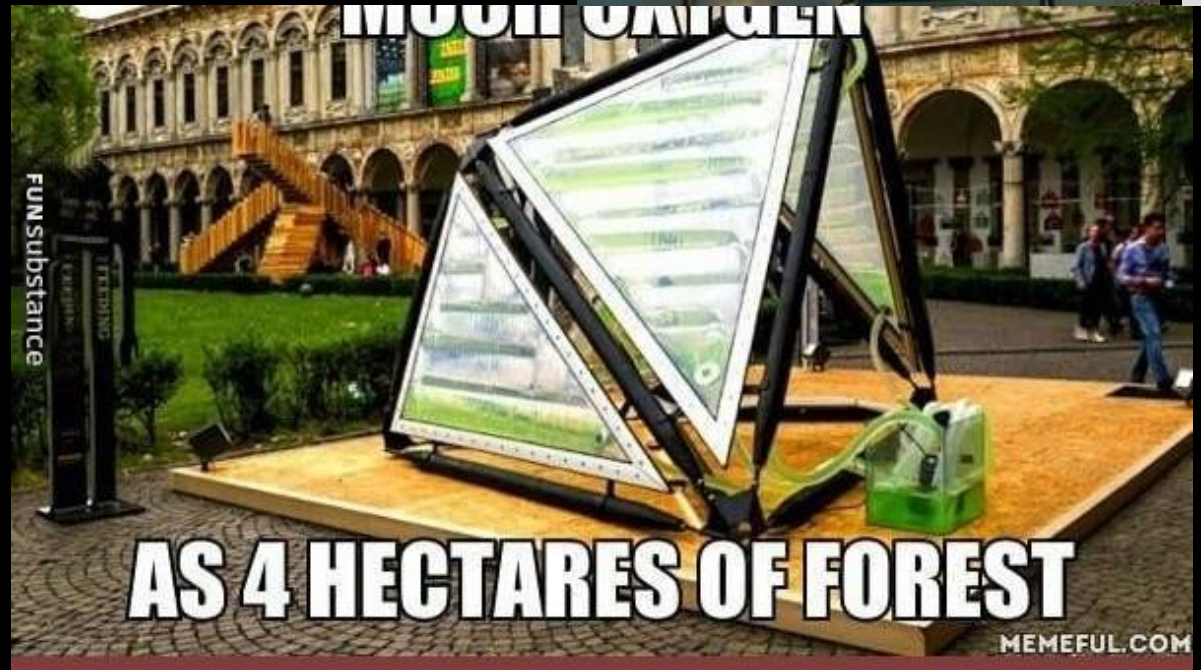




BIQ_The Algae House

FACADE DE PHOTO-BIO REACTEUR





Water Walls:
Highly Reliable, Massively Redundant Life Support Architecture

Michael Flynn, NASA-Ames, PI
Marc M. Cohen, Architect, Col

THE SOLUTION: Water Walls --

- **High Reliability, Mechanically Passive Life Support Architecture, using Forward Osmosis (FO) Electrochemical Processes**
- **Low Resupply Mass and Cost**

THE PROBLEM:

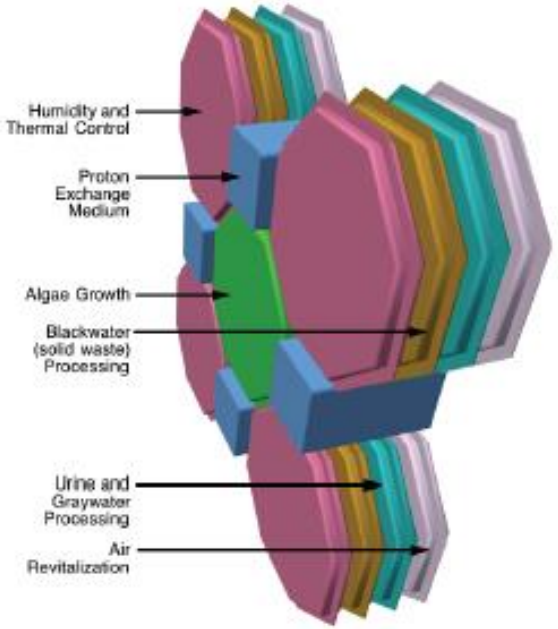
- **Low Relibility Mechanical Life Support Systems**
- **High Mass and Cost of Resupplying LS Consumables**

The lessons learned from the development of the ISS life support system are that mechanically complex system are unreliable, difficult to maintain, expensive, and require high-mass and cost. resupply of consumables.

Algae Growth Experiment FO Bag

Water Walls incorporates life support, thermal, and radiation protection functions into the walls of the spacecraft. WW saves mass by combining radiation protection, thermal control, and life support functions within the mass allocation of a sole-purpose radiation shield.

Water Walls Integrated Module

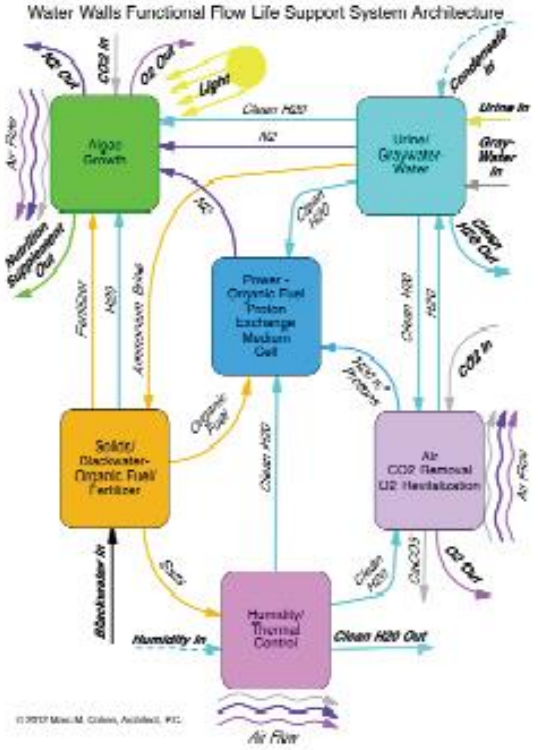


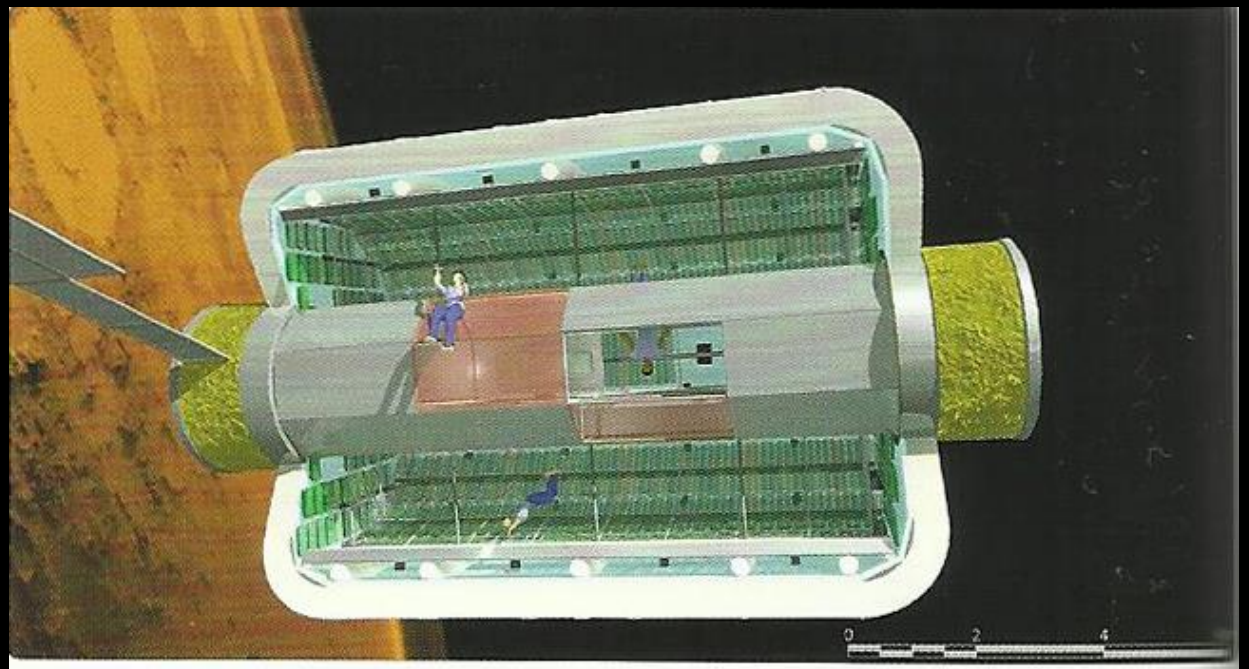
- The WW module combines the key functions of air, water, and waste processing, water recovery, and thermal control in an ensemble that provides ~40cm of radiation shielding.
- The effluent from one FO bag is the feedstock to another FO bag or PEM cell.

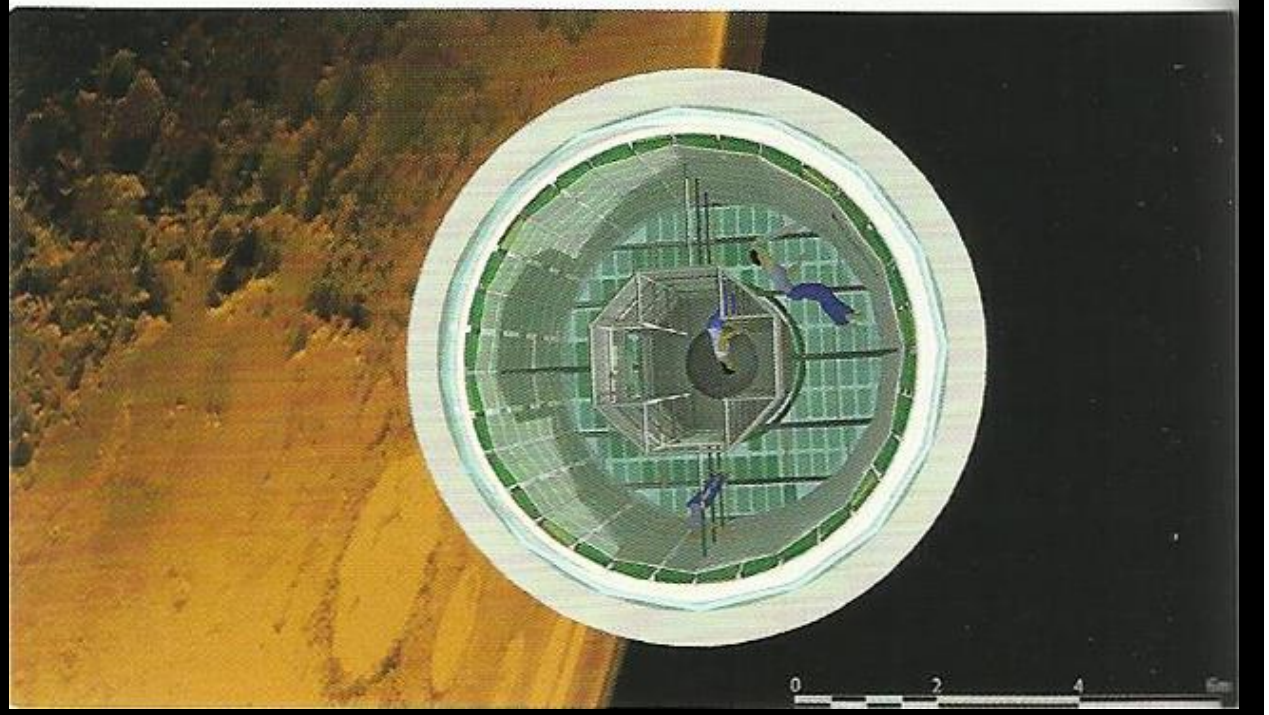
X-Drink Bag water purification with Ames-developed FO Membrane

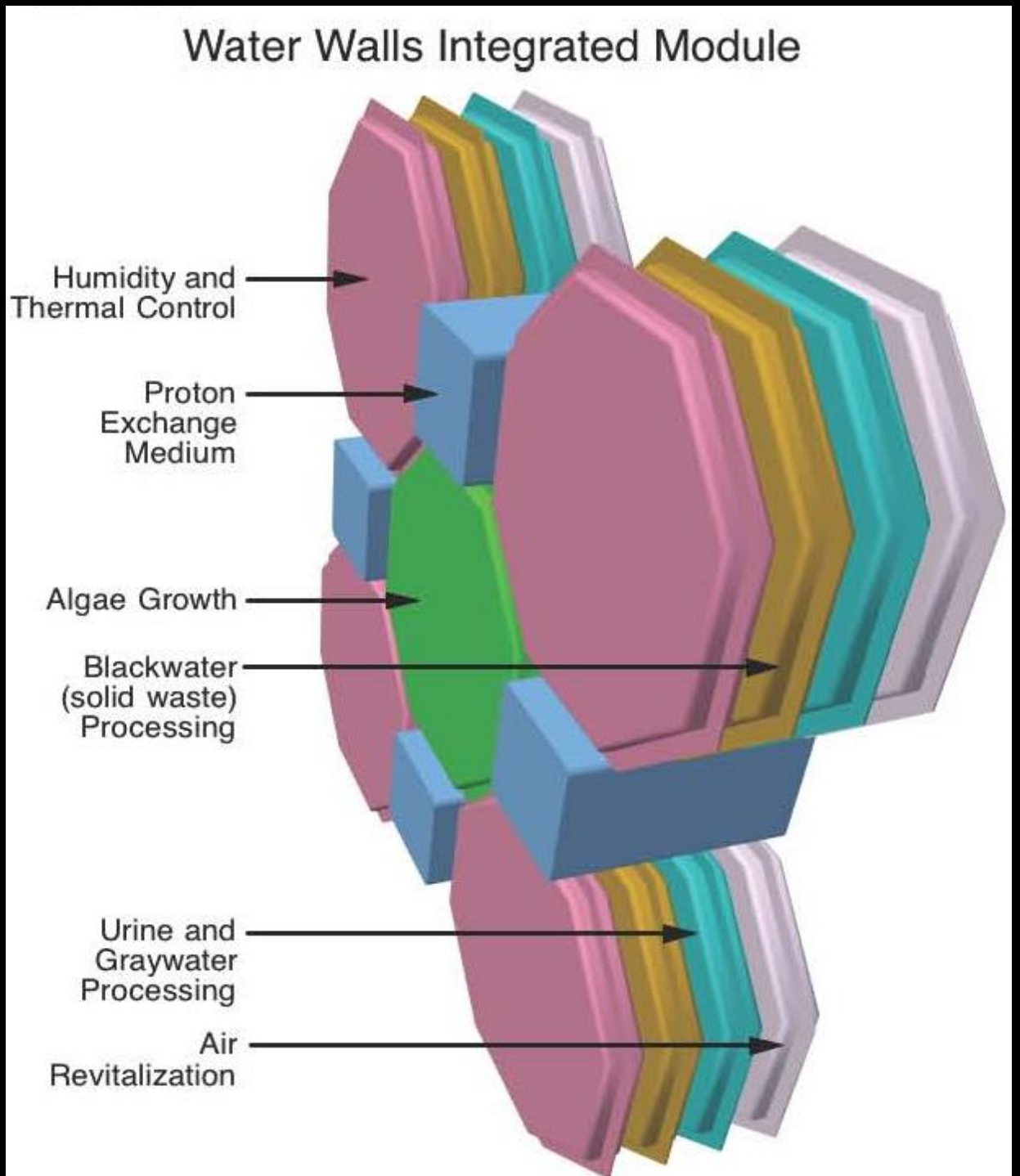
STS-135 Flight expt. Urine/H20 FO Bag

Water Walls Functional Flow Life Support System Architecture

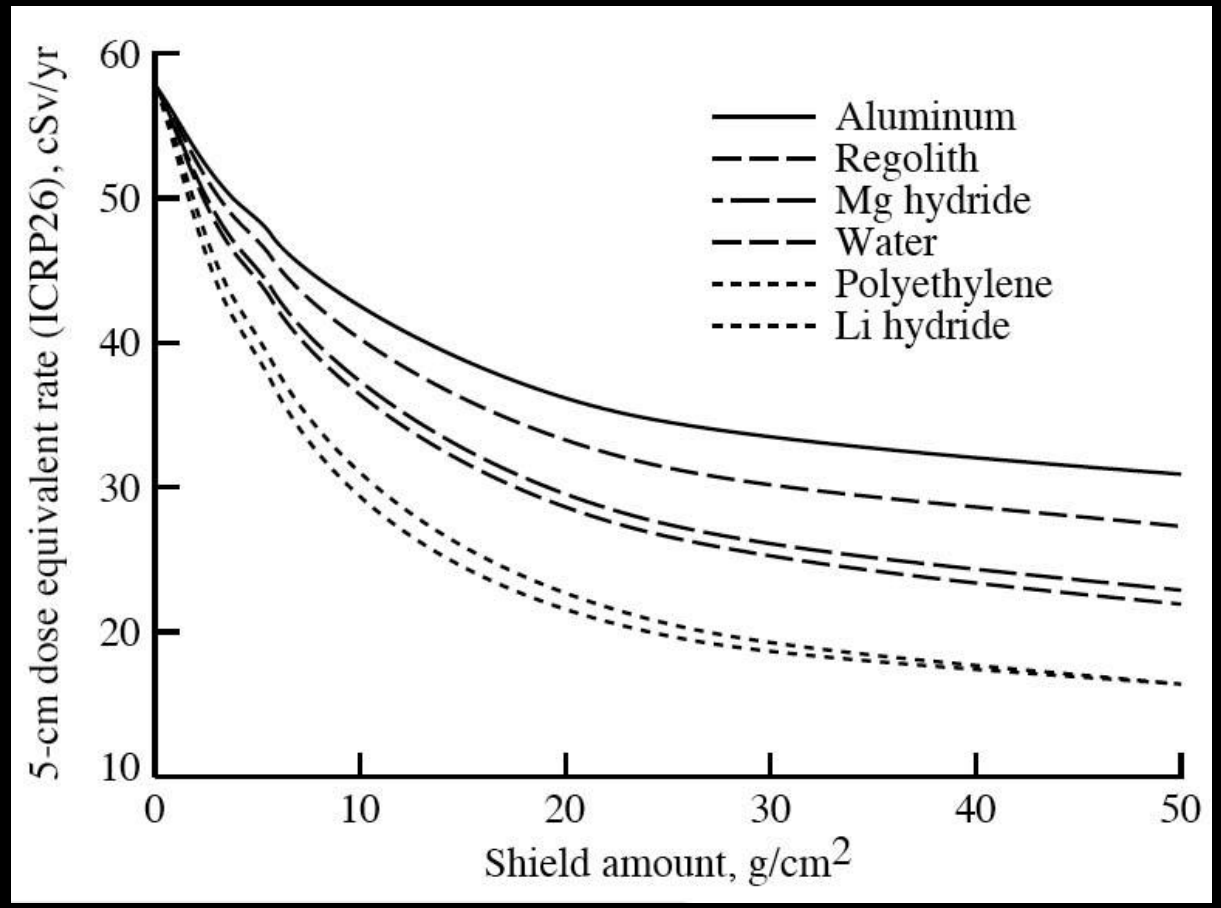


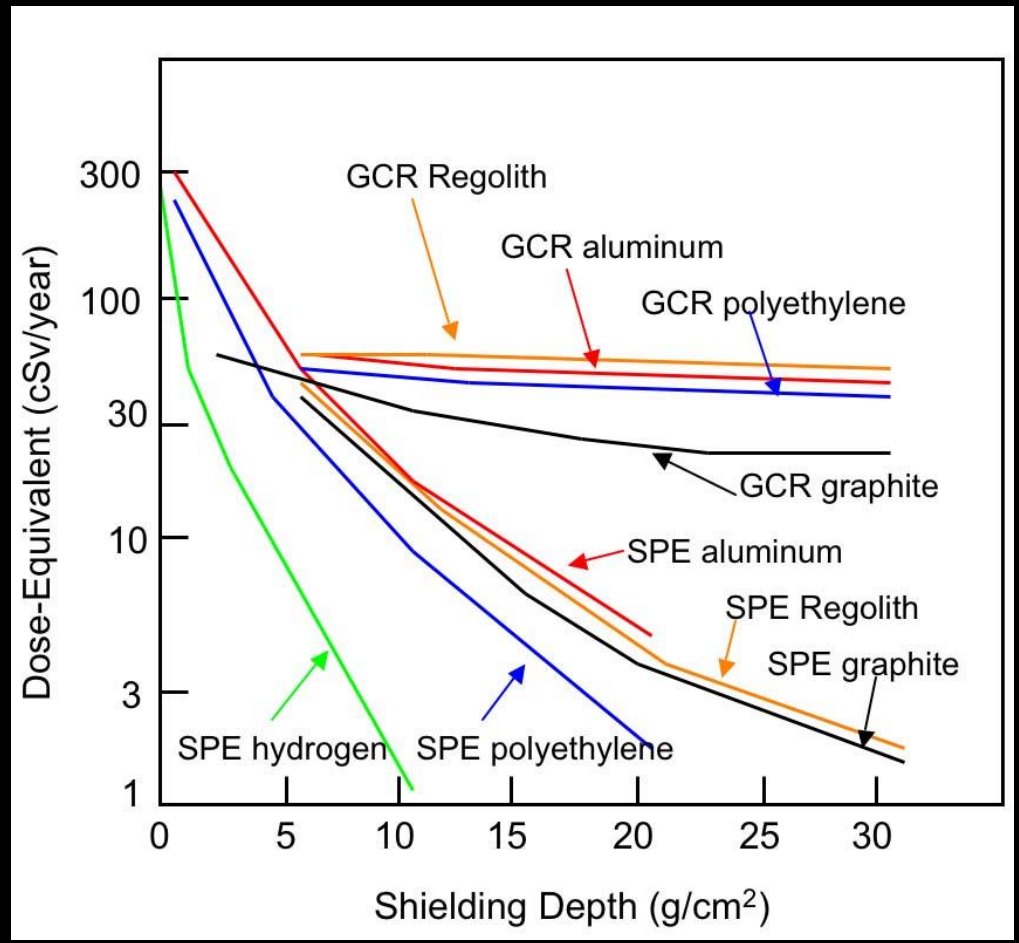





Water Walls Integrated Module
Humidity and Thermal Control
Proton Exchange Medium
Algae Growth
Blackwater (solid waste) Processing
Urine and Graywater Processing
Air Revitalization

MATERIAUX UTILISABLES POUR LA PROTECTION DE RATIATION





***Régolithe** : poussière lunaire

Human centred design

Les déchets du corps ; CO2, Urine, etc.

Recycler à ressources qui soutiens la vie

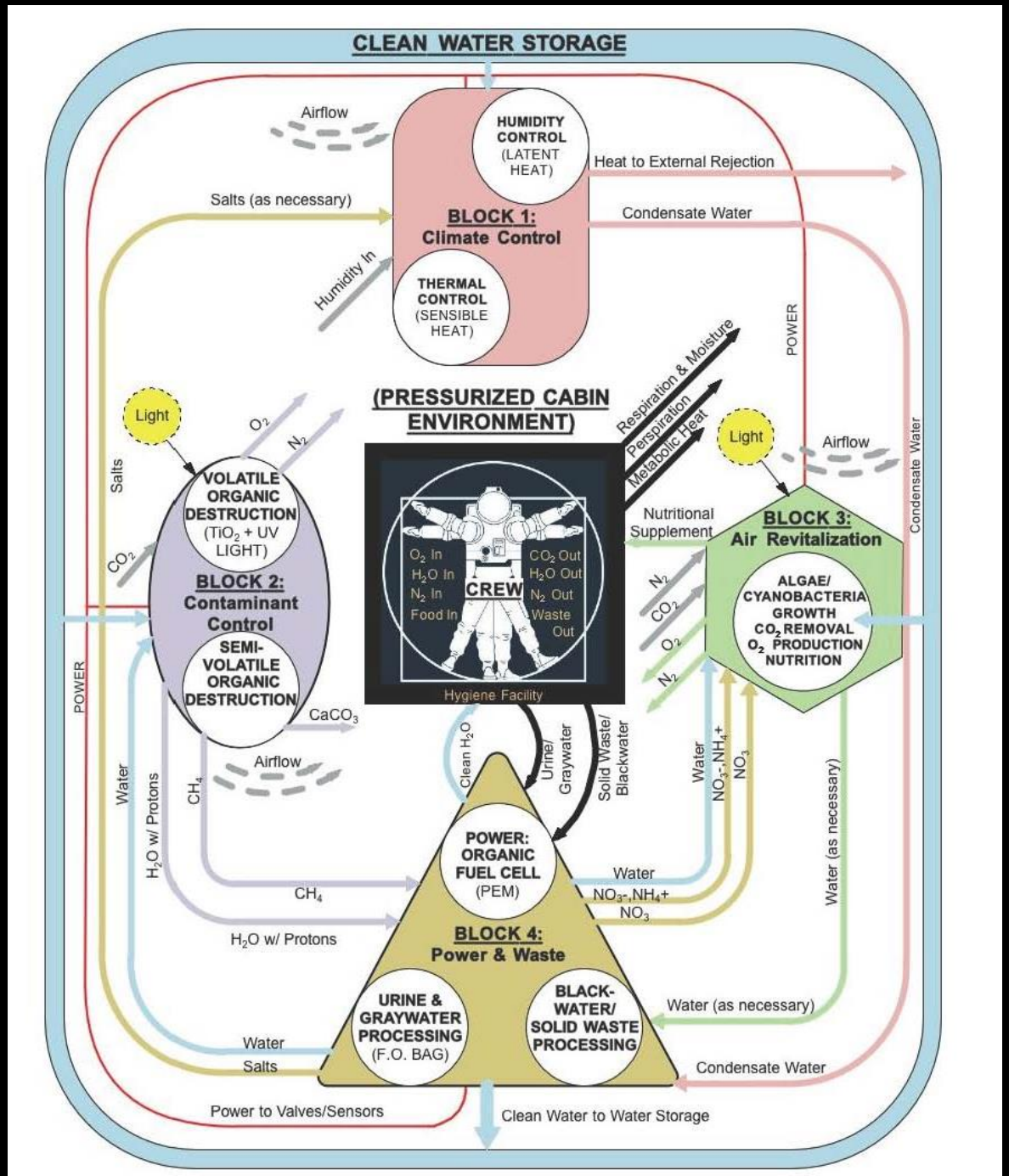


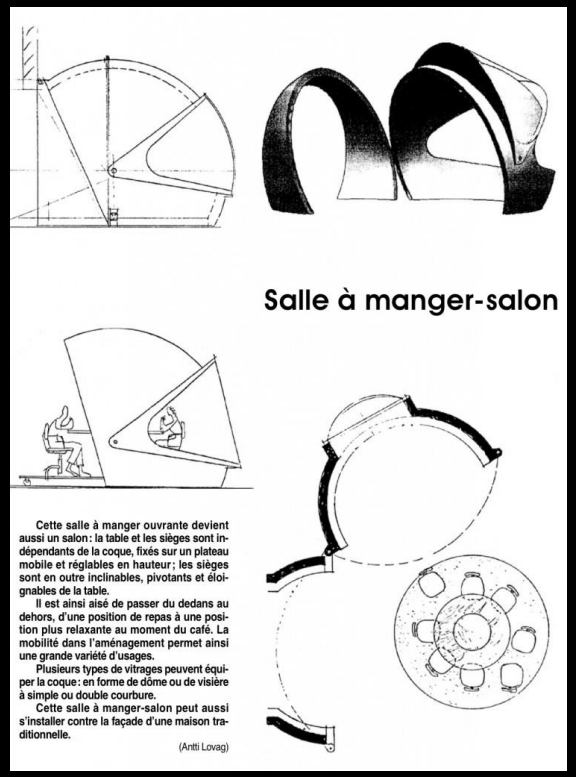
FIGURE 3. Water Walls Process Block Diagram (26 FEB 2013).

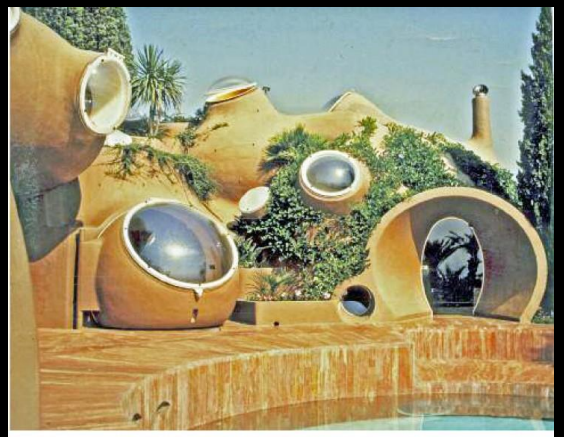
Les Maison Bulle

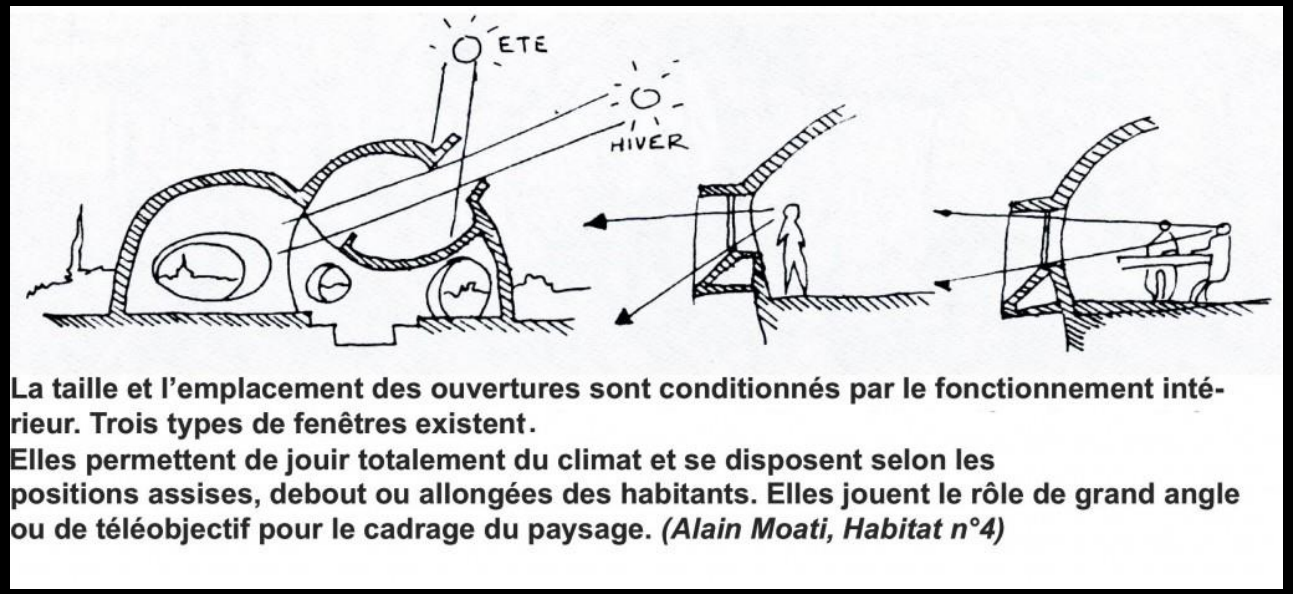

PASSAGE COUVERT
BUREAU
SAM.
CUISINE
BAR
CONV FEU
HALL
ATELIER
LOCAL TECH.
SEJOUR
TERRASSE
CELLIER
TOIL.
SDB.
SALON
PISCINE
VEST.
CH.
GARAGE
TER.
STUDIO
SDB.
SEJOUR
CH.
TERRASSE
MAISON 2 REZ DE JARDIN
ECH : 1/100

Principes des Maison Bulle

1. Une maison qui doit être adaptée à son occupants:
2. Réfléchir à son habitat Réfléchir sur sa façon de vivant
3. Optimiser l'espace en supprimant inutile
4. Respecter du site
5. Ouverture; Établir une continuité entre l'intérieur et l'extérieur
6. Function of the furniture







Etudes des systèmes constructives de Maison Bulle

- ***Sliding template*** *(Fig.30)* : *The mobile template allows the implementation of the fibered concrete from the inside of the shell in successive slices and at the same time ensures its surface regularity for a minimum number of times. The manufacture of the template must therefore be simple in order to be able to multiply it easily.*

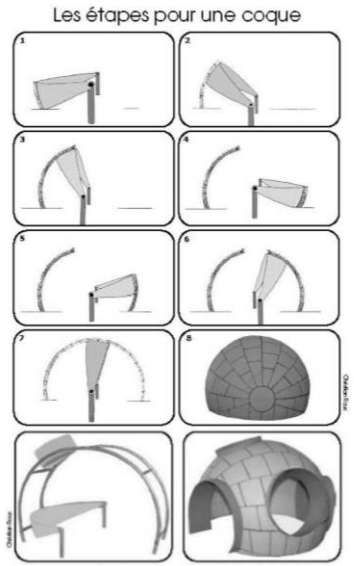


Figure 29. Schematic presentation of the operation of a sliding template. (Habitat n°25)

- ***The concrete shell*** *or* ***ferrocement***

  **Pros: Very wide variety of feasible forms, solidity of the hulls with a reinforcement and a correct concreting.*

  **Cons: Long-term goal of labour, technical reinforcement and hard regular concreting.*

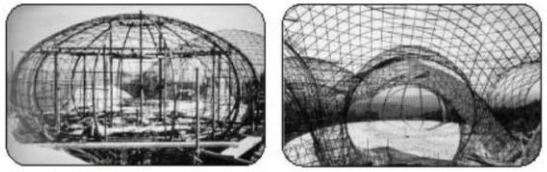


Figure 30. Two phases of reinforcement of Antti Lovag: 1. setting up of concrete reinforcing rods on jigs. 2. Disassembly of the templates for the installation of the lost formwork (grid) before partial reassembly of the templates for the projection of the micro concrete. (Habitat n°25)

- ***Fibre concrete and polystyrene on moulds in modules***

  **Pros: Easy implementation of moulds, in principle, solid and lightweight shell, thermal insulation and weather tightness effective*

  **Cons: Design and development of molds requiring a financial investment, standardized aspect despite diversity.*

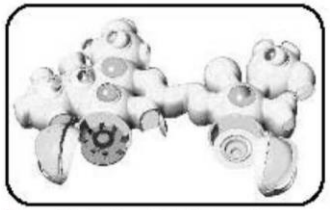


Figure 31. Hull project designed on a computer to be realized with stratified molds (Habitat n°25)

- ***Fibre concrete on rigidified textile mold***

  **Pros: Rapidity of implementation, "artistic" form*

  **Cons: Difficult mastery of shapes that only partially correspond to use, complex thermal insulation due to the shapes.*

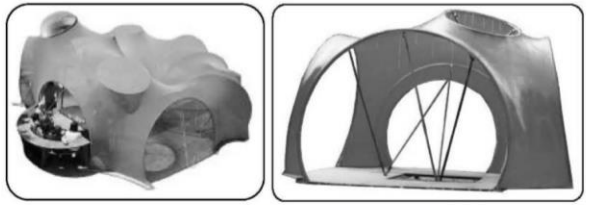


Figure 32. Stretchable stiffening textile mould test, under the supervision of Antti Lovag. (Habitat n°25)

- ***Molded plastic and insulating foam***

  **Pros & Cons: Plastic material can become a positive point but also negative*

Figure 33. Hulls molded by glass reinforced resin _home of Martine and Pierre Jovine Colleu. (Habitat n°25)

- ***Concrete shell with inflatable mould***

  **Pros: Beautiful exterior appearance*

  **Cons: Little diversity possible due to membrane constraints inconvenient of the concrete veil without the diversity.*

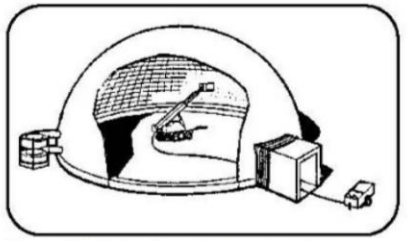
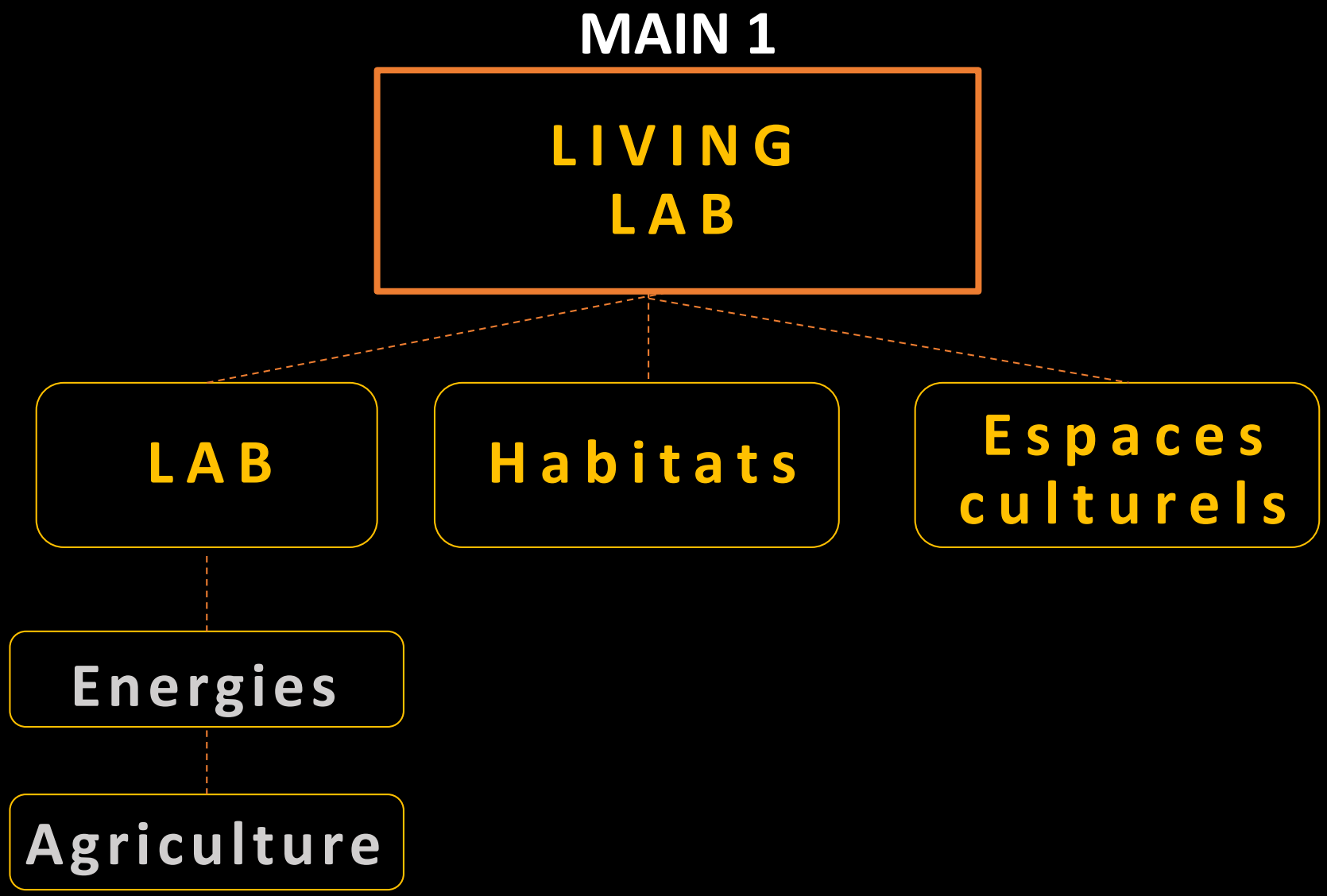


Figure 34. Grain silo under construction: concreting is carried out using a gondola. (Habitat n°25)

PROGRAMME


MAIN 1
LIVING LAB
LAB
Habitats
Espaces culturels
Energies
Agriculture

PROGRAMME

MAIN 2

BUISNESS PARC

Hotel

Art Parc

OPTIONS

ENTREPOT

INDUSTRIE MINERE

PROGRAMMES

Station de recherche antarctique Halley V, Hugh Broughton Architectes

PROGRAMME

Typologie de l'architecture lunaire

Enveloppe de protection (rayonnement, poussière, micro-débris / météorite)

+ Système d'énergie renouvelable intégrée à la façade

+ Habitabilité (Reflète de la vie lunaire, vie de haute qualité, design passif, multifonctionnel et confort pour les habitants)

+ Optimisation du contexte (fenestration, en utilisant des ressources in-situ)

+ Module extensible (/ construction facile)

+ Conception à faible coût

Architecture dans un enveloppe

Amazon sphere, 2018_ NBBJ

The Montreal Biosphère, 1967_ Buckminster Fuller

EXEMPLE DE MAQUETTE DE FACADE