# A Biomimetic Approach to Architecture and Design


## Petra Gruber

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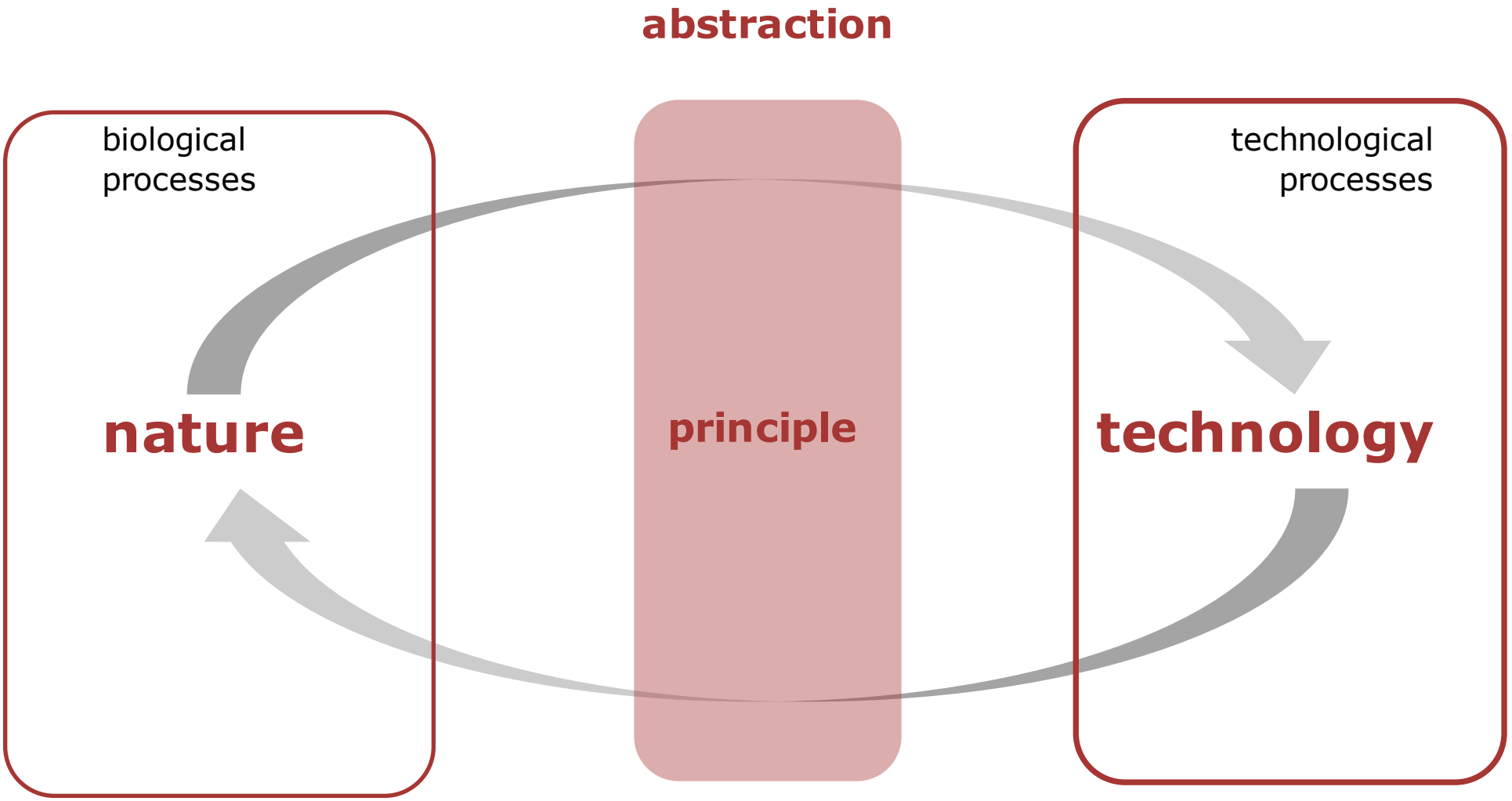
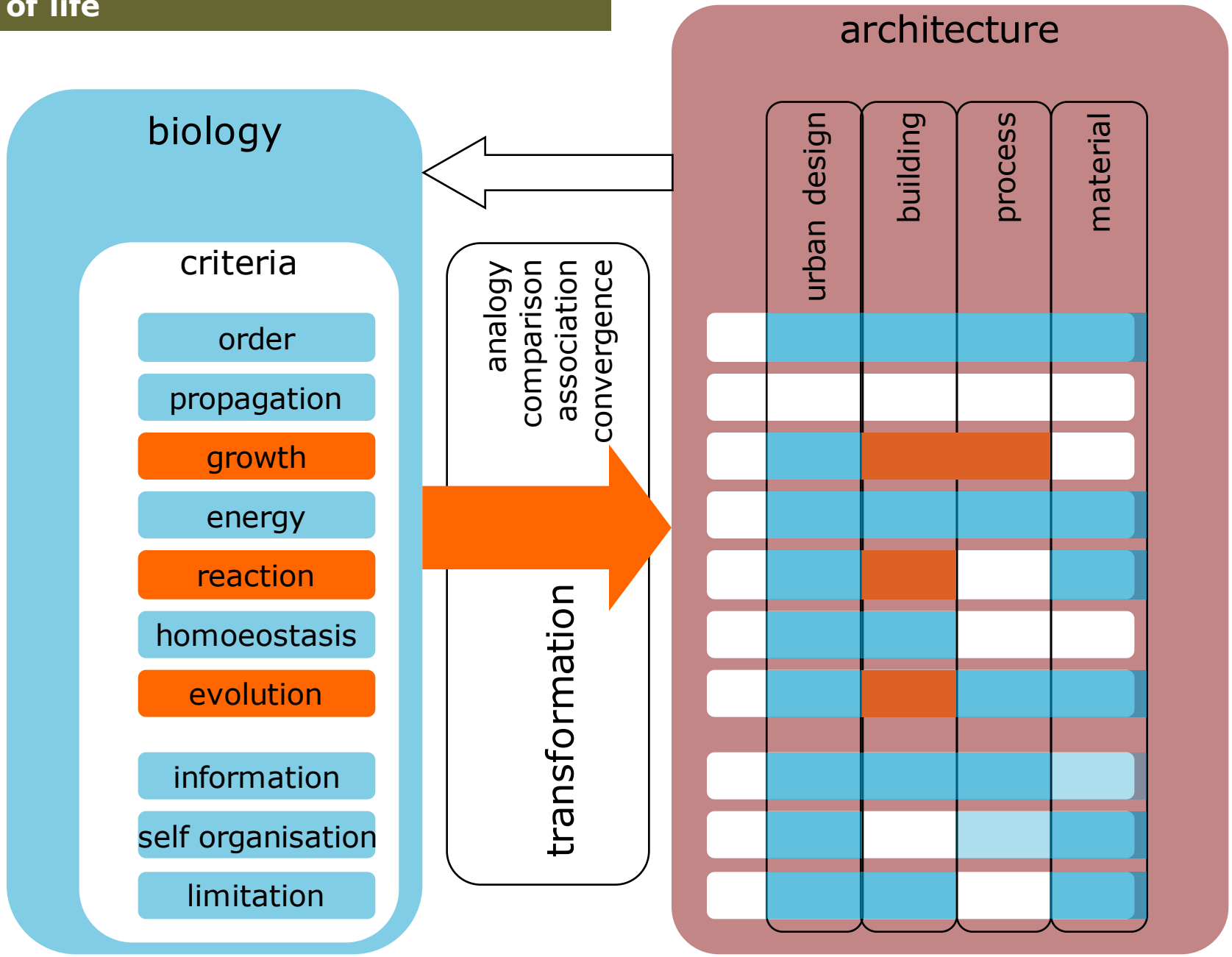
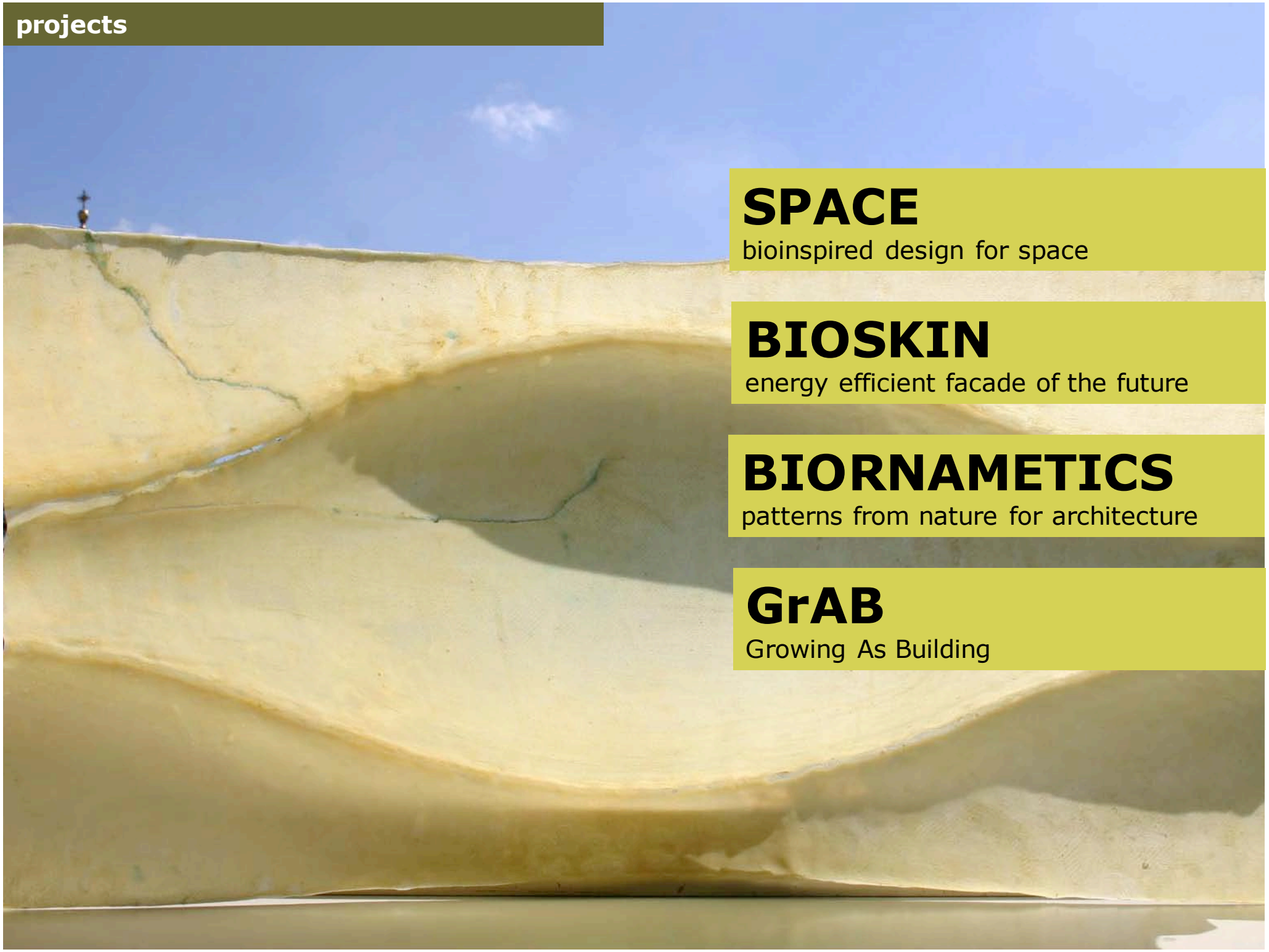
## methods




extended basic research

## signs of life





## SPACE
bioinspired design for space

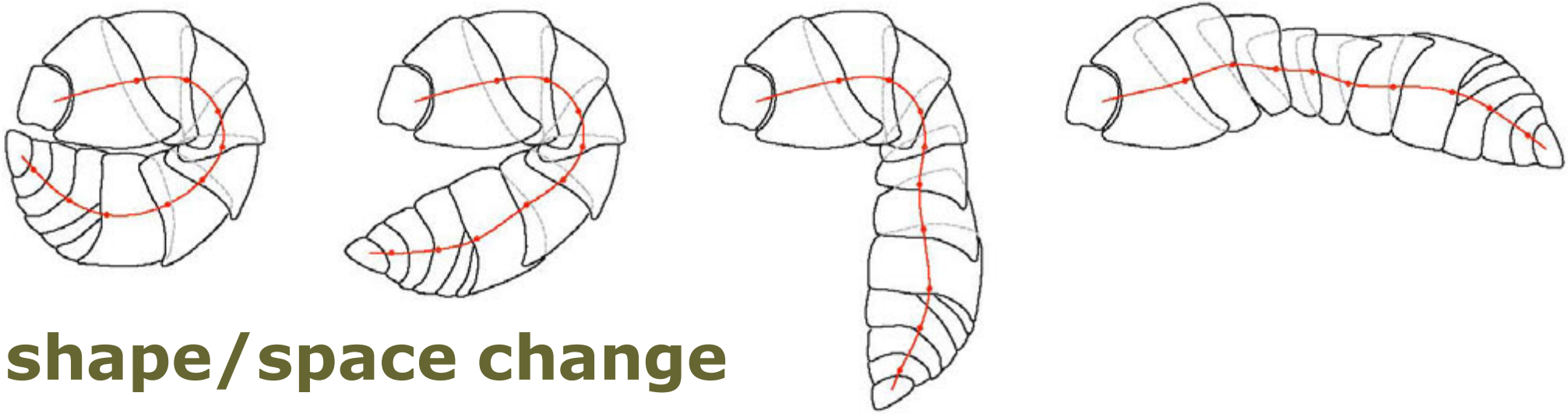
## BIOSKIN
energy efficient facade of the future

## BIORNAMETICS
patterns from nature for architecture

## GrAB
Growing As Building

# Biomimetic design proposals

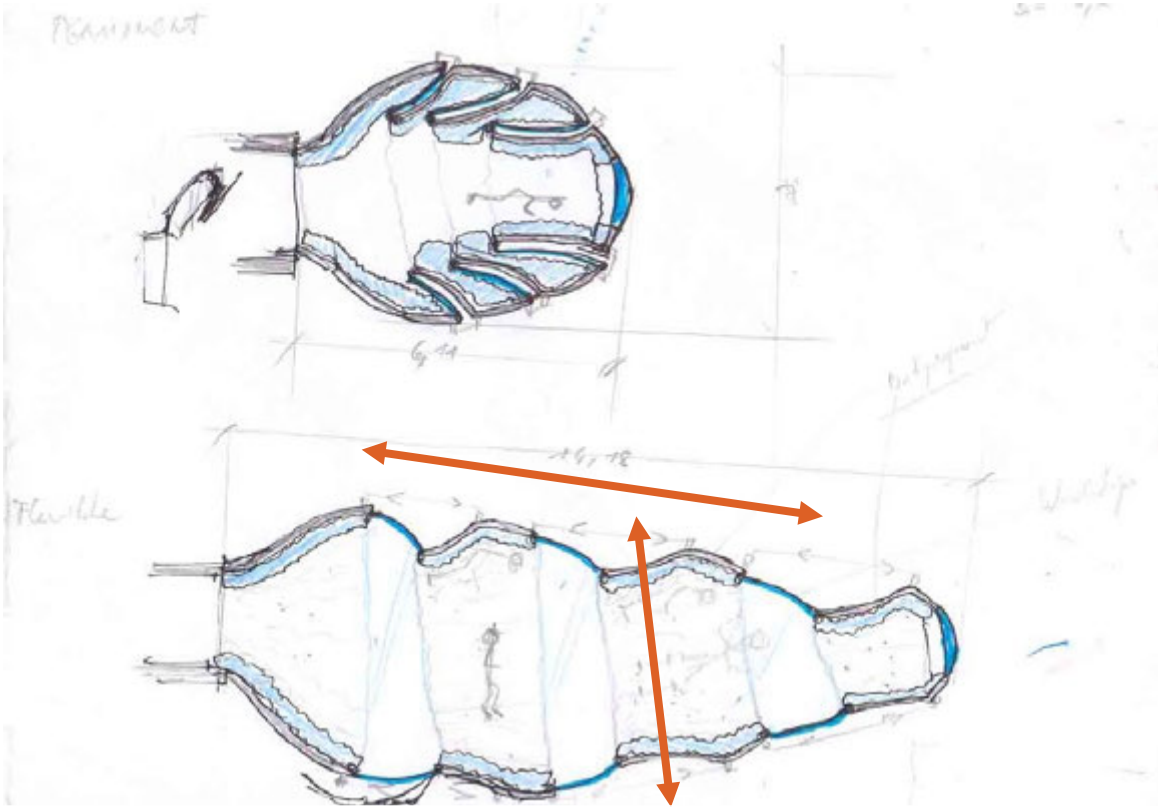
pillbug shell, katharina fuchs 2007

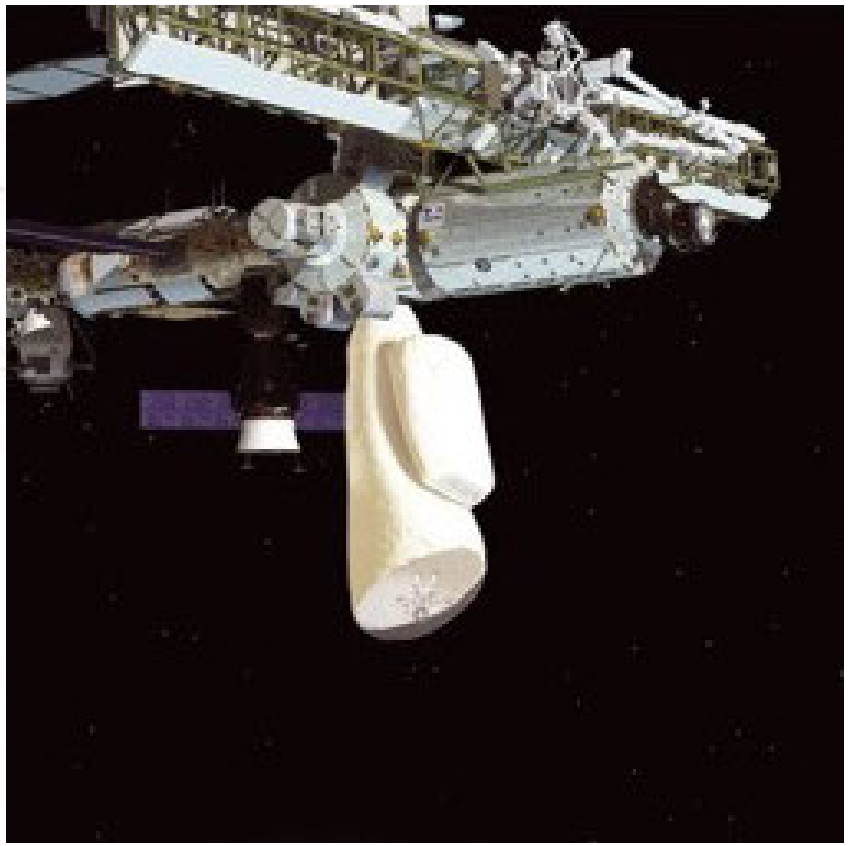


## shape/space change

# Transformation structure|space
# 2005

space loggia, stefano caneppele

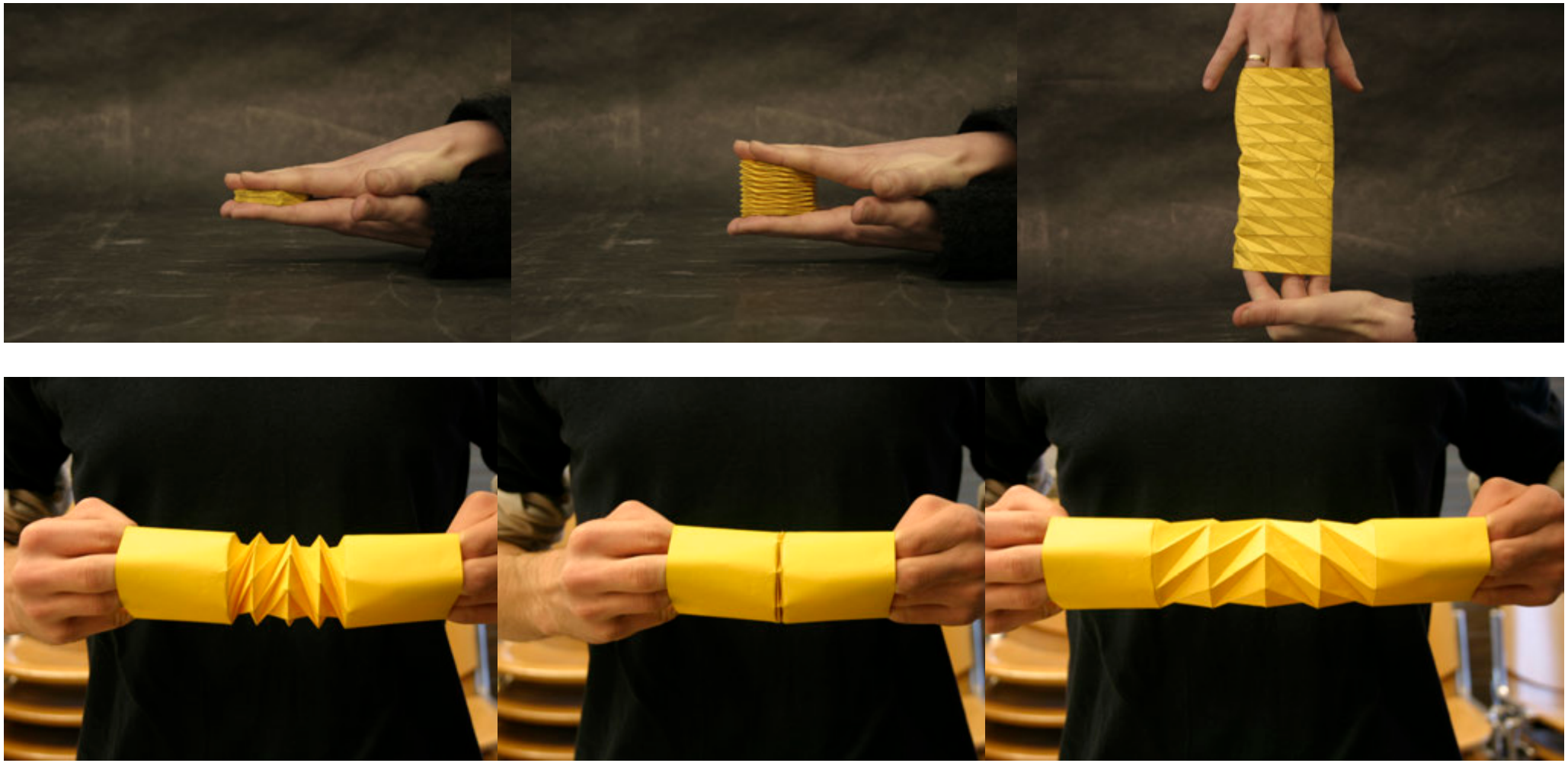




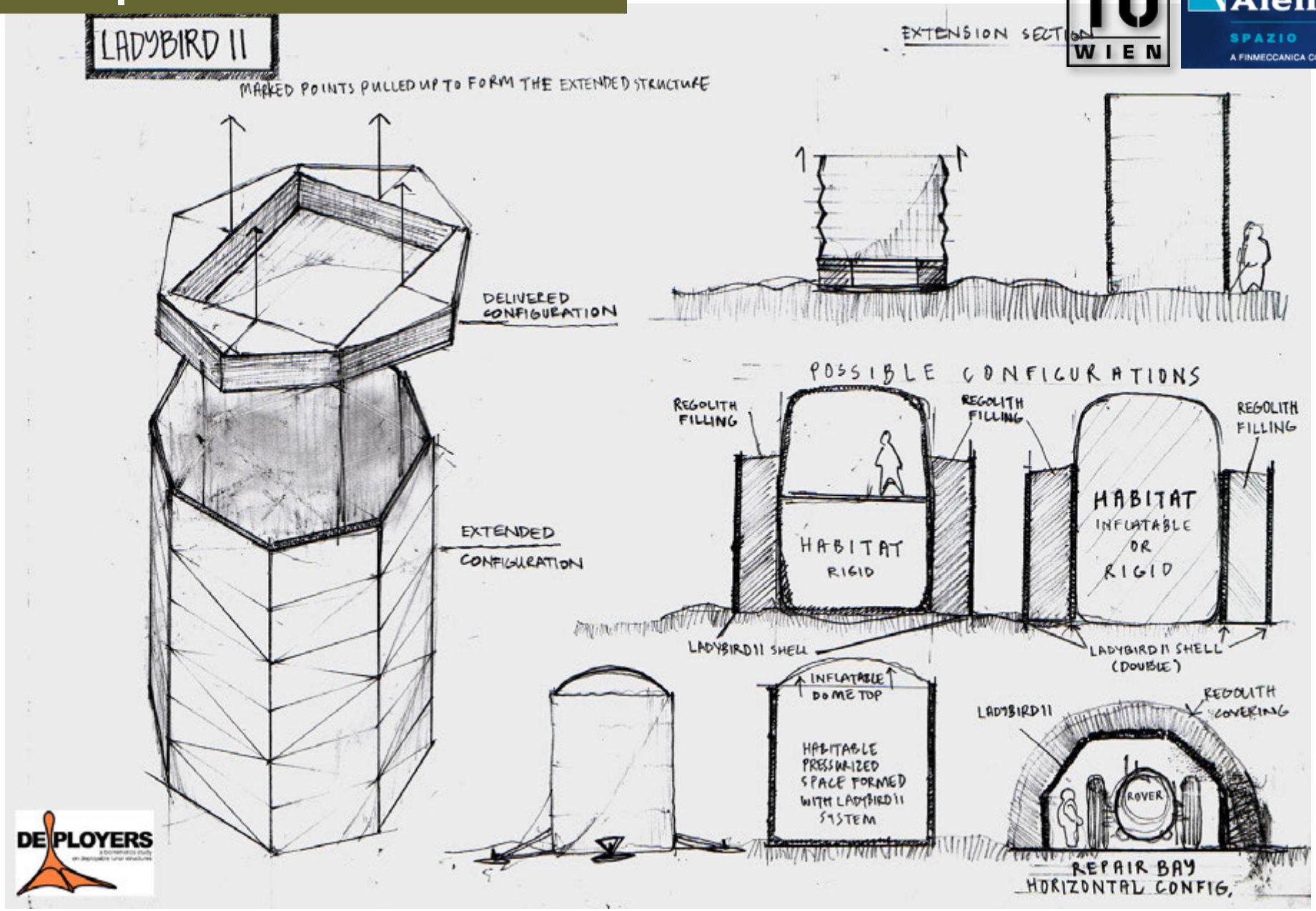
## shape/space change

# Lunar Base Design

Vienna University of Technology, Alcatel Alenia Spazio 2005



# lunar exploration architecture

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# Lunar Base Design

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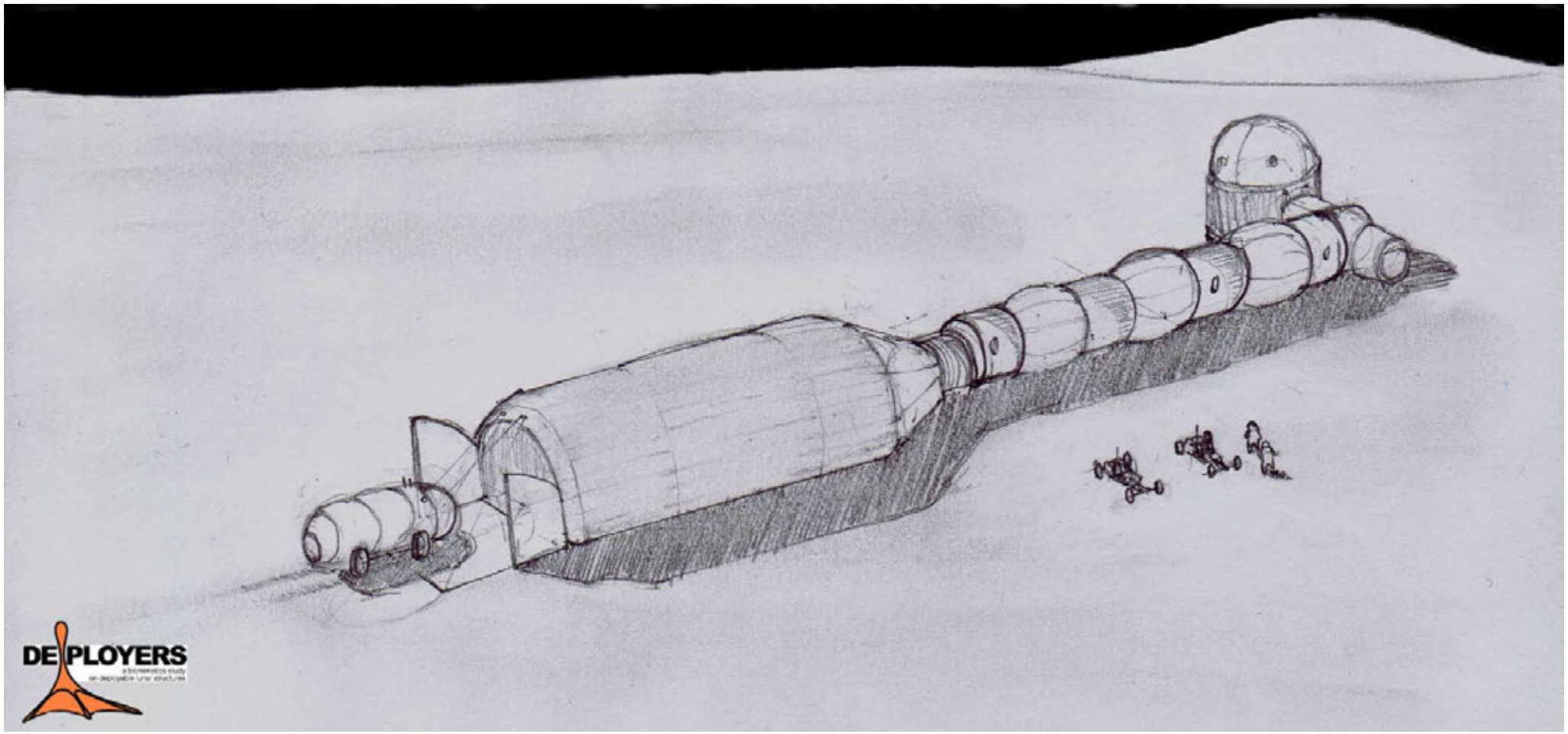


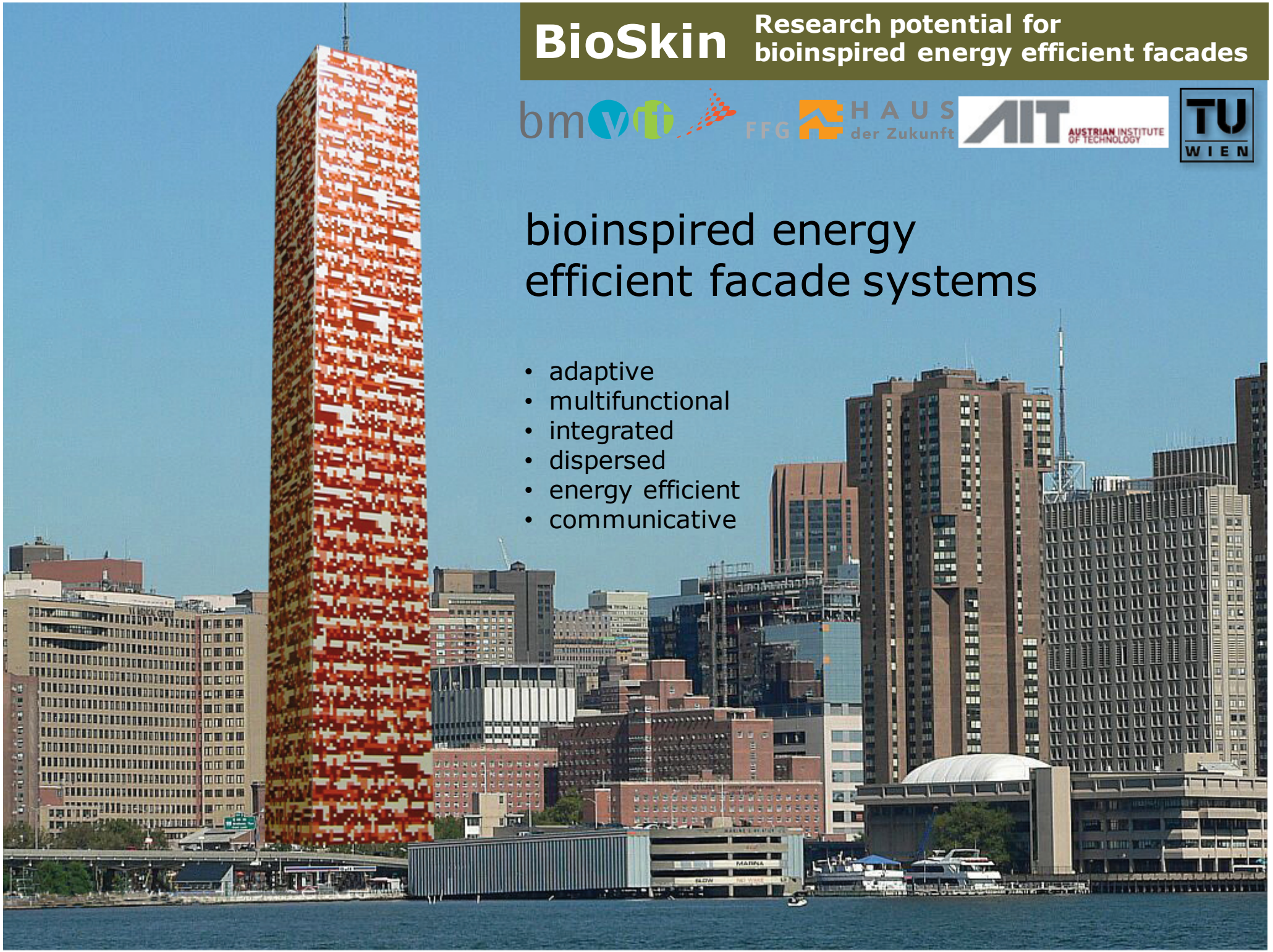
# BioSkin

**Research potential for bioinspired energy efficient facades**

bmvit FFG HAUS der Zukunft AIT AUSTRIAN INSTITUTE OF TECHNOLOGY TU WIEN

## bioinspired energy efficient facade systems

- adaptive
- multifunctional
- integrated
- dispersed
- energy efficient
- communicative



# BioSkin

**Research potential for bioinspired energy efficient facades**

bmvit FFG HAUS der Zukunft AIT AUSTRIAN INSTITUTE OF TECHNOLOGY TU WIEN

| facade issues | 40 detailed questions biologised | database of 240 models |
|---|---|---|
| **light** → | change/filter/control wavelength | Fibers guide light: venus flower basket |
| heat protection | transmit light with minimal loss of intensity | Facets in insects |
| air exchange | **direct/guide light** → | Leaves focus light: begonias |
| cooling | bundle light | Lenses in eyes |
| energy | intensify light - luminosity | Crustacean optical systems |
| transport | use light effectively | Brittlestar calcite microlenses |
| sustainability | transmit light over (long) distances | Butterfly scales - structural colours |
| | generate light | Feathers - reflectivity and structure |
| | transmit light selectively | |
| | disperse/scatter light | |
| | generate constant luminance/light density | |
| | change/control transmission factor | |
| | change/control reflectance/reflectivity | |
| | generate sunshade | |
| | avoid light | |
| | react/adapt to changing light conditions | |

# BioSkin

**Research potential for bioinspired energy efficient facades**

**database of 240 models from nature**

Fibers guide light: venus flower basket
Facets in insects
Leaves focus light: begonias

Lenses in eyes
Crustacean optical systems

Brittlestar calcite microlenses
Butterfly scales - structural colours
Feathers - reflectivity and structure

priorisation according to:

- facade technology
- technological transferability
- scaleability of phenomenon
- availability of basic research

**abstraction of principles and 30 selected models**

→ light transfer by fibres and crystals
**venus flower basket**

→ light transfer by lensen and facets
**facets in insects**

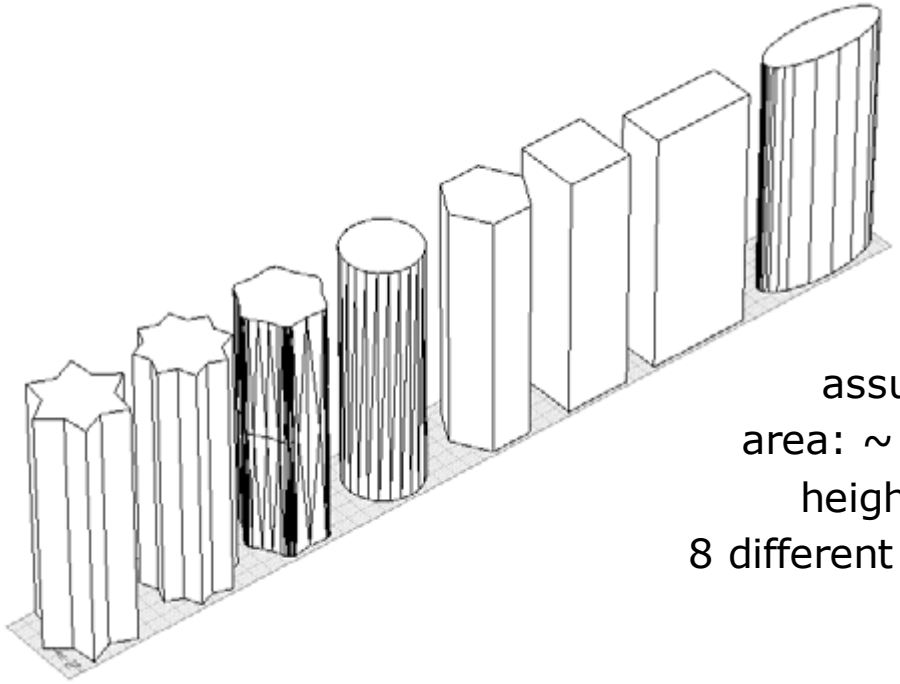
→ photonic structure
**brittlestar calcite microlenses**

development of technical concepts

**BioSkin** Research potential for bioinspired energy efficient facades

# self shading by shape

cacti



assumption
area: ~ 450m²
height: 80m
8 different shapes

[D. Bach, FH Villach, Masters Biomimetics in Energy Systems)

analysis:
influence of shape on energy management
self shading – passive cooling effect

science to architecture : design by research

# BIORNAMETICS

Barbara Imhof
Petra Gruber

Waltraut Hoheneder
Ille Gebeshuber
George Jeronimidis
Clemens Grünberger

Greg Lynn
Kristy Balliet
Justin Diles
Klaus Bollinger
Georg Gläser

Moritz Dörstelmann
Bika Sibila Rebek
Joseph Hofmarcher
Lisa Sommerhuber

Hisham Abdel-Aal
Natasha Chayaamor



FWF Der Wissenschaftsfonds

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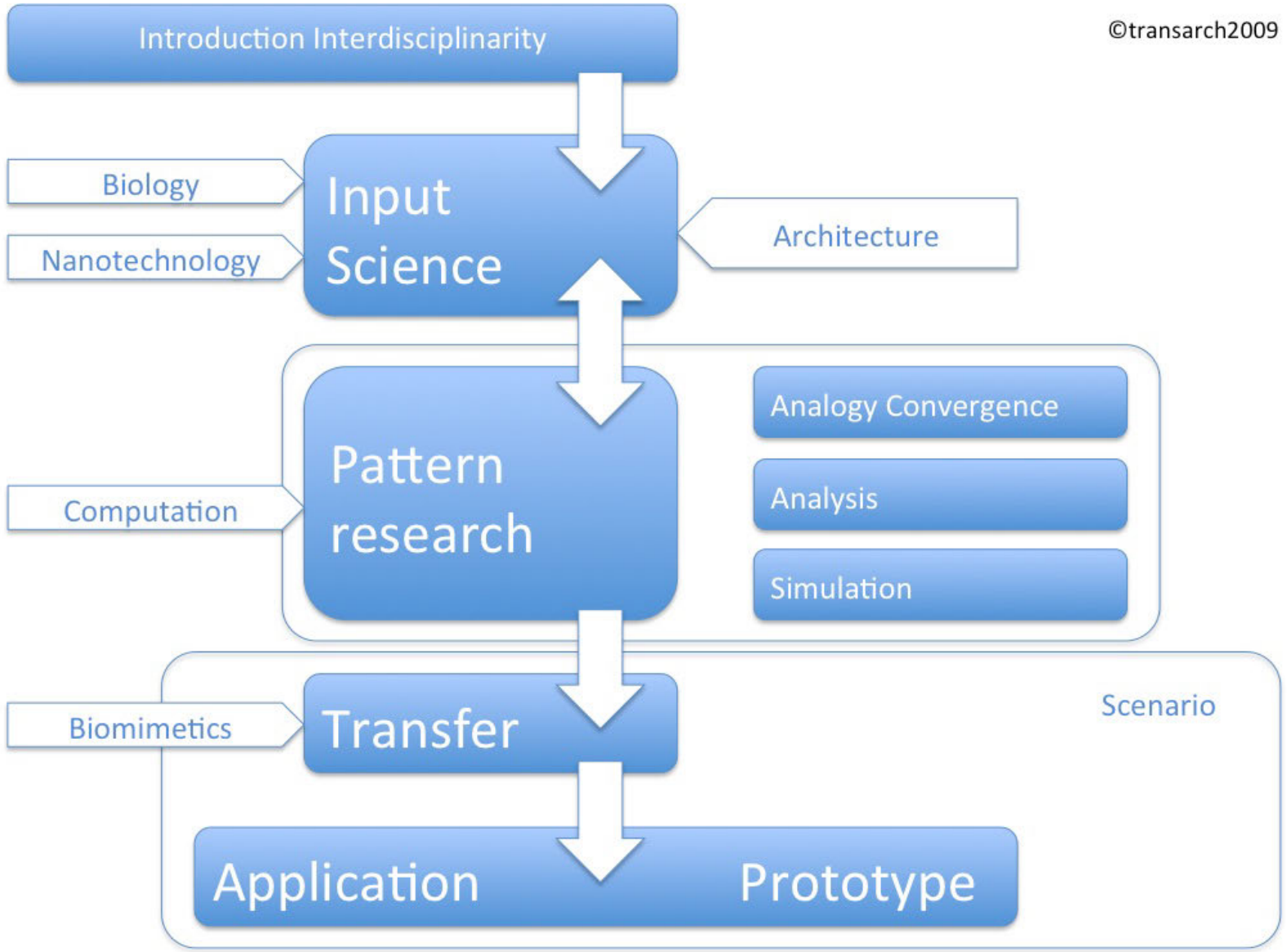
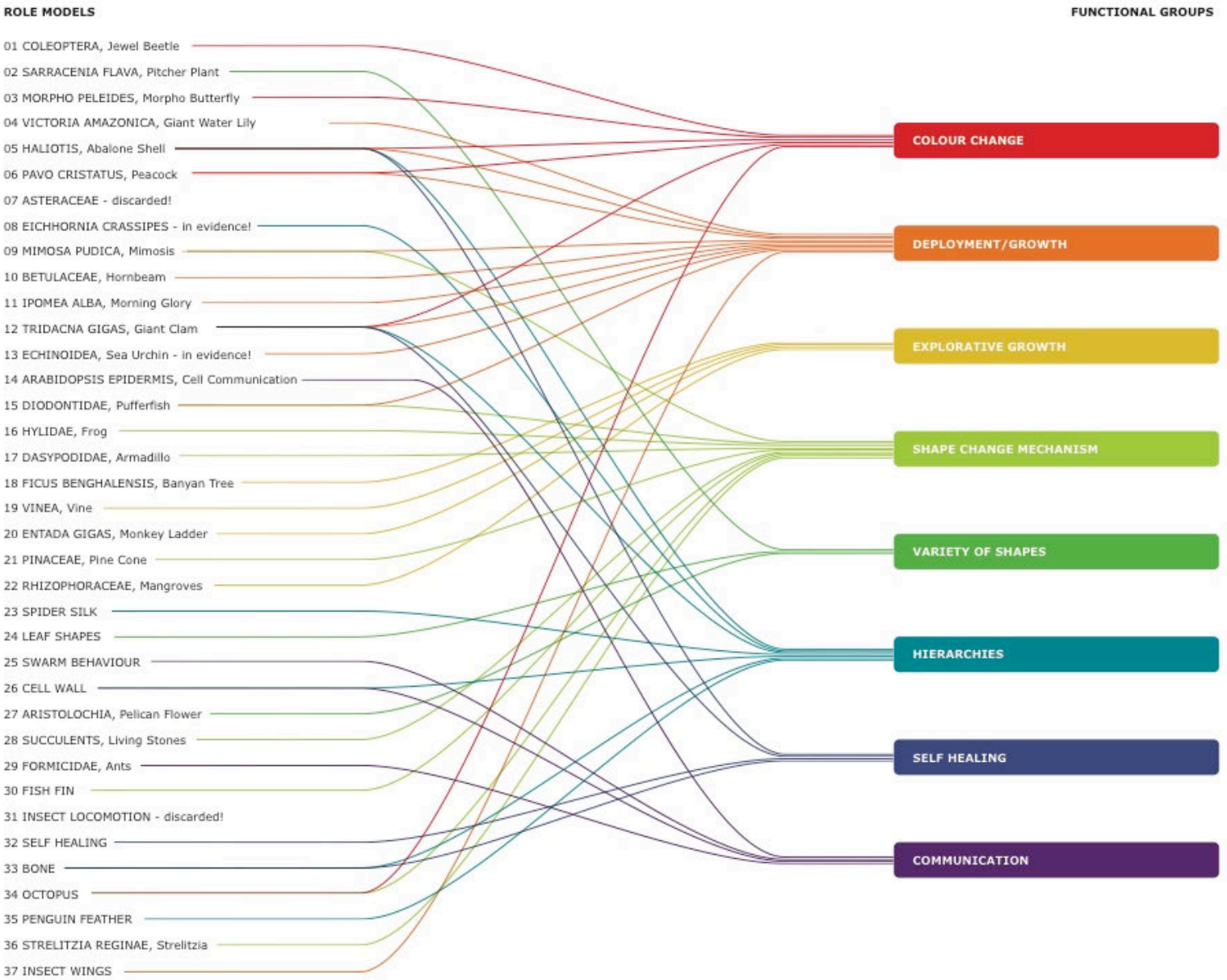
Universität für angewandte Kunst Wien
University of Applied Arts Vienna

# Science to architecture : design by research



# Science to architecture : design by research

Database
Functional
groups



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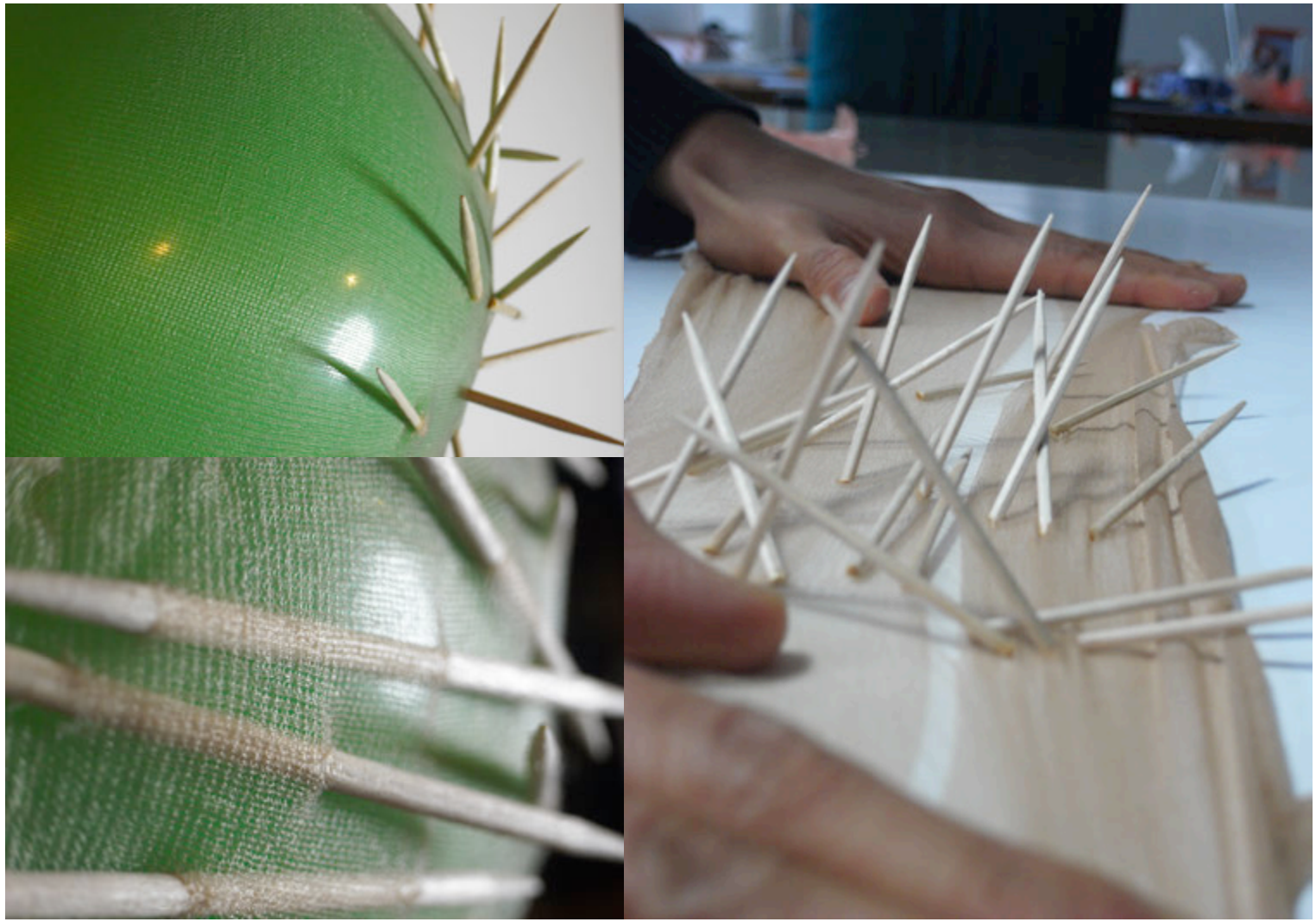
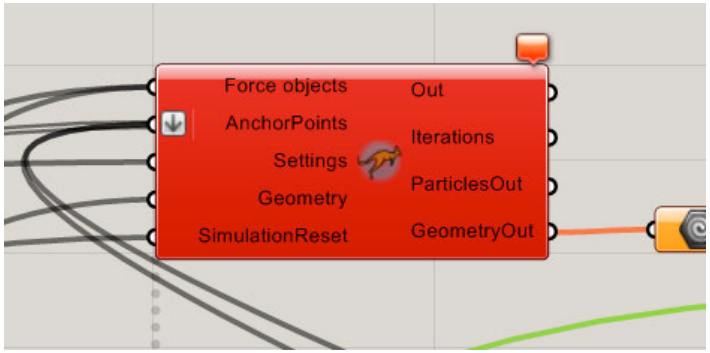
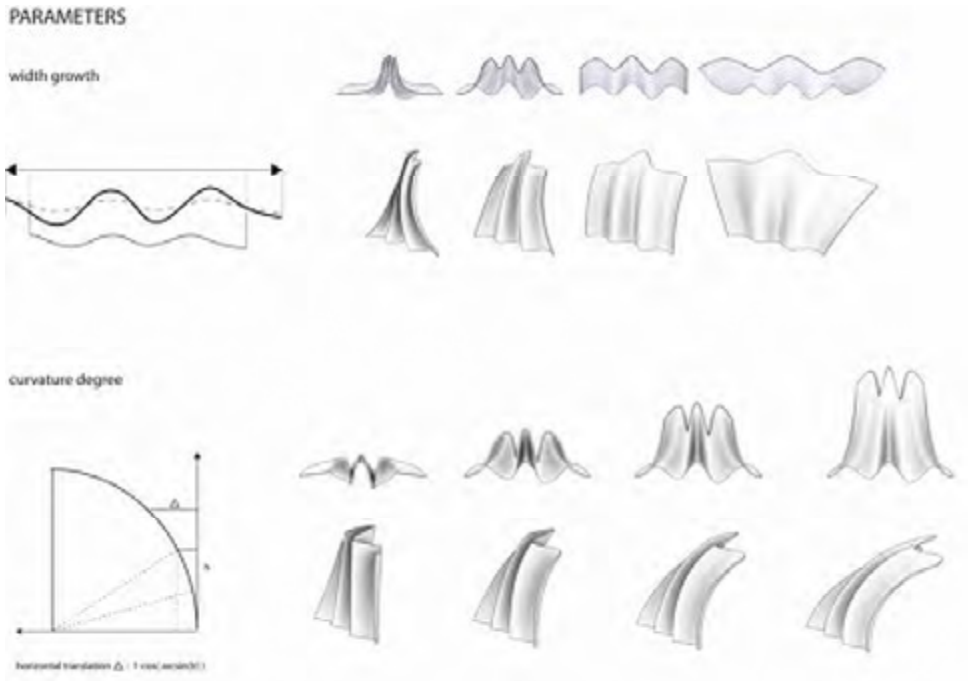
## Working models
## 15_Pufferfish



## Simulations
## 12_Giant clam

Rules:
- Width growth
- Curvature degree
- Translation height



# Science to architecture: design by research

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# GrAB - Growing As Building

**takes growth patterns and dynamics from nature and applies them to architecture with the goal of creating a new living architecture.**


Barbara Imhof, Petra Gruber
Waltraut Hoheneder, Viktor Gudenus
Damjan Minovski, Tanja Oberwinkler

Julian Vincent, Thomas Speck
Angelo Vermeulen

Andreas Körner, Rafael Sánchez
Ceren Yönetim, Mohammedneja Shikur



Universität für angewandte Kunst Wien
University of Applied Arts Vienna

Der Wissenschaftsfonds

# GOALS

GrAB

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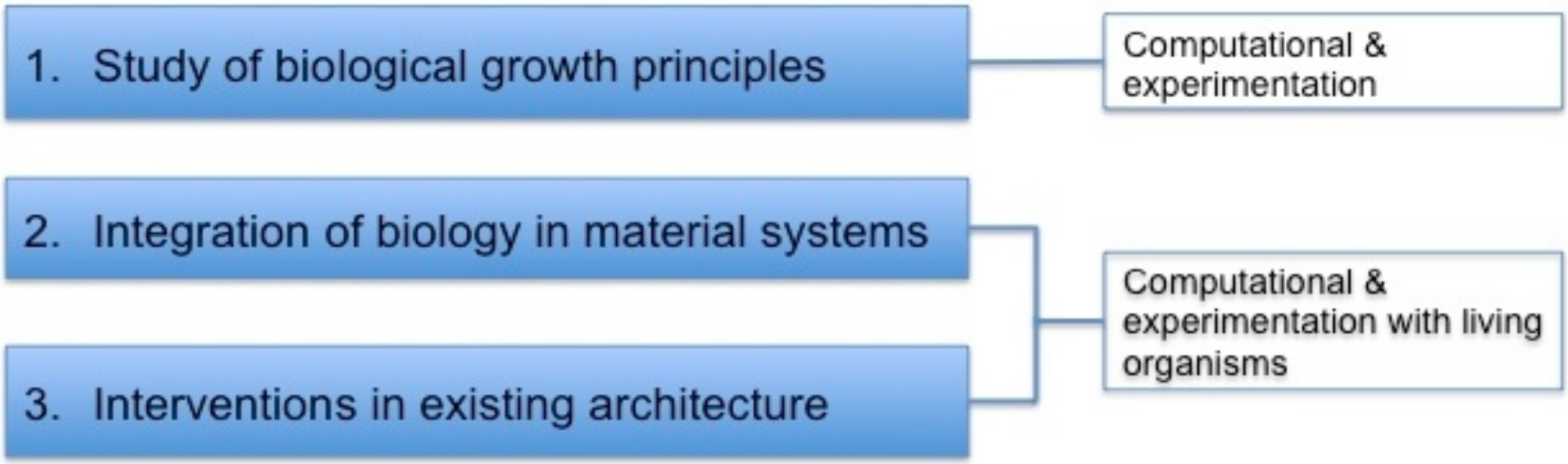
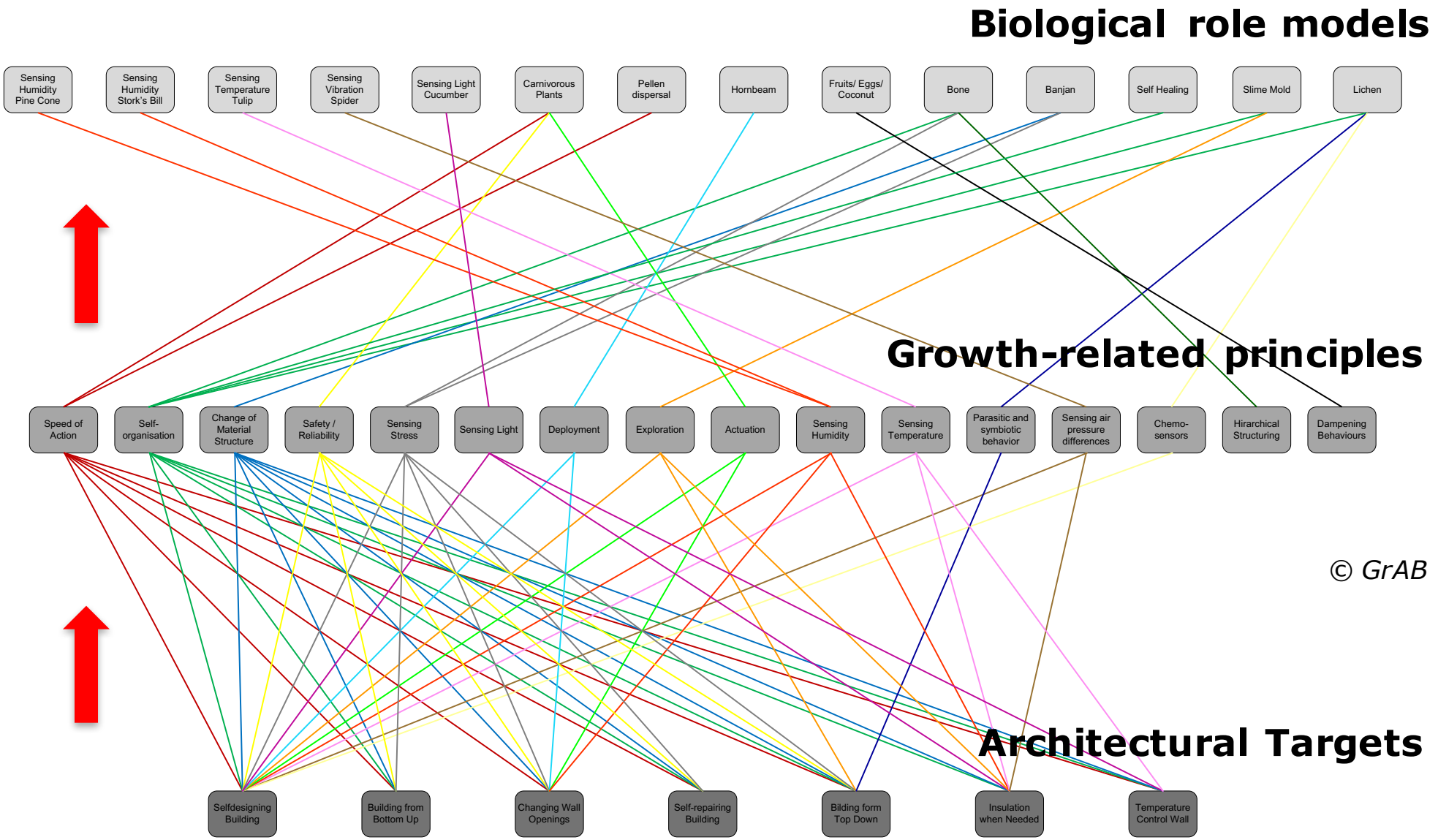


# ANALOGIES

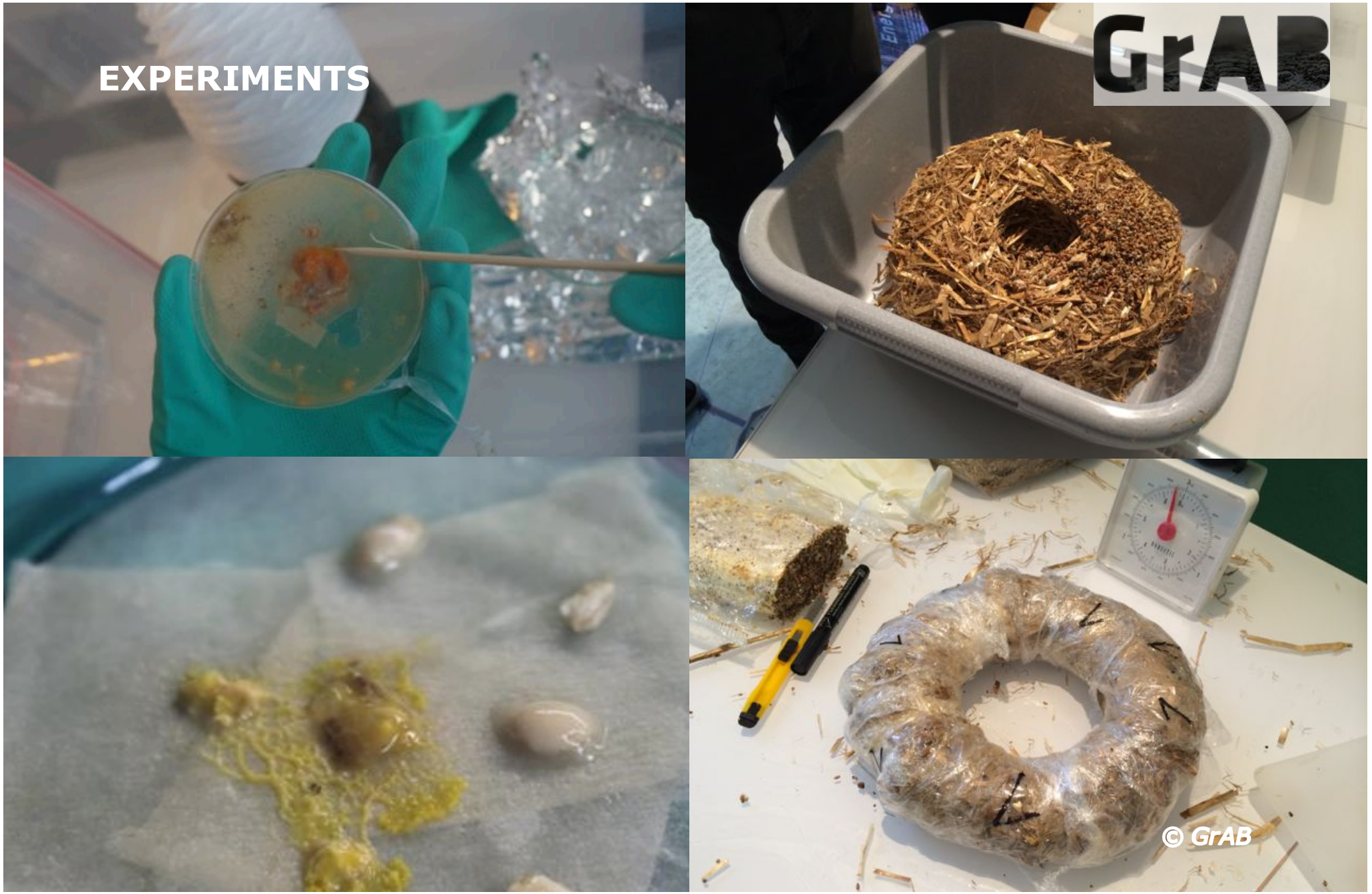
GrAB



# BIOLAB

GrAB

Establishment of the BIOLAB at the University of Applied Arts

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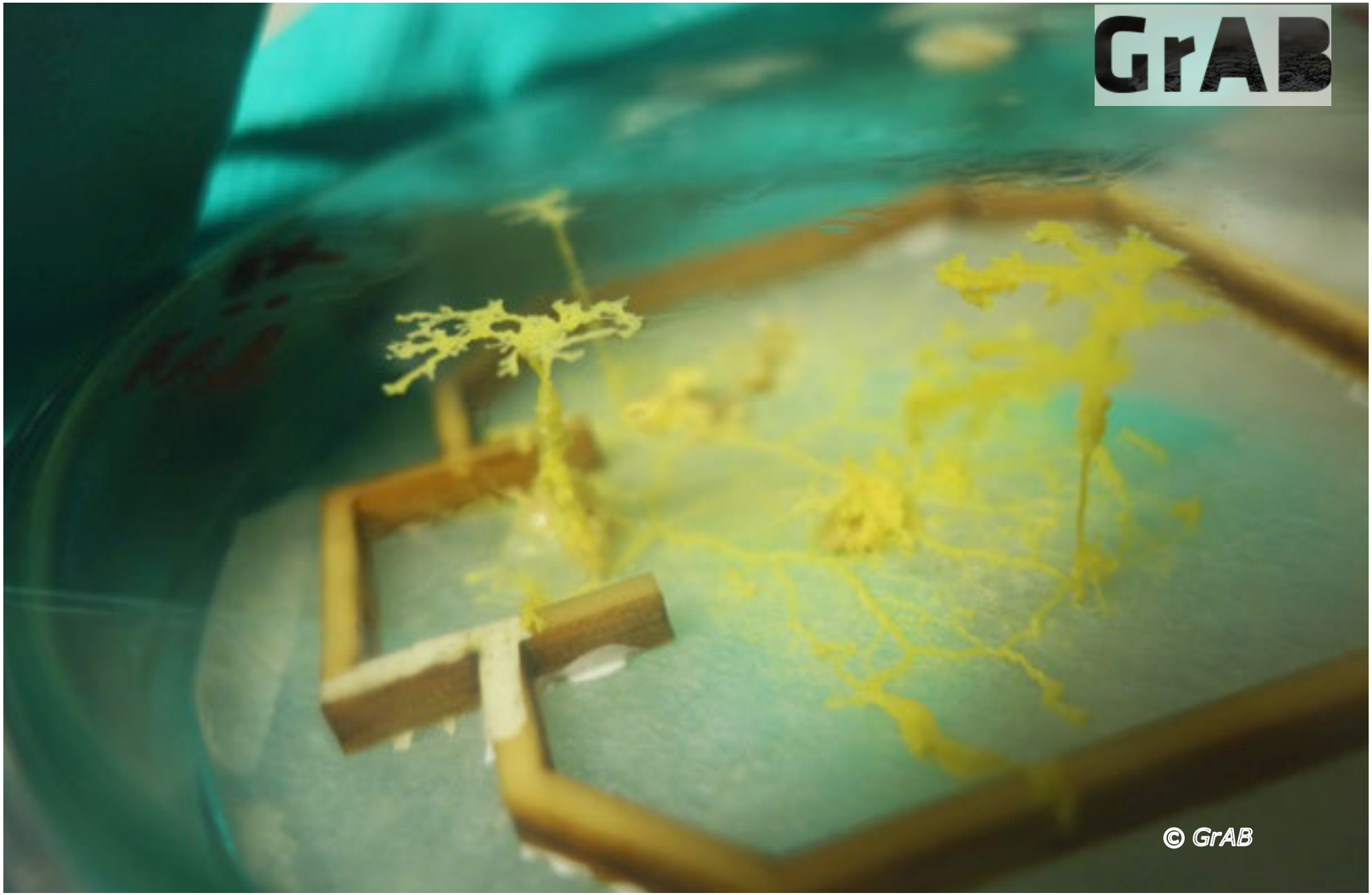


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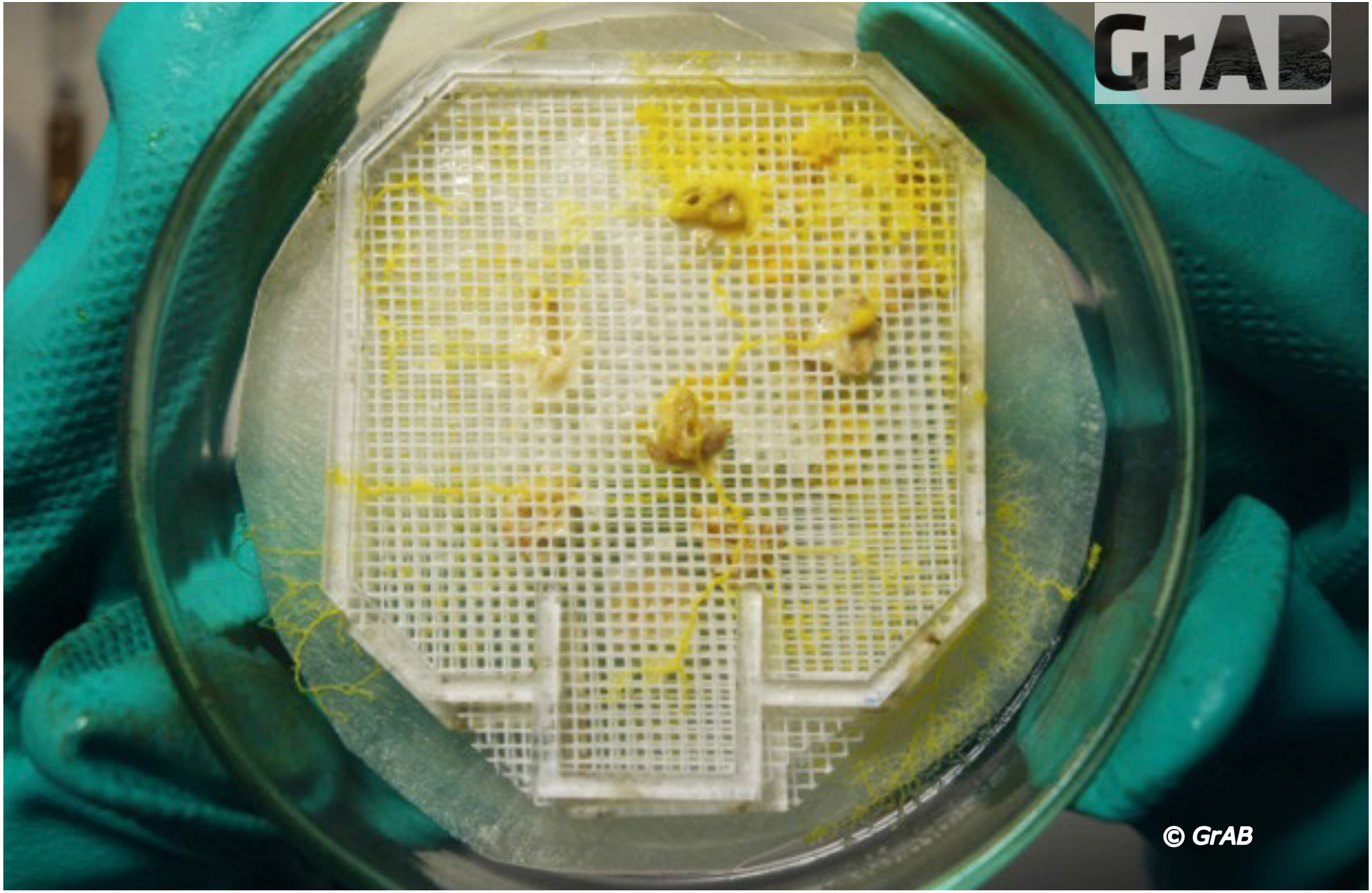


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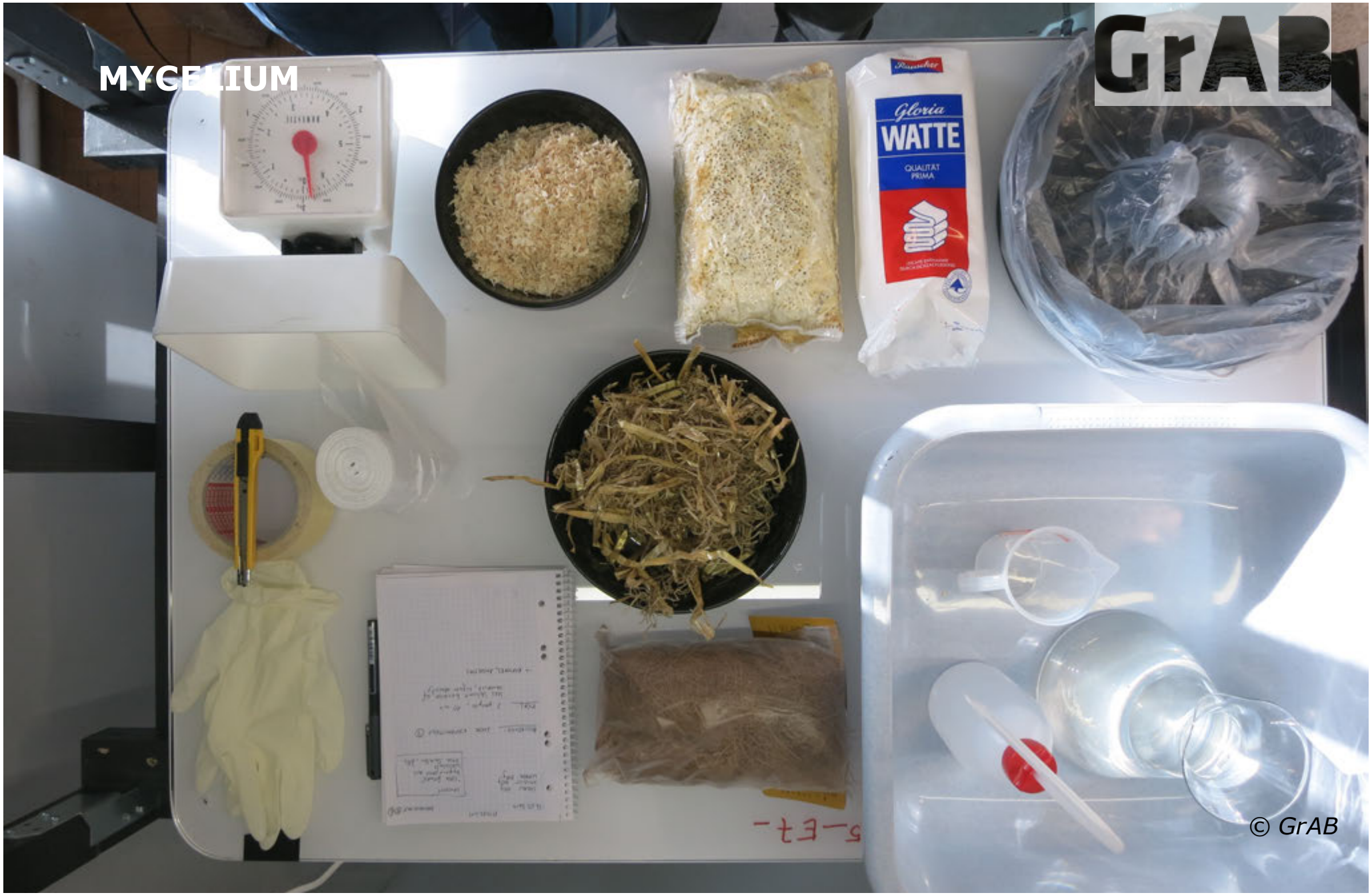


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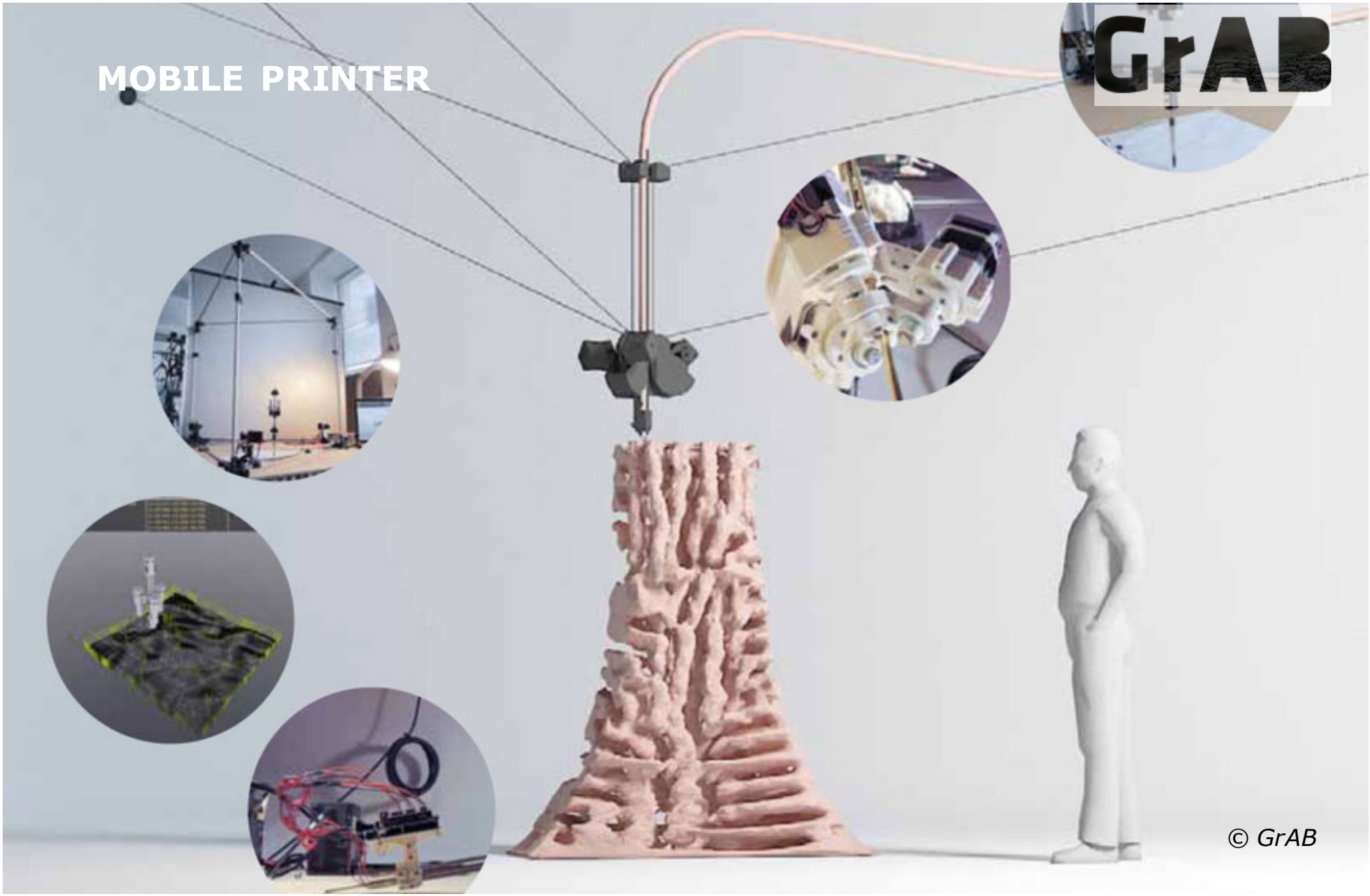


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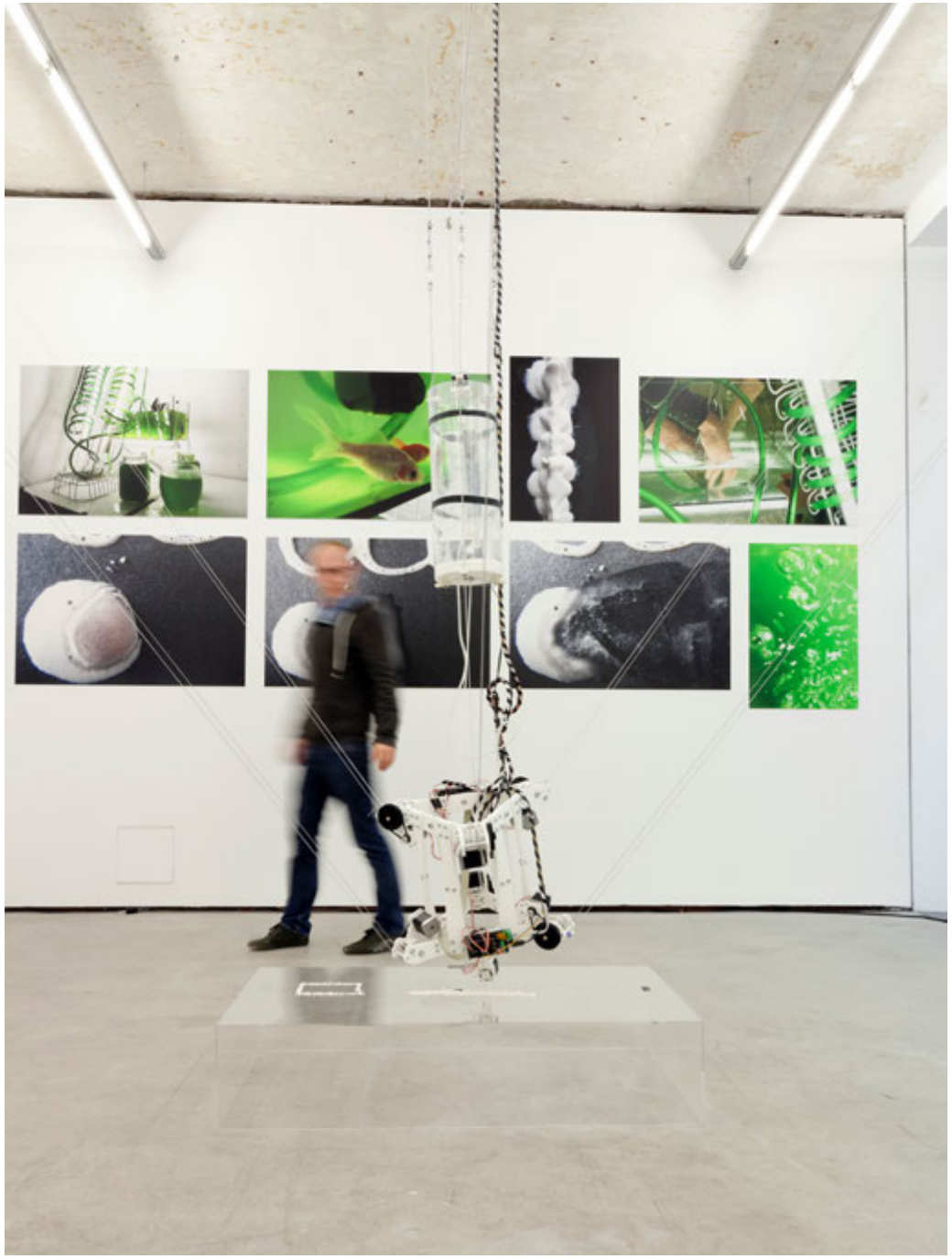

GrAB

Local printer
Material cycle

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## research at BRIC

- further exploration of the overlap between architecture, arts and biology

- material and structures
- selfassembly and selfdesign
- energy
- sustainable design

- link to additive production technologies
- establishment of the biomimicry fablab

# resources

www.bionicfacades.net
www.biornametics.com
www.growingasbuilding.org

# thank you!

**petra pruber pgruber@uakron.edu**