THE SPINNED PAVILLION

ICD/ITKE FORSCHUNGSPAVILLON 2016-17

INSPIRATION PRESENTATION – CHRISTINE VON RAVEN

ARCH 4/510 - PROFESSOR NANCY YEN-WEN CHENG SPRING 2017

PROBLEM / AIM

Aim of a Pavillion Structure with:

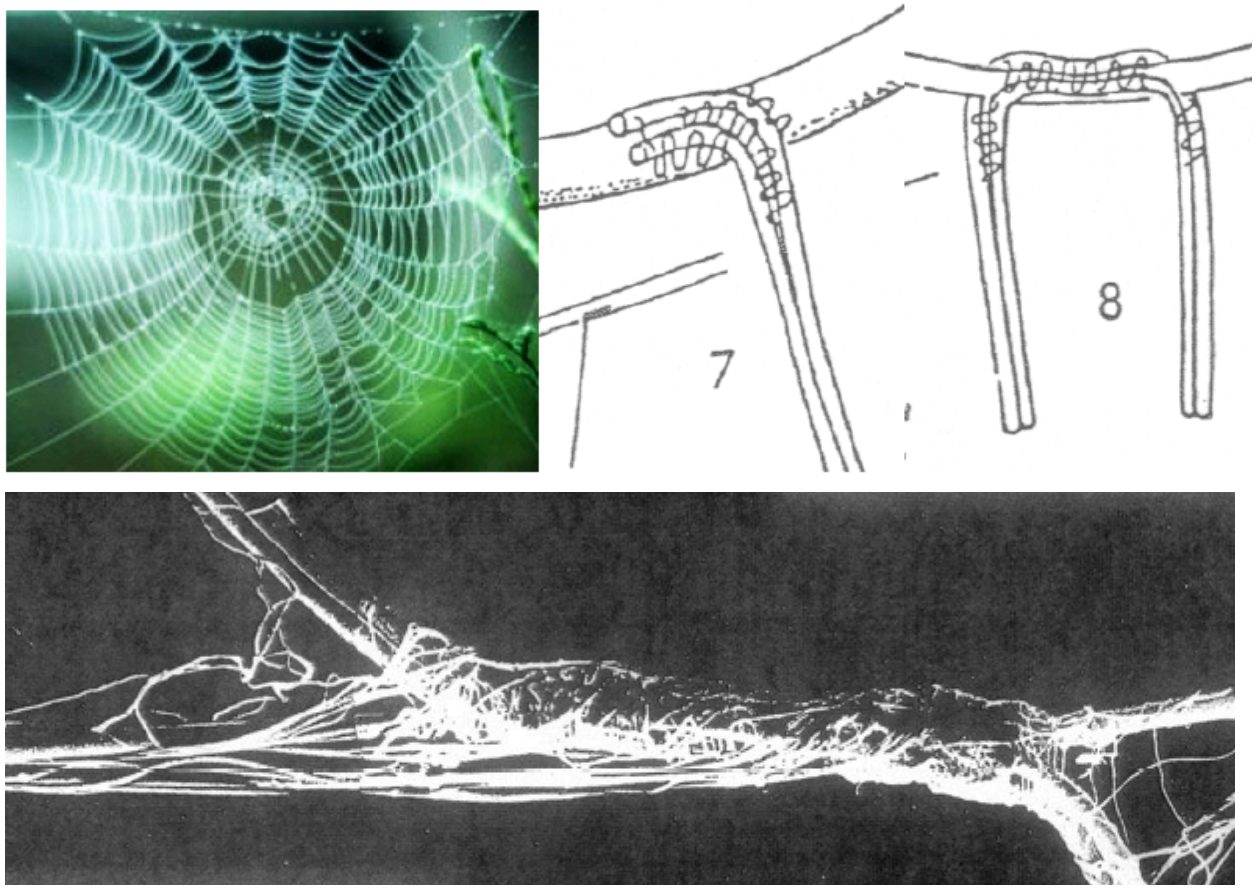
- **Maximal span**
- **Minimal required formwork**

Problem:

- Material self-weight is of high concern for larger span structures

Solution:

- Fibre composite materials
  - readily used in highly engineered applications
  - Still barely investigated for architectural applications
- Investigation of natural construction processes of long span fibre composite structures



Radial tetravalent plane net and node details
- extrem light-weight / large-span stucture
- ‚Sesmless' joined material for maximal strenght

>> Pérez García, Agustín; Gómez Martínez, Fernando; Natural structures: strategies for geometric and morphological optimization; IASS Symposium 2009, Valencia

BIOMIMETIC INVESTIGATION

- Analyzing of functional principles and construction logics of **natural lightweight structures**
- Two species of leaf miner moths (Lyonetia clerkella and Leucoptera erythrinella)
- **Larvae spin** silk "hammocks" stretching **between connection points** on a bent leaf (images right)
- Basically tension forces

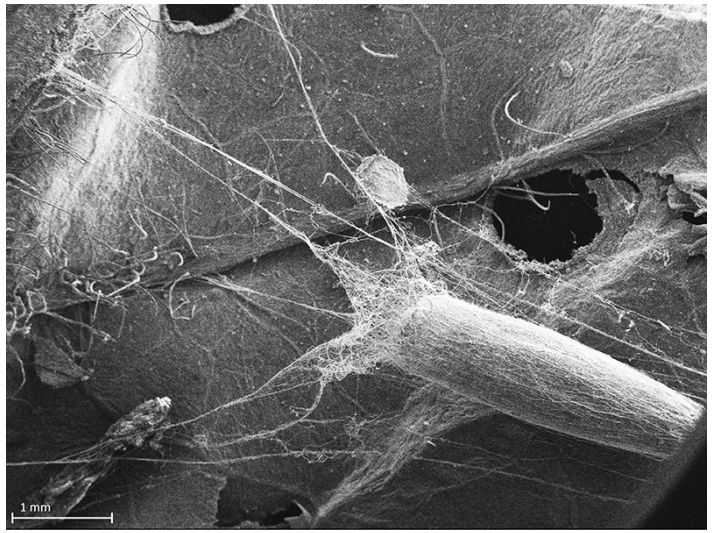
>> Cooperation with the Institute of Evolution and Ecology and the department for Paleobiology of the University of Tübingen

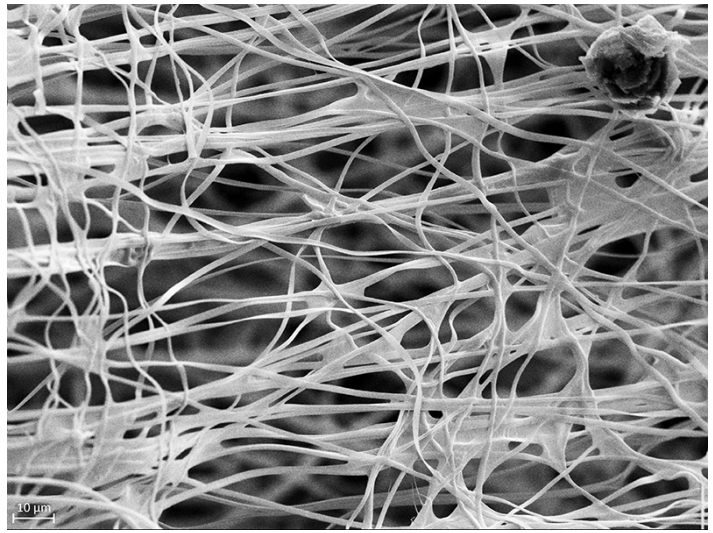
TRANSFER INTO DESIGN

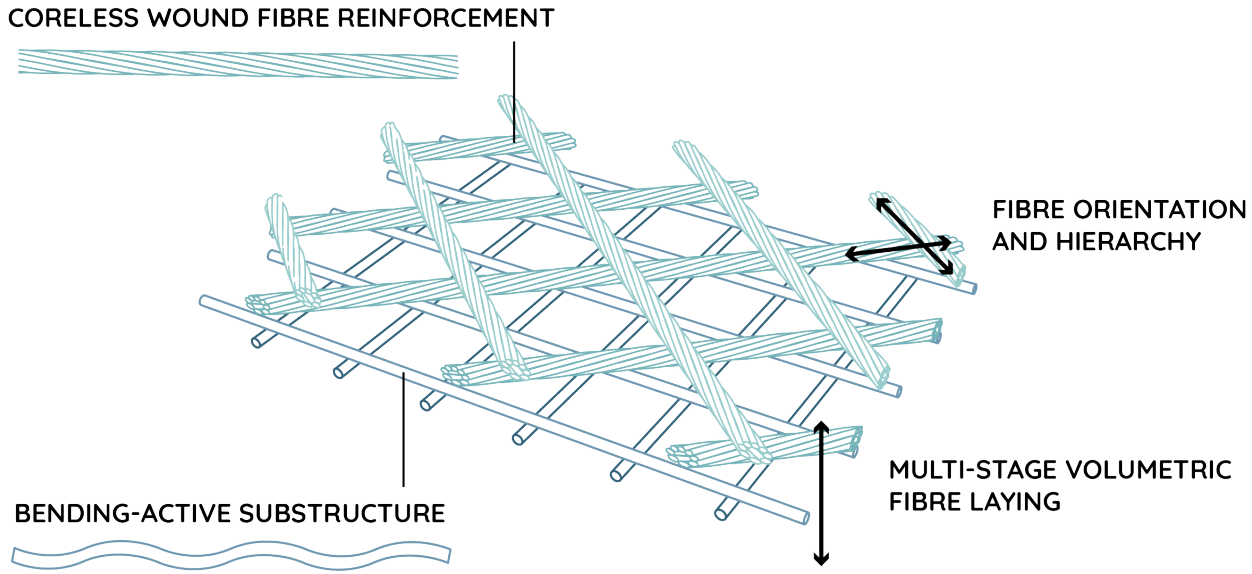
Transfer of **morphological** and **procedural** principles for long span fibrous construction into fabrication and structural concepts

Concepts abstracted from the biological role models:

- The combination of a bending-active substructure and coreless wound fibre reinforcement
  - Creation of **an integrated composite winding frame**
- Fibre orientation and hierarchy over a long span structure and multi-stage volumetric fibre laying processes
  - Generation of **complex three dimensional geometrie**s







Morphology

Process

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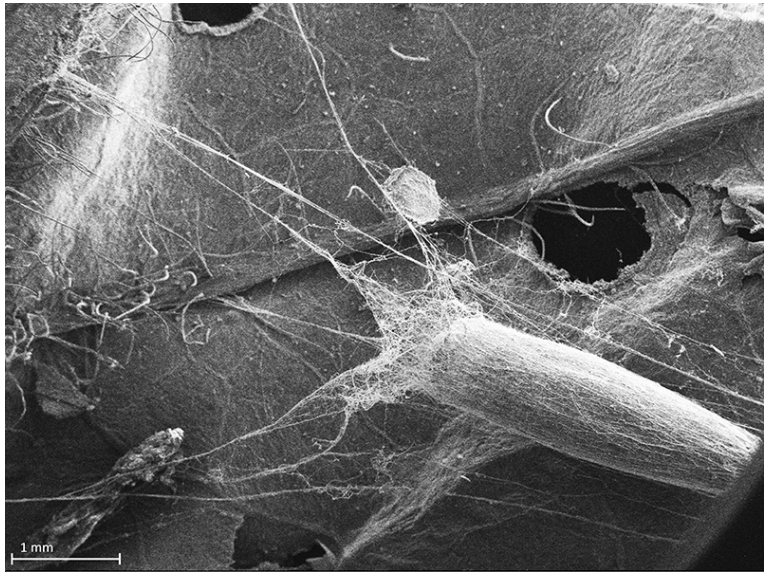
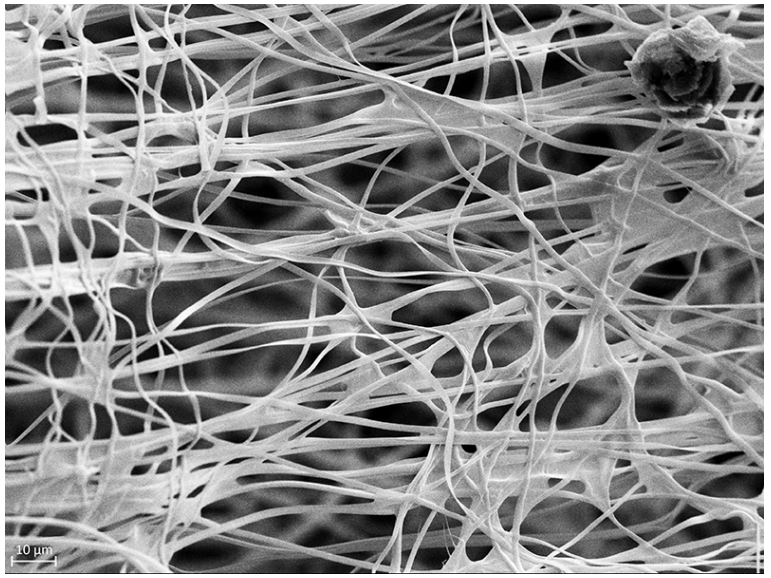
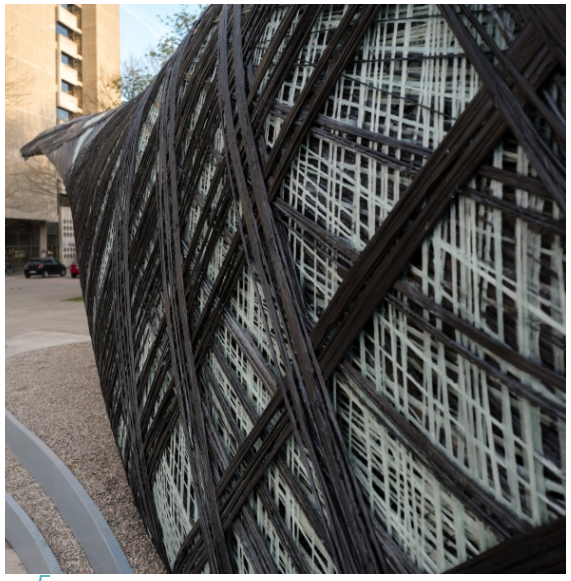




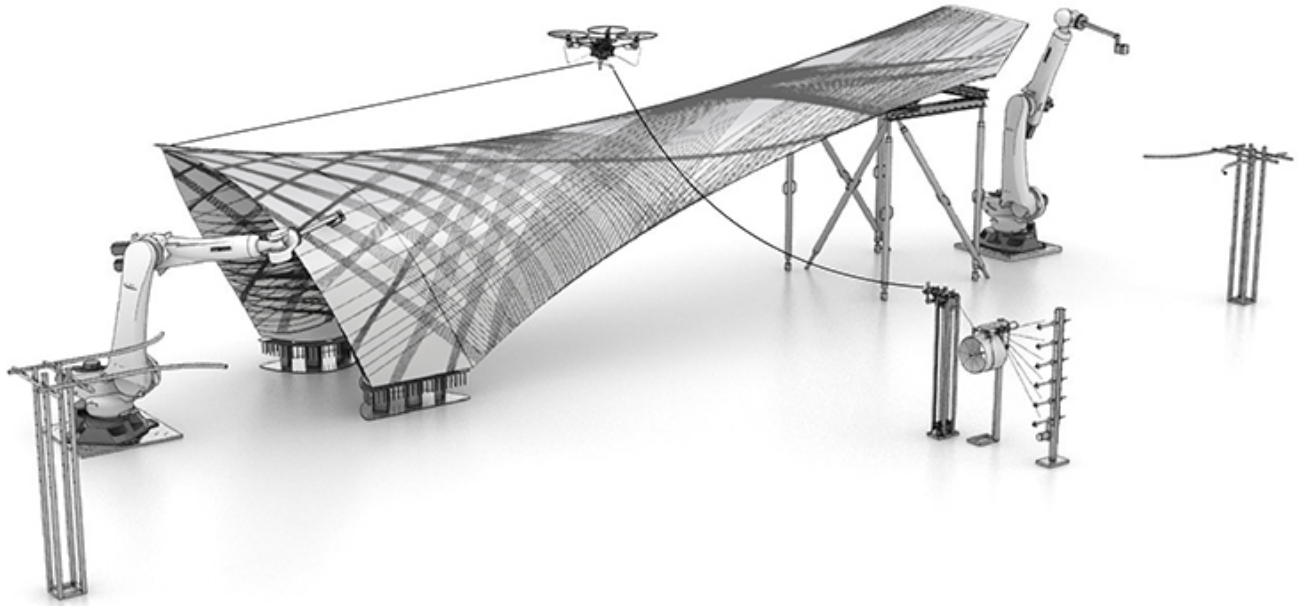


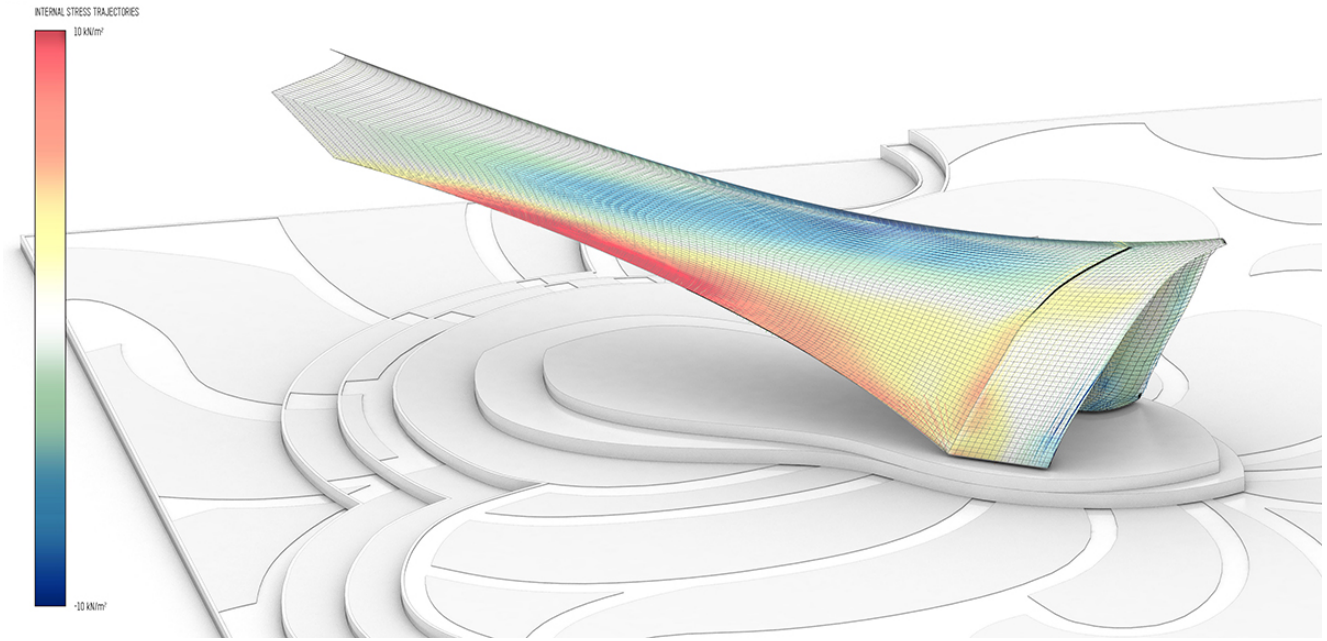
TRANSFER INTO DESIGN

- Interface and communication of multiple robotic systems (**robotic arms** and a **drone**) helped tp create a **seamless fibre laying** process

Integrative computational design and construction created by the in incorporation of

- *biological principles*
- *structural capacities*
- *material behavior*
- *fabrication logics*
- *architectural design constraints*





PROJECT INFORMATION

- Completion: March 2017
- Material: resin-impregnated glass and carbon fibre
- Area: 26.5 m² ~ 258 ft²
- Volume: 58 m³ ~ 2000 ft³
- Fibre length: 184 km ~ 114 miles
- Weight: 1000 Kg ~ 2200 lb
- Overall dimensions: 12.0m x 2.6m x 3.1m ~ 40ft x 8.5ft x 10ft

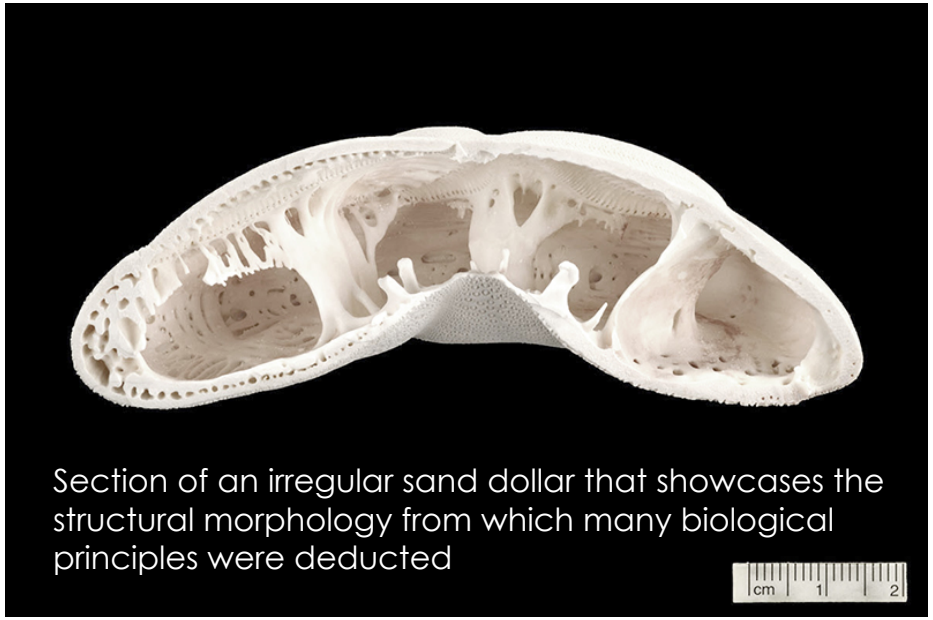
ANNUAL PAVILLIONS

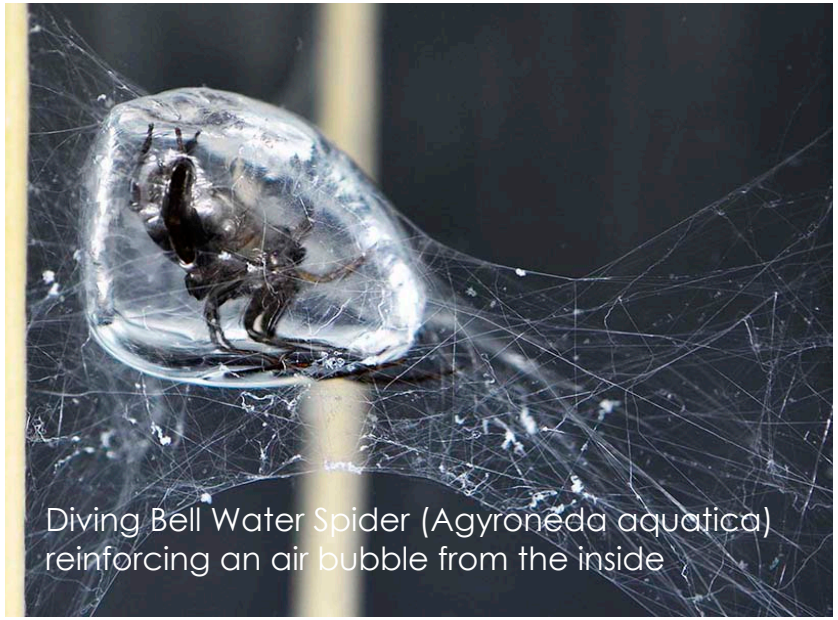
2015-16

Studies on sea urchins and **sanddolar** led to the transfer of constructional principles and the development of new construction methods for timber plate shells

2014-15

The **waterspider** constructs a reinforced air bubble to survive. This is a stable construct that can withstand mechanical stresses, such as changing water currents, to provide a safe and stable habitat for the spider


Section of an irregular sand dollar that showcases the structural morphology from which many biological principles were deducted


Diving Bell Water Spider (Agyroneda aquatica) reinforcing an air bubble from the inside

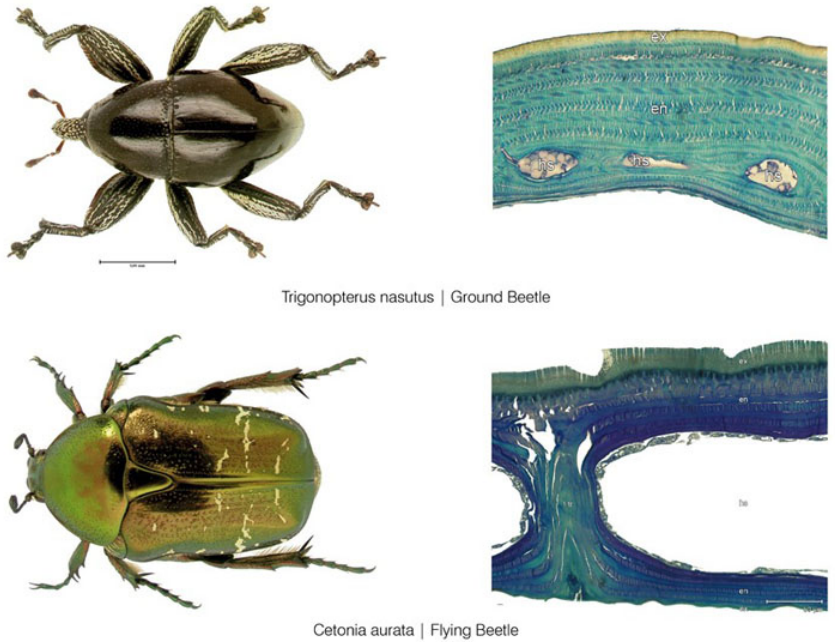
ANNUAL PAVILLIONS

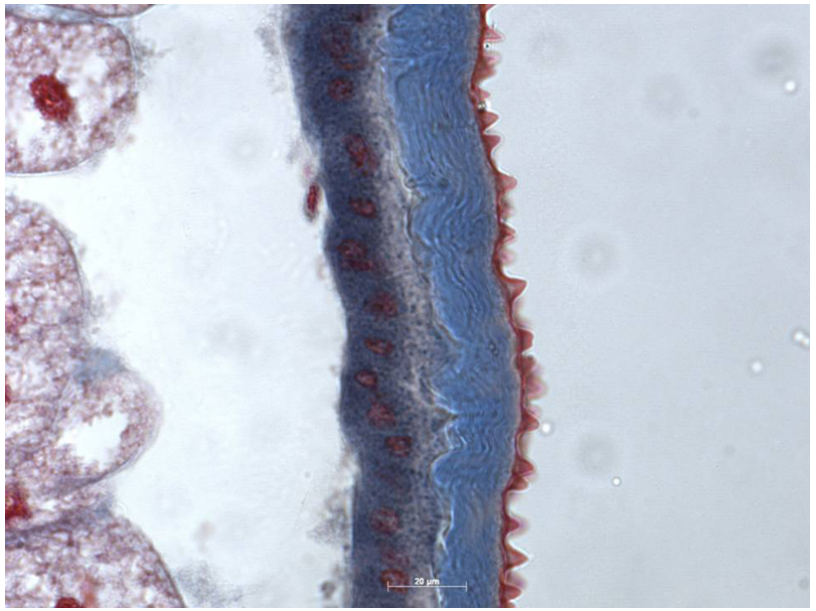
2013-14

Elytron, a protective **shell for beetles**' wings and abdomen, has proved to be a suitable role model for highly material efficient construction.

2012

The **exoskeleton of the lobster** (Homarus americanus) was analysed in greater detail for its local material differentiation, which finally served as the biological role model of the project.





BIOMIMICRY & PARAMETRIC DESIGN

CHRISTINE VON RAVEN

ICD/ITKE Research-Pavillon 2016-17

Institute for Computational Design and Construction (ICD) - Prof. Achim Menges
Institute of Building Structures and Structural Design (ITKE) - Prof. Dr.-Ing. Jan Knippers
University of Stuttgart, Faculty of Architecture and Urban Planning
As far not specific quoted all information and images from both institutes webpages

Video Vimeo ICD/ITKE - Forschungspavillion 2016-17

Credits

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