



Bioverbundwerkstoffe_Chancen & Herausforderungen
Leichte, innovative Baustoffe

Nachhaltige Architektur zwischen Materialität und Digitalisierung

Jun. Prof. Dr.-Ing. M.Eng. Arch. Hanaa Dahy

www.hanaadahy.com

BioMat.

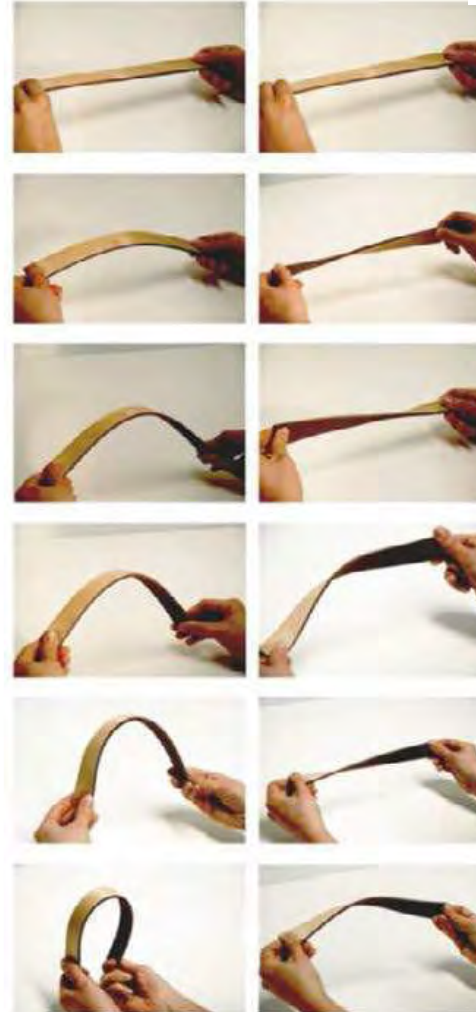
G FNR



Biomaterialien



Biomimetik



Smart Materialien



Entwurf & Fertigung

Nachhaltige Architektur... 'Materialien als Entwurfswerkzeug'



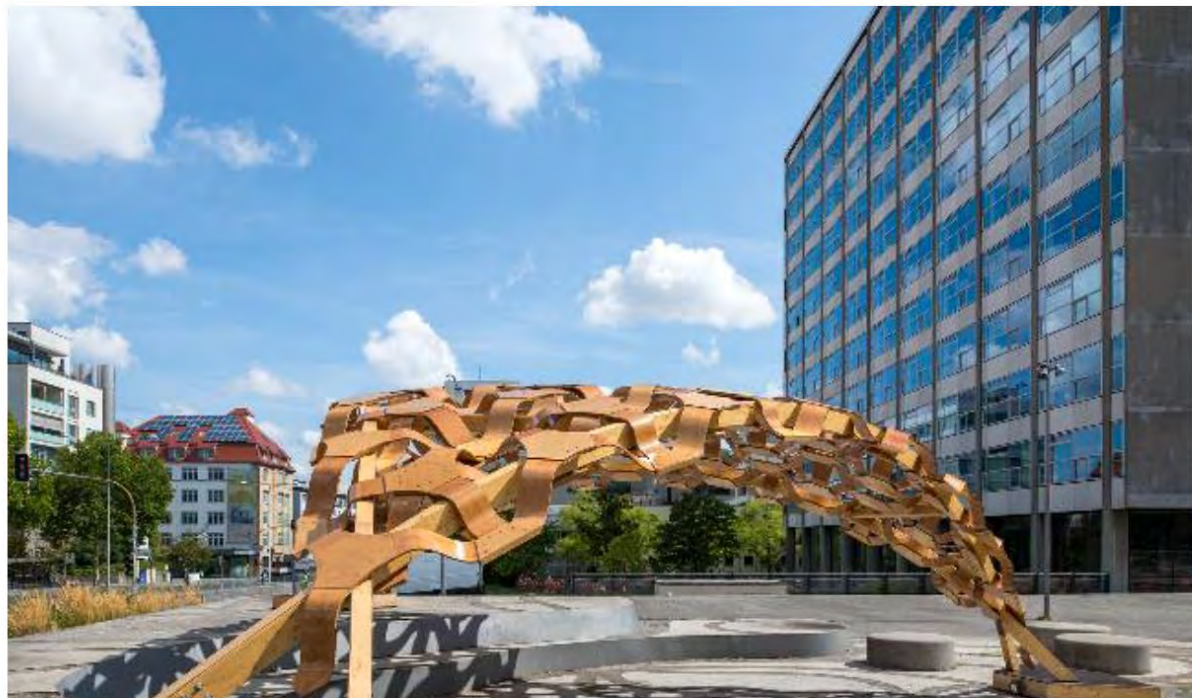
AALBORG
UNIVERSITY

DEPARTMENT OF PLANNING

[HOME - PLAN](#) / [BIOMAT@COPENHAGEN RESEARCH CENTRE](#) /

[FOUNDER OF THE RESEARCH CENTRE](#) [PUBLICATIONS AND PATENTS](#) [CONCEPT AND VISION](#) [PREVIOUS WORK](#)

BIOMAT@COPENHAGEN RESEARCH CENTRE



[FOUNDER OF THE RESEARCH CENTRE](#) >

[PUBLICATIONS AND PATENTS](#) >

[CONCEPT AND VISION](#) >

[PREVIOUS WORK](#) >



BioMat Team



Bio-based Materials and
Materials Cycles in Architecture

TEAM:

Jun.-Prof. Dr.-Ing. Arch. Hanaa Dahy
M.Sc. Paulina Grabowska
M.Sc. Vanessa Costalonga
Dipl.-Ing. M.Arch. Evgenia Spyridonos
M.Arch. Piotr Baszyński
Dr. -Ing.arch. Jan Petrš
M.Sc. Asmaa Hassan

WEBSITE:

<http://www.hanaadahy.com>



Effekt von Bauwerken auf die Umwelt

> 60 % des weltweiten Ressourcenverbrauchs

> 50% der weltweiten Abfallproduktion

> 35 % des weltweiten Energieverbrauchs

> 35 % der weltweiten CO₂ – Emissionen



***BIOMATERIALIEN in der
Architektur!***

Nachhaltige Konstruktionen durch Biokomposite und (digitale) Fertigungstechnologien



BioMat Biocomposite Pavilion 2018



Active-bending LightPRO Biocomposite Shell Structure, 2021



Active-bending LightPRO Biocomposite Shell Structure, 2021



BioMat Biocomposite Pavilion 2018



Tailored Biocomposite Mock-up 2019



Minimal Surface; Modular Biocomposite Structure, 2020



***BIO-MATERIALS in
Architecture!***



***EXTRUSION for Architecture!
PULTRUSION for Architecture!
3D PRINTING for Architecture!
TAILORING for Architecture!***

***.
.
.
.***

***Solutions FROM Architects
TO Architects!***

Funded Projects



Building materials like insect exoskeletons

Project: Building materials like insect exoskeletons
Funding Body: Carl Zeiss Foundation
Role: Principal Investigator
Period: 2021 – 2026



Design and digital fabrication of biocomposite facade panels

Project: Design and digital fabrication of biocomposite facade panels
Project Type: Part of Cluster of Excellence
Funding Body: German Research Foundation (DFG), EXC 2120: Cluster of Excellence IntCDC
Role: Principle Investigator (RP6)
Period: 2019– 2022



Rethinking building materials (Stuttgart Change Labs)

Project: Rethinking building materials
Project Type: Part of Stuttgart Change Labs
Funding Body: University of Stuttgart
Role: Principle Investigator
Period: 2020



BioProfile

Project: Extrudierte und Co-extrudierte Profile aus pflanzenreststoffverstärkten Biokunststoffen für Fenster und weitere architektonische Anwendungen
Project Type: Research-Industrial Project Grant
Funding Body: BMEL – Fachagentur Nachwachsende Rohstoffe e.V. (FNR), German Government
Project Partner: Fraunhofer Institute for Wood Research, Naftex GmbH, Profine GmbH, ETS Extrusionstechnik Mathias Stange
Role: Principle Investigator
Period: 2017– 2020



Interreg EU Project (Smart Circular Bridge)

Role: PI (Principal Investigator) and Director of the German team involved in the project. Task: Design and construction principle of three bridges.
Coordinator: TU/e Eindhoven, University of Technology, Netherlands,
Partners: TU/e Technische Universiteit Eindhoven, KU Leuven, FiberCore Europe BV, 24SEA BVBA, VolkerInfra BV, Lineo – groupe NatUp fibres (Before Ecotechnilin), Centre of Expertise Biobased Economy (Stichting Avans), Vrije Universiteit Brussel, Gemeente Bergen Op Zoom, Gemeente Almere, Gemeinde Ilsfeld, Proesler Kommunikation, Concrefy
Period: 2019-2023



MML

Project: MML Materials Matter Lab – function follows fiction
Project Type: Fellowship Fund for Innovation in High School Teaching
Funding Body: Baden-Württemberg Stiftung, Stiftungsverband für die Deutsche Hochschullehre
Role: Principle Investigator
Period: 2017– 2018



LeichtPRO Project: Pultruded load-bearing lightweight profiles made of natural fibre composites (LeichtPRO)

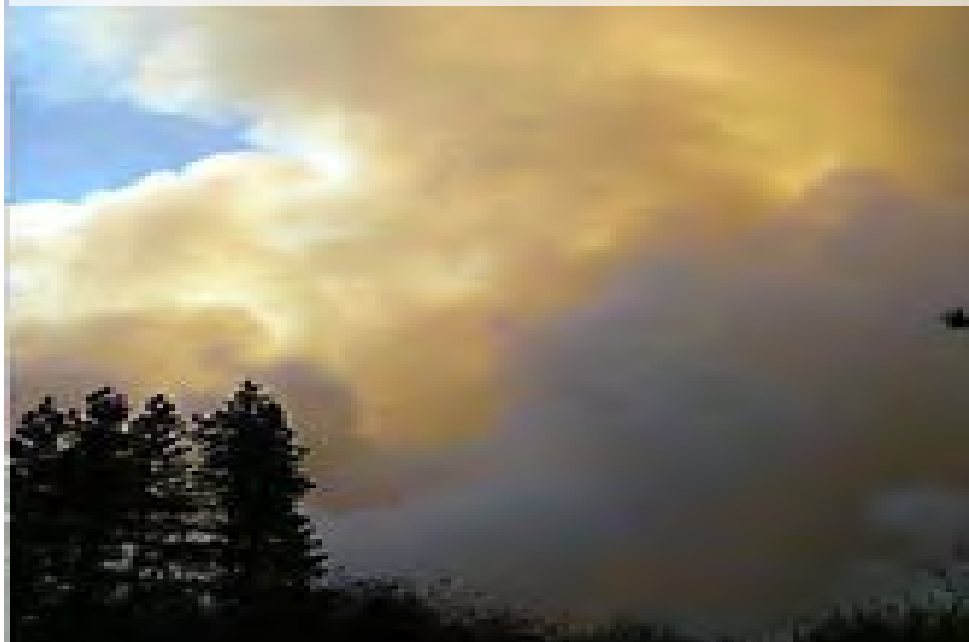
Role: Application and management
Sponsored by: BMEL- Agency for Renewable Resources e.V. (FNR), German Federal Government
Field of research: Development of light profiles processed through pultrusion of long natural fibres
Cooperation partners: German Institute for Textile and Fiber Research (DITF) Denkendorf, Zenvision GmbH, CG TEC GmbH Carbon- und Glasfasertechnik, B.A.M. GmbH, Steinhuder Werkzeugbau



High Density Flexible BIO-Fibreboard

Project: Hochdichte flexible BIO-Faserplatte
Project Type: Research-Industrial Technology Transfer Project Grant
Funding Body: University of Stuttgart
Role: Principle Investigator
Period: 2016– 2018

Worley-Idaho – USA. Photo credit: Jessica Caplan



China's Guizhou province. Photo credit: (china.org.cn)



Sueca (Valencia)-Spain. Photo credit: Wong, A.- Arbokem Inc., 2011



Chile- South America. Photo credit: Matt, 2012



BIOFLEXI[®]

Registered Market Name since June 2019

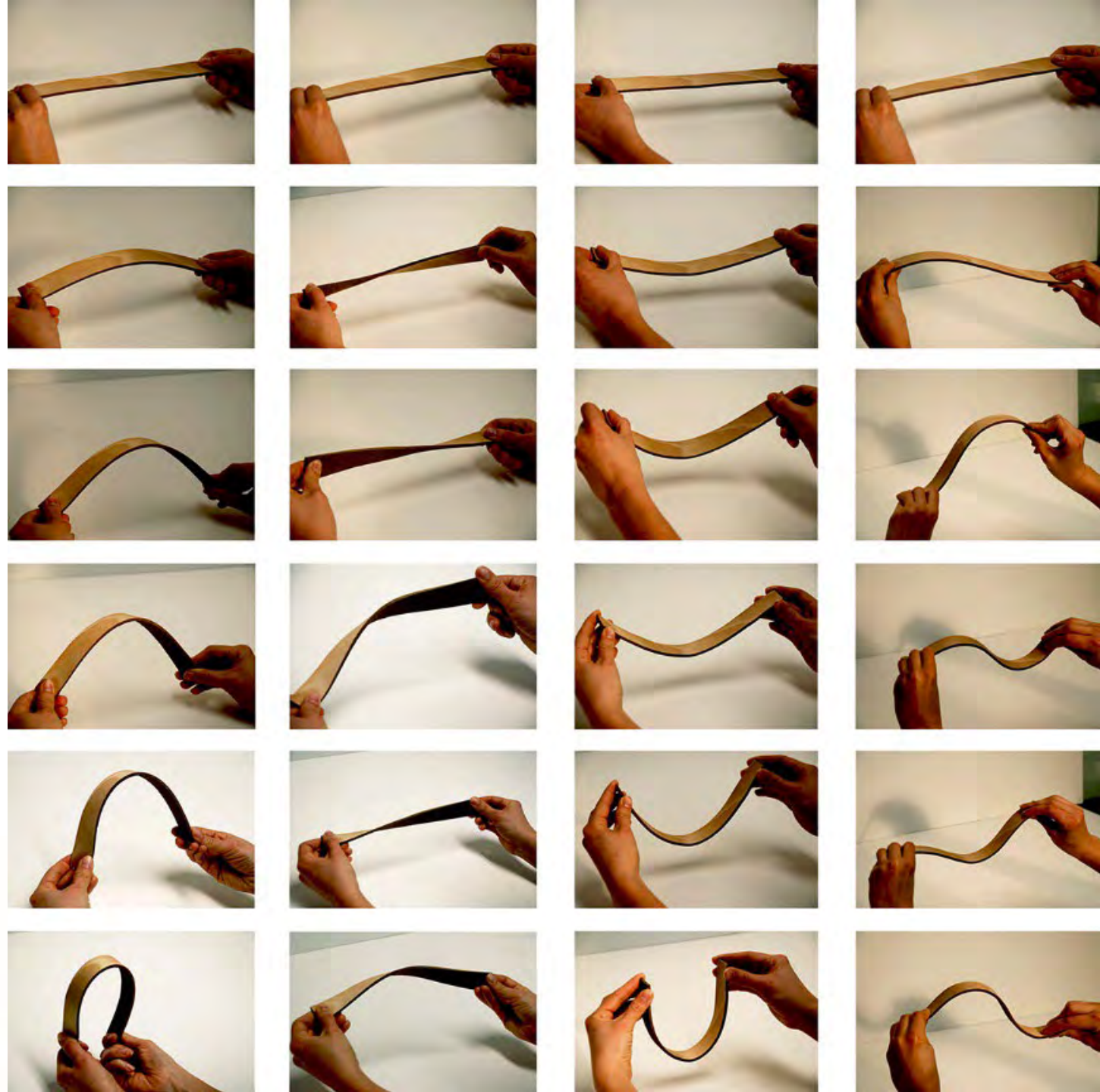
PATENT:

Titel: Flexible high-density fiberboard and method for manufacturing the same
DE: Flexible hochverdichtete Faserplatten und deren Methoden der Herstellung

Development of a HDF fibreboard with elastic binders- with high NF contents 80-90%

European Patent - (No. EP 14 002 343.3), registered and published in 2018 as: EP 2 965882 B1, EP2965882 A1

International Patent - (WO2016005026A1)- Amerikanisch US20170144327



materialPREIS2016
1. Auszeichnung Studie



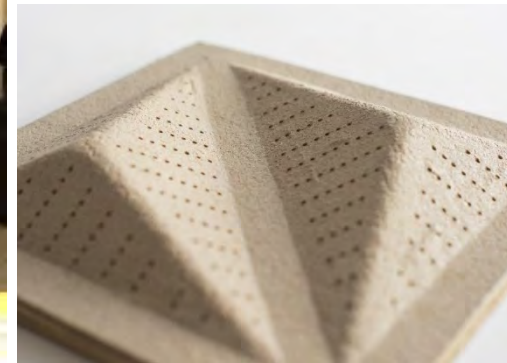
PLUS Partner. PLUS project (sandwich elements made of agricultural residues with integrated sound absorption and heat insulation functions)

2015-2018

Fabrication: laser cutting and vacuum thermoforming



Fabrication: CNC milling and thermoforming



aufgrund eines Beschlusses des Deutschen Bundestages



Bioprofile Partners. Bioprofile project (extruded and co-extruded profiles from plant residues-based fibre reinforced bioplastics for windows and other architectural applications).


2017-2020



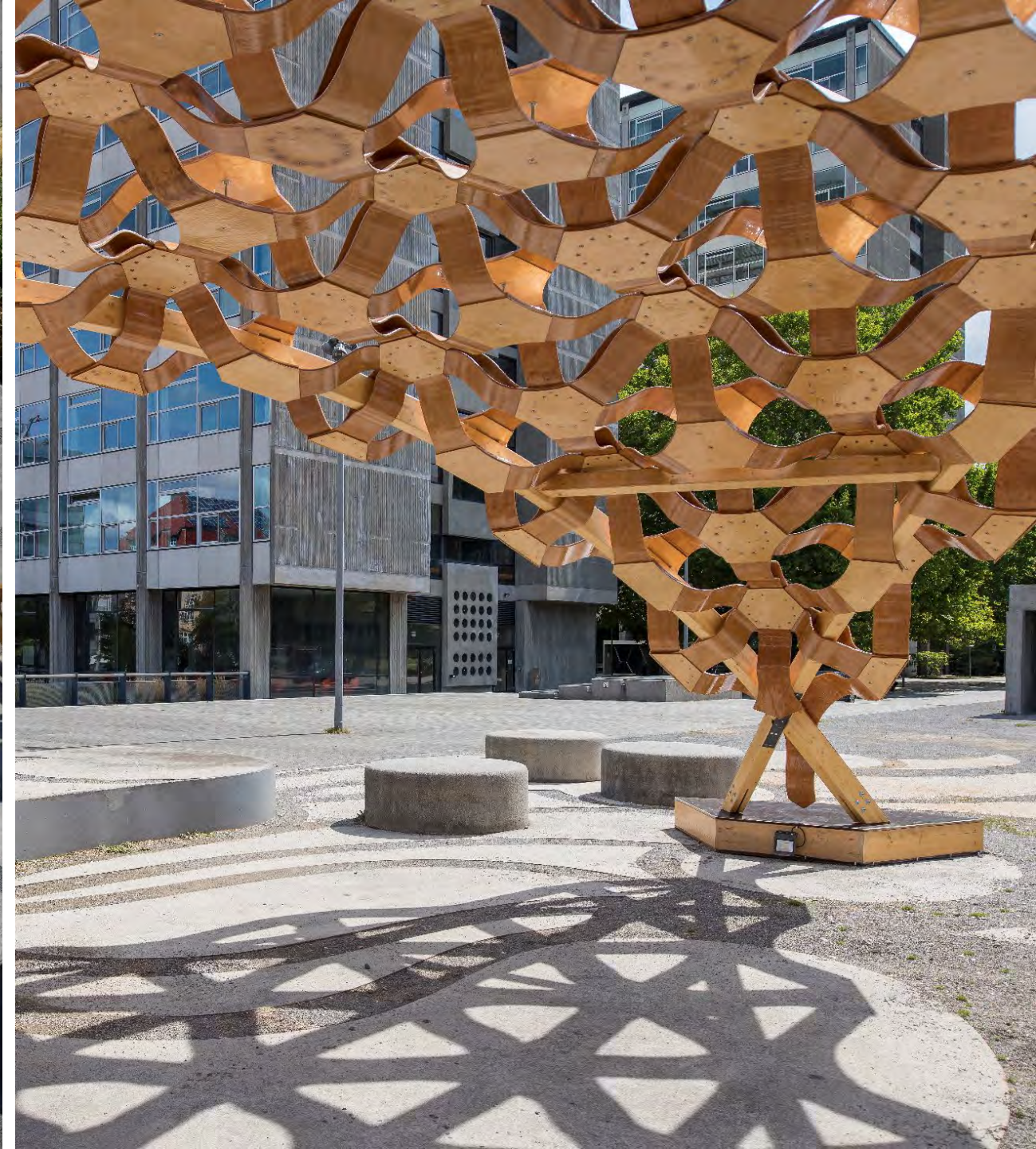
First successful industrial production. June 2017 © Dahy



Fabrication of alternative free-form architecture components

An aerial photograph of a modern pavilion. The pavilion's facade is a complex, three-dimensional lattice structure made of light-colored wood and biocomposites, creating a series of interconnected, irregular shapes. The structure is supported by several thin, dark metal poles. The pavilion is situated on a paved area with a large, intricate, light-colored geometric pattern. The shadow of the pavilion is cast onto the ground, mirroring its complex lattice structure. In the background, there is a patch of green grass and some tall, thin plants.

FLEXIBLE FORMS
Wood & Biocomposites PAVILION







WS 17/18



1

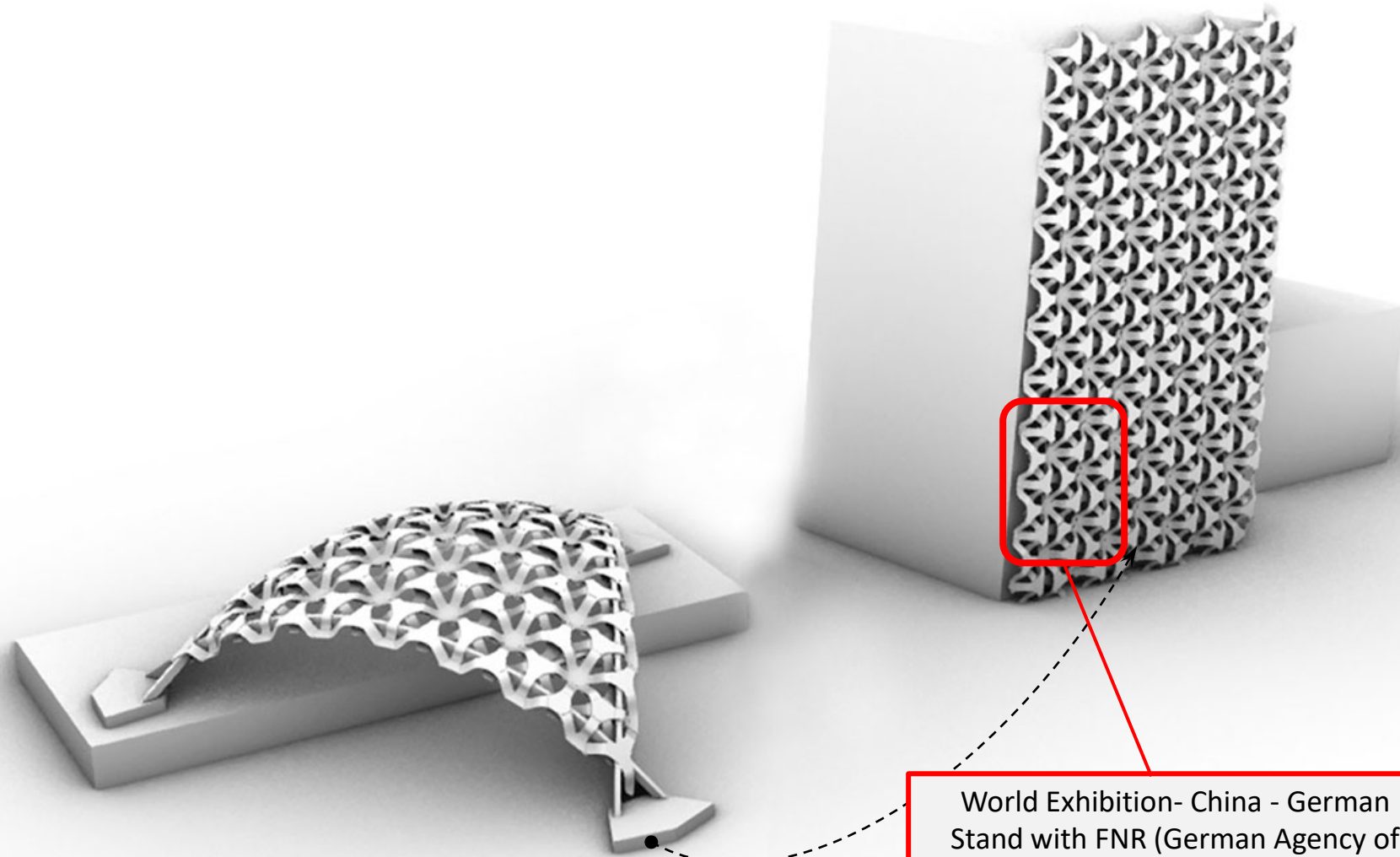


2

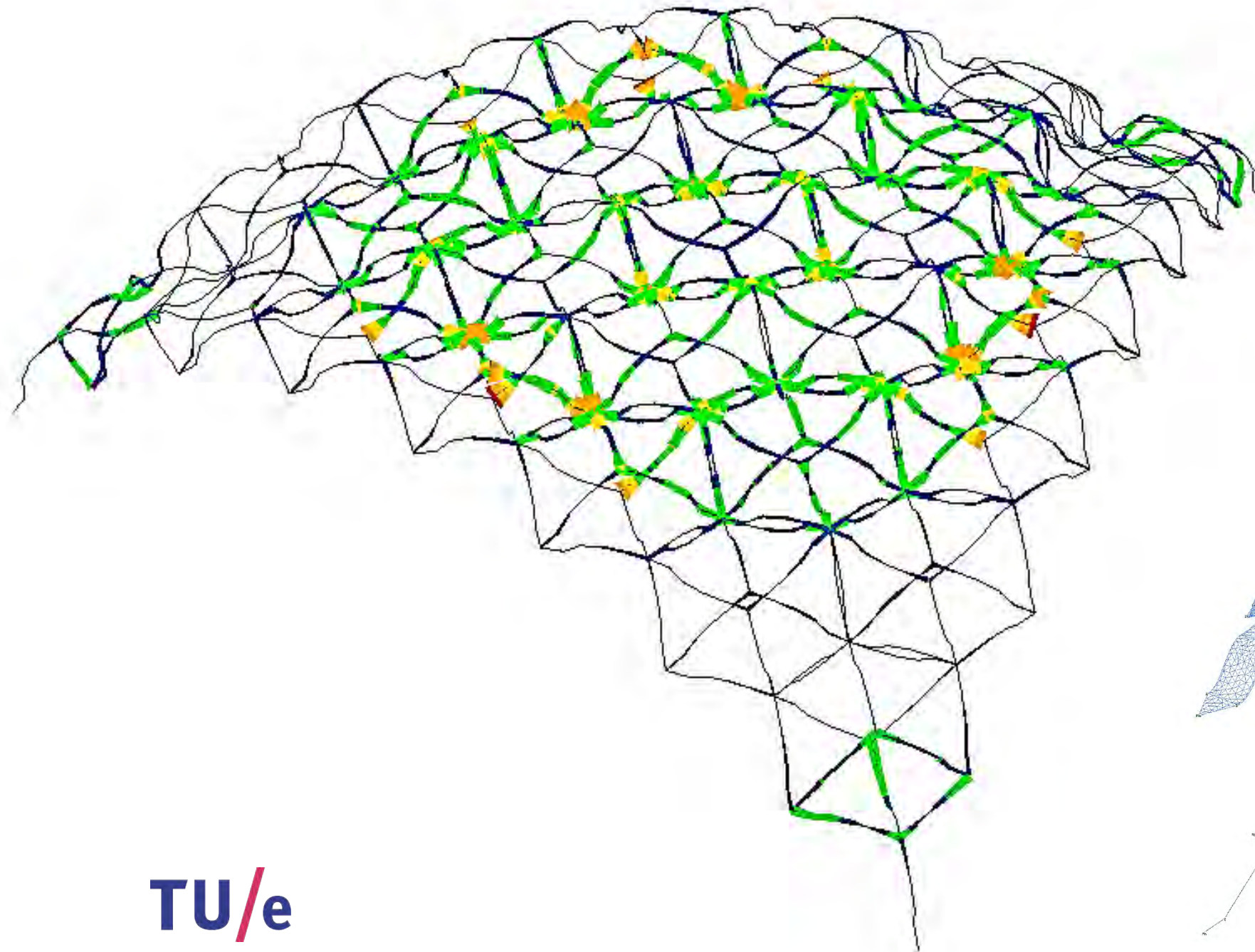


3

Design for Deconstruction (DfD)



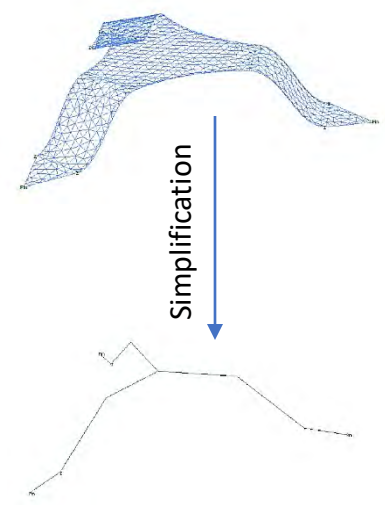
World Exhibition- China - German Stand with FNR (German Agency of Renewable Resources)_2019



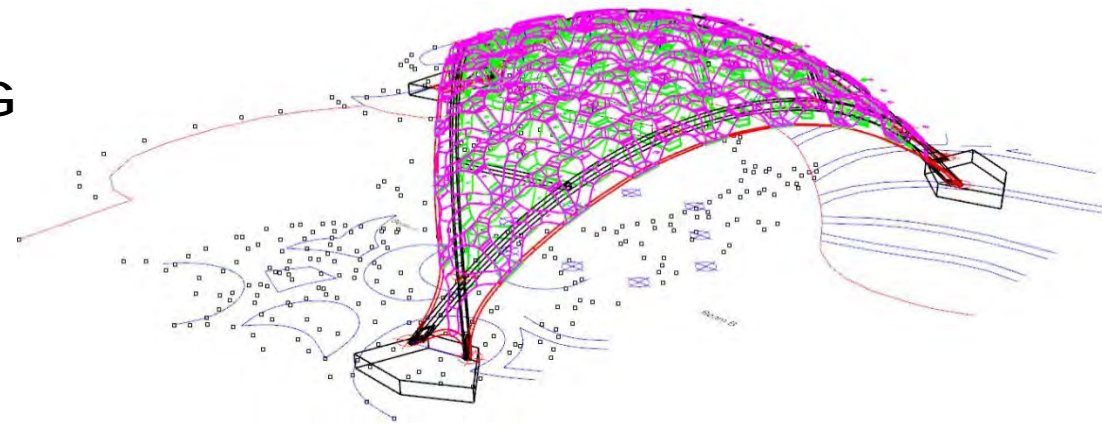
Element list "Bioflexi"
Scale 1 31,38
Isometric Scale 1 38,43
Beam Stress, Von Mises 20,00

12,50 N/mm ²
10,00 N/mm ²
7,500 N/mm ²
5,000 N/mm ²
2,500 N/mm ²
0,0 N/mm ²

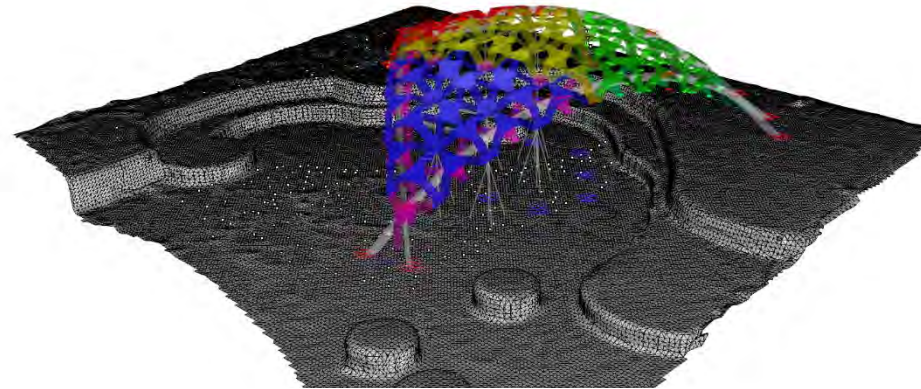
Case L2 Gravity
Case L3 Wind compression
Case L4 Wind suction
Case A1 Wind Compression(D
Contour case
Case A2 Wind Suction(Desc C
Case A3 Wind Compression2(I
Case A4 Wind Suction 2(Desc
Case A5 Self Weight(Desc L2



3D SCANNING



1. BEFORE



2. DURING



3. AFTER

Cooperation:

Institute of Engineering
Geodesy (IIGS, Faculty
06: Aerospace
Engineering and
Geodesy) - Prof.
Volker Schwieger and
Mr. Gabriel Kerekes









Tailored BioComposite CANOPY (BioMat 2019)

1 Semester LP1-9 except LP4! (no building permit was necessary!) – Other process in the planning and execution of building constructions



Flax plant (annual renewable resource)

Made by:



In Cooperation with:





Fibre Placement- IFB



Tailored BioComposite CANOPY (BioMat 2019)



FAB
RICA
TE

UCLPRESS

JANE BURRY / JENNY SABIN / BOB GHEIL / MARILENA SKAWARA

Size:

1,5 x 2,3 x 2 m

Weight:

35 Kg

Amounts and Types of flax applied:

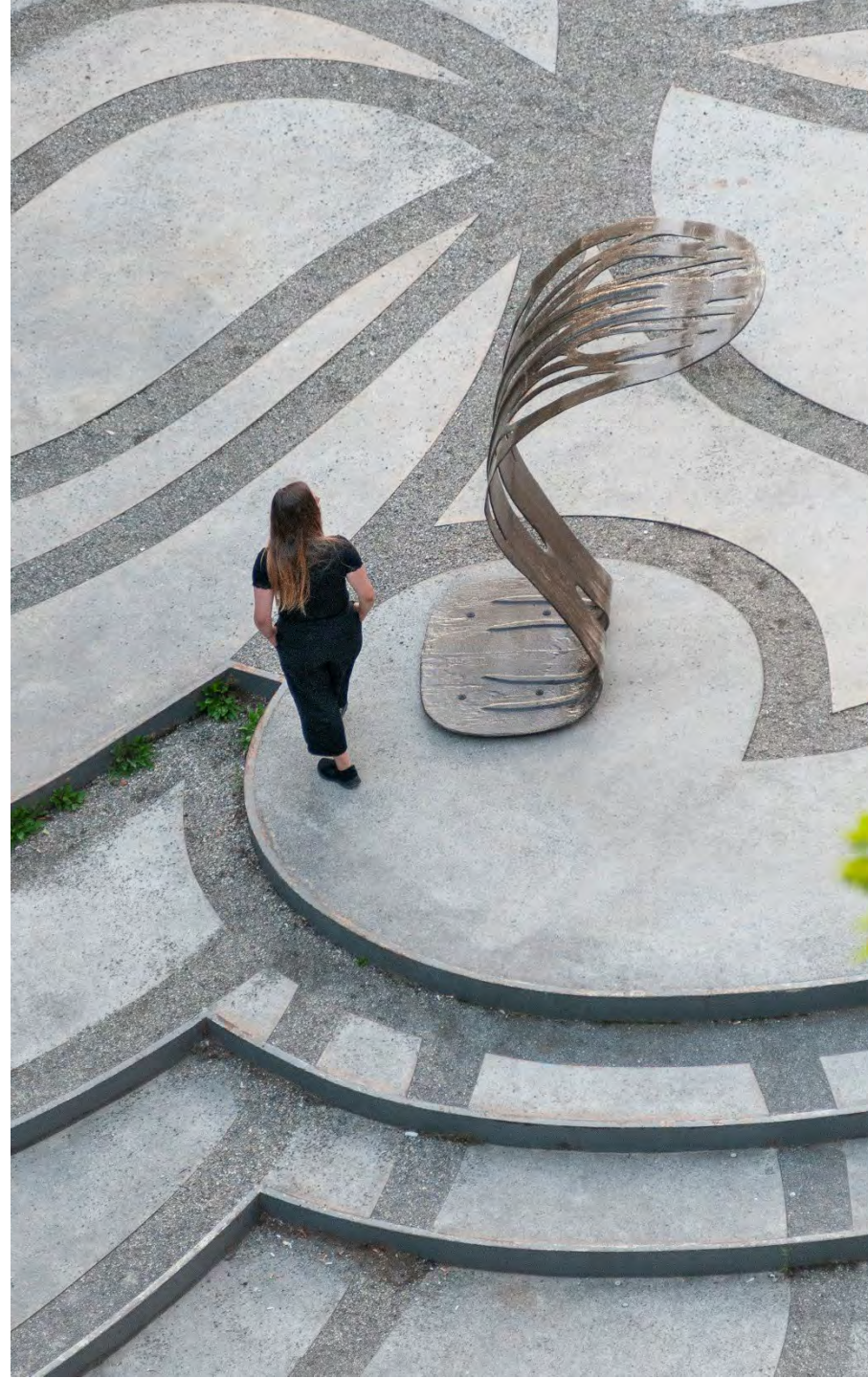
5 yarns of:

Flax rovings for TFP (Tailored Fibre Placement) non-twisted, (2400 Tex)

+

1 yarn of:

flax tapes, (60 cm wide)



TAILOR FIBER PLACEMENT (TFP)



TAILOR FIBER PLACEMENT (TFP)





TFP + CORELESS FILAMENT WINDING



©BioMat at ITKE/University of Stuttgart



TFP + CORELESS FILAMENT WINDING

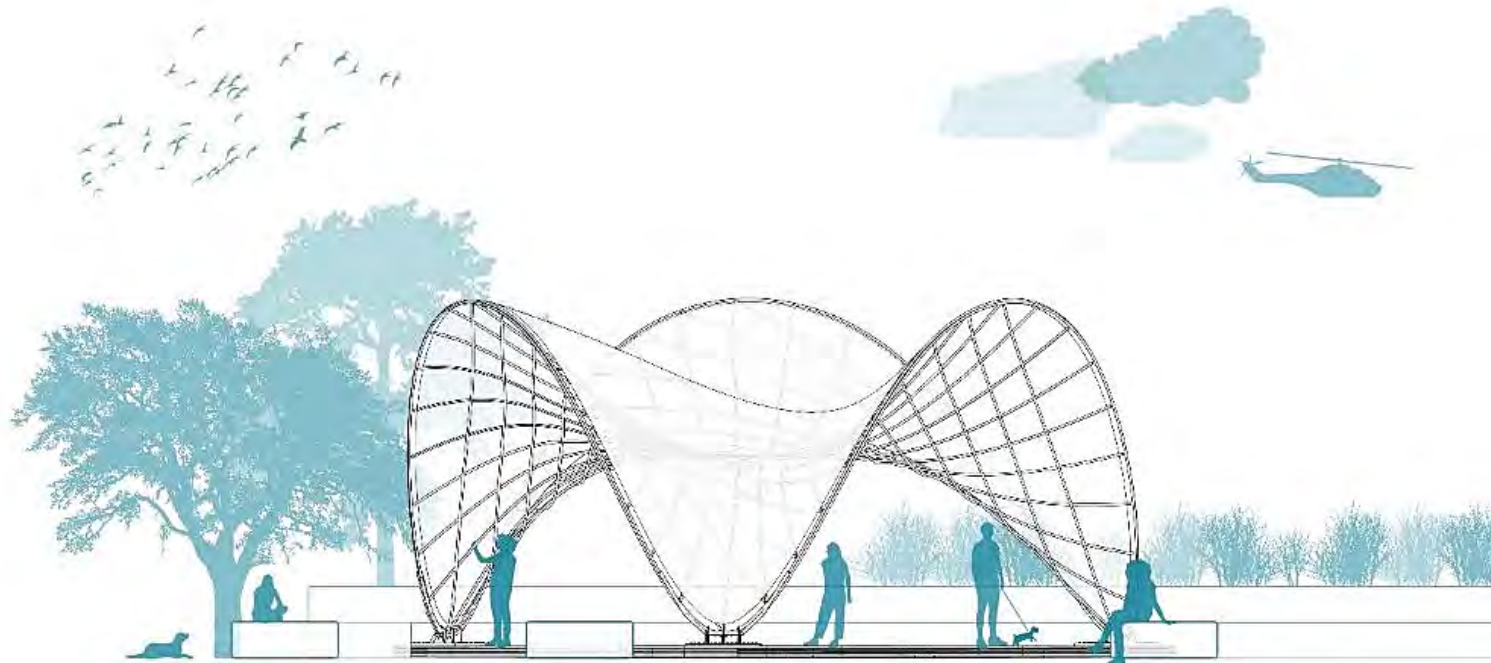


COOPERATION

- Institute of **Aircraft Design**(IFB) (represented in RP 14 and 15) successfully continues. Composites, TFP
 - Prof. Peter Middendorf, Benjamin Grisin
- Institute of **Engineering Geodesy** (IIGS) (represented in RP 18) – Quality Control
 - Prof. Volker Schwieger, Laura Balange
- Institute for **Acoustics and Building Physics** (IABP) – Acoustic design
 - Prof. Philip Leistner, Eva Veres
- Chemistry of **Bio-Inspired Structural Materials** at IGVP –Chitosan integration
 - Dr. Linus Stegbauer
- In addition to **Schüco** & **EFW** companies

*From **IntCDC Lab**, many thanks for:
Aleksa Arsic, Kai Stiefenhofer & Seraj Klassen*





Rendering: Evgenia Spyridonos, ©BioMat/ Universität Stuttgart



mateco

S78 ES 24 580

080 20 11 600
freec.

mateco







**Green
Concept
Award**
Winner
2022



materialPREIS 2021
Auszeichnung Publikums-Voting





Interreg Project (High-Tech Bridges out of Biocomposites) LP 1-9



Interreg 
EUROPEAN UNION
North-West Europe
Smart Circular Bridge
European Regional Development Fund

THEMATIC PRIORITY:
 RESOURCE AND MATERIALS EFFICIENCY

PROJECT AREA

Project objectives: Promoting circular infrastructure
Realisation of a smart circular pedestrian/cyclist
bridge system. Preparation of market penetration

Total budget received from Interreg North-West Europe (2019-2023):
€3.93 million of ERDF

Total project budget:
€6.86 million

www.nweurope.eu

15 Partners from: Germany, Netherlands, Belgium, France
5 Universities, 7 Companies, 3 Cities

Project Duration:
2019-2023

Task: Design & Build of 3 High-Tech Bridges from flax fibres with integrated sensors for structural health monitoring

Locations:

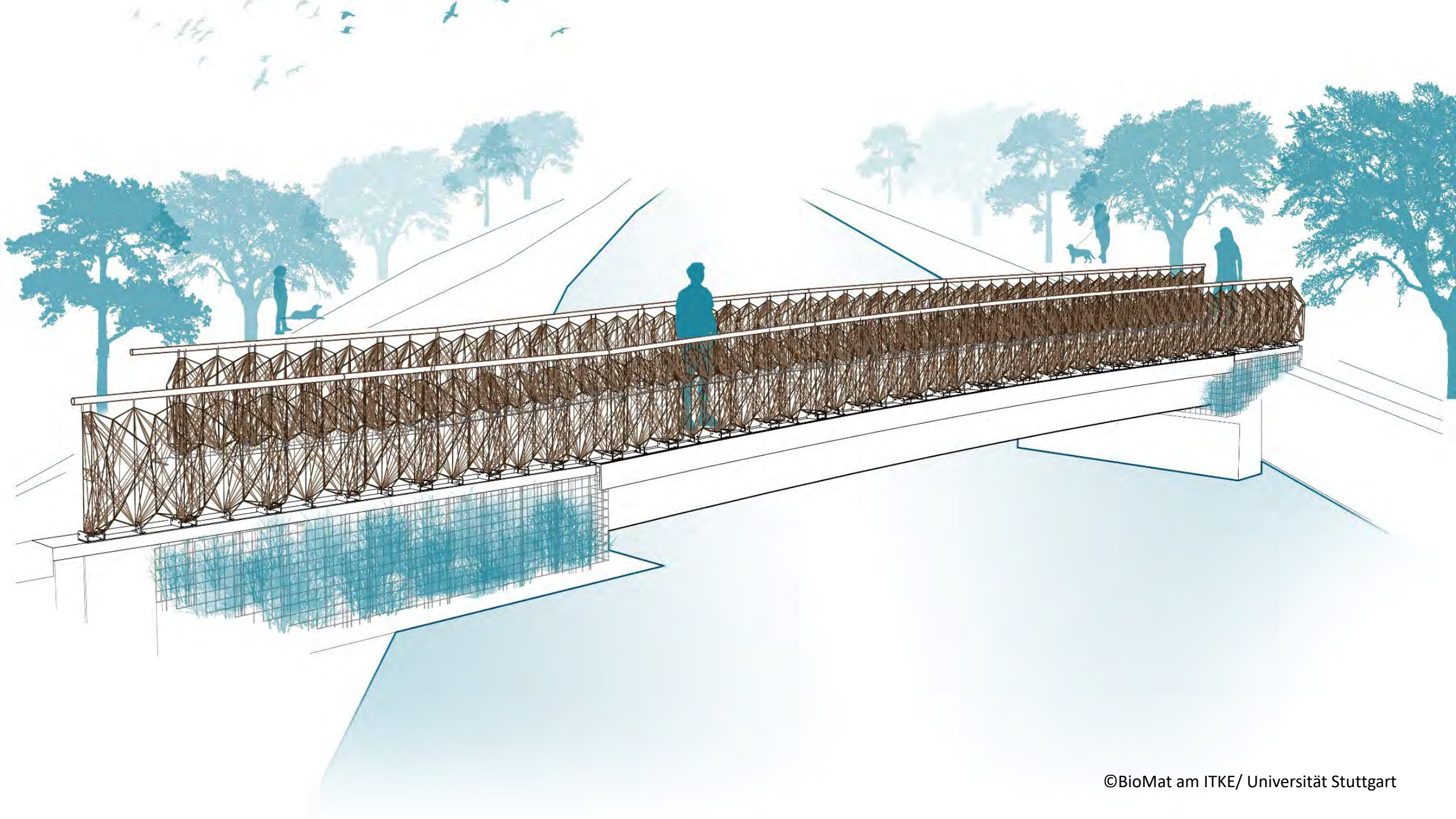
Bridge 1 (Almere, Netherlands/ opened on the **earth day** 22.04.2022) ✓
Bridge 2 (Ulm, Germany/ to be opened in December 2022 or January 2023) →
Bridge 3 (Bergen op Zoom, Netherlands/ to be opened in 2023) → →

The project is coordinated by the Netherlands partner: TU/e. For more info, please visit: www.nweurope.eu/smartcircularbridge

www.nweurope.eu

*1st Smart Circular Bridge
Almere
Floriade Expo 2022
Netherlands*



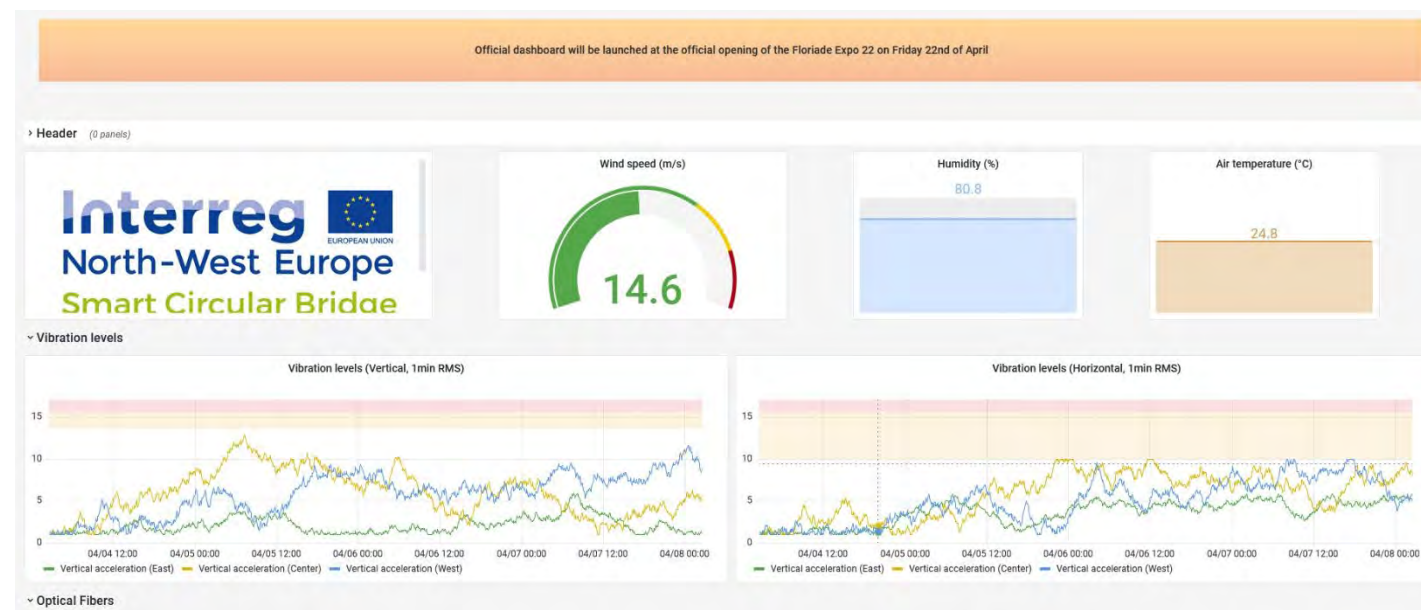




Production process: fibre mats made from flax are wrapped around lightweight foam cores. ©(FiberCore Company)/ SCB



Structural Health Monitoring: artificial intelligence evaluates data from almost 100 sensors within the bridge in real time. The picture shows the installation of one of the fiber optic sensors.



The data from the sensors can be viewed in real-time on a dashboard on a public website. (dashboard.smartcircularbridge.eu/)



Production process: fibre mats made from flax are wrapped around light-weight foam cores.



2nd Smart Circular Bridge, SCB Ulm (2022-2023)



Nachhaltige Konstruktionen durch Biokomposite und (digitale) Fertigungstechnologien



BioMat Biocomposite Pavilion 2018



SCB- Almere, 2022



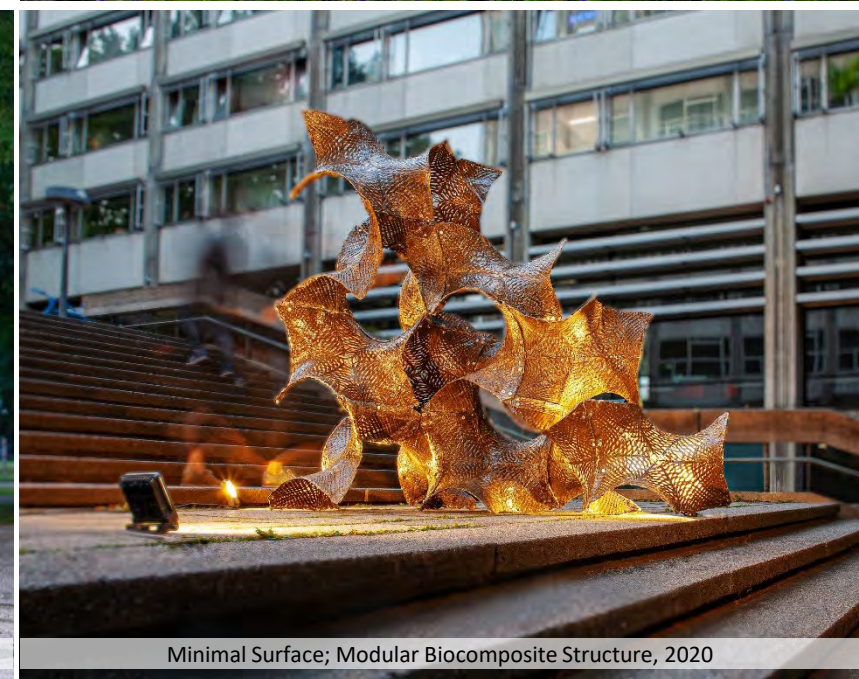
Active-bending LightPRO Biocomposite Shell Structure, 2021



BioMat Biocomposite Pavilion 2018



Tailored Biocomposite Mock-up 2019



Minimal Surface; Modular Biocomposite Structure, 2020

(C) BioMat at ITKE/University of Stuttgart

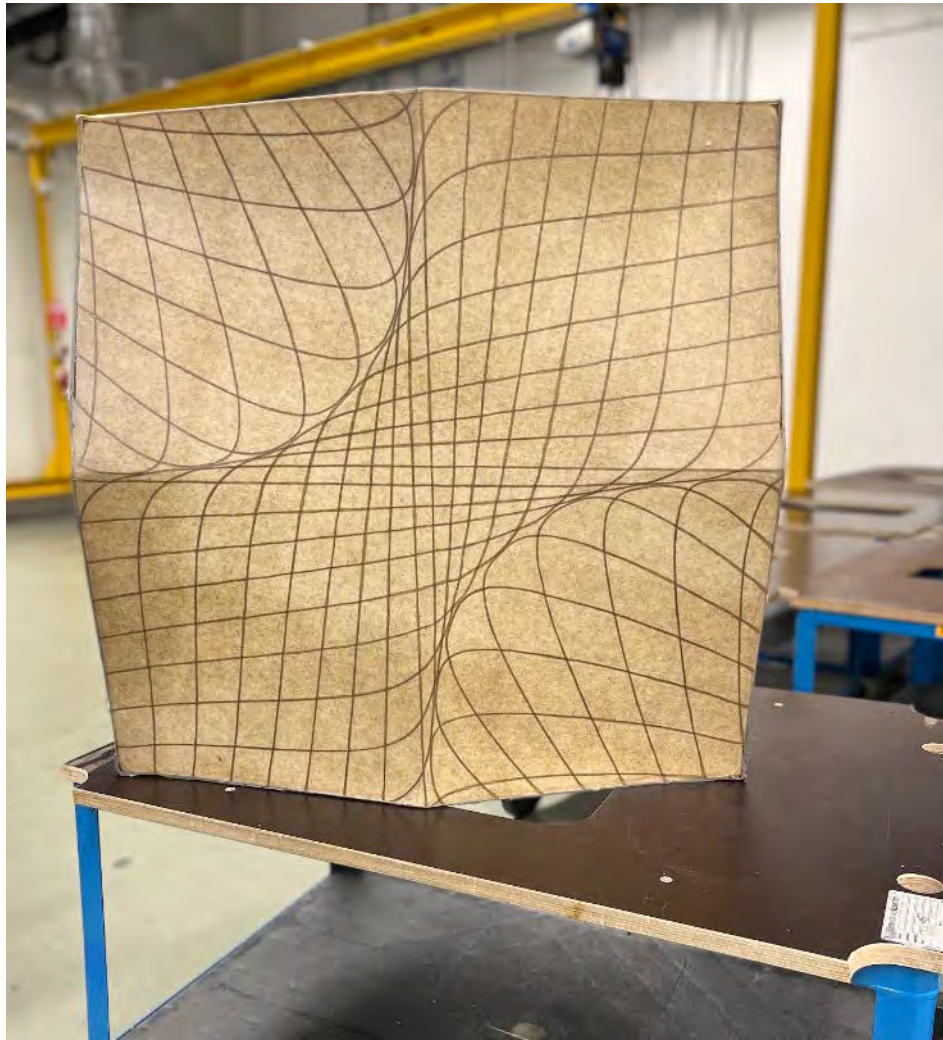
**BioMat Forschungsdemonstratoren + SCB Brücke
2018-2022**



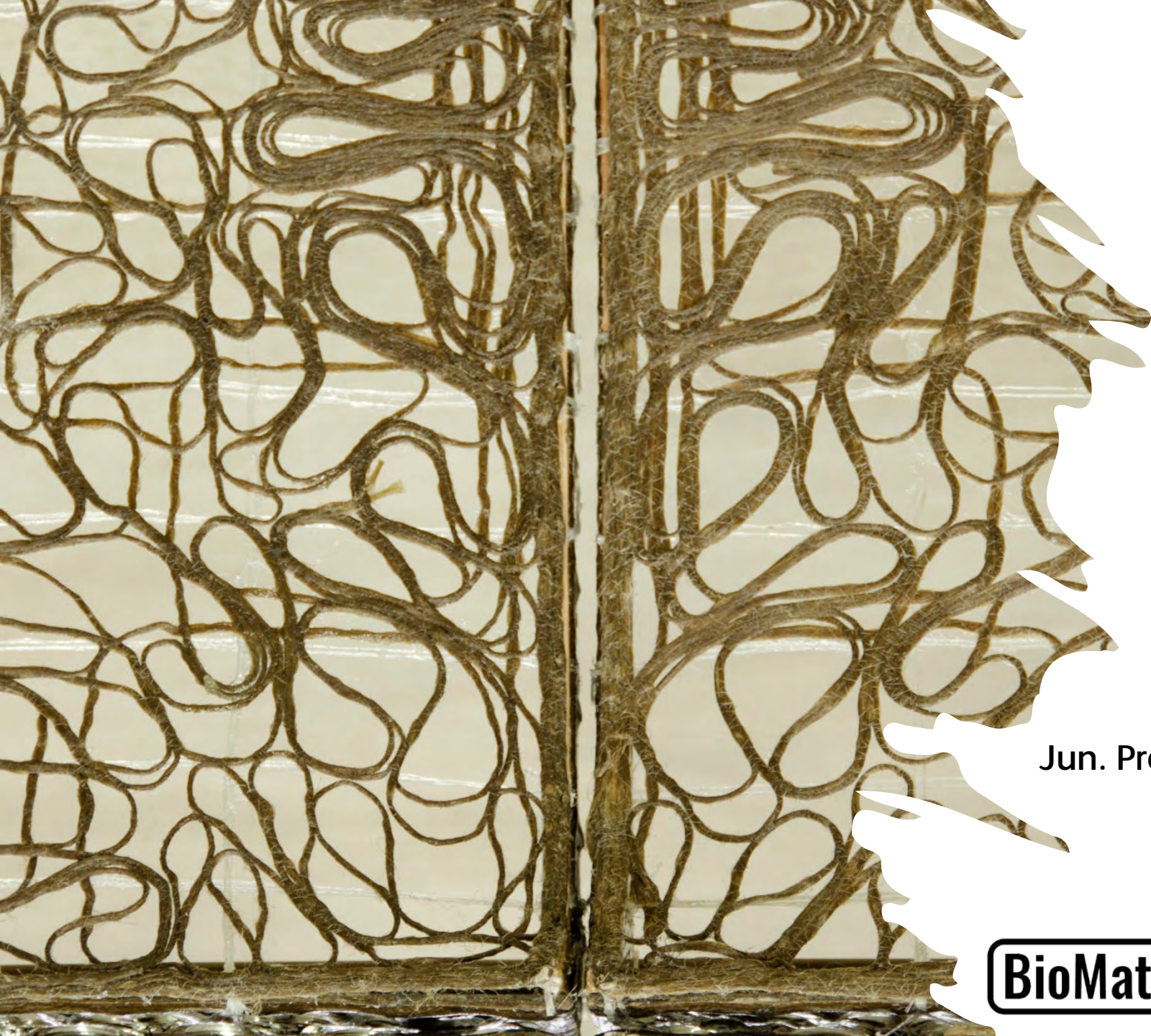
BioMat Fassadenelemente 2022

BioComposite Facade Panels (Opening market_Product Development/ JEC)

PARIS
Booth 5 C80
3.-5. May 2022



In Cooperation with EFW (Elbe Flugwerkzeuge GmbH, Faserinstitut Bremen e.V. , hightex-Dresden, Fraunhofer IFAM)



DANKESCHÖN!

Jun. Prof. Dr.-Ing. M.Eng. Arch. Hanaa Dahy

www.hanaadahy.com

BioMat.

