SCALING MATTERS: FROM THE LAB TO THE FIELD

Progress Presentations Doctoral Program »Matters of Activity«

September 2022

Matters of Activity Image Space Material

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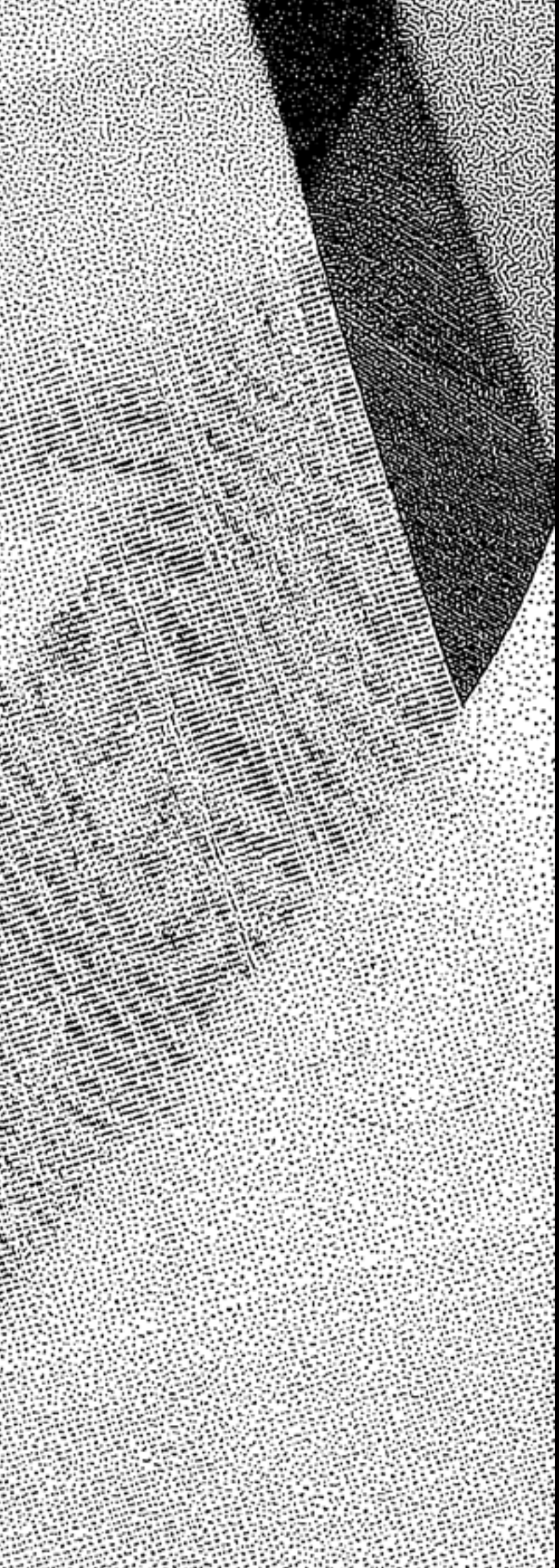


KAROLA DIERICHS & FRANZISKA WEGENER

Welcome

The 2022 presentation of the Doctoral Program »Matters of Activity« is both a review and an outlook of the doctoral research conducted at the Cluster between 2020 and 2022. Under the title »Scaling Matters: From the Lab to the Field«, Pre-Doctoral Researchers at varying stages of their research—from the very beginning to the final phase of their theses—present their heterogeneous work, whilst continuing to negotiate common themes, methods, questions, tools.

The format combines talks and an exhibition and invites MoA members to engage individually with the presenting and a selection of their research objects. Developed in the regular meetings of MoA's Doctoral Program as a practice of science communication and of peer-group formation the presentations can be viewed as a documentation of the program's approach. The small cohort size allows for an intense interdisciplinary exchange aiding the research and development of sustainable strategies and technologies. It creates an ideal basis for collaboratively researching active materiality with a high scientific standard, which is at the same time application-oriented. On the one hand, the perspective »From the Lab to the Field« points to the interrelation of laboratory work conducted in Berlin with fieldwork pursued on the activity of matter across the world. On the other, it refers to research development carried out in the program's laboratory within the field of further academic research and practical applications.

The MoA retreat on *Landgut Stober*, which is taking place in person for the first time since the Coronavirus outbreak, offers an intimate and concentrated place to share ideas, identify common grounds, offer suggestions, and exchange with one another. With this spirit, we cordially invite you to join and enrich the discussion with your perspective!

FRANK BAUER &
YOONHA KIM

Scaling Matters

Why would one choose scaling as a unifying principle to approach diversity among young researchers inquiring into active materiality? Why would one assume that scaling matters to their working process? Attempting an answer, the present format understands scaling as some transdisciplinary, operative constant, and it does so from various sides—as we learned how many concurring disciplinary perspectives contribute to its image while projecting this collective endeavor. It is fascinating to witness that whether it is in design, natural sciences or humanities, researchers use ›scaling‹ to approach active materials. Therefore, definitions of ›scale‹ used among the MoA PhD projects are not consistent, and even within a single project, one can find the concept used in manifold and often complementary ways. Rather than suggesting one concise explanation of such complexity, we would hence like to propose a conversation on the dynamic use of scaling in an interdisciplinary research setting.

The most common understanding of scale is, »the size or level of something.« As in »the microscopic to the macroscopic scale,« »at architectural scale,« or »on a global scale.« Facing prominent signs of the climate catastrophe, urgent calls to tackle the matter in multiscale frameworks are ever more present.[1] Modeled on colonial strategies[2] in the 1960s, media theorist Marshall McLuhan argued how electronic media, like any media across the realms of the personal, social and global scale, would effectively collapse the world into a village—to him, only a consequential »result from the new scale that is introduced into our affairs.«[3] In more recent years, as high-frequency finance and algorithmic trading introduced the speed of light to stock exchange, and the slow growth of lichens was explored in biological studies,[4] it became apparent how scaling does not only concern matters of size, but also time.

For our fellows Anna Schäffner and Dominic Eger Domingos, scale is closer to meaning »a set of levels or numbers which are used in a particular system of measuring things or are used when comparing things.«[5] Confronted with various actors in an operating room, such as a robotic arm, human surgeon, patient and instruments, researchers may try to make sense of the meshwork of actors by using the scale of severity, scale of stress potential, and also the scale of communication flow. In fact, certain tools are indeed shaping the perspective on scaling as an activity. This is something architectural theorist Francesca Hughes highlights in *The Architecture of Error* when she follows some of the more peculiar, and at times problematic, effects of digitization on architecture, bringing along »a production culture that now calculates and draws masonry walls with software designed to cut lenses or map brain tumors.«[6]

Many disciplines know scale as an element for differentiation, be it in terms of macro versus micro economy, local versus global history, qualitative versus quantitative analysis. Resonating, perhaps unexpectedly, with Hughes in the realm of knowledge production, the Stanford Literary Lab by literary scholar Franco Morretti, drew on the scale of reading specifically by proposing concurring reading logics on their psychological and theoretical grounds respectively. To truly understand literary history, he argues how »one needs the help of computers to crunch data from thousands of books at a time.«[7] Rather than an individual close reading, some collective and smart form of distant reading of big data would contribute better to literary criticism.

Our approach, however, would rather attempt to dissolve such opposition in the first place—asking for discourses which may revolve increasingly less around such motives of extremity and opposition in favor of motives of continuity and process.

Operations of scaling could then very much function as an epistemological workhorse, if you will. This is reminiscent of the photographer Thomas Demand, whose *Model Studies* activate the profane details of architectural scale models from John Lautner's office—when in a broader sense, his transforming of cardboard and acrylic into landscapes of meaning may invoke an alternative attention to scale and materiality. Not so differently, the present work of our MoA PhD cohort often investigates different scales of materials while dealing with the complexity of matter. Rather than picking from the binary logic of macro and micro, some combinatory and creative take on scale is cultivated, simultaneously encouraging researchers themselves to take different standpoints and produce diverse forms of data.

For example, Rasa Weber, by diving into the ocean surrounding the island of Curaçao, pays attention to the mineral accretion of limestone on the coastal ecosystem's scale while zooming into the material surface. Similarly, Felix Rasehorn and colleagues worked towards an archive of tessellated materiality, which may inspire future designers to work with geometric and material activation at once. Dimitra Almpani-Lekka argues there is no ultimate scale that gives an immediate answer to all questions; however, perceiving activities discovered through multiscale chemical and mechanical impacts helps find an explanation to the active materials. Even though their approaches are from different angles, one may see them united in putting into practice a thought formulated by plant ecologist Robin Wall Kimmerer two decades ago:

»when the ecological rules of the large transcend the boundaries of scale and still illuminate the behavior of the smallest beings. It is a search for order, a desire for a glimpse of the threads that hold the world together.«[8]

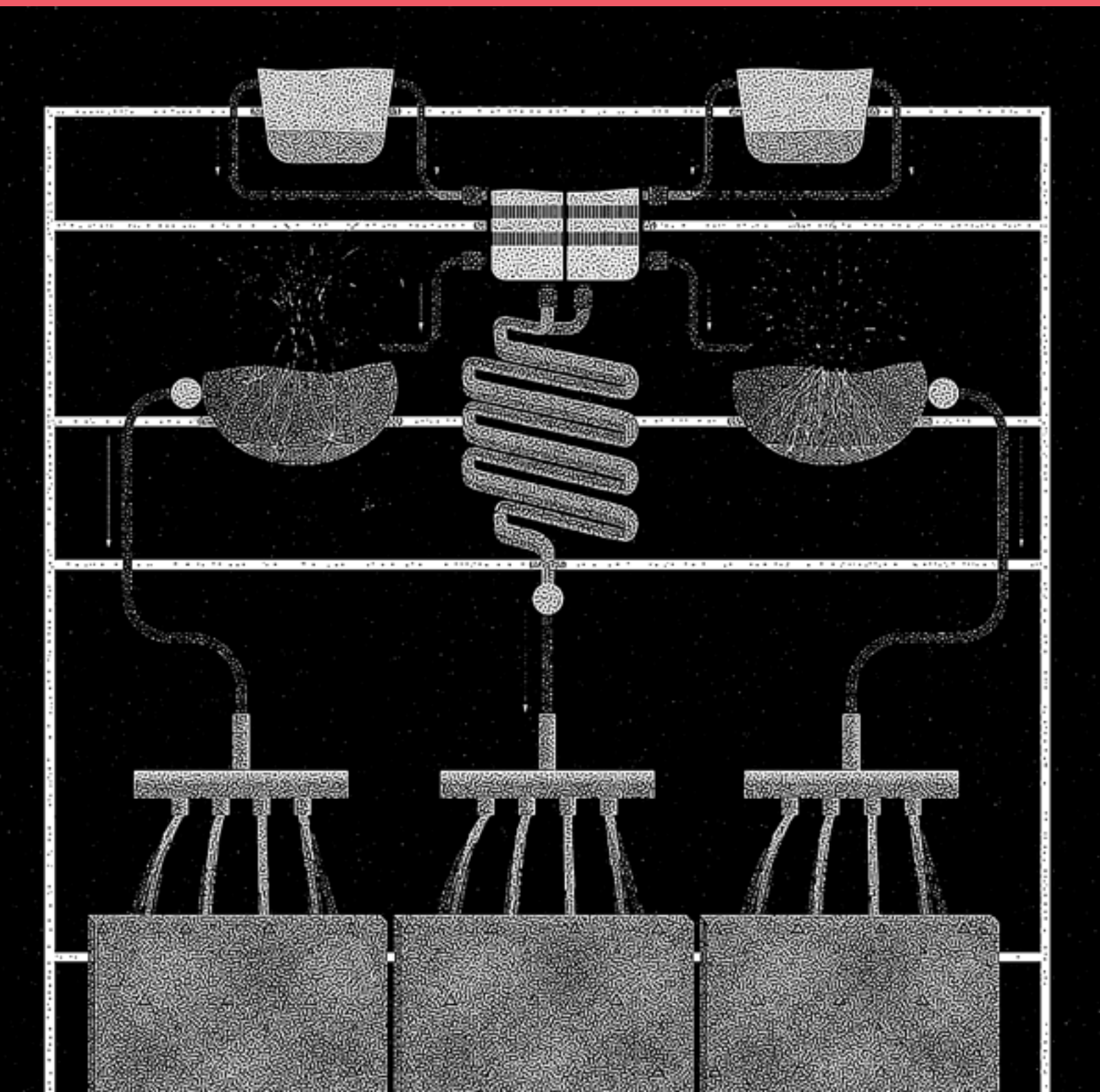
Matters are a complex dynamic between multiple scales of movements. The fuzziness of material complexity can be overwhelming when trying to get to know and correspond to its being. Perhaps scaling matters because it calls for approaches which always define and engage with systems of range, measurement and dimension anew—inevitable to any researcher seeking some sort of comfort while never knowing ›the other‹ as a complete whole.

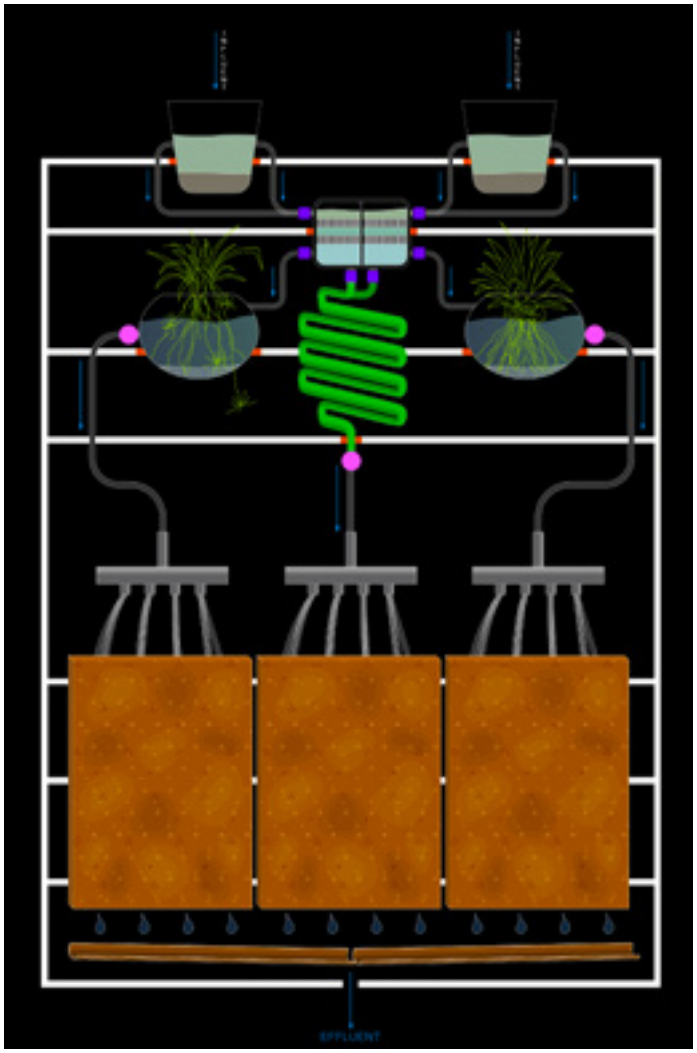
DIMITRA
ALMPANI-
LEKKA

Biosystemic Approaches in Architecture: An Investigation of Water Treatment through Design across Different Scales

Architecture

Object Space Agency





Indoor water bio-remediation system, 2022.
Concept, design and material research: Dimitra Almpani-Lekka
Design support: Paulina Grebenstein

Water is a vital resource for the sustenance of life. Due to population growth, long-term droughts, industrialization, and mounting water pollution it is becoming increasingly scarce. Domestic water demand in industrialized countries consists of 30–60% of the urban water demand, of which 60–70% is transformed into greywater, with the rest being used mostly in toilet flushes. Considering that domestic and industrial water demand is predicted to rapidly increase by 2050, it is obvious that architecture needs to address this issue by integrating design solutions related to water management.

The proposed design project is for the creation of an indoor water bioremediation and air filtering device. The device is a shelving system with consecutive levels that correspond to the following different steps in the water remediation process:

1. Influent grey water collection
2. Physical filtering of larger suspended particles
3. Phyto- and bio-remediation vessels
4. Sphagnum moss planted plates
5. Effluent water release

The purpose of the device is to test alternative methods of water and air filtration systems that rely on natural biological processes aided by biotechnology. The project explores alternative models of living where the user is engaging in the infrastructural process of water treatment and is in an everyday interdependent symbiosis with different species. The project aims to create a dialogue between the »outside« and the »inside« and question the border between them by transforming the way we use and experience interior space.

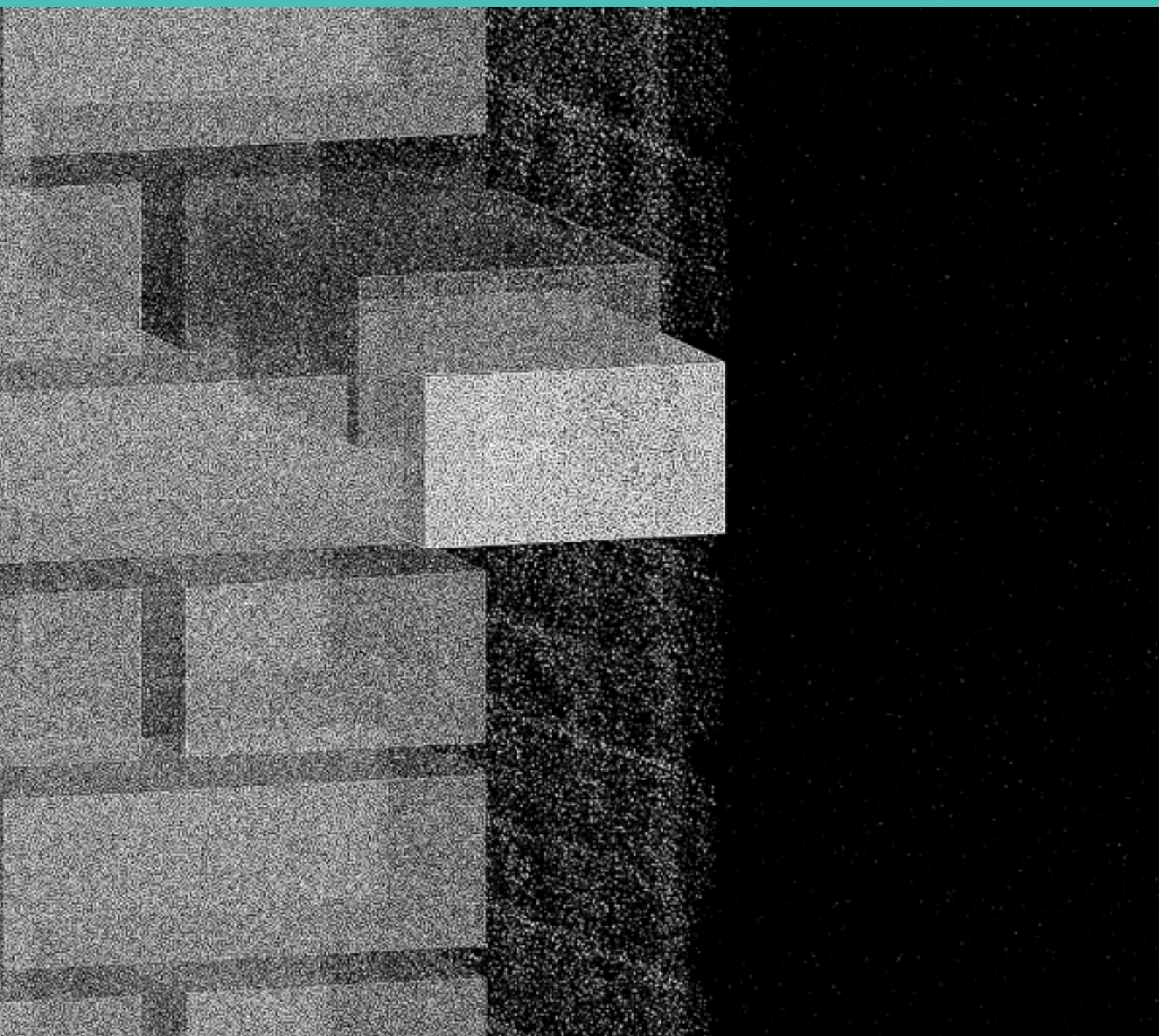
Dimitra Almpani-Lekka is an Architect (Dipl. Arch. Eng.) who has been working in the field of landscape architecture for the last few years. She is member of the SciArt Collective *MY-CO-X* that experiments with the use of mycelium-based composite materials in architecture. Almpani-Lekka explores architectural structures as potentially active, integrated parts of the environment's metabolic processes and is part of the project »Object Space Angency« and currently a PhD Candidate at the University of Ioannina, in Greece, under the supervision of Prof. Dr. Yannis Zavoleas and Prof. Dr. Claudia Mareis.

FRANK BAUER

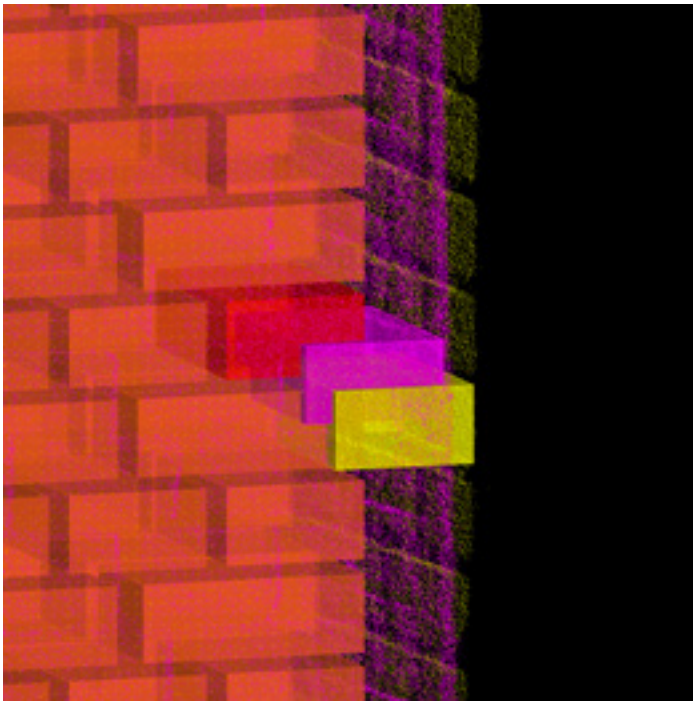
Disegno in ›Digital Chains‹

Material Form Function
& Symbolic Material

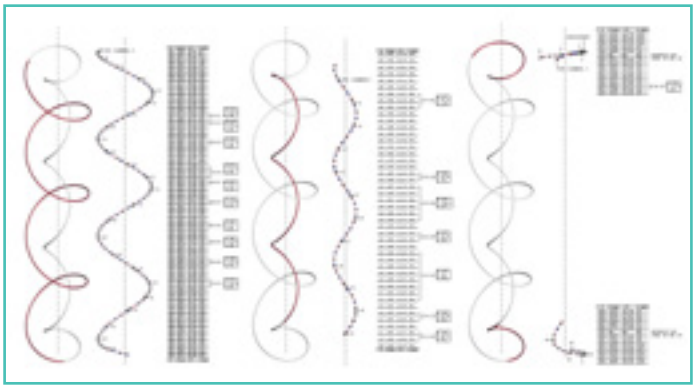
Architecture



The thesis aims to install persistent and instrumental strategies in building. Its relevance stems from the manifold ways in which the translation of complex geometries through emerging building technologies require bespoke and smart notation, material and manufacturing systems. Assuming that prevalent work on transdisciplinary dependencies of such strategies in digital making remains in its infancy, it suggests looking for them outside of disciplinary borders and existing shapes of practice—exemplified in two exhibited objects spanning from preservation to art production. The argument questions how existing strategies foregrounding motives of control, optimization and machine learning may be augmented through human and blended modes of feedback and recursivity. It reveals emerging relations of notation and manufacturing, putting notions of the ›digital chain‹ into perspective, and rather calls for specific forms of elegance and activity between data-driven and physical manufacturing which employ constraint spaces of production. Before the trans-temporal affordance, productivity and activity of notation, it uses methodologies of »Persistent Modeling« to merge data engineering, material experiments, simulations, 3D captures, prototyping and digital manufacturing along several trajectories. Throughout this process, individual case studies and experiments support inquiries into the research questions which follow how emerging notational logics are in fact building new notions of materiality.



Quantitative deviation analysis, study *Persistent Model of the Built*, industry partners: Uretek, Carl Stahl, Plan3D.
Copyright: Frank Bauer



Bending data set, notation study for helix geometry, industry partners: s-hamacher, Thomann, SOE.
Copyright: Frank Bauer

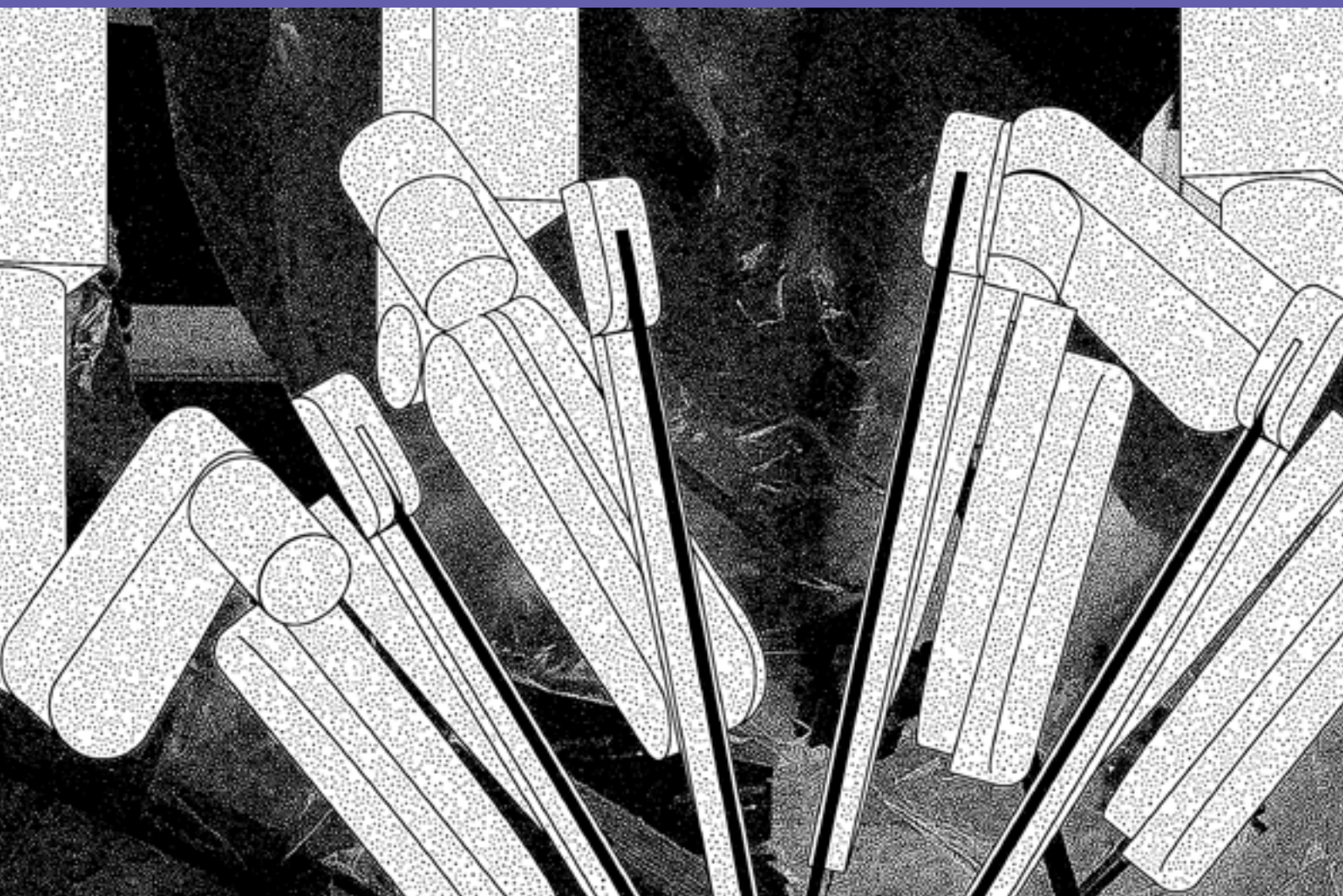
Frank Bauer engineers instrumental and operative extensions of manufacturing in the realm of computational art production. He studied architecture at University of the Arts (UdK), with stays at Illinois Institute of Technology / University of Illinois Chicago, and political science and cultural history in Freiburg, Berlin, and Mainz. Following positions at the Fondation Vasarely and KWY Lisbon, he co-founded Büro Vogel Bauer—a planning agency for fine arts production. His teaching efforts are situated within the BA and MA programs at UdK, the research-based MA Design & Computation (UdK/TU Berlin), as well as on international MA programs like the Design for Manufacture MArch at The Bartlett (UCL), where he attempts to shift discourses from possibility to constraint spaces of technology. Frank's thesis is supervised by Prof. Dr. Norbert Palz and Prof. Dr. Wolfgang Schäffner.

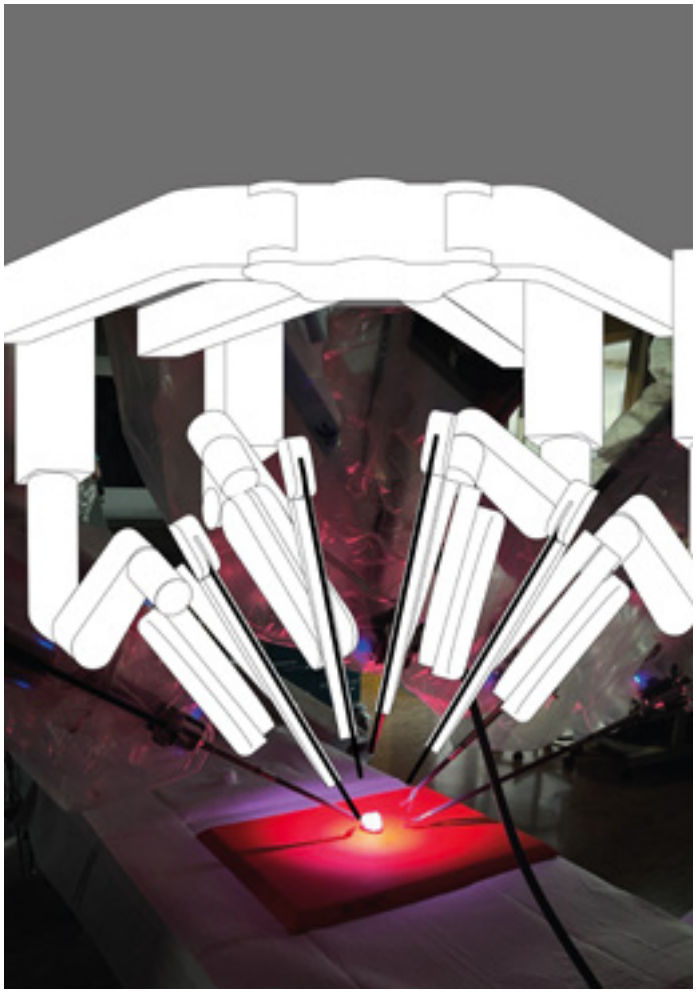
DOMINIC EGER
DOMINGOS
& ANNA
SCHÄFFNER

Rethinking Human-AI Collaboration: Scenario-based Design of Socio-Material Practices in Robotic-Assisted Surgery

Product Design

Cutting & Filtering





Graphic representation of a Da Vinci robot in its functional environment.
Copyright: Anna Schäffer

Robotic Assisted Surgery is a project of MoA's »Filtering« group, which focuses on developing new human-machine collaboration designs for future digital operating rooms.

In this context, sensory perception, information filtering, and collaborative (AI-supported) decision-making are vital aspects that will be evaluated in relation to all relevant actors in the operating room—human, non-human, and their environments.

Currently, surgeons work with minimal-invasive telemanipulators, i.e., human actions are synchronously reproduced as machine movements[9] by a surgical-robotic system. The next generation of robotic assistance focuses on the surgeon-robot interaction and suggests full automation. Research focuses on independent improvements in sensory perception,[10] situational awareness, and medical decision-making. However, previous developments show that such isolated considerations of single actors and problems could lead to undesirable influences on other actors.

The understanding of robust collaboration in robotic surgery, where humans, machines, and their environment collaborate and coexist, has not been developed in depth for robot-assisted surgery.[11] Within this research, the design team is reflecting on how we can analyze such an operational situation from the perspective of all key actors. In our first attempts, the design team developed a new visual language that serves as a tool to display, analyze, and imagine future scenarios in an interdisciplinary approach.

Anna Schäffner is a Pre-Doctoral Researcher within the project »Filtering«, and a practice-based PhD Candidate in the SACRe Doctoral program at École nationale superieure des Arts Décoratifs, Paris (EndSAD) - under the supervision of Prof. Samuel Bianchini and Prof. Dr. Patricia Ribault.
Her research focuses on soft robotics, and the design of deformation as a vector of movement, as a capacity for dynamic material adaptation and expressiveness. Through the practice of design, she explores hybrid forms of interacting, advancing the relation between robotic objects and their environments. Anna's thesis is supervised by Prof. Samuel Bianchini and Prof. Dr. Patricia Ribault.

Dominic Eger Domingos is a Pre-Doctoral Researcher within the projects »Filtering« and »Cutting«. Since his MA at weißensee school of art and design berlin, his focus has been on digital cutting. He develops concepts of digital materiality and physical interaction with haptic feedback by creating tangible prototypes. Domingos' work contributes to an interdisciplinary understanding of complex interaction challenges, creating scenarios for enacting concepts and, thus, fostering new settings for collaborative surgical robotic tools.

JOHANNA
HEHEMEYER-
CÜRTEN

REVALUATION OF TREE BARK
Waste Material to Precious Material: How can the Value of Tree Bark be Increased?

Fashion & Textile Design

Material Form Function

The subject of Johanna's PhD project is to reinterpret the existing knowledge about tree bark and make it relevant for today. To do this, she investigates sustainable designs and application scenarios with tree bark that reconcile the material life-span with the use-phase of an object.

Plants make up 80% of the biomass on our planet[12] and wood has always been one of the most important raw materials. Considering the current ecological crisis and the growing demand for biodegradable materials, tree bark could play an important role. Bark makes up 10–20% of a tree and, in Germany alone, about 4 million cubic meters of bark are produced annually as a by-product or waste product of the wood industry.[13]

However, bark has been known as a material for thousands of years. Stone tools for treating bark have been found in China dating back to around 8000 BC.[14]

In addition to its use, the importance and value of tree bark has changed throughout history. For example, the Celts (800 BC–1 AD) used hats made of birch bark probably as a status symbol.[15]

The aim of the project is to develop textile materials to create kinetic installations and spaces. Currently, Johanna is developing folding techniques with pine bark in combination with hemp yarns, which could then be applied to temporary folding roofs, for example.

Pleated Pine Bark.
Photo and Copyright: Johanna Hehemeyer-Cürten

Johanna Hehemeyer-Cürten is a fashion- and material designer with a strong interest in biomaterials and material innovation. She studied at the Maastricht Institute of Arts and the weißensee school of art and design berlin.
As a Pre-Doctoral Researcher in the project »Material Form Function« and in the research group »Adaptive Fibrous Materials« at the Max Planck Institute of Colloids and Interfaces she develops sustainable design strategies for tree bark using weaving- and folding techniques. Johanna's thesis is supervised by Prof. Dr. Karola Dierichs and Dr. Michaela Eder.

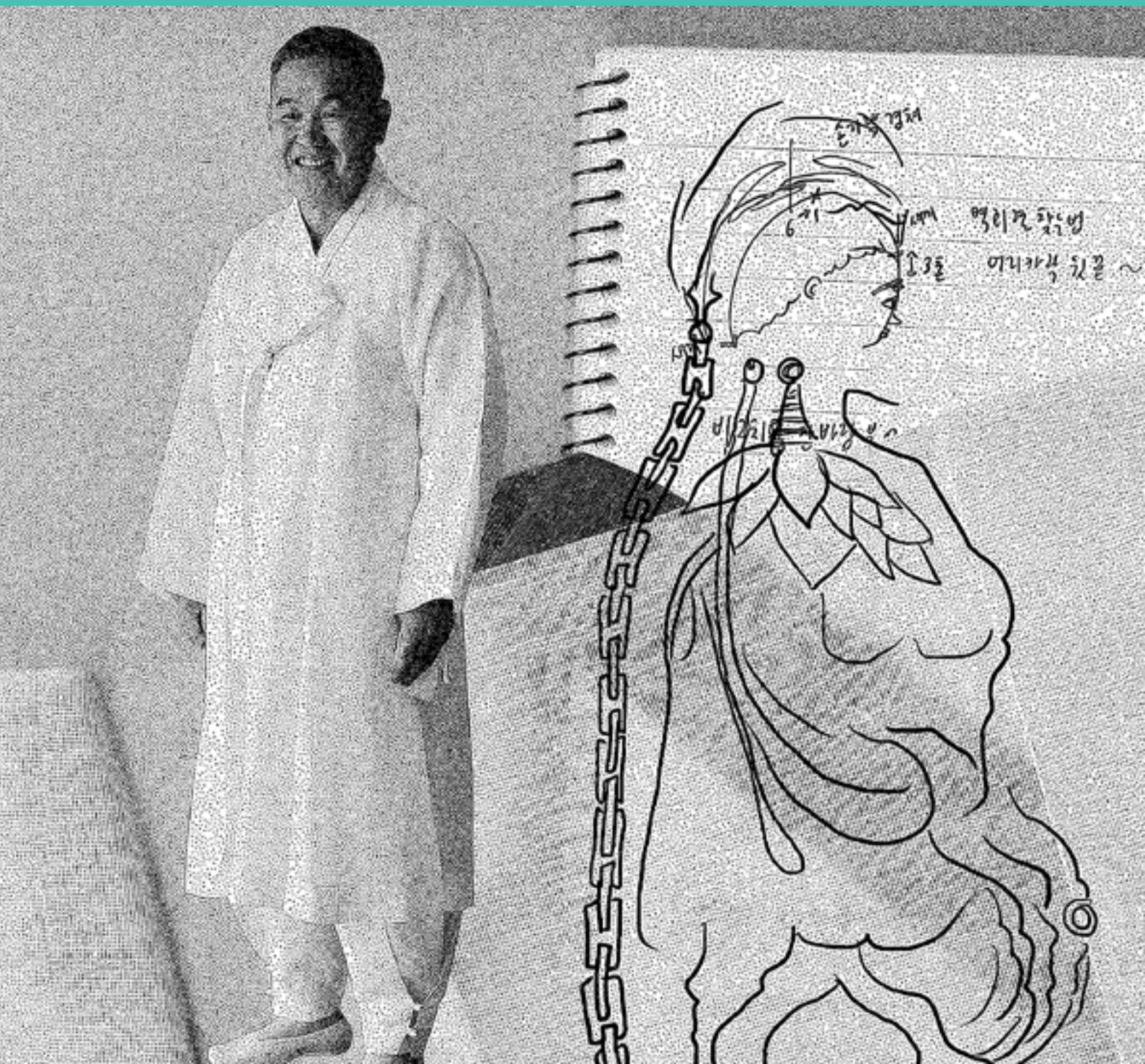
Pleated Pine Bark.
Photo and Copyright: Johanna Hehemeyer-Cürten

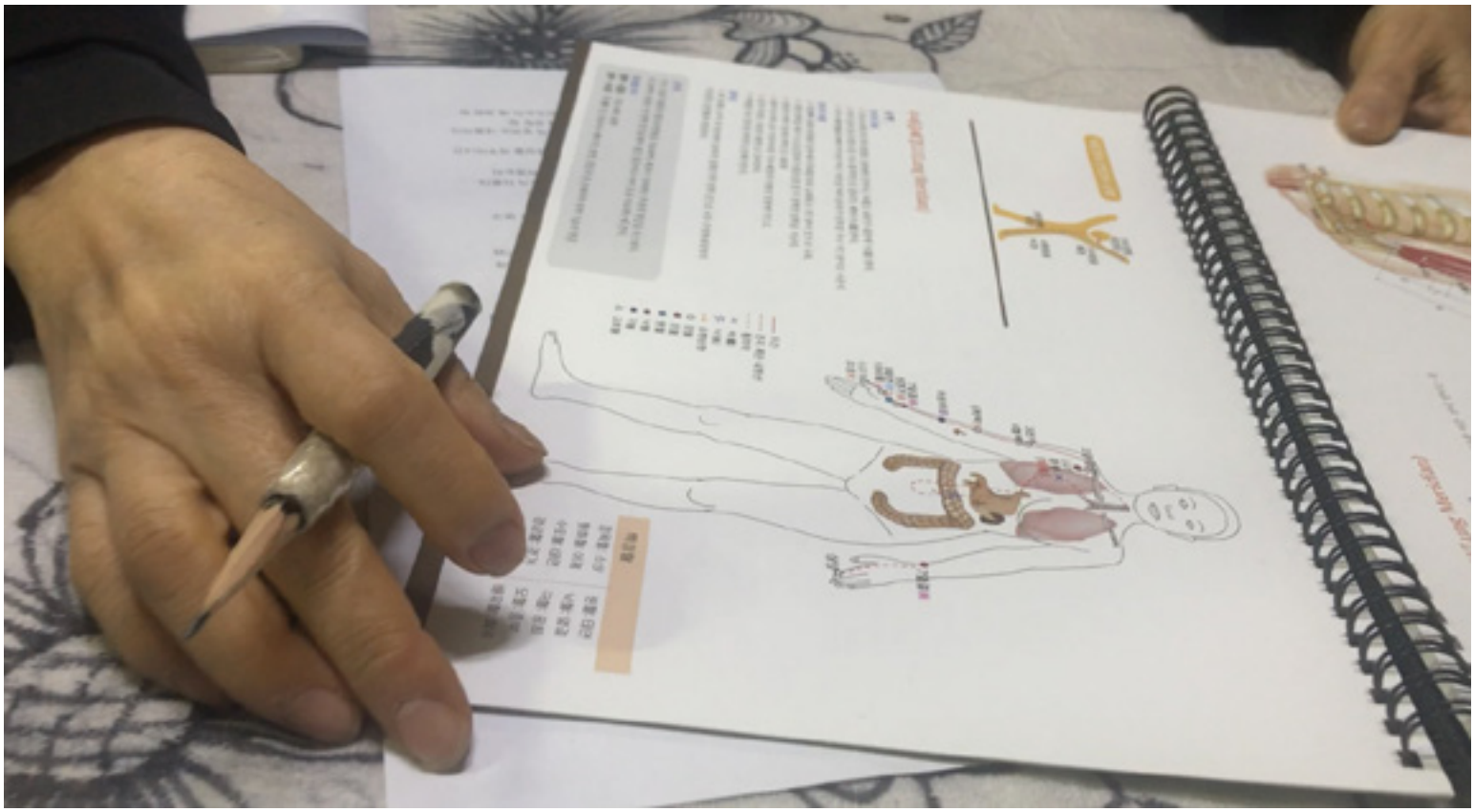
YOONHA KIM

Wearing Sallim: Korean Cosmotechnics and Alternative Worldings

Design & Anthropology

Object Space Agency





Lee Kiyeon describes the relation between hanbok, the body and the cosmos. Photograph by Yoonha Kim.

Previous spread: Silk weavor HuHo, scan of fieldnote and ShinHyungJangBuDo (chart of the overall body, viscera, and bowels). Photograph by Yoonha Kim.

Weaving a new culture of active materials can draw on traditional clothing from a spatial-temporal zone that highlights the enlivening (*Sallim*) aspect of the Anthropos as in-between beings (*Sai Jonjae*) taking part of the meshwork of inextricably linked symbionts.[20]

Through multi-sited fieldwork and wearing as a method of knowledge-making, Kim looks into the traditional Korean garment *Hanbok* (or *Uriot*) as a cosmogram[21] and a case of cosmotechnics.[22] In East Asian cosmology, the universe is perpetually shifting through the interaction of yin and yang. To make sense of the a priori turbulent world, analogical worlding brings order by finding a pattern of similarity between different scales of things.[23] For thousands of years hanbok making and wearing practices have been reflecting the correspondence between macrocosm and microcosm.

Rather than arguing everything is connected or enforcing environmentalism, the specificity of entanglement and the stance human actors should take matter in proposing alienness beyond a master pattern of the Singularity.[24] After sociotechnical Westernization, hanbok is still multiplying through the friction[25] between the commercialization of daily life and the reimagination of heritage.

In the 1980s, Lee Kiyeon started a movement of wearing traditional clothing as a way of practicing an alternative material culture against neoliberal globalization. Since then, a group of people have been reviving an overall mode of being in the more-than-human world from before industrialization across diverse daily activities in Korea: minimizing waste, giving value to ragged materials, fermenting, mending, and taking care of each other. Kim follows this re-enchantment of local worlding, corresponding with the sensitive silkworms and their spirits, fine dust, weavers, wet looms, smartphones, acupuncturists, clothes makers and the twenty-four solar terms marking changes in animal and material conditions.

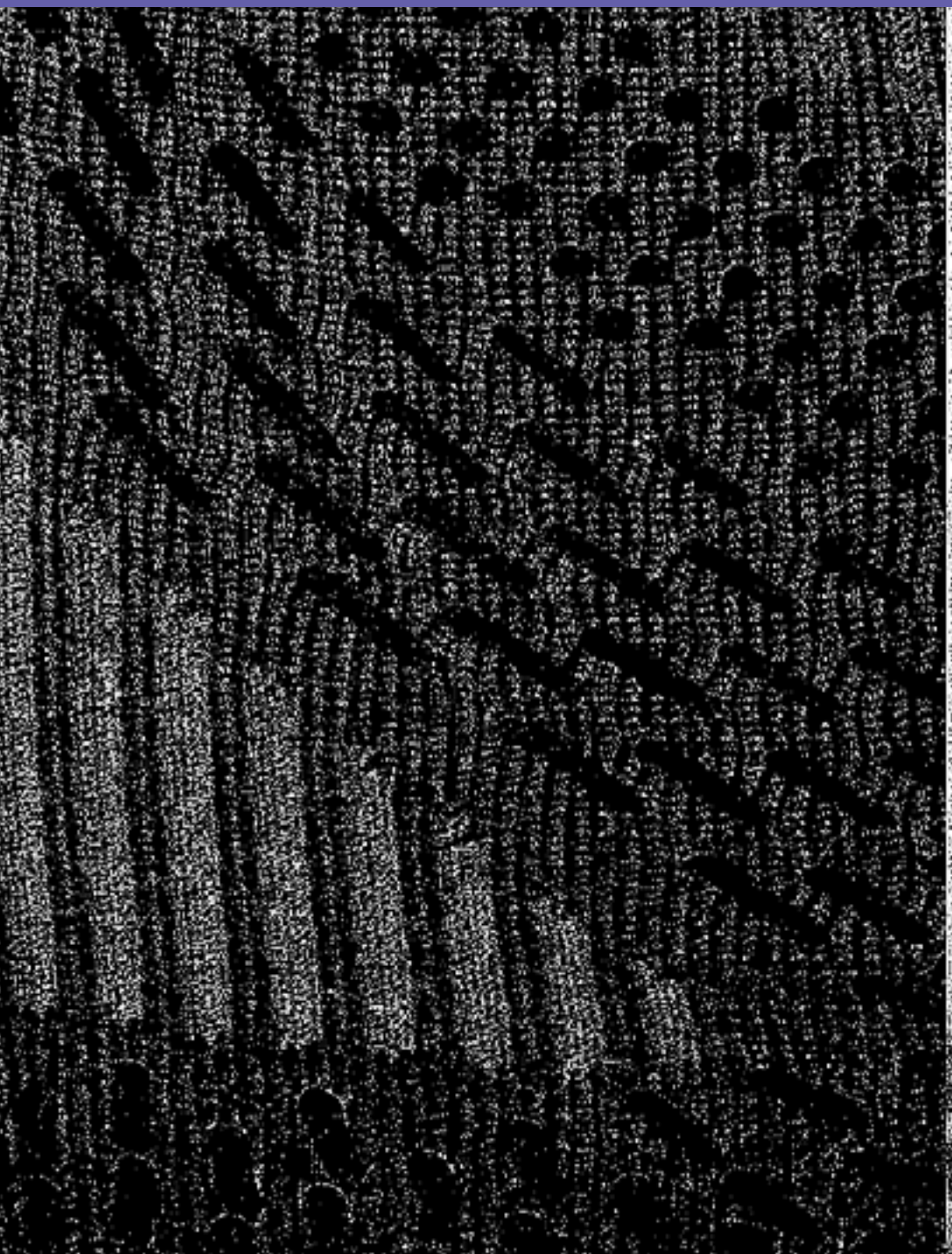
Yoonha Kim is an anthropologist with a background in design. She is interested in the relationship between technology and locality in the age of the planetary. Her project is situated at the intersection of Design Anthropology and heritage studies within »Object Space Agency« and is supervised by Prof. Dr. Sharon Macdonald and Prof. Dr. Claudia Mareis. From curatorial practices to filmmaking and sensorial workshops with emergent technologies, she explores multi-modal forms of anthropological research.

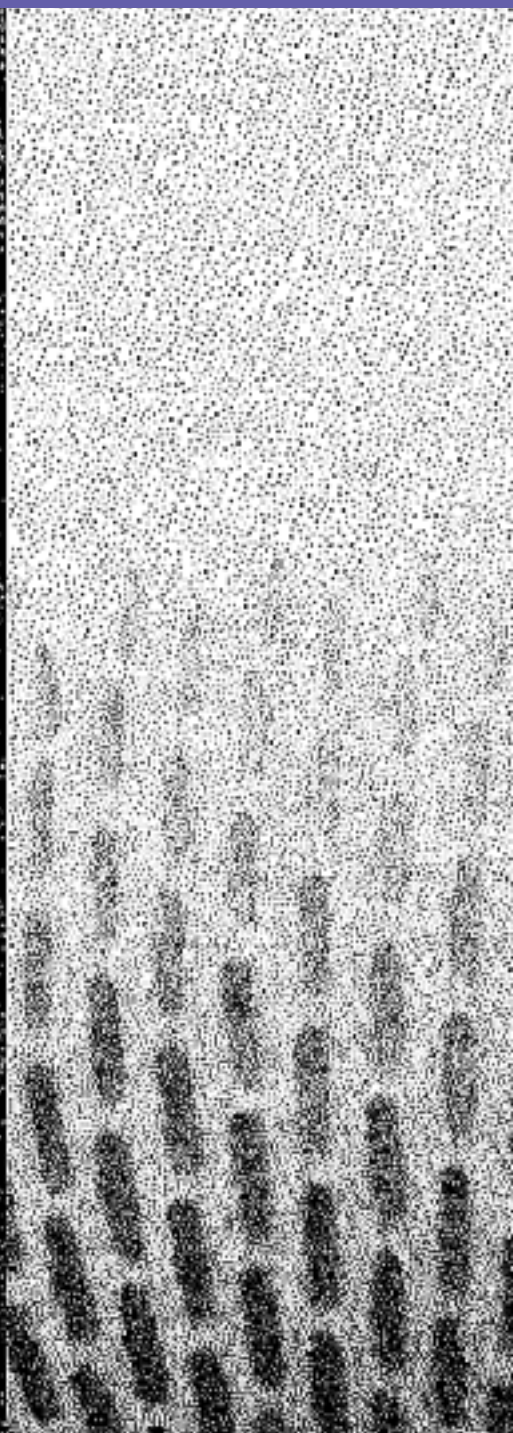
FELIX
RASEHORN

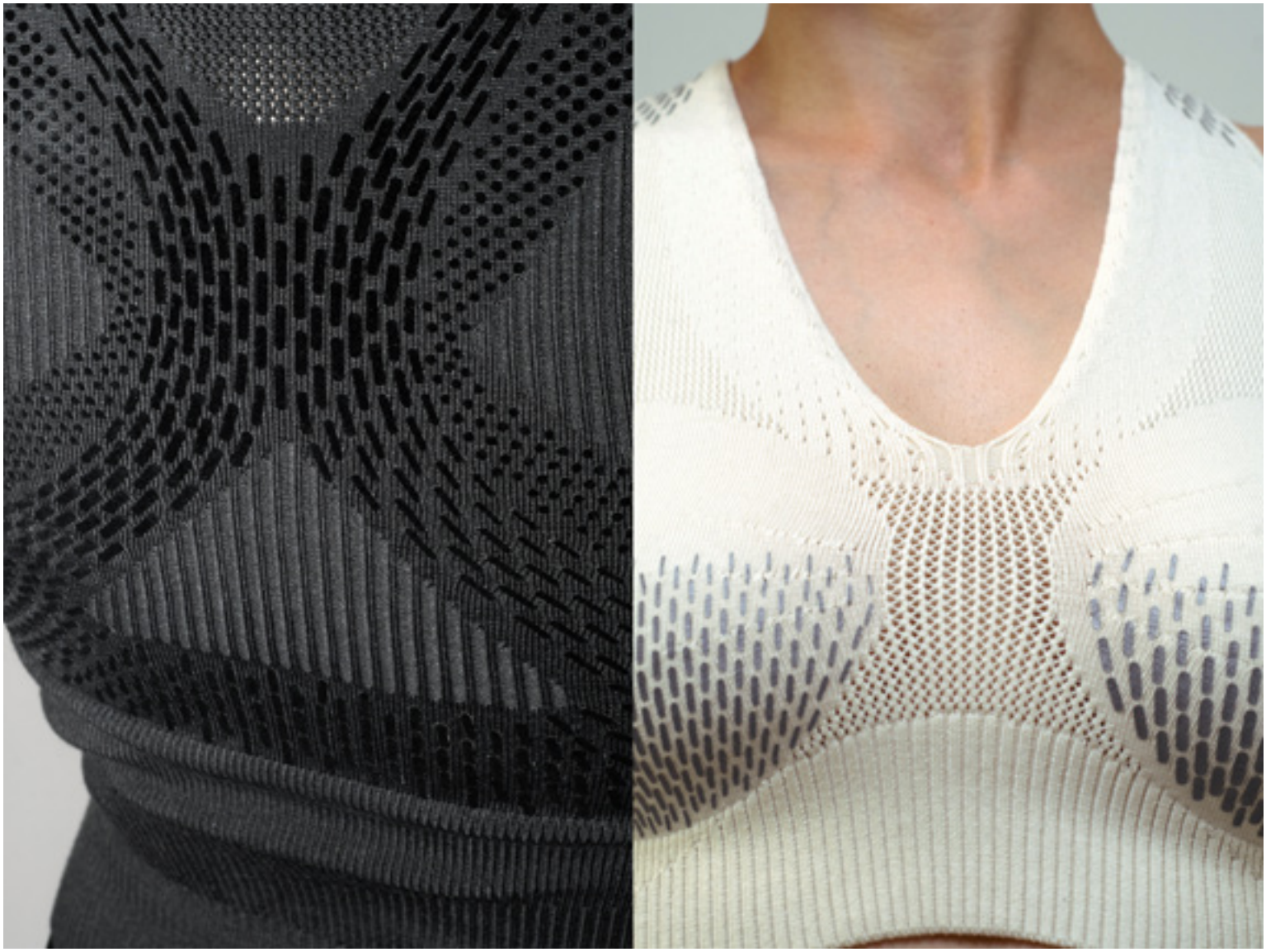
TESSELLATION EVERYWHERE
Designing Hierarchical Structures to Achieve Context Sensitivity and Multifunctionality

Product Design

Cutting & Material Form Function







embrace 2 - Photo by Arnoud Ele, Project lead: Silke Hofmann
(funded by Re:Fream)

In nature, Tessellated Material Systems (TMS) appear convergently across species and in different granularities. Their evolutionary success is based on the ability to unify mechanically opposing properties in one functional system. While the application of tessellation in design and architecture often focused—and still focuses—on the geometrical and structural benefits, this practice-based PhD project explores a design approach that shifts the focus from structure to material. Designing hierarchical materials allows for recognizing context sensitive information, leading to multi-functionality and personalization. The irregularities and asymmetries in natural TMS create inherent functional properties that can be productive strategies for constructing adaptive and context-aware surfaces. The underlying natural processes responsible for pattern formation can be regarded as functions or programs, which are, per definition, context specific; the context of a pattern is an essential parameter to consider. If such context is misunderstood or insufficiently understood, a biomimetic approach alone cannot lead to meaningful Designs or applications (Vincent, Menges, Hensel, n.d.). The challenge of applying principles of TMS in real word scenarios is therefore not purely technical, but involves the implementation, coordination and evaluation of contextual information—design practice.

Felix Rasehorn is a creative researcher and practice-based Pre-Doctoral Researcher in the projects »Cutting« and »Material Form Function«. With a background in design and prototyping of interactive experiences at the weißensee school of art and design berlin, he is interested in the production of knowledge through practice. In 2019, he co-founded WINT—a Berlin-based design lab dedicated to exploring ecological and technological responsibilities for shaping desirable futures. Since 2020, Felix is part of »PEP (Program Entwurfsbasierte Promotion)« at TU Berlin , supervised by Prof. Ignacio Borrego and Prof. Jürgen Weidinger. In his doctoral studies, Felix is interested in the convergence of tessellations in nature and its applications in design.

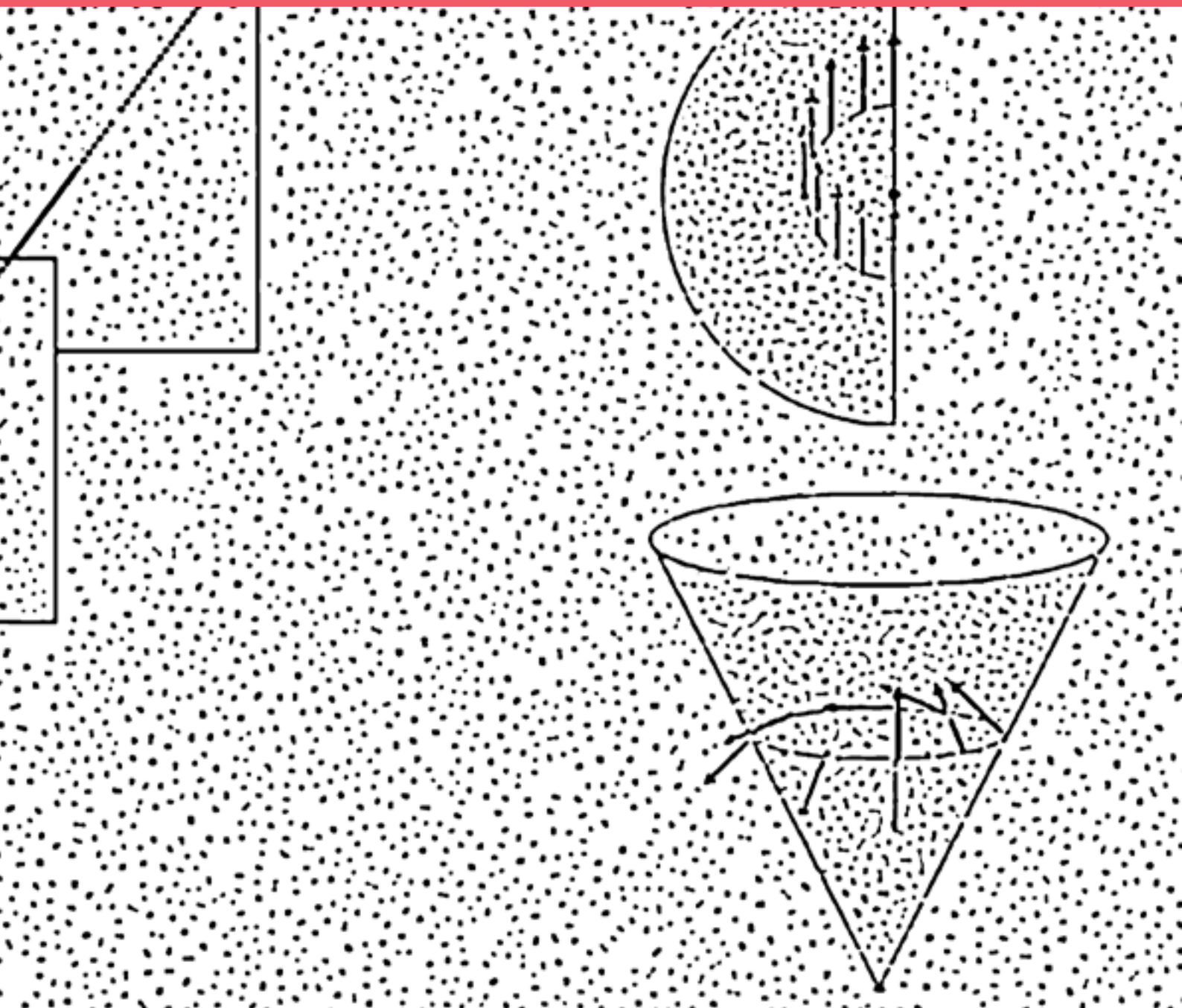
Boxfish project - Photo by Felix Rasehorn

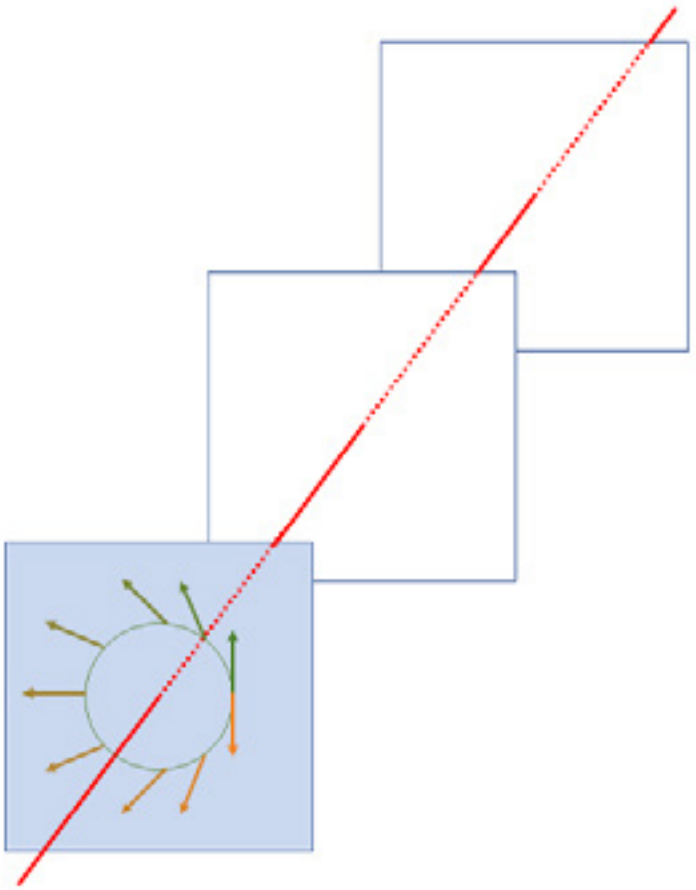
JAKUB
RONDOMANSKI

Geometric and Topological Analysis of Spaces of Self-Adjoint Operators

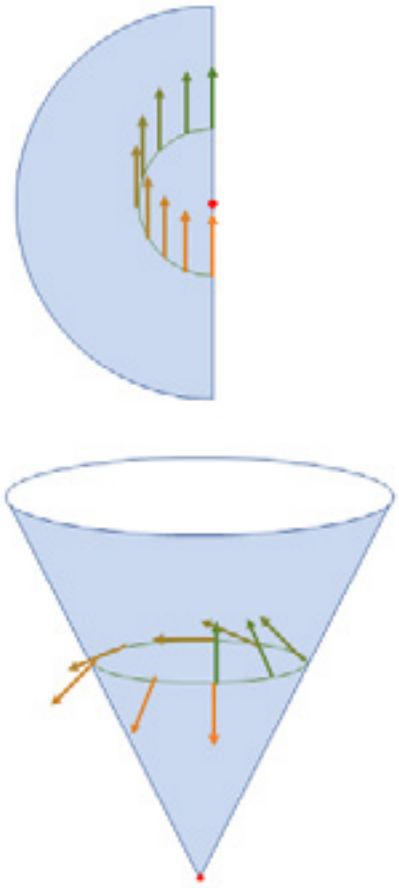
Mathematics

Filtering





Left: The 3D-space of symmetric 2×2 matrices foliated into 2D-planes, each consisting of matrices with equal trace. The red line consists of matrices with equal eigenvalues. On the green circle is a continuously changing eigenvector.



Right: Parallel transport of a tangential vector around a cone (bottom right: standard embedding in 3D-space, top right: cut and flattened in a 2D-plane).

Self-adjoint operators are of central importance throughout the physical sciences. In quantum mechanics, all observables (i.e., measurable quantities) are described by such operators. But even in classical systems, the Laplace operator is involved in any differential equation describing a dynamical process like the vibration of a solid body, the movement of a fluid or the spreading of heat.

The key property of self-adjoint operators is given by the spectral theorem of functional analysis. It states that each operator splits the space it acts on in a discrete sequence of pairwise orthogonal, linear spaces of eigenvectors, i.e., vectors which only get scaled by the operator. The sequence is ordered by the size of characteristic frequencies, which means that a small-scale noise in the system will only affect the eigenmodes with the highest frequencies. This allows a substantial reduction of complexity in the processing of discrete geometries.

In our project, we look at closed curves in the space of all self-adjoint operators and observe how a frame of eigenvectors rotates along it. A geometric result is that we can model this rotation as a parallel transport, if we put a metric on this space which is flat everywhere apart from the subspaces with equal eigenvalues, on which it has infinite, conic curvature. A topological result is that we can find a branched covering space on which the rotational effects trivialize. In the talk, we will look at the 3-dimensional case.

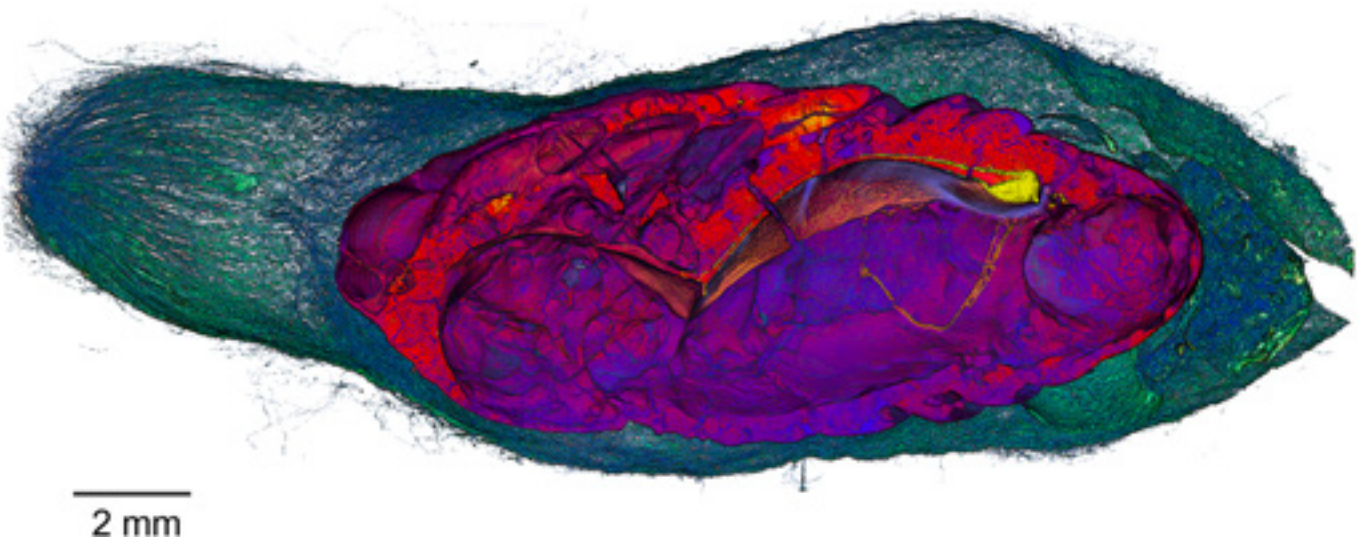
Jakub Rondomanski finished his MSc in mathematics with a thesis on the spectra of Dirac operators and the use of spinor methods in submanifold theory. During his master's, he also worked on meshing problems in 3D volumes as a student assistant. Since January 2021, Jakub is a Pre-Doctoral Researcher in the »Filtering« project were he works with applications of topological and geometric methods in geometry processing, solid state physics, and molecular dynamics. Jakub's thesis is supervised by Prof. Dr. Konrad Polthier

NIKOLAI
ROSENTHAL

Multi-Scale Characterization of Fiber Systems and Fiber Structures in Nature and their Geometric-Constructive and Design Development into Fiber-Based Constructions for Spatial Applications

Medical Engineering

Material Form Function & Weaving



Colorized micro CT image of an individual silk cocoon (green hues) of Epanaphe spec. and the pupae (red hues) inside the cocoon.
Copyright: Nikolai Rosenthal / Max Planck Institute of Colloids and Interfaces

Fiber systems are ubiquitous in nature and serve a vast range of functions. The research focuses on the examination of structures created by wild silk moths as one model system and *Bombyx mori* as a reference system.

Silk is produced by a great variety of arthropods to actively create external structures. These structures provide a great variety of functions, e. g., protecting the organism, its eggs, capturing prey, as well as creating a controlled micro-environment. While the properties of silk and silk structures made by spiders and *Bombyx mori* are subjects of intense research, this is not the case for African wild silks, especially outside the context of sericulture, like the properties and structures created by the moths. Caterpillars of many African wild silk moth species live in communities and collaboratively weave a communal silk nest, in which they spin small individual cocoons for metamorphosis. The nests are attached to trees, rocks or found in empty burrows in the ground. The nest structure adapts to, and incorporates, the environment.

The cultural use of silk cocoons and nests by humans, their processing to create a variety of fabrics, fishing nets, charms, and more, as well as their use in spiritual contexts, implicates their properties beyond their classic material properties and offers another point of view into the biological system.

The relationship between the composition, architecture and material properties of silk is explored through consideration of the natural environmental conditions. State-of-the-art imaging and material characterization techniques are used and combined with simulations and physical models to understand the interaction and biomechanics of the biological systems. The overarching goal is to characterize the silken composite structures and their functions and transfer these to biomimetic technical solutions, e. g., in architecture, the textile industry, design, and modeling.

Nikolai Rosenthal earned his MSc in Medical Engineering at the University of Stuttgart in collaboration with the Deutsche Institute für Textil- und Faserforschung (DITF) and Max Planck Institute of Colloids and Interfaces with a thesis on properties and ultrastructure of the insect cuticle and applications in biomimetic medical devices. Hitherto, he worked on behavioral neuroscience at the Marine Science Center of Northeastern University, Boston, the Max-Planck Institute for Plant Breeding Research, and the Max Planck Institute for Intelligent Systems. Before joining »Matters of Activity« and the projects »Material Form Function« and »Weaving«, Nikolai worked as a scientist at the DITF on textile sensors and actors, textile solutions in an architectural context, construction, and urban consolidation. His thesis is supervised by Dr. Michaela Eder, Prof. Dr. Claudia Fleck, Prof. Dr. Dr.h.c. Peter Fratzl and Prof. Christiane Sauer.

MAXIE
SCHNEIDER

Polymorph Textility

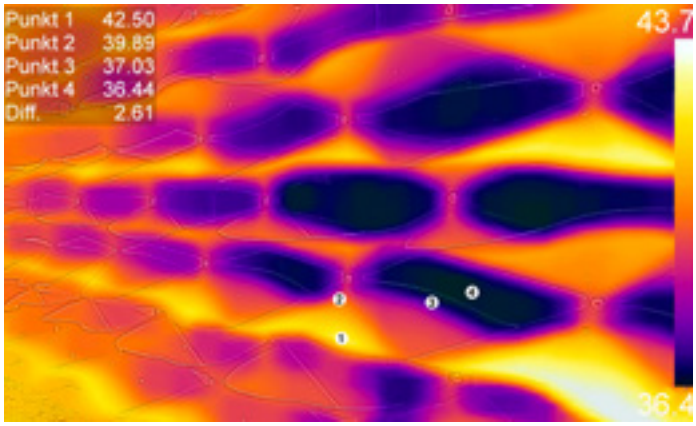
Architecture & Design

Material Form Function & Weaving

The PhD project »Polymorph Textility« explores material programming and shape behavior in response to external climatic stimuli in a practice based research project.

The aim is to elaborate a multi-scalar design method for self-forming textiles with shape memory alloys as a thermally activecontrol component. Physical and computational experimentation with inherent material capabilities are relevant, thus they may renovate predominant limitations of building culture towards more integrated, adaptive and sustainable strategies. With the development of a computer aided design-to-fabrication framework, such actuated hybrid membranes with dynamic elasticity and compliant bending and buckling morphologies can be introduced. Under the supervision of Prof. Christiane Sauer and within the research consortium »Adaptex«, performative and sensory qualities of the systems are proposed and validated through physical implementation in solar shading components.

Installation of Adaptex Wave Shading System at GUTech Eco House in Muscat. Photo: Maxie Schneider



Thermography shows the effect of shading and the influence of solar radiation on surface temperatures. Picture: Maxie Schneider

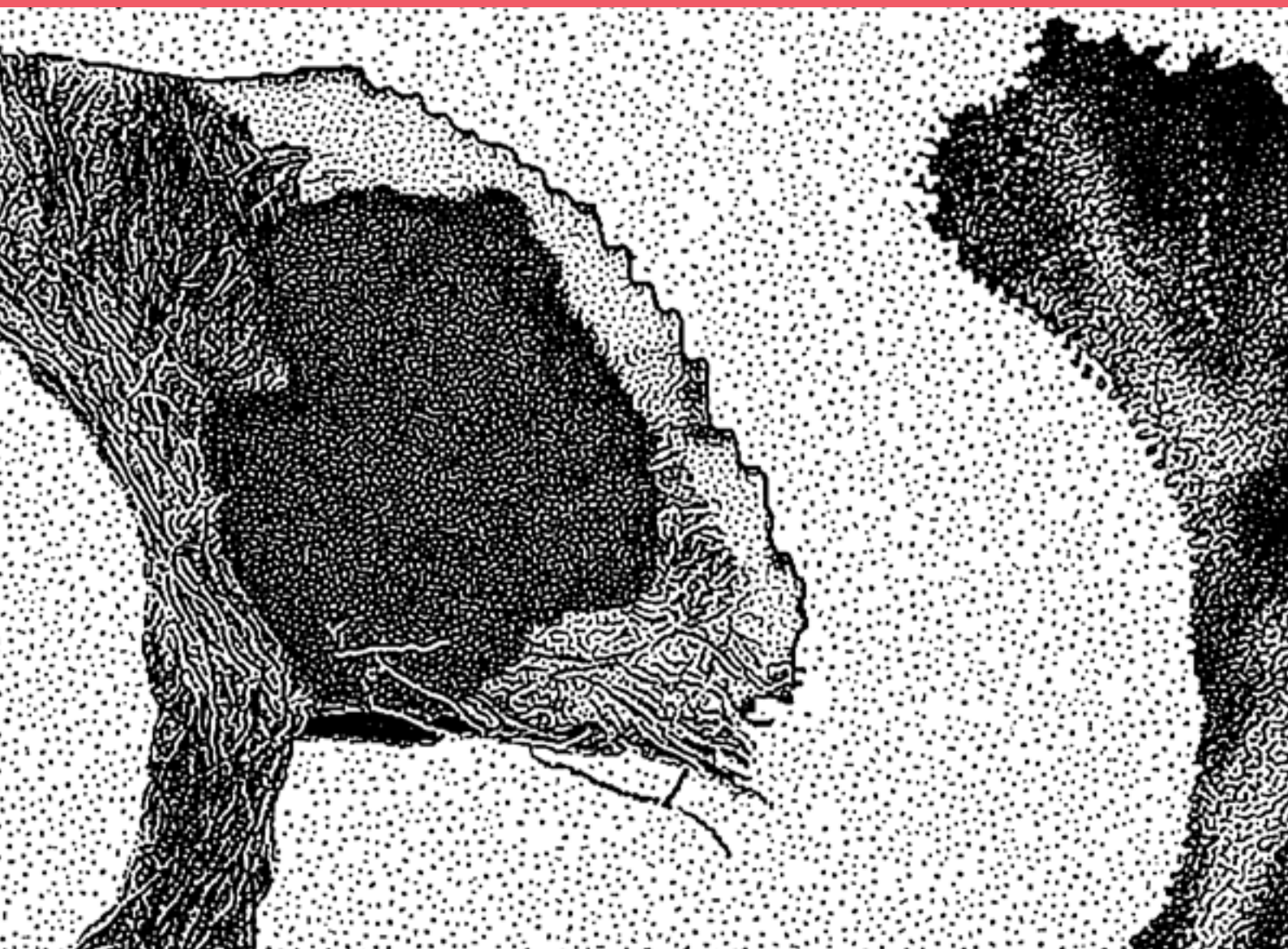
Maxie Schneider is an architectural design researcher. Her work combines material-based physical and digital prototyping to develop new building techniques and material systems. She has collaborated on various design-build projects and advanced material experiments into structural implementation. Since 2017, she teaches textiles in spatial context at the weißensee school of art and design berlin. Maxie is a Pre-Doctoral Researcher at »Matters of Activity« and Max Planck Institute of Colloids and Interfaces, bridging the projects »Weaving« and »Material Form Function«. As a practice-based PhD candidate at TU Berlin, she investigates adaptive hybrid textile structures and the functionalization of softness in architecture. Maxie's thesis is supervised by Prof. Christiane Sauer , Prof. Ignacio Borrego and Prof. Jürgen Weidinger.

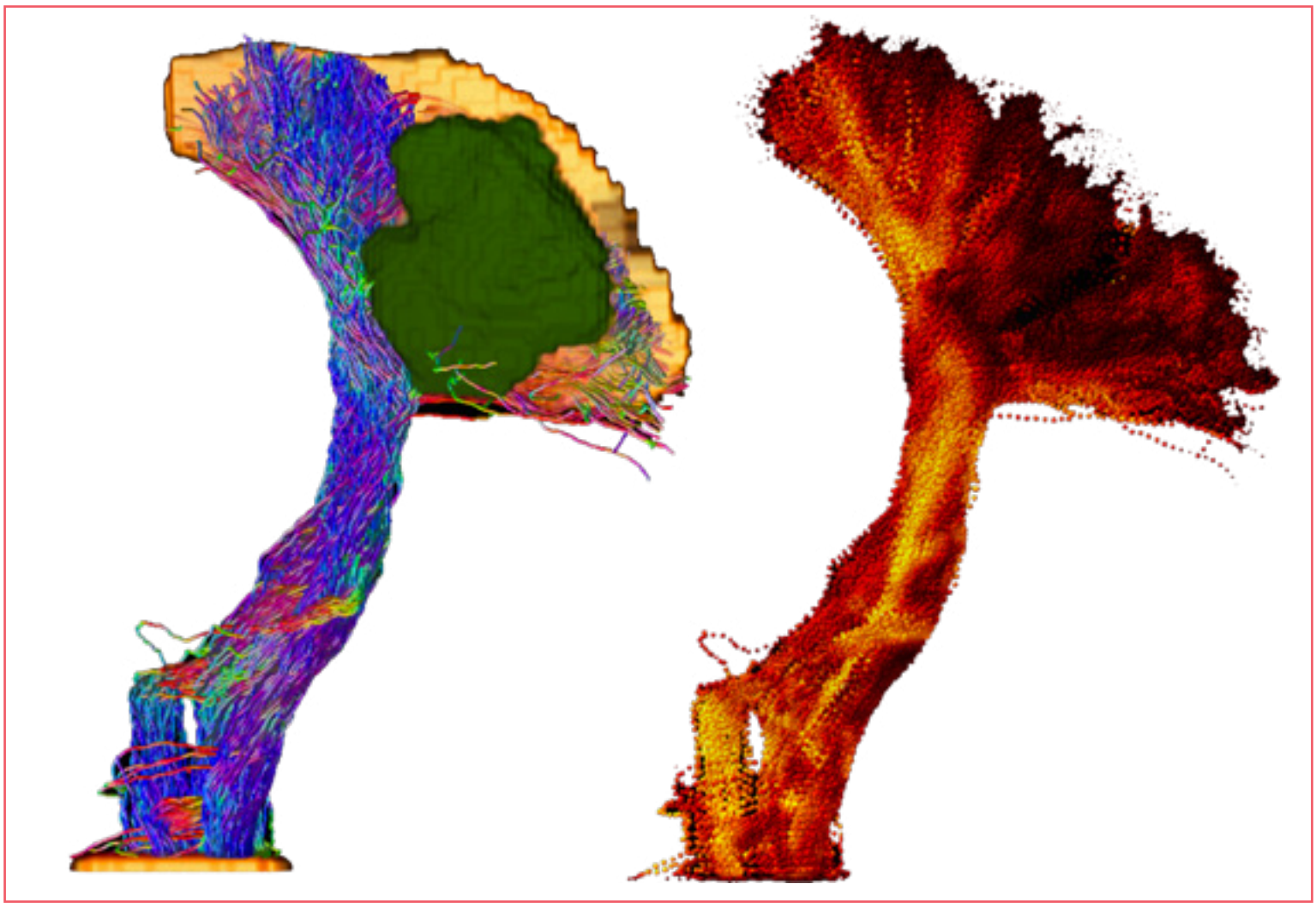
BOSHRA
SHAMS

Applying Machine Learning Methods to Improve our Understanding of the Local and Global Impact of Brain Tumors on Structural Connectivity

Computational Neuroscience

Cutting

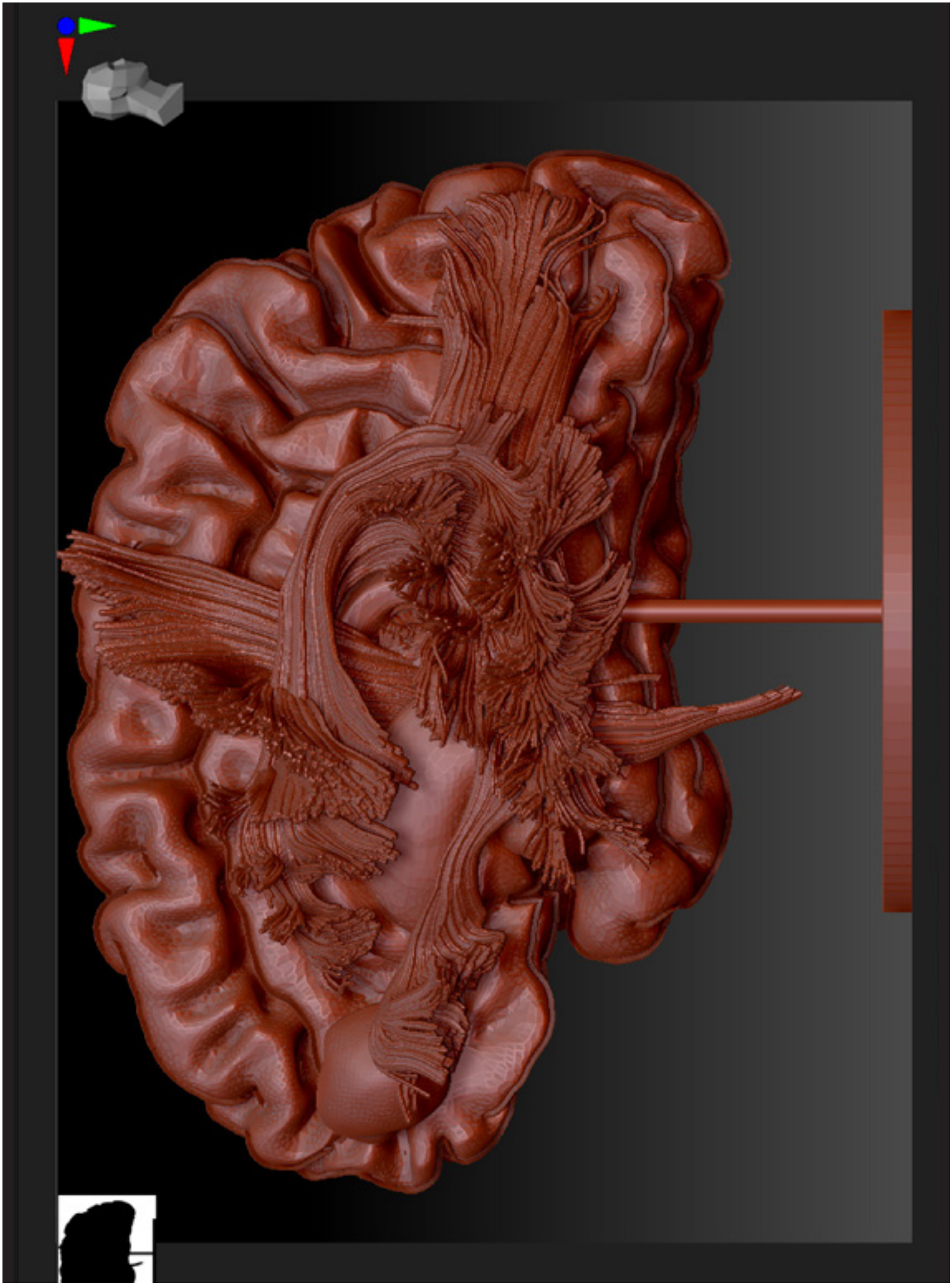




Corticospinal tract tractography in relation to brain tumor; Subsequent resampling, detailed white matter analysis and motor status assessment. Copyright: Lucius Fekonja

One of the most important prognostic factors of survival duration following brain tumor surgery is the extent of resection. The presence of eloquent areas within or near a tumor often limits resection, as resection performed in these areas would result in functional loss and thus affect prognosis. Therefore, to balance between maximizing tumor resection and sparing important functional hubs in neuro-oncological surgery, an advanced understanding of brain tumor impact on brain structural connectivity is of great importance for all specialists treating brain tumor patients, especially in relation to malignant gliomas. These tumors grow in an invasive pattern, posing a high risk of neurological deterioration. Diffusion MRI models reveal detailed insights into white matter changes with development, function and tumor-induced local microstructural changes. Also, tumors may lead to brain structural network (connectome) alterations. A connectome can potentially serve as a predictive biomarker in various diseases, e.g., tumor-induced alterations in connectomic profiles related to clinical phenotypes and functional deficits. To improve treatment efficiency and level of control, we aim to establish models based on machine learning to extract diagnostic and prognostic biomarkers for functional impairment in tumor patients by investigating local and global impacts of tumors on white matter architecture, large-scale human brain networks, and individual cognitive function.

Boshra studied computer science and artificial intelligence during her bachelor and master degree. After graduating, she joined Forschungszentrum Jülich and focused on »Functional Connectivity Fingerprinting«. She is currently doing her PhD at Charité—Universitätsmedizin Berlin (supervision Prof. Dr. Thomas Picht) and is a Research Associate in the »Cutting« project. Her research lies at the intersection of machine learning and neuroscience. She aims to exploit cutting edge deep learning methods to better understand structural-functional relationships which facilitate patient-oriented diagnostic and prognostic tools in neuro-oncological surgery.



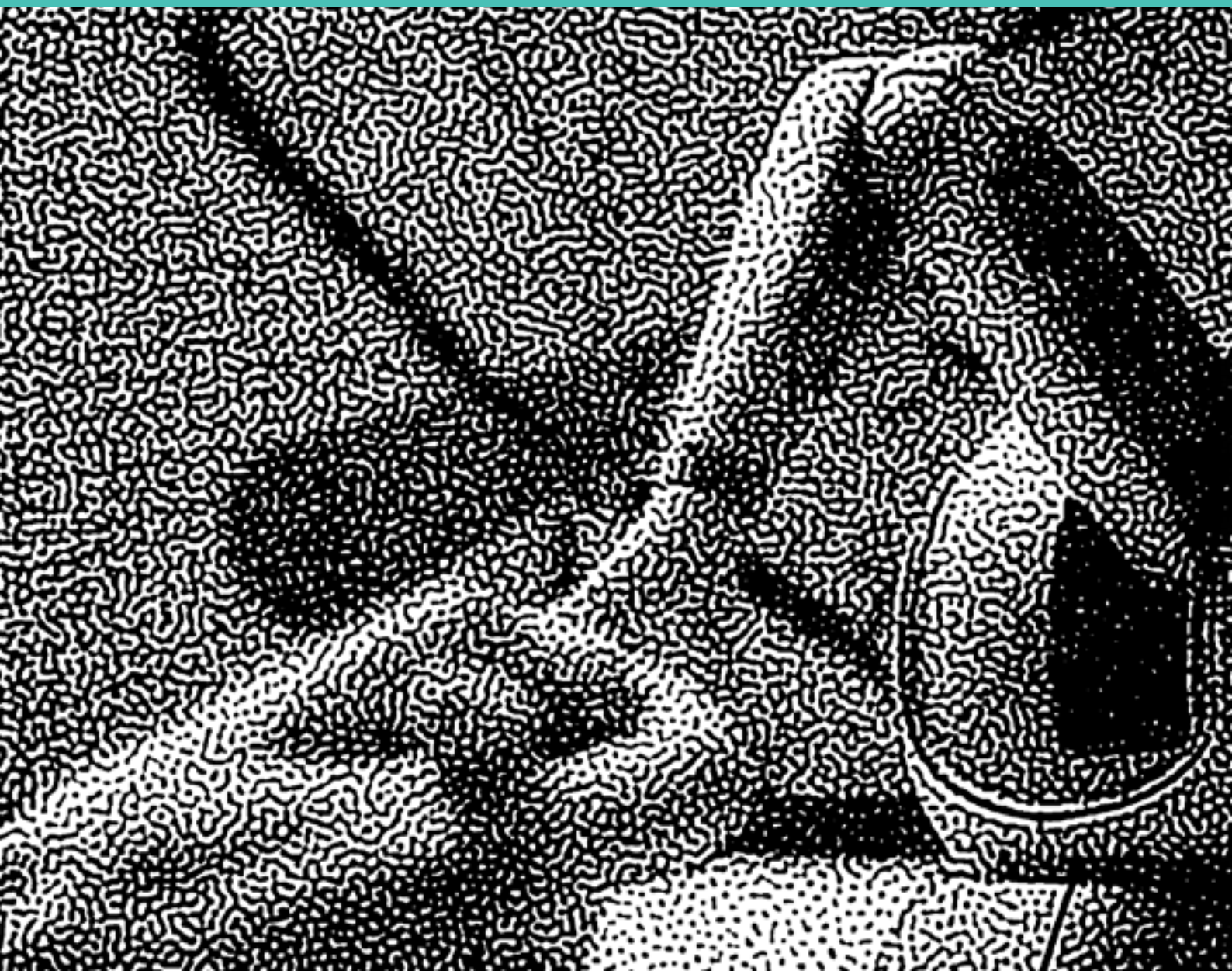
3d model of a brain with left hemisphere for 3d printing, single fiber bundle and segmented tumor created based on MRI data

LUCAS
SIQUEIRA
RODRIGUES

Visuo-Haptic Exploration of Biomedical Tomographic Data

Computer Science

Cutting



Volume-Rendering Haptics.
Copyright: 3D Sytems and Lucas Rodrigues

This experimental setting delves into the potential utility of visuo-haptic exploration in the context of anatomical and paleontological dissections and preparations. Three-dimensional image data will be transferred into virtual reality and manipulated with novel software tools that will assist researchers in image segmentation — a data-processing method in which we identify and delineate boundaries between different materials or tissues and assign meaning to them. Interactive segmentation methods will enable users to simultaneously manipulate data and discover its embedded features. In that manner, researchers will augment their perception and understanding of the information depicted in the data. This new virtual reality implementation will incorporate force-feedback haptics to assign materiality to datasets. We expect many potential benefits of the transfer of such datasets from 2D screen representations to visuo-haptic virtual reality. Researchers will understand complex anatomical structures using tangible instruments to explore matter in a more intuitive way. Additionally, we will investigate the potential of a multi-sensory integration on the developmental process of mental representations of complex structures. By extending the activity of digital cutting and segmenting as a hands-on approach to thinking, we strive to bring dissection—a classic analog craftsmanship—into the digital universe of the twenty-first century.

Lucas Siqueira Rodrigues is a Pre-Doctoral Researcher in the »Cutting« project. He holds a master's degree in Human-Computer Interaction from KTH Royal Institute of Technology and Paris-Saclay. In his doctoral studies, he aims to further develop the concept and application of »Virtual Dissection« with a particular focus on haptic feedback in interactive data visualizations within virtual reality environments towards the attainment of knowledge surrounding form-function relationships in biomedical tomographic data. Lucas' research is supervised by Prof. Dr. Ing. Johann Habakuk Israel, Prof. Dr. John A. Nyakatura and Dr.-Ing. Stefan Zachow.

RASA WEBER

Minus Zero – Interspecies Design in Underwater Environments

Title of Thesis:
Growing Matter.
A Sympoietic Design Approach
to the Ocean.

Design & Architecture

Material Form Function

PhD Thesis *Growing Matter,* sampling at minus eight meters.
Rasa Weber, STARESO – Station de Recherche Sous-Marines et Océanographiques, Corsica, 2022.

The development of scuba diving in the twentieth century gave humans the opportunity to ›go visit‹ underwater environments. While it unlocked unknown territory to think and act, it also provoked colonial ideas of the human conquest of the sea. The ocean turned into an archive of design imaginaries.

Designers and architects have recently developed a growing interest in collaborative forms of making beyond species barriers.[26] They introduce a different perspective on the design process as a highly complex, entangled and growing system. Inspired by an environmental anthropology beyond-the-human, design practitioners start to situate their research methods in specific ecological environments. While the past decade was widely dedicated to bringing designers into laboratories —provoked by Schäffner's proclaimed *design turn*,[27] among others—the recently addressed challenges of scaling and the complex planetary entanglements lead to fundamental transformations in transdisciplinary research. The forest, the wetlands, and the ocean turn into terrains of exploration for actively deploying a set of design methods, which allow for a more empathic environmental approach in ›Catastrophic Times‹.[28] The ocean is a widely unexplored field for design research. When immersing the design researcher's body in the ecological relations of the seascape, the act of *ecological attunement*[29] is essential for developing sensitive modes of engagement. Meanwhile, the growing interest in marine fieldwork is nourished by positions of immersive anthropology in marine environments,[30] as well as by a historic tradition of of underwater sketching (e.g. Ransonnet-Villez 1860s, Bostelmann 1920s) photography (e.g. Butan 1900) and videography (e.g. Cousteau 1940s, Hass 1940). As part of her PhD thesis »Growing Matter«, which explores mineral accretion of limestone in marine environments and its symbiotic relation to ecosystem growth, the designer Rasa Weber develops field methods of ›underwater design anthropology‹ in collaboration with biologist Anja Wegner (Jordan Lab: Max-Planck Institute of Animal Behavior).

Rasa Weber is a designer with a focus on bio-based materials and interdisciplinary research. She is a researcher at Zürich University of the Arts (ZHdK).
In her thesis »Growing Matter« (supervised by Prof. Dr. Karmen Franinović, ZHdK and Prof. Dr. Karin Harrasser, University of the Arts Linz), she researches on the process of underwater mineral accretion and its symbiotic potential for the ecological formation of reefs. At the intersection of marine biology and design, she explores the notion of Interspecies Architecture with her practice-based and theoretical research on sympoietic design processes with human, animal and microbial actors in the ocean.

PhD Thesis *Growing Matter,* sketching at minus ten meters.
Rasa Weber, Curacao, 2022

BABETTE
WERNER

Strategies of (Re-)Staging Process-Based Art by Otto Piene within the Context of the 1960s

Art & Visual History

Object Space Agency

Otto Piene, *The Proliferation of the Sun*, 1964/2014, first digital (re-) staging at Neue Nationalgalerie, Berlin, 2014, 7-channel video installation based on 1,200 digitized glass slides, div. textiles, sound, 25'
Photo: David von Becker

In her thesis Babette Werner researches the analog and digital (re-)stagings of process-based and inter-media art from the late 1950s until today and their potential for sustainable archival and curatorial practices. Werner explores the notion of an ecological aesthetic with her practice-based and theoretical research. At the intersection of art and visual history, conservation and media studies, the focus is put on artist Otto Piene, who experimented with natural phenomena, and light and slide installations. Two of Piene's early performative and kinetic slide installations from the 1960s are selected as the main examples. In the hybrid performance and installation, *The Proliferation of the Sun* (1964/2014), hand-painted glass slides are the main component of the immersive work. For the installation *Lichtballet »Hommage à New York«* (1966/2016), colored glass slides are used selectively alongside diapositives. Both works within Piene's typology of the light ballet are entangled through the use of similar materials such as hand-painted glass slides, carousel projectors, sound, textiles and kinetic light elements. Furthermore, due to conservation regulations, the slides can no longer be activated. For their (re-) stagings in 2014 and 2016, the fragile slides were elaborately reproduced in analog and digital form. Combined with other factors, the media transfers led to two different outcomes of display.

Werner's thesis aims to close research gaps in Piene's work[31] and make an urgently needed contribution to the media-reflexive digitization of process-based art.[32] The framework for this is the notion that ›(re-)staging‹—understood as an extended sculptural genre—can be made usable at the interplay between memory and imagination, both as an archival strategy and as a method of exhibition practice.[33]

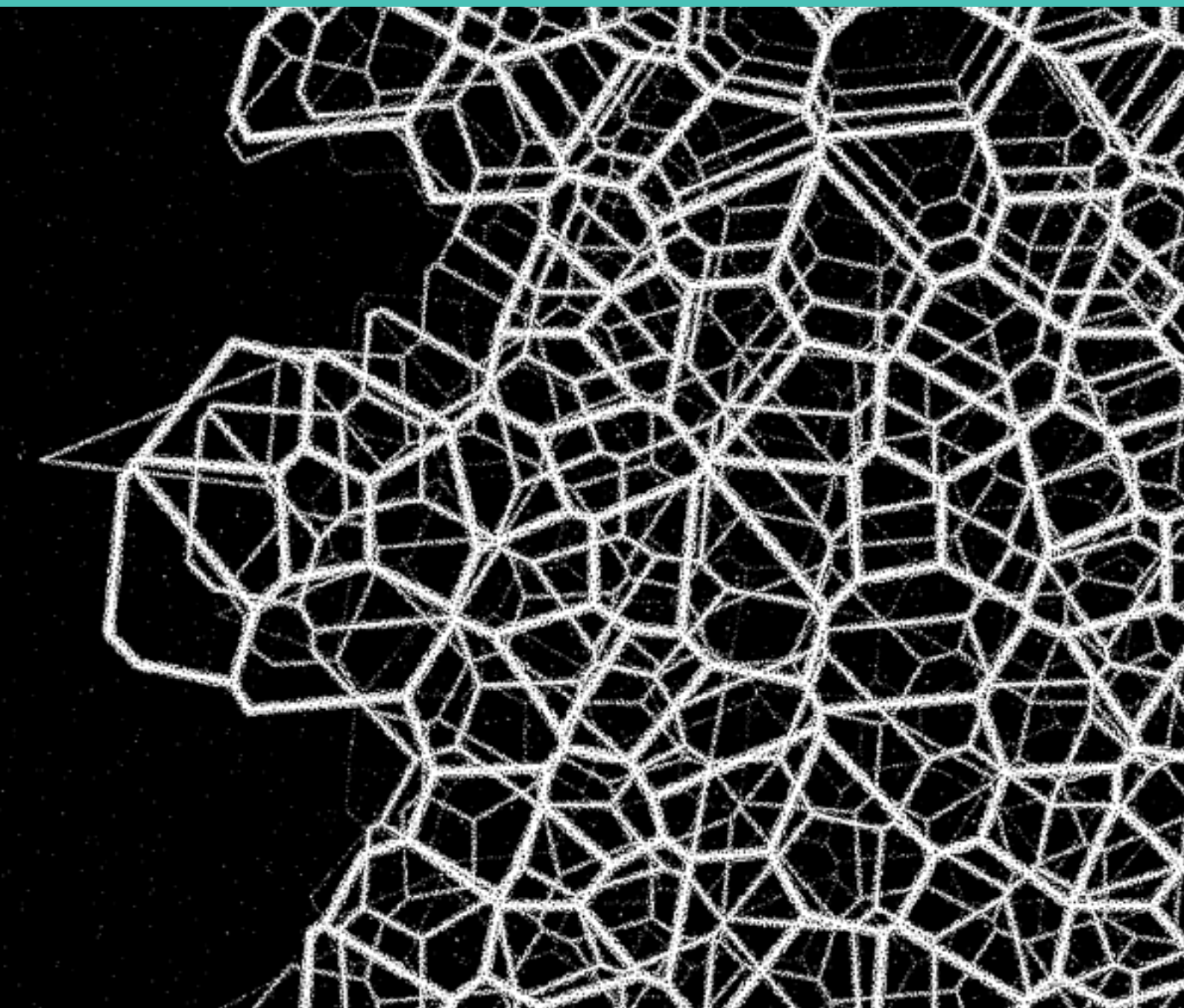
The art and visual historian Babette Werner explores interdisciplinary approaches dealing with time, space and transformation at the intersection of art, ecology and technology. Werner researches links between visual interpretations of natural phenomena and social discourses and seeks to contribute to a genealogy of an ecological aesthetic. She works as a curator and writer and develops exhibitions in the field of visual and performing arts for international art institutions, including »Otto Piene. More Sky« for the Neue Nationalgalerie—Staatliche Museen zu Berlin. Werner's thesis is supervised by Prof. Dr. Claudia Blümle, and Prof. Dr. Stefan Neuner.

BINRU YANG

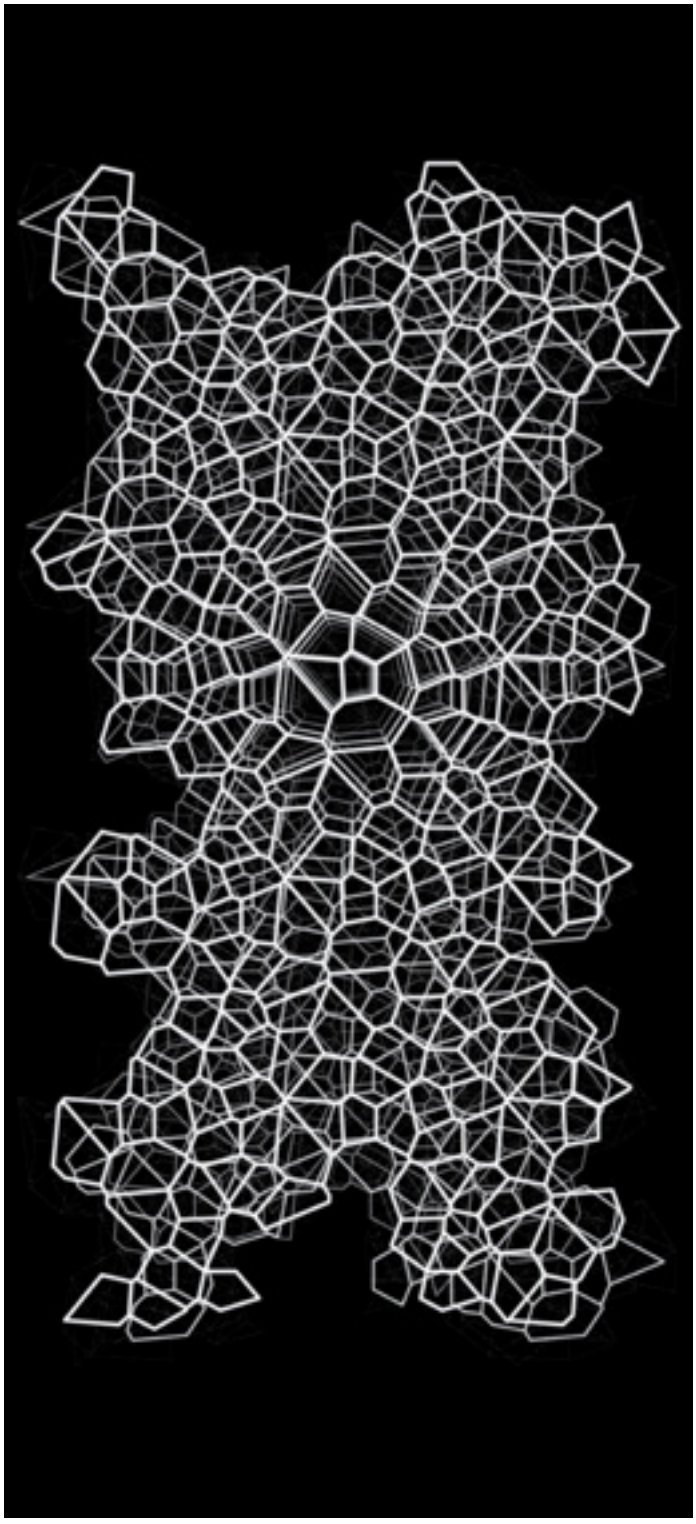
Keeping Cartilage Covered: Quantifying Growth Rules in Stingray Tessellated Cartilage

Lightweight Engineering

Material Form Function



Sharks and rays have cartilaginous skeletons covered by a continuous layer of abutting mineralized tiles (tesserae). Since these skeletons never stop growing, the presence of tesserae creates a challenging growth constraint: how can a continuous tiled covering be dynamically maintained while the volume of the underlying cartilage increases? To answer this, we examined the development of a stingray skeletal element (hyomandibula) in micro-CT datasets, to quantify structural aspects of tesserae over 100% animal size increase. As animals age, the hyomandibula grows isometrically and, although new tesserae are added, most skeletal growth is accomplished by proportional growth of individual tesserae. Curiously, this trend was not followed in juveniles, where disproportionately large tesserae suggest fusions of smaller tesserae. Tesserae are typically brick-like in cross-section (three to four times wider than they are thick), but several skeletal regions exhibited distinct trends: multilayered, thin tesserae at the cranial articulation; irregular, patchy tesserae where muscles attach; and columnar tesserae forming stout ridges. Across ontogeny, tesserae ranged from four- to eight-sided shapes, but were predominantly hexagonal (i.e., with 6 neighbors), especially in flat regions (zero mean curvature), whereas either individual very large or multiple small tesserae were employed to tile curved surfaces. These results provide quantitative insights into how nature can craft complex shapes from tiled architecture and into the dynamic interplays governing growth in tessellated cartilage, where topological requirements (e.g., filling of gaps generated by growth) are balanced by both geometrical and mechanical constraints (e.g., neighboring tesserae, muscular forces).



»Time - Form - Performance Tessellation Design Law«.

Binru Yang is a Pre-Doctoral Researcher in the project »Material Form Function« and engineer by training. Her current study object is driven by her curiosity for tessellation in the natural world. With the help of digital engineering and material science tools, she observes examples in nature to verify certain form-function relationships. She then uses these found formal variations and boundary conditions to explore novel uses and performances which have not evolved naturally. Her thesis is supervised by Prof. Dr. Mason Dean and Prof. Dr. Dr.hc. Peter Fratzl.

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