Professorship for Green Technologies
School of Engineering and Design
Technische Universität München

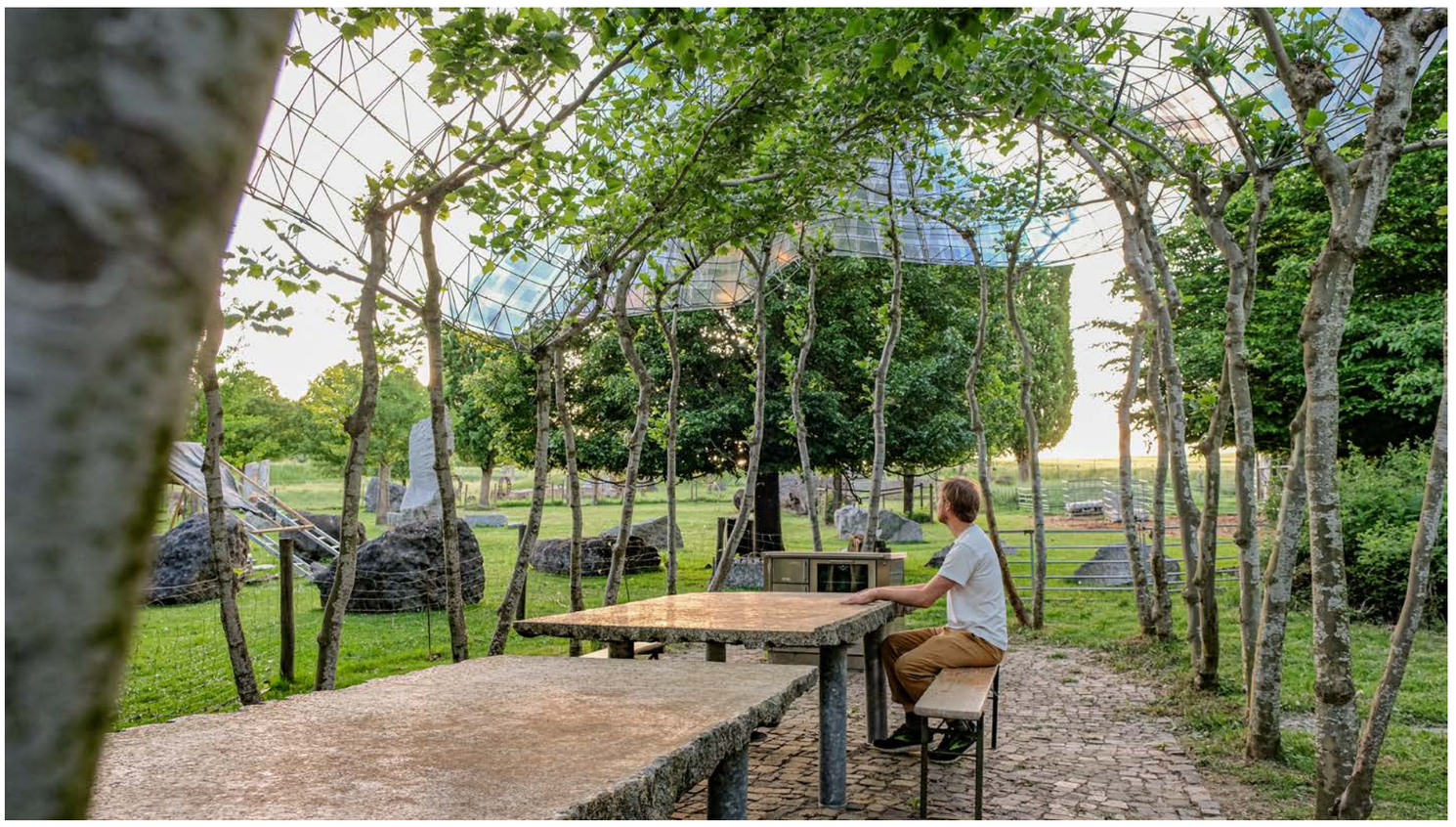
Arbor Kitchen

Floor Area: 57.06 m^2

Completion Date: April 22, 2022

Location: Riedstraße 26, 88639 Wald, Baden-Württemberg, Germany

A grove of 32 London Plane trees was planted in 2012 at Neue Kunst am Ried Sculpture Park (Baden-Württemberg, Germany), a space for artists to exhibit work that engages with nature. The trees surround stone tables and an oven for visitors to gather, eat, cook, and discuss. The design task was to create a roof that provides shelter to the tables while allowing the trees to continue to grow. The client wanted the structure to interact with the landscape and to preserve the play of light through the canopy by minimizing the use of technical elements. Arbor Kitchen solves this by using the living trees as the main load-bearing structure. The branches and trunks guide all loads to the ground where the building is anchored solely by roots.



Inside View of Arbor Kitchen © Kristina Pujkilovic, TUM

Overall View of Arbor Kitchen © Kristina Pujkilovic, TUM

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Wave Form of the Roof Structure © Kristina Pujkilovic, TUM

In comparison to industrialized building materials, living tree structures are dynamic and heterogeneous. They have complex and diverse topologies and evolving functionality, and for this reason, can provide benefits throughout growth, maturity, and decay. These characteristics of living architecture contradict the contemporary design process (such as in modular structures), where complexity in design and construction is addressed by standardization. Designing living architecture as complex, dynamic structures demand a new approach with digital and data-driven methods at its core. The recent revolutions in data acquisition, computing and sharing allow broader horizons in building design – detailed changes can be precisely and regularly mapped, future environmental effects, growth, and mechanics can be predicted, and information can be communicated easily for multifaceted design.

Look Up Inside Arbor Kitchen © Kristina Pujkilovic, TUM

The design solution of Arbor Kitchen resulting from this approach is a shingled space-frame roof structure of 57m² with a total weight of only 800kg that is fully supported by the existing trees. A student design group used photogrammetric point clouds to design the frame to fit the trees' natural forms. The frame was then prefabricated and lifted into the boughs of the tree. After the first year of intergrowth between the trees and spaceframe, the shingles were added in April 2022. In the coming years, the trees will grow up through the space-frame, intergrowing with the rebar, fulfilling the client's needs better each year by improving stability and providing increased shade by the growth of the canopy. Reacting to growth, branches are guided and pruned each year, resulting in a co-creation process with the tree.

This interactive processual approach draws on vernacular living architecture like the Living Root Bridges of the Khasi people of Meghalaya (India). Their multi-generational projects build on tacit environmental knowledge and experience, combined with continuous care. In our designed living architecture, the tacit knowledge is replaced by scientific knowledge and precise documentation of the development. Thereby, the traditional co-creation process is supplemented by a digital layer that allows long-term planning around uncertainty. The paradigm in design thinking is shifting towards adaptive environmental, social, and cultural systems, designed continuously with improving data and growth.

A Glimpse at the Roof Corner © Kristina Pujkilovic, TUM

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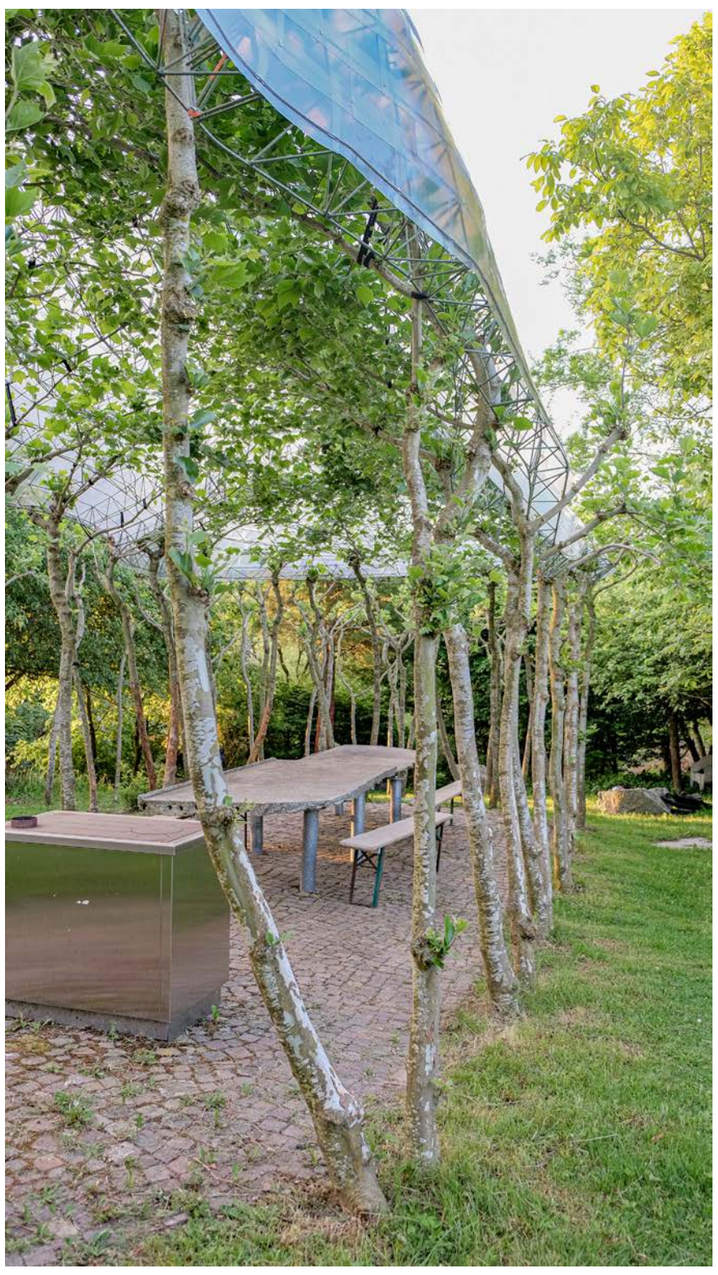
Technical Details (Left) and Space Frame Installation (Right) © Qiguan Shu, TUM

The aesthetics of Arbor Kitchen are deeply rooted in the origins of art. Aristotle tells us that ‘art takes nature as its model’. Trees’ diversity in species, shape, colour and texture inspired the romantics – as ideal forms and colours; and the impressionists – when light disperses through leaves, the environment is cast in fresh green. Besides visual pleasure, living material integrates multiple senses: the smell, touch, and dynamics in seasons contribute to the overall experience of space. For us the connections to nature are as important as the building itself. Architecture should be immersed in the environment and reflect complexity in its design concept. The tree faithfully documents its growth, life story, changes of the environment and interaction with technical components. The balance of emergent biological complexity and stable system simplicity is central to this project. In The Algorithmic Beauty of Plants, Astrid Lindenmayer shows how countless species can be represented with small tweaks to simple algorithms. Detailed data helps us understand these systems, and when this data enmeshes beautifully with the living reality, we see the tree’s embedment in its environment.



Views of Arbor Kitchen in Various Distances © Kristina Pujkilovic, TUM

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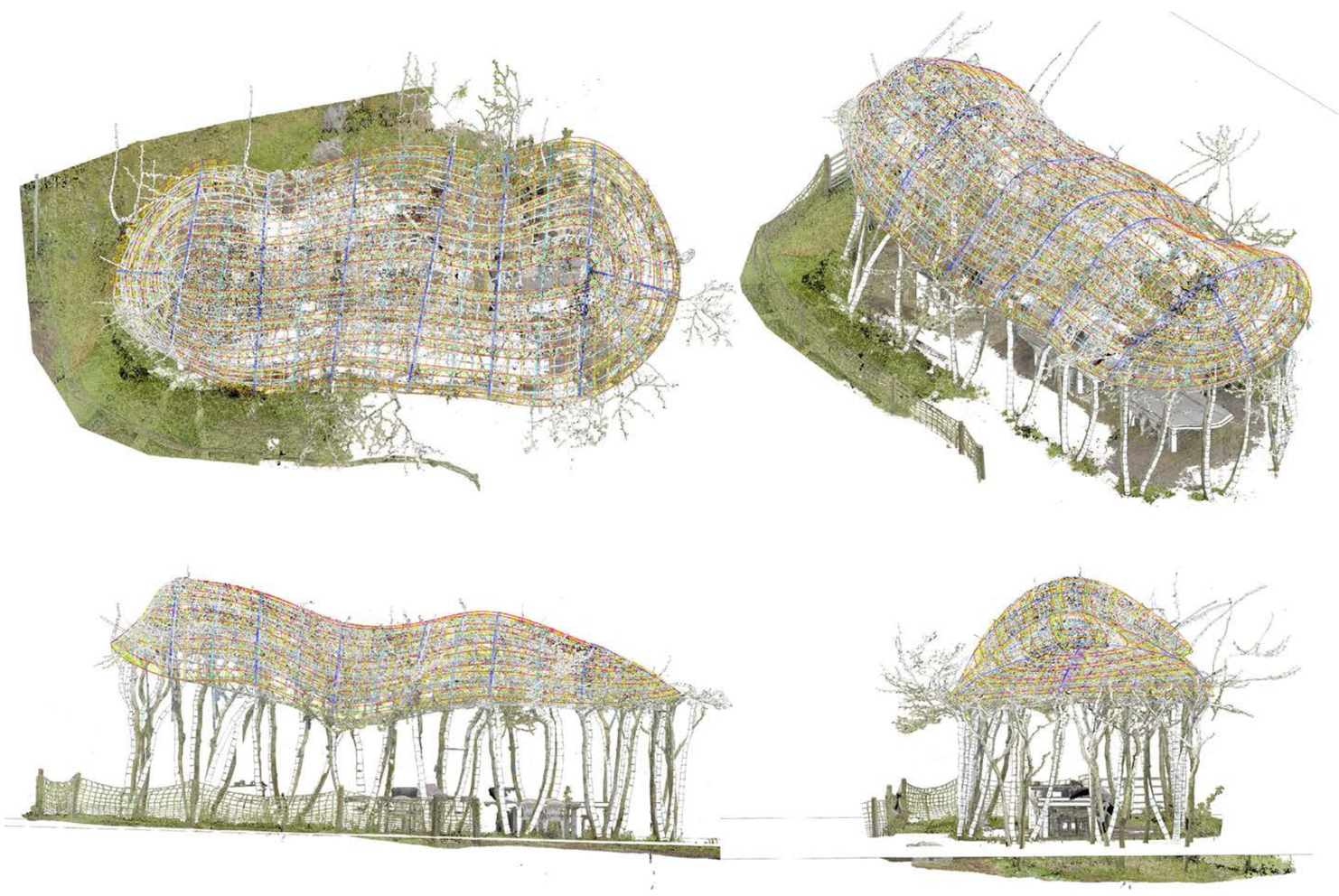
Growth Scenario of Arbor Kitchen © Student Design Team, TUM

Designing for growth involves two fundamental challenges: dynamics and complexity. The data revolution has provided many disparate tools that address individual aspects of these challenges. Parametric tools allow extremely precise structures that fit input data. Growth models, drawing on large datasets, allow prediction over many timeframes. Laser and photogrammetric surveys allow extremely precise mapping of complex objects. The challenge, and innovation, lies in combining these tools to allow design freedom. Designing with homogenized technical materials conservatively develops these tools in incremental steps, while designing with life combines them for a new design space – from which Arbor Kitchen emerges. Starting from point clouds, digital skills and botanical knowledge, Arbor Kitchen answers the question: how can a roof be designed from precise data of tree form, environmental conditions, and an understanding of growth?

The current industrial design paradigm places the operational time at the center of the building life cycle, with raw materials processing, construction, deconstruction, and recycling playing secondary roles. Much of the building material is wasted – 54% of construction and demolition waste in the EU goes to landfill. In trees, the construction (growth), function (maturity) and end-of-life (regeneration or recycling) are essential to the life cycle. Accordingly, pruning, planting, and self-renewal are integral aspects of living architecture. While the life span of conventional buildings is defined by the decay of the material, living architecture can strengthen over time through the interplay of maintenance, growth and regeneration. Furthermore, trees play a wider role in the built environment – they provide habitat corridors, reduce storm-water runoff, stabilize slopes, and clean polluted air. Engaging with nature in Arbor Kitchen means understanding the temporal processes of living buildings and actively engaging with growth and decay as design principles. We wish to use this Award to promote our new methods to diverse stakeholders, opening up new application scenarios for a new paradigm of ongoing design with living trees.



Digital Model of Arbor Kitchen in Comparison to LiDAR Scan © Qiguan Shu, Wilfrid Middleton TUM

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