Meristem Wall: An Exploration of 3d-printed Architecture

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1 *Meristem Wall* at Time Space Existence, Palazzo Mora, Venice.

Meristem Wall is a prototype for a 3D-printed building envelope, featuring a dynamically controllable network of integrated air channels that allow a fluid and adaptive relationship between inside and outside. The wall integrates functional lighting and electricity, windows, and a custom CNC-knitted textile interior. It is fabricated through binder-jet sand 3D printing and points towards a climatically performative architecture inclusive of nonhuman life in urban contexts.

Based on previous research that demonstrated airflow transfer in a reticulated branching network (Andréen 2016), the system of channels can be controlled through an embedded system of sensors and actuators to enable selective transport of heat and moisture. Their tortuosity and narrow diameter limits cross-drafts. The outer part of the wall shifts the channels to a nested landscape of intertwined surfaces, providing an extensive biological habitat in the building itself. *Meristem Wall* presents a vision for 3D printing in the construction sector (Turner and Soar 2008) and how the technology may come to reshape our relationship to the natural and built environment.

Computational Design Model

The design of the wall is the result of a simulation that is managed through a unifying voxel model. Multiple algorithms come together to deliver several functions, negotiating their internal relationship through emergent, local interactions (Varenne 2013).

2 Assembly of the wall in Venice

3 The interior is fitted with a custom CNC-knitted fabric and integrated lighting

The model self-organizes using a custom particle-spring system (PSS). The PSS is defined by the boundary constraints of the wall, which includes both its volumetric definition as well as dynamic (Kanellos and Hanna, 2008) and static connections (e.g. sightlines/windows, plumbing and wiring, structural loads) to the surrounding building. It incorporates the reticulated transient network which forms the base of the Meristem Wall, as well as channels and passages that traverse it, carrying global flows, wiring, and loads.

The topological model obtained through the PSS is used to define a surface in 3-dimensional space, which is converted to a voxel model (Bernhard et al, 2018). The latter is locally defined, making it suited for further algorithmic processing and fabrication. In Meristem Wall, local adaptations of the geometry were made in the model to fit installations and fixtures and to provide anchor points for the interior textile. Additionally, the bioreceptivity (Guillitte, 1995) of the external surface is targeting several scales of growth: nests, porous pockets, surface texture and rugosity derived from the material print process.

The textile is converging in the computational model of the wall. Its main role is to provide a semi-permeable membrane to the inside of the wall which allows for the passage of airflows. The scale of the knit pattern changes locally at the channel inlets to a high density, in order to filter out insects and larger particles. The knitted patterns vary outside of these to reflect the exterior wall ecology, giving different transparencies; at the same time, it gives a soft, colorful, and tactile surface facing the internal room.

Digital Fabrication

The wall was fabricated through binder-jet sand 3D printing by Voxeljet, and CNC knitted using a seven gage CNC industrial knitting machine (Steiger Libra 1.130). The printing process supports high resolutions of sub-millimeter scale and complex cantilevered geometries while simultaneously accommodating large volumes. Consequently, it would have

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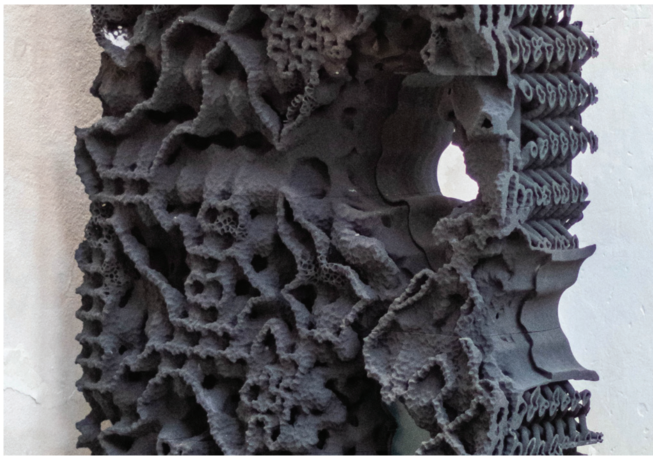
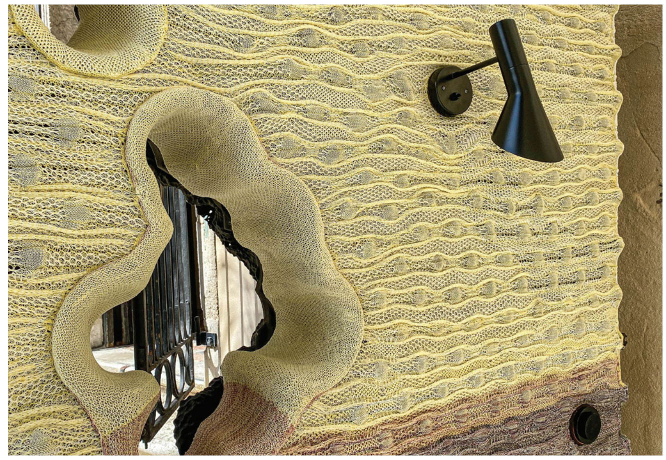
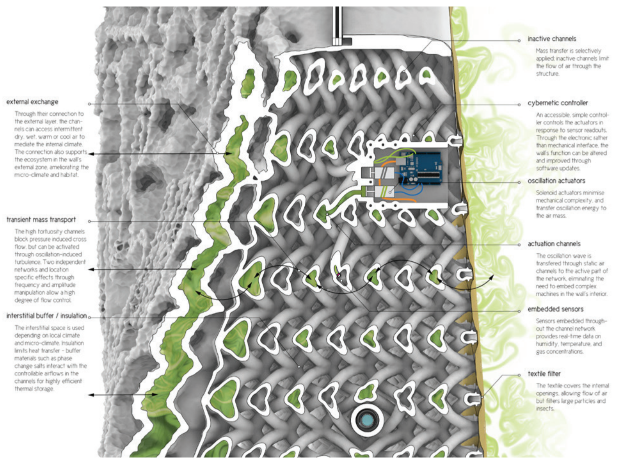


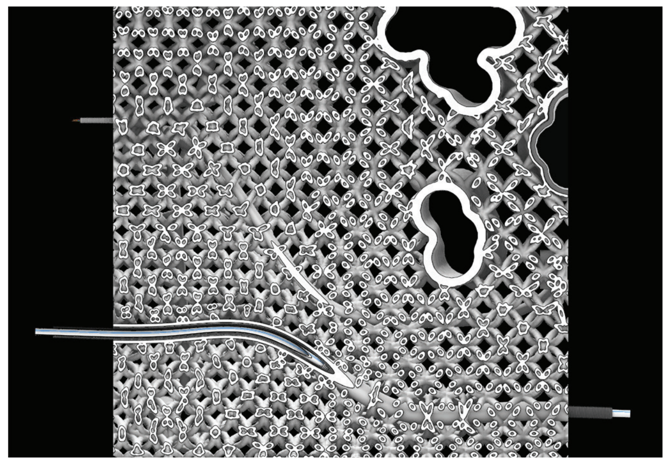
5 The external wall surface is designed to maximize bioreceptivity



6 Light fixtures and cabling integrated into the 3D-printed structure



7 Transversal section showing the network of reticulated channels that can be selectively activated to generate local air transport; activation occurs through oscillation of the air in the channels, and is controlled based on embedded sensors tracking relative humidity and temperature



8 Longitudinal section showing network integration with wall functions

been possible to be fabricated in one piece, but *Meristem Wall* was fabricated in 21 sections to facilitate transport and handling. The fabric was fitted onto the 3D-printed elements by attaching to the custom fixtures through looping nylon strands integrated as weft in-lays into the knit, so the entire installation is dissasemblable.

ACKNOWLEDGMENTS

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Meristem Wall is currently exhibited at the Time Space Existence exhibition at the Venice Biennale.

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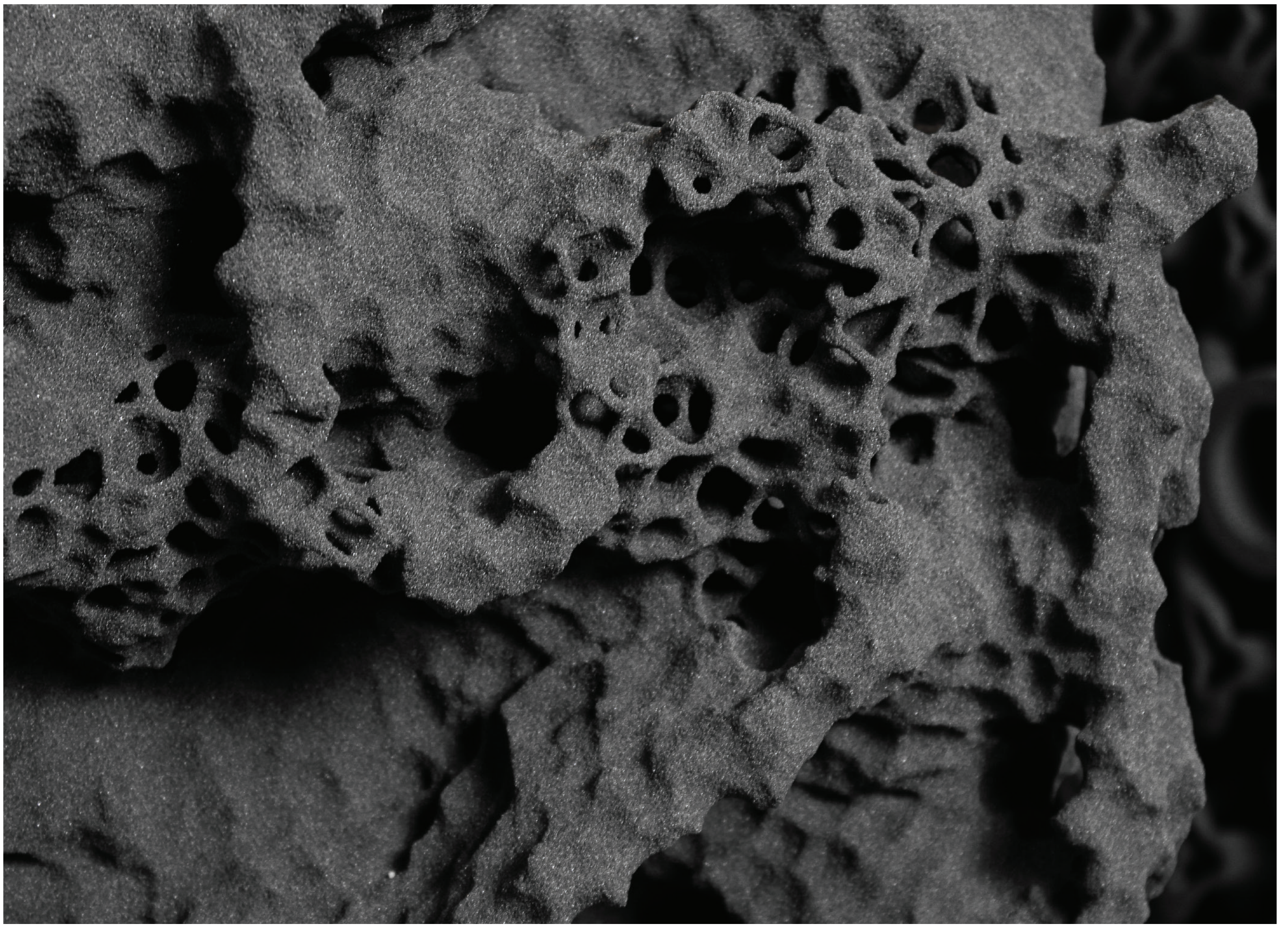

9 Bioreceptivity detail; the variable scale of the exterior surface pockets creates a diversity of microclimates and ecological niches

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IMAGE CREDITS

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10 As well as providing color, tactility, and enhancing acoustics, the knitted textile provides a filter over the channel openings

11 Fabric is fixed using integrated hooks and nylon threads

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David Andréen is a senior lecturer at Lund university where he leads the bioDigital Matter research group. His practice concerns architecture, digital fabrication, and computation, with a particular interest on how principles of biology can help shape new sustainable paradigms in the design of the built environment. He completed his doctorate at the Bartlett ULC, investigating termite mounds as models for complex, functional form and related principles of emergence and self-organization.