

A project by Gramazio Kohler Research, ETH Zurich

Augmented Bricklaying

The Kitrvs winery façade, built from 13596 individually rotated and tilted bricks is currently the largest architectural project entirely assembled on-site with an augmented reality fabrication interface. Researchers from Gramazio Kohler Research collaborated with incon.ai, a spinoff recently launched by the Robotic Systems Lab of ETH Zürich, to develop the custom made dynamic optical guidance system. This system was used by local Greek masons to construct the 225m² large façade in less than three months. The developed augmented bricklaying process combines the power of computational design with the dexterity and skills of human craftsman, introducing an entirely new fabrication paradigm.

Gramazio Kohler Research – the Chair for Architecture and Digital Fabrication at ETH Zurich – is known for its pioneering use of robotics in architecture, demonstrated for the first time in the intricate brickwork design of “Gantenbein Winery” façade in 2006. Nevertheless, the introduction of robotics into architecture still faces many barriers, including the limited mobility and dexterity of existing industrial robots, and the relative difficulty of automating and handling malleable building materials. To address these challenges, the project “Augmented Bricklaying” reintroduces craftsmen into a digital fabrication process. By optically instructing masons with tailored digital information through a custom augmented reality user interface, a direct connection to the digital design model can be established. This craft-specific user interface allows masons to intuitively understand where to place the bricks according to the digital blueprint and computationally derived spatial model. The technological innovation of this system uses visual-inertial object tracking features and real-time feedback to precisely relate what has already been physically built to the digital model, exceeding the accuracy of conventional holographic representations used as state of the art in this domain. Through this augmented reality interface, the masons no longer depend on physical templates but can work with enhanced spatial precision while maintaining their craft and expertise in mortar handling.

Kitrvs winery is located in the hilly landscape of Pydna at the foot of Mount Olympus, overlooking the Thermaic Gulf of the Aegean Sea. The newly constructed building will be used to process and store wine, produced in the surrounding vineyards. The semi-transparent parametric façade design, derived from a Perlin noise field, produces an ever-changing pattern resembling light moving across a liquid surface. Gaps between the individual bricks allow for ventilation and control the impact of the strong Greek light. The design leverages the physical possibility to differentiate the height of the applied mortar between the brick layers. Mortar, usually treated as a secondary material in the design of fair-faced brick walls, became a dominant element in the appearance of the façade.

Through the re-introduction of craftsmanship into digital fabrication processes, “Augmented Bricklaying” pursues a human centered approach to the notion of a fully automated building site. “Augmented Bricklaying” can thus be understood as a way to overcome the known limitations of robotic automation, at the same time expanding the scope of digital fabrication through a socially sustainable model of digitalized building construction.

About Gramazio Kohler Research

Since its inception in 2005, the research group at ETH Zurich led by Prof. Fabio Gramazio and Prof. Matthias Kohler has been at the forefront of digital fabrication in architecture. With their robotic laboratories and work that ranges from installations to prototypical buildings, they have inspired architects and researchers alike to explore the capacities of computational and robotic tools to design in the digital age.

www.gramaziokohler.arch.ethz.ch

Technical Data Sheet:

<u>Design period:</u>	January 2019 – August 2019
<u>Fabrication period:</u>	September – December 2019
	Fabrication: 3 months
<u>Bricks:</u>	13596 locally sourced bricks
<u>Facade:</u>	Infill masonry façade made of eight elements of 5x5 meter and three elements of 5x3 meters
<u>Size</u>	225m ² of a double fair-faced brick façade
<u>Design</u>	Differentiation of brick courses through a variation of mortar height (5mm to 30mm). The rotation of the individual bricks was related to the amount of the underlying mortar (-20° to +20° rotation). The gap between the individual bricks was used to allow ventilation and light into the building and ranges from between 22 and 24mm
<u>Structural support:</u>	The structural support system of the fair-faced non-loadbearing façade consists of four horizontal bars per wall and custom-made metal blades cut, inserted and glued into the brick wall on-site.

Parametric Digital Design and Fabrication Model using Grasshopper software, Compas and Python as a programming language. Direct File-to-Fabrication process.

Project info:

<u>Project name:</u>	Augmented Bricklaying / KITRVS Winery, Greece
<u>location:</u>	Kitros, Pydna, Greece
<u>architect:</u>	Gramazio Kohler Research / ETH Zürich
<u>client:</u>	Garypidis
<u>program:</u>	Winery

Team:

Gramazio Kohler Research, ETH Zurich

Collaborators:

Dr. Kathrin Dörfler, Daniela Mitterberger, Dr. Timothy Sandy, Foteini Salveridou, Fernando Cena, Lukas Stadlmann, Lefteris Kotsonis, Eleni Alexi, Dimitris Ntantamis

Selected experts:

Tobias Bonwetsch, ROB Technologies
AR tracking system provided by [incon.ai](https://www.incon.ai)

Photography:

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