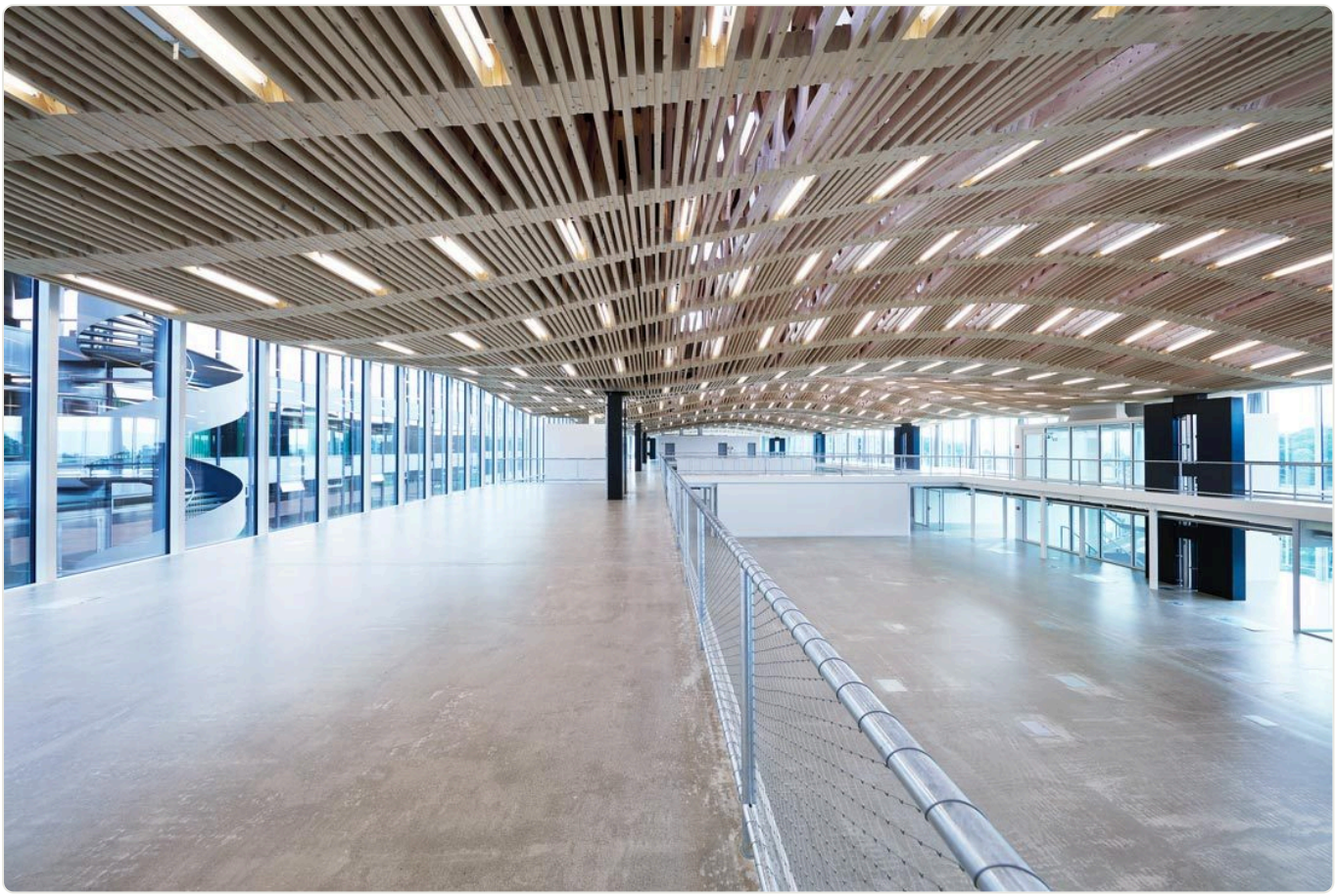
CASE STUDY · ROBOTIC TIMBER FABRICATION

The Sequential Roof

Gramazio Kohler Research (ETH Zurich) · Arch_Tec_Lab roof, Zurich · 2016

Analysed by Ping-Ju Tung, with the Ping-2 method (research, image verification, structured note).



Arch_Tec_Lab, the Sequential Roof: 2,308 m² assembled from roughly 50,000 unique softwood slats.

OVERVIEW

Team	Gramazio Kohler Research (ETH Zurich)
Year	2016
Location	Zurich, Switzerland (Arch_Tec_Lab roof)
Type	Large-span experimental timber roof, 2,308 m²
Scale	168 trusses, around 50,000 unique slats, 800,000+ nails
Style	Parametricism / algorithmic detail, digital fabrication

CONCEPT AND THEORETICAL CONTEXT

The Sequential Roof is a milestone in large-scale automated timber assembly at ETH Zurich. Gramazio Kohler rejected the traditional reliance on continuous, straight, equal-length timber. Built on a belief in a fully automated process, the design uses a single algorithm that unifies form, structural calculation and fabrication scripting, cutting a large roof into tens of thousands of tiny, short, normally low-grade softwood slats. By

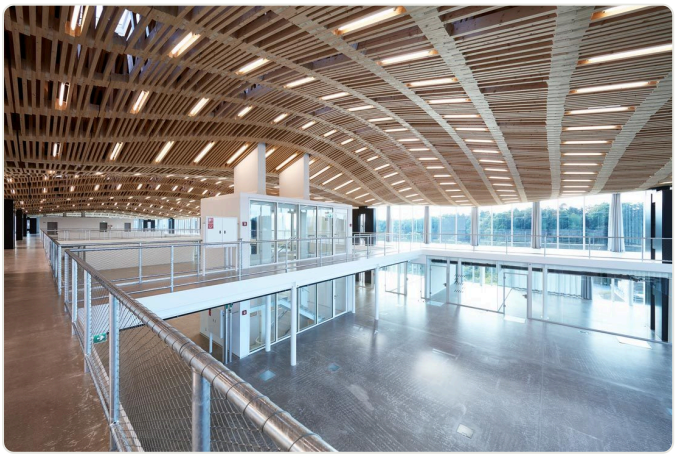
tuning the tilt and position of every slat, a non-standard doubly curved roof spanning more than 12 metres is built from one standardised material.

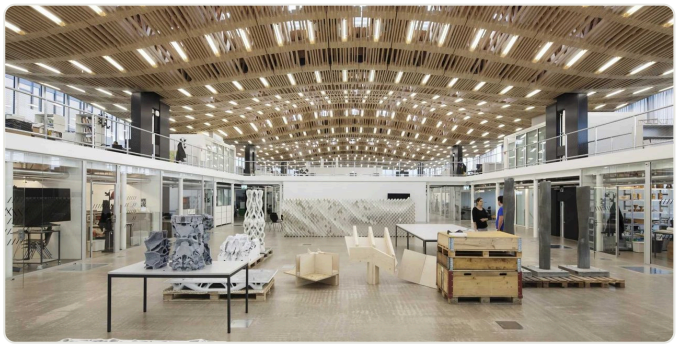


The Arch_Tec_Lab in Zurich; the Sequential Roof crowns the top of the building.

MECHANISM: MASS CUSTOMISATION BY ROBOT

- **Mass customisation.** The roof is made of about 50,000 slats and over 800,000 steel nails. Across the 2,300 m² roof almost no two slats share the same cut angle and hole positions.
- **Industrial robot, re-scripted.** An industrial arm normally repeats one identical motion. Here the team re-scripted a six-axis arm to pick timber, cut a precise unique bevel by algorithm, then place and fix it with a pneumatic nail gun, showing how technology can make complex geometry cost the same as simple geometry.



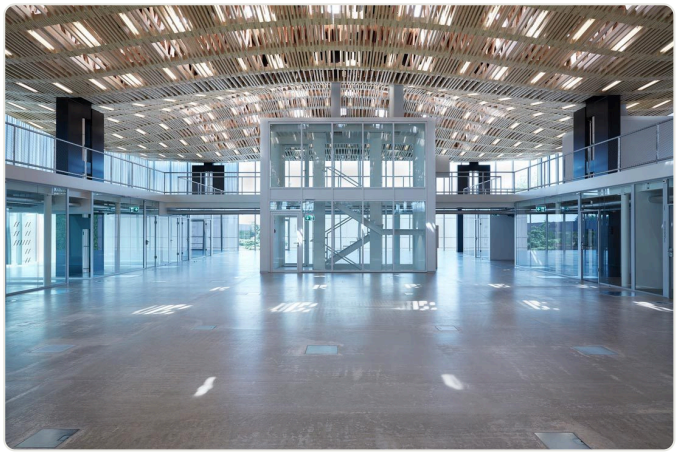


CRITICAL EVALUATION

It is a peak of digital construction, but from a practical and capital standpoint it exposes real limits:

1. **A complexity-capital barrier.** Reshaping geometry is free inside the computer, but realising the roof needs multi-million-dollar robotic hardware and a team of elite programmers. The technique barely transfers to ordinary construction or to developing economies: it is an elite experiment.
2. **The illusion of full automation.** Robots assembled the trusses in the factory, yet fitting them onto a slightly skewed existing steel frame still relied on human workers judging the final tolerance by eye. Timber swells and shrinks with humidity, breaking the robot's millimetre precision.
3. **Inflexible material dependence.** The system demands highly standardised softwood slats. Hand it irregular natural waste timber of varying length, thickness and wormholes, and the closed system stalls.





CONNECTION TO MY RESEARCH

Two crossing lines of technological ethics: automation against augmentation. The Sequential Roof chose to **kill the craftsman**, using expensive robots to fully automate geometric complexity. My Euston design and Augmented Carpentry choose the other path: **empower the craftsman**. With an AR headset such as HoloLens, I do not need a multi-million-dollar robot, only a few thousand dollars of equipment, so that the human brain combined with digital guidance can work irregular waste timber by hand. Gramazio Kohler proved the limit of the machine; my work argues that the human-in-the-loop is the more financially resilient and widely adoptable future for material reuse and sustainable building.

SOURCES

- The Sequential Roof / Gramazio Kohler Research, ArchDaily and ETH Zurich (verified and corrected during research)
- Critiques on robotic fabrication transferability, architectural journals (on high capital barriers and real timber-tolerance limits)