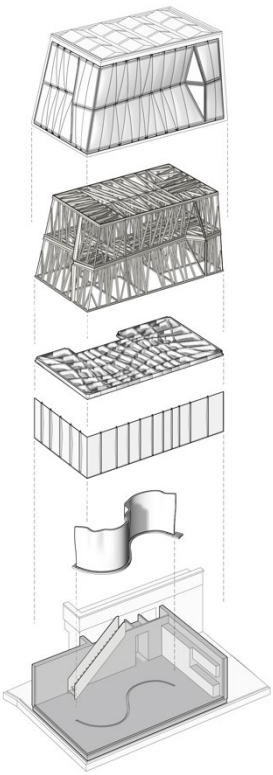
DFAB HOUSE
Factsheet Digital Fabrication

DFAB HOUSE is a collaborative demonstrator of the Swiss National Centre of Competence in Research (NCCR) Digital Fabrication (home institute ETH Zurich) on the NEST building of Empa and Eawag. The 200m^2 house is the result of a long-term collaboration between researchers in eight ETH Zurich professorships and industry experts and planning professionals from more than 30 companies. The result is a demonstrator showcasing how digital fabrication processes can revolutionise the way we design and build, with these processes exemplified by six highly original Innovation Objects. It is the first house in the world to be designed, planned and built using predominantly digital processes.



Lightweight Translucent Façade

Spatial Timber Assemblies

Smart Slab

Smart Dynamic Casting

Mesh Mould

In situ Fabricator

In situ Fabricator

The In situ Fabricator is a context-aware mobile construction robot for fabricating building elements directly on construction sites. Its integrated on-board sensing and computation system is developed to enable autonomous repositioning procedures, localisation of the end effector and the adaptation of fabrication data according to unforeseen material behaviour – without the need for external measurement devices.

Days spent building on-site: 22
Total building time: 125 hours

Mesh Mould

The Mesh Mould combines formwork and reinforcement into one robotically fabricated construction system. As such the In situ Fabricator robot builds up a 3D mesh structure which acts as both formwork and structural reinforcement. Specially developed cement mortar is then poured into the mesh structure and trowelled off by hand, allowing the unique shape of the load-bearing wall.

Length of wall: 12m
Height of wall: 3m
Total number of welding knots: 22,300

Smart Slab

The Smart Slab showcases a new generation of a radically optimised digital building processes from design to fabrication. It uses large-scale 3D sand printing to automate and optimise the most labour-intense process in concrete construction: fabricating the formwork. The 295 unique 3D-printed formwork parts fully enable the plasticity of concrete to create a free-form, highly optimised building component featuring intricate ornamental structures which create a rich architectural experience.

Area: 78m^2
Max. Cantilever: ~4m
Smart Slab Weight: 15.7t (~65% reduction compared to standard slab)
On site assembly: 4 days

Smart Dynamic Casting

Smart Dynamic Casting enabled the production of 15 bespoke reinforced concrete mullions. Each mullion was produced by digitally controlled slip-forming, by which self-compacting concrete is fed into a flexible formwork that shapes the concrete as it hardens. This technique allows each mullion to be individually produced in the most suitable geometry for the load-bearing requirements for their exact location.

Number of reinforced concrete mullions installed in DFAB HOUSE: 15
Total volume of concrete per mullion (average): 23 litres
Time taken to slip-form one mullion: 4 hours

Spatial Timber Assemblies

An innovative robot-based fabrication process which uses the dual robot system in ETH Zurich's Robotic Fabrication Lab (RFL) to prefabricate timber frame modules for the upper floors of DFAB HOUSE. By using the robots, the timber can be cut, held and positioned reference-free in space, based on the computer layout, allowing for novel and complex geometries.

Precision of beam placement when four or more transmitters can track the robot in the RFL: under 1mm
Maximum weight of timber beams assembled by the robot: 55kg
Number of beams in DFAB HOUSE with a completely unique geometry: 487
Number of modules: 6
Onsite installation time: 12 hours

Lightweight Translucent Façade

Aerogel granules are inserted and stabilized between specially developed membrane panels through a novel process. The result is a thin and double curved lightweight façade system with superinsulation properties that enables light to enter the building through the entire wall.

Thickness of façade: 80-120mm
Percentage of energy saved: U-value 0.165

Research

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Architecture

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Design and project management: Konrad Graser (Lead), Marco Baur, Sarah Schneider

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Structural design

Concept: Prof. Dr. Joseph Schwartz

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Contributors: Dr. Jaime Mata Falcón, Prof. Dr. Walter Kaufmann, Daniel Rönz, Thomas Wehrle

Client

Empa

Planning team

Architecture: NCCR Digital Fabrication

General planner: ERNE AG Holzbau

Structural engineering: Dr. Schwartz Consulting AG

Building physics: BAKUS Bauphysik und Akustik GmbH

Electrical engineering: Elektro Siegrist AG

HVAC/Sprinkler planner: Häusler Ingenieure AG

Building technology: Schibli Gebäudetechnik

Lighting design: Sommerlatte & Sommerlatte AG

Partners

Georg Ackermann GmbH

AGITEC AG

Bürgin Creations

Cabot Aerogel GmbH

Christenguss AG

ERNE AG Holzbau

Fischer Rista AG

Frutiger AG

Gom International AG

Lehni AG

NOE-Schaltechnik GmbH

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Pemat AG

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Schlatter Industries AG

best wood SCHNEIDER GmbH

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Sika Technology AG

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Stahl Gerlafingen AG

Stahlton AG

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