The Concrete Initiative Workshop
Starting from the design-phase: material efficiency and beyond

Prof. Dr. Robert J. Flatt, Institute for Building Materials, ETH Zurich
National Centre of Competence in Research Digital Fabrication

Interdisciplinary initiative to foster the innovation capacity of architecture and construction

Launch: June 2014

Duration: 3 x 4 year phases = 12 years

Composition:
22 Professors, (+6 associated)
8 Postdocs
47 PhD researchers (+17 associated)
MAS teaching program
Industry collaboration programme

Robotic Fabrication Lab, Institute for Technology in Architecture, ETH Zurich
All Investigators in Phase 2

Philippe Block
Architecture and Structures
ETH Zurich

Robert Flatt
Building Materials
ETH Zurich

Margarita Chli
Vision for Robotics
ETH Zurich

Stelian Coros
Computational Robotics
ETH Zurich

Benjamin Dillenburger
Digital Building Tech.
ETH Zurich

Fabio Gramazio
Architecture and Digital Fabrication
ETH Zurich

Marco Hutter
Robotic Systems
ETH Zurich

Walter Kaufmann
Structural Engineering
ETH Zurich

Matthias Kohler
Architecture and Digital Fabrication
ETH Zurich

Mark Pauly
Computer Graphics and Geometry
EPFL

Christophe Girot
Landscape Architecture
ETH Zurich

Joseph Schwartz
Structural Design
ETH Zurich

Kristina Shea
Engineering, Design and Computing
ETH Zurich

Roland Siegwart
Autonomous Systems
ETH Zurich

Yves Weinand
Timber Construction
EPFL

Eleni Chatzi
Structural Mechanics
ETH Zurich

Arno Schlüter
Architecture and Building Systems
ETH Zurich

Corentin Fivet
Structural Xploration
EPFL

Gudela Grote
Work and Organ. Psychology
ETH Zurich

Guillaume Habert
Sustainable Construction
ETH Zurich

Daniel Hall
Innovative and Industr. Construction
ETH Zurich

Agathe Koller-Hodac
Mechatronics and Automation
HSR

Andreas Lübbe
Façade and Metal Construction
HSU

Roy Smith
Automatic Control
ETH Zurich

Olga Sorkine-Hornung
Interactive Geometry
ETH Zurich

Melanie Zeilinger
Dynamic and Systems Control
ETH Zurich

Andrea Frangi
Timber Structures
ETH Zurich

Andreas Wieser
Geosensors and Engineering Geodesy
ETH Zurich

Mark Pauly
Computer Graphics and Geometry
EPFL
The 3for2 concept:
Achieving space, material, and energy savings through integrated systems

Conventional Design

3for2 Design

- Radiant ceiling panels for sensible cooling
- Dedicated Outdoor Air System (DOAS) with decentralized Ventilation units
- Slanted façade for shading with Low U-Value / Low SHGC glazing
- Building Integrated Photovoltaics
- Automation system with room / component sensors
- Slab integrated, meshed duct network for air distribution, diffusors

Physical Chemistry of Building Materials
ETH Zurich
3for2@UWCSEA
New construction: 2015

Designed and managed by the A/S team, 3for2@UWCSEA is a 600 m² office space which hosts the administrative staff of UWCSEA. It is one of the first commercial-scale applications of passive chilled beams and displacement ventilation for offices in the tropics. It is set to become Singapore’s most energy-efficient office by 2018.
March to June 2017
NCCR Research on Display at the Centre Pompidou in Paris

NCCR research on display in the exhibition „Mutation-Créations / Imprimer le monde“
Centre Pompidou / Audrey Laurans
May to November 2016
Impressive Contributions of NCCR Investigators at Venice Biennale

Left: Incidental Space by Christian Kerez, including work by the Digital Building Technologies Group; Right: Beyond Bending by the Block Research Group,
Left: Swiss Arts Council Pro Helvetia / Oliver Dubuis; Right: ETH Zurich / Iwan Baan,
October 2017
Ultra-thin HiLo Roof Passes Field Test

Construction prototype for the ultra-thin HiLo concrete roof in the Robotic Fabrication Laboratory at ETH Zurich
Block Research Group / Michael Lyrenmann
October 2018
KnitCandela: a homage to Félix Candela by Zaha Hadid Architects

Homage to Félix Candela at the Museo Universitario arte contempoáneo (MUAC) in Mexico city; Architectural design by Zaha Hadid Architects; formwork technology, structural design and construction system by Block Reserach Group (ETH Zurich).
3D Printed concrete

Gramazio Kohler Research
ETH Zurich
Layered based printing
Concrete / mortar / paste extrusion
Challenges in extrusion print (Contour crafting)

**Concrete**
Operation window (not too fast, not too slow)
- Too fast => collapse
- Too slow => cold joints
- Depends on material AND contour length

Durability ???

Robustness ???

**Opportunities**
Printing lost formwork
Combined reinforcement strategies
Alternative masonry

**Reinforcement**
Ordinary reinforcement
- Placed a posteriori (only vertical)
Post tensioning
- In printed channels to be infilled
Fibers
- Problem of orientation
=> Combination depending on requirements
=> Large scale testing ???

**Threats**
Robustness at large scale and large throughput
Mechanical integrity
Durability
February 2018 (28th)
Opening of the dfab House of NEST at EMPA
NEST – dfab house

- Robotically fabricated timber units
- Smart Slab (3D Printed)
- SDC facade mullions
- Mesh Mould wall
- Unit backbone
- Base
The whole NCCR research network
NCCR research network
Conclusions

• Think different – Build different!

• Despite the norms, but not despite safety, economy or ecology

• Doing the exact same thing digitally, will rarely pay off

• Added value, functionality or integration will pay off

• New horizon for design tools informed by new construction methods

• Exciting application for concrete technology, cement chemistry and chemical admixtures, but this alone is not enough!
Thank you for your attention

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