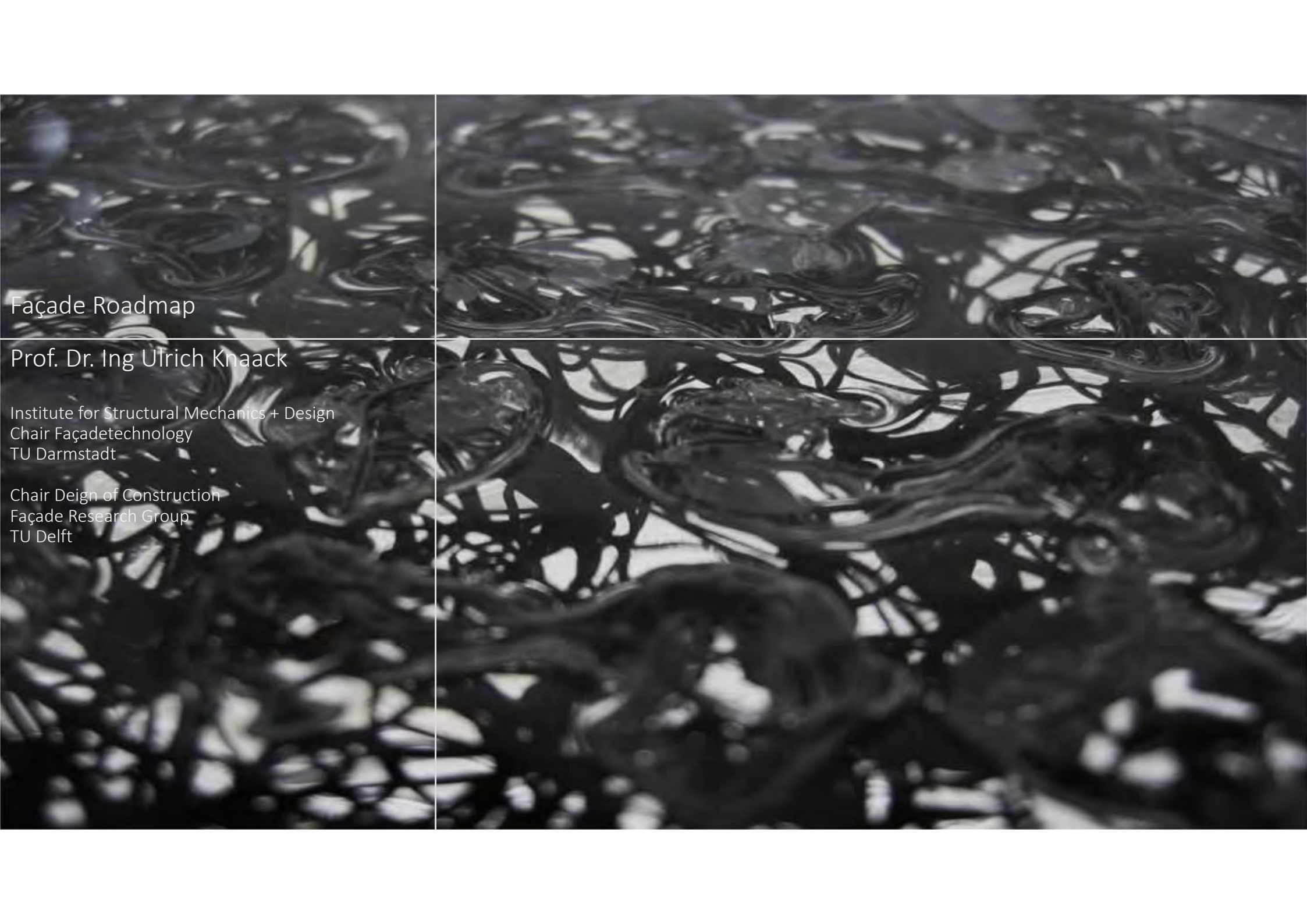




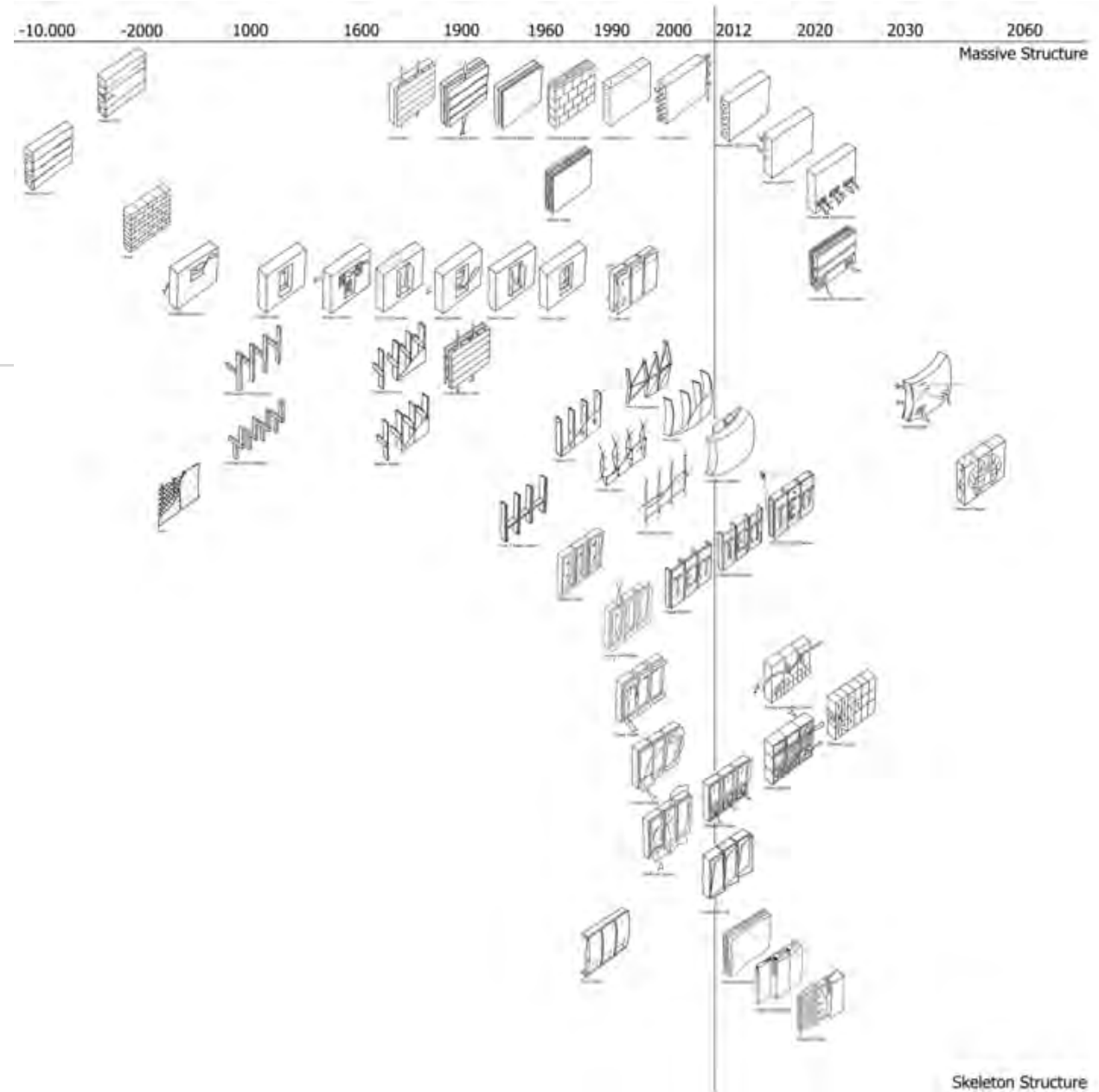
Façade Roadmap

Prof. Dr. Ing Ulrich Knaack

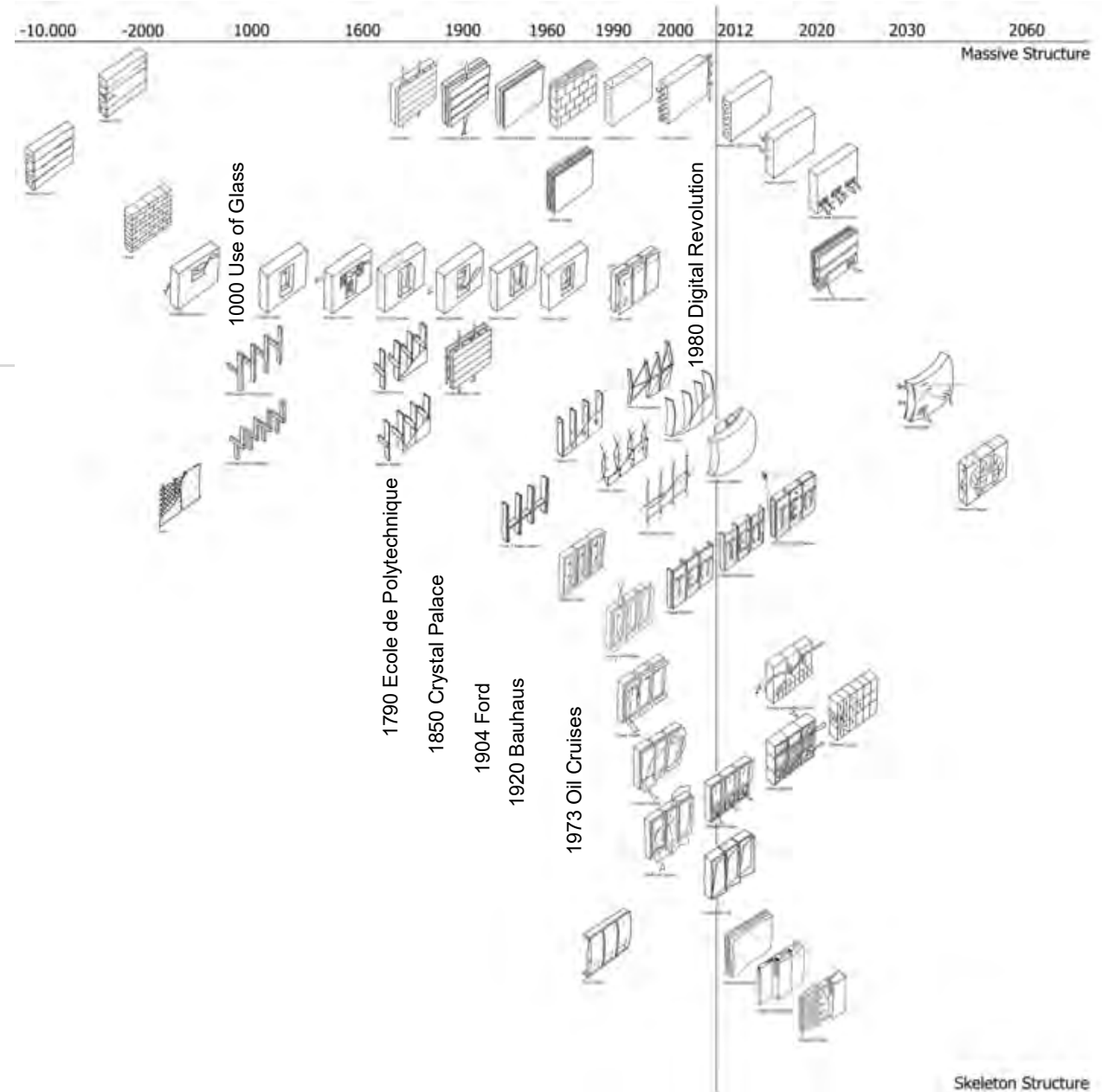
Institute for Structural Mechanics + Design
Chair Façadetechnology
TU Darmstadt

Chair Deign of Construction
Façade Research Group
TU Delft

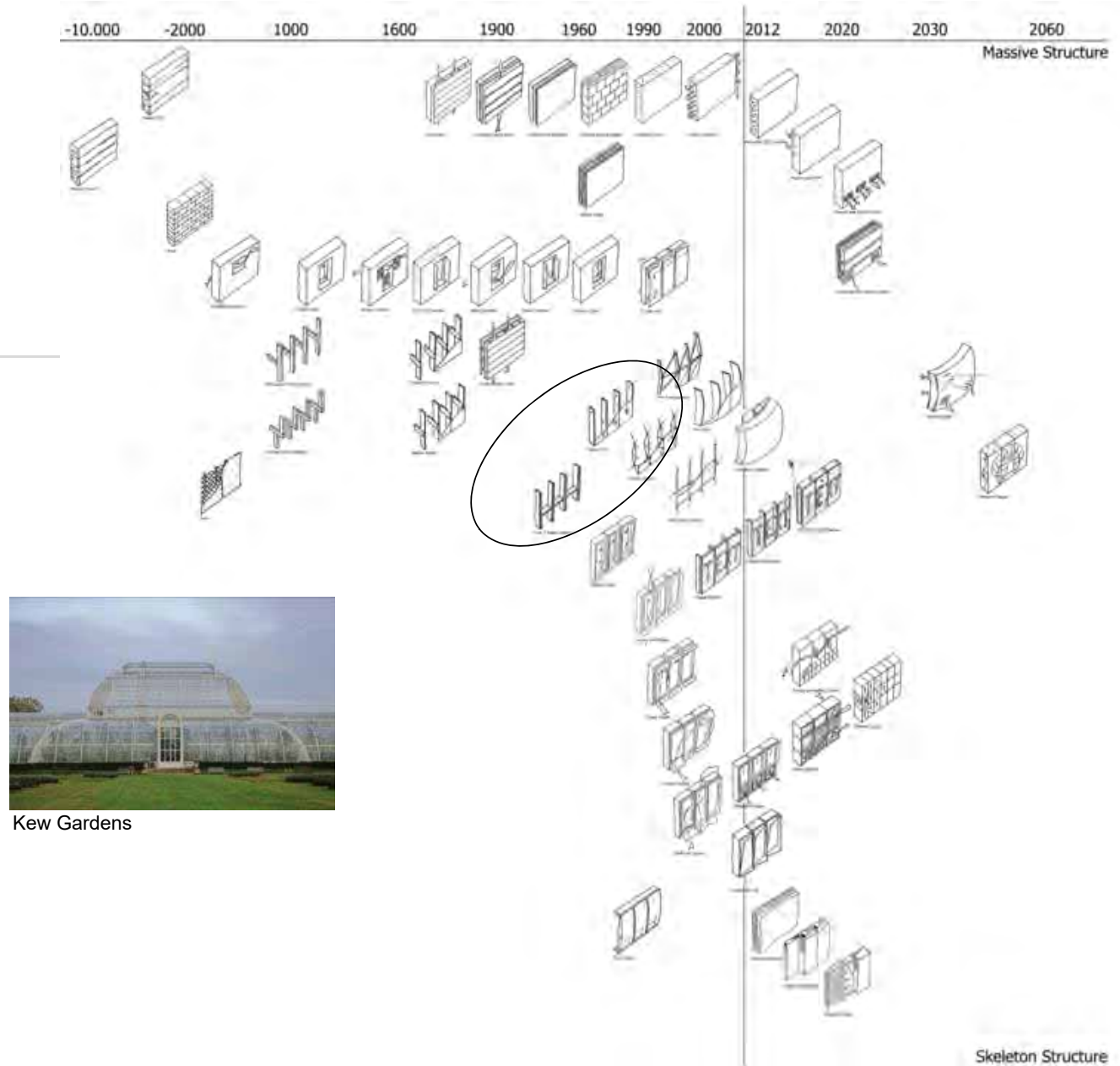
Façade Roadmap



Influences

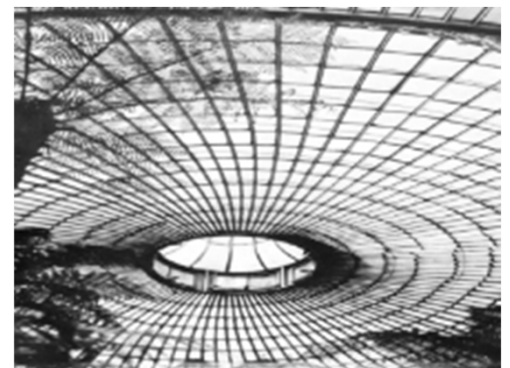


Façade Roadmap

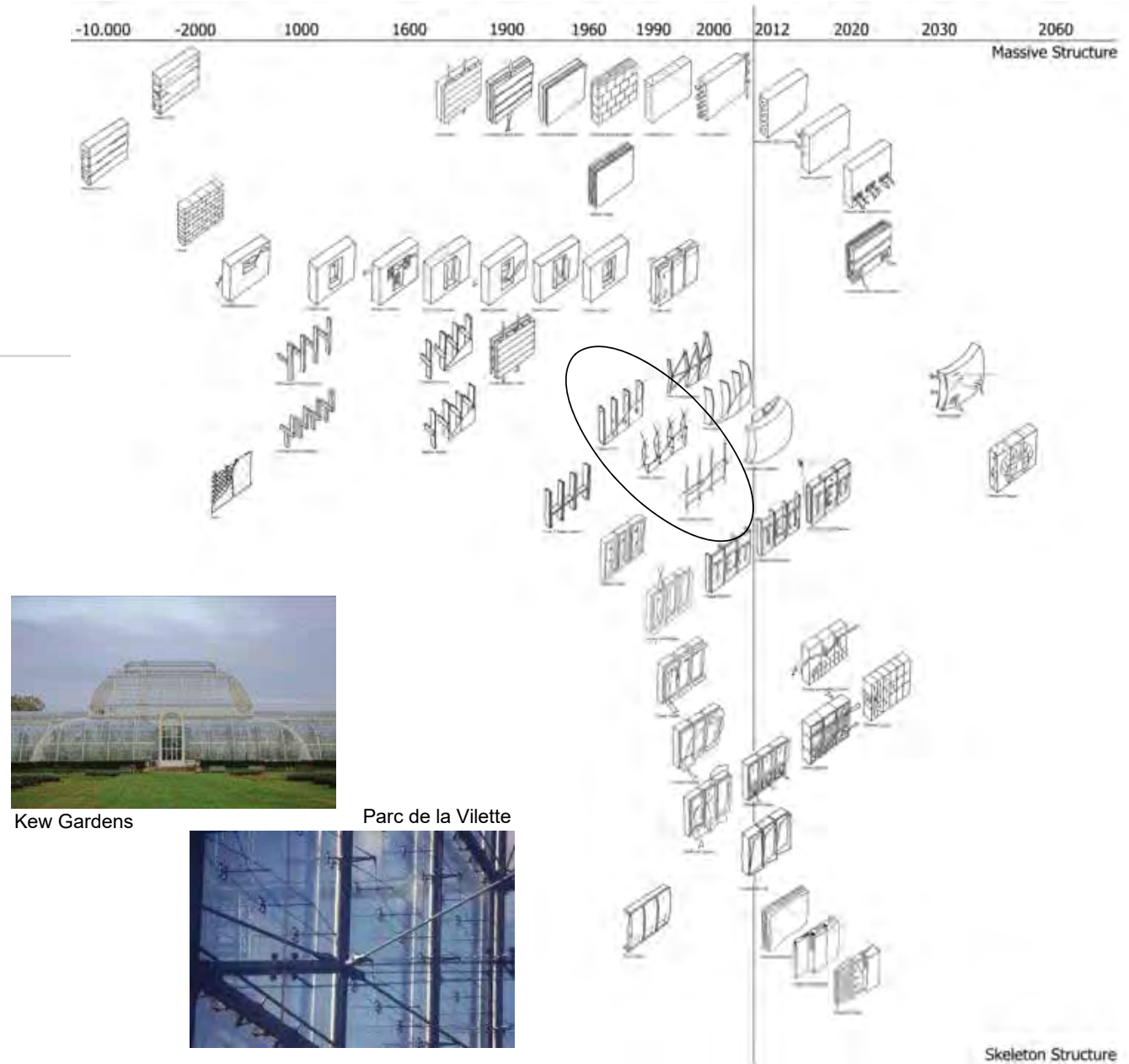


Kew Gardens

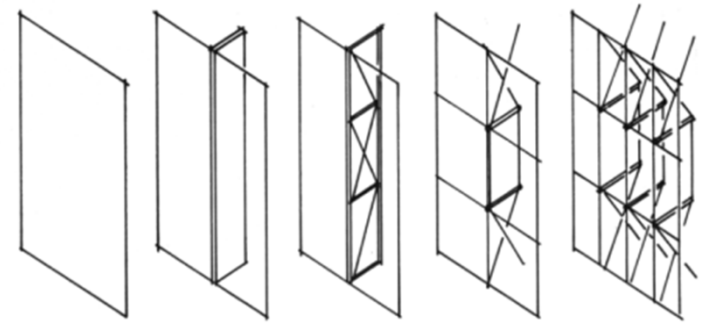
first generation structural glass @1840



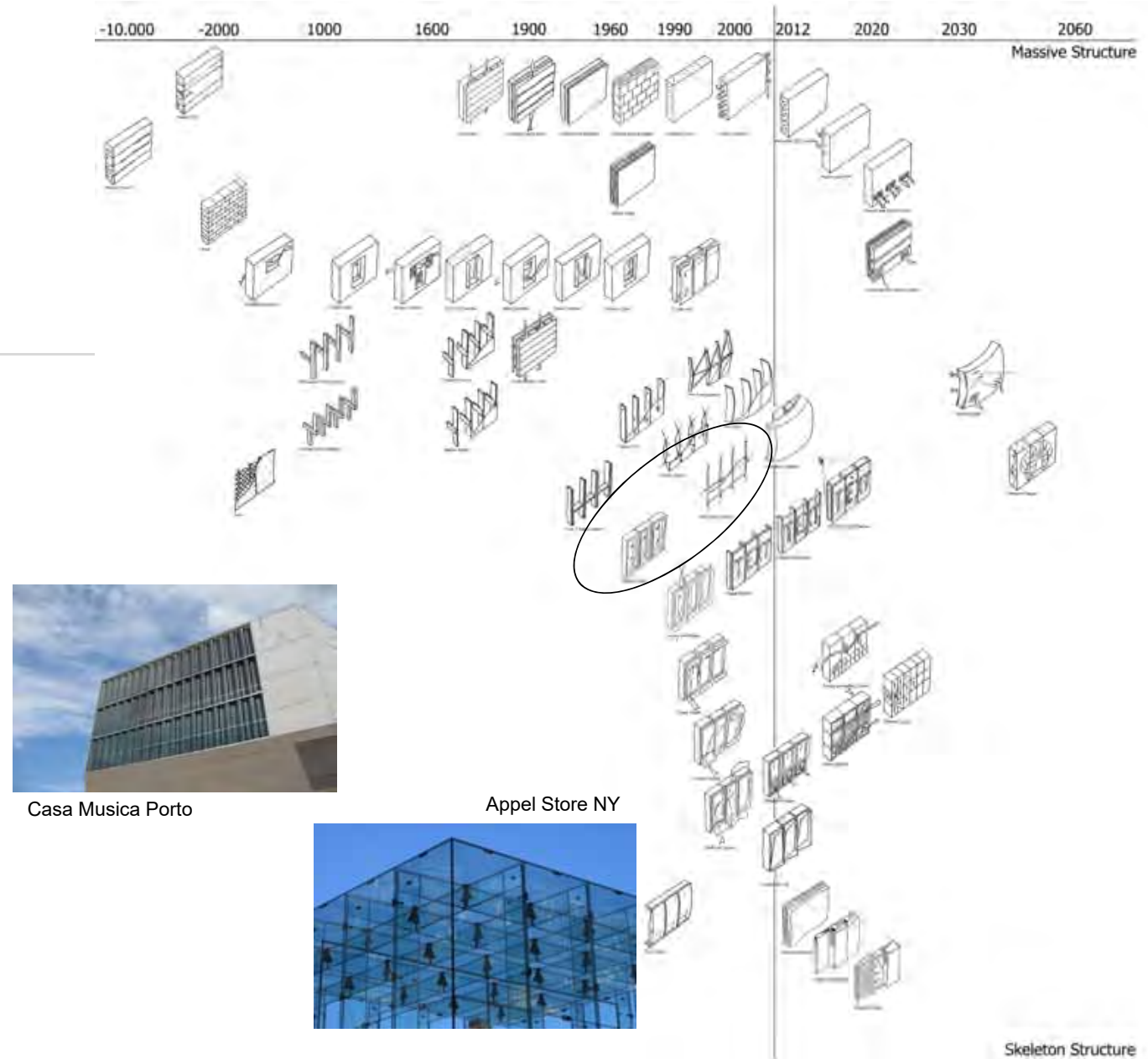
Façade Roadmap



second generation
structural glass @ 1980



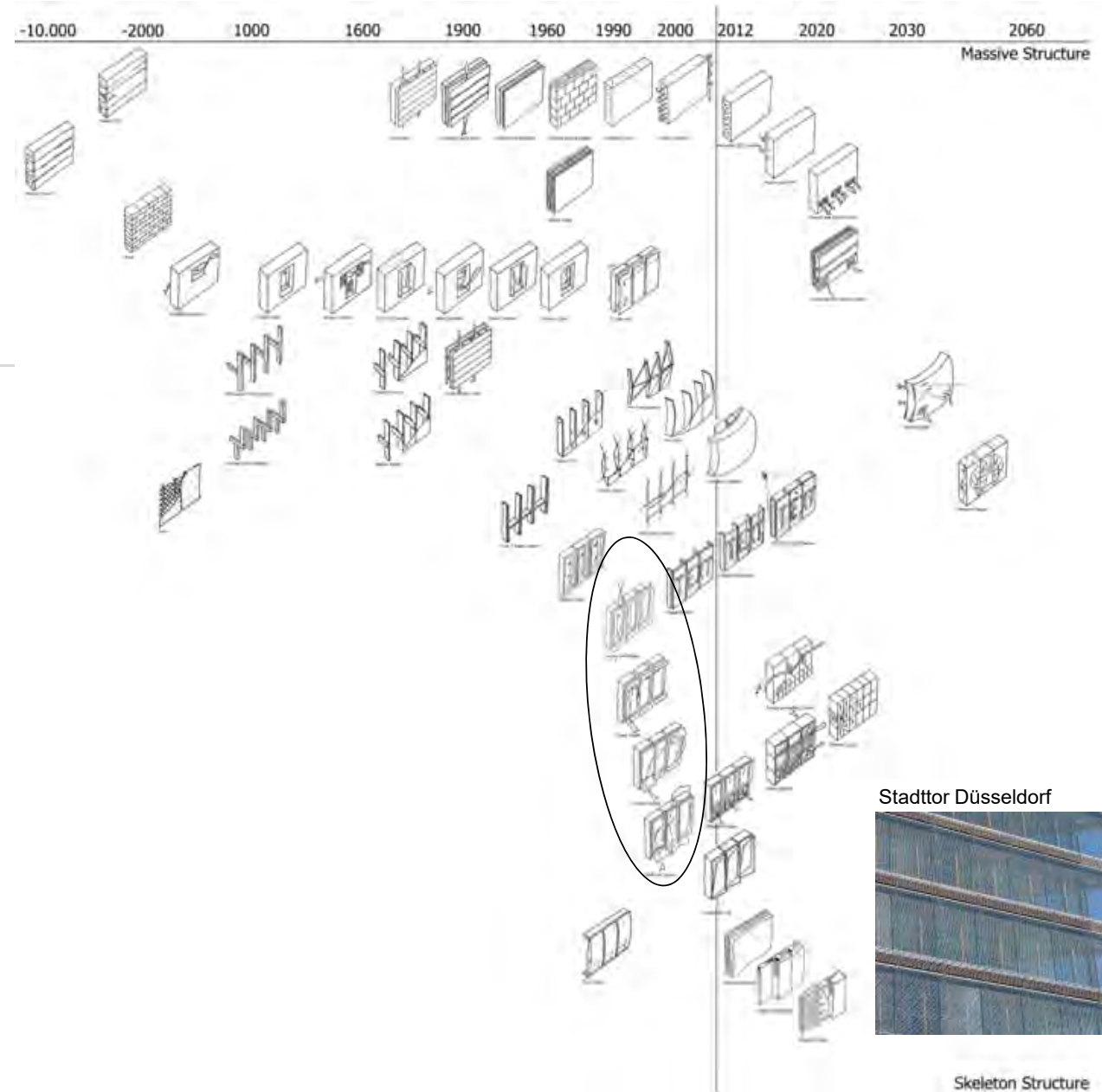
Façade Roadmap



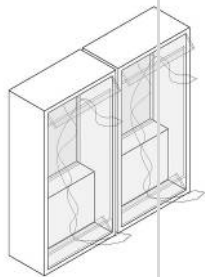
Third generation
structural glass @2015



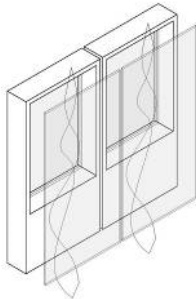
Façade Roadmap



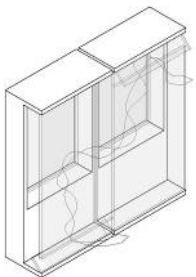
Façade Roadmap
double facades @ 2000



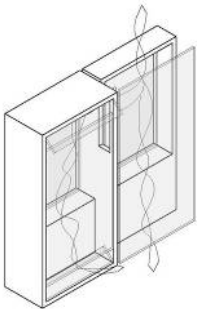
boxed window facade



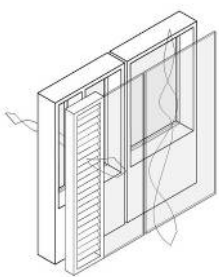
second skin facade



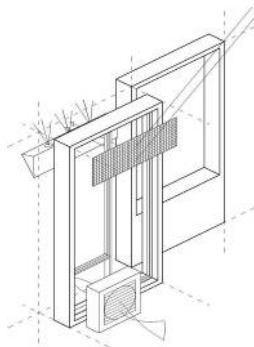
corridor facade



chimney boxed window facade

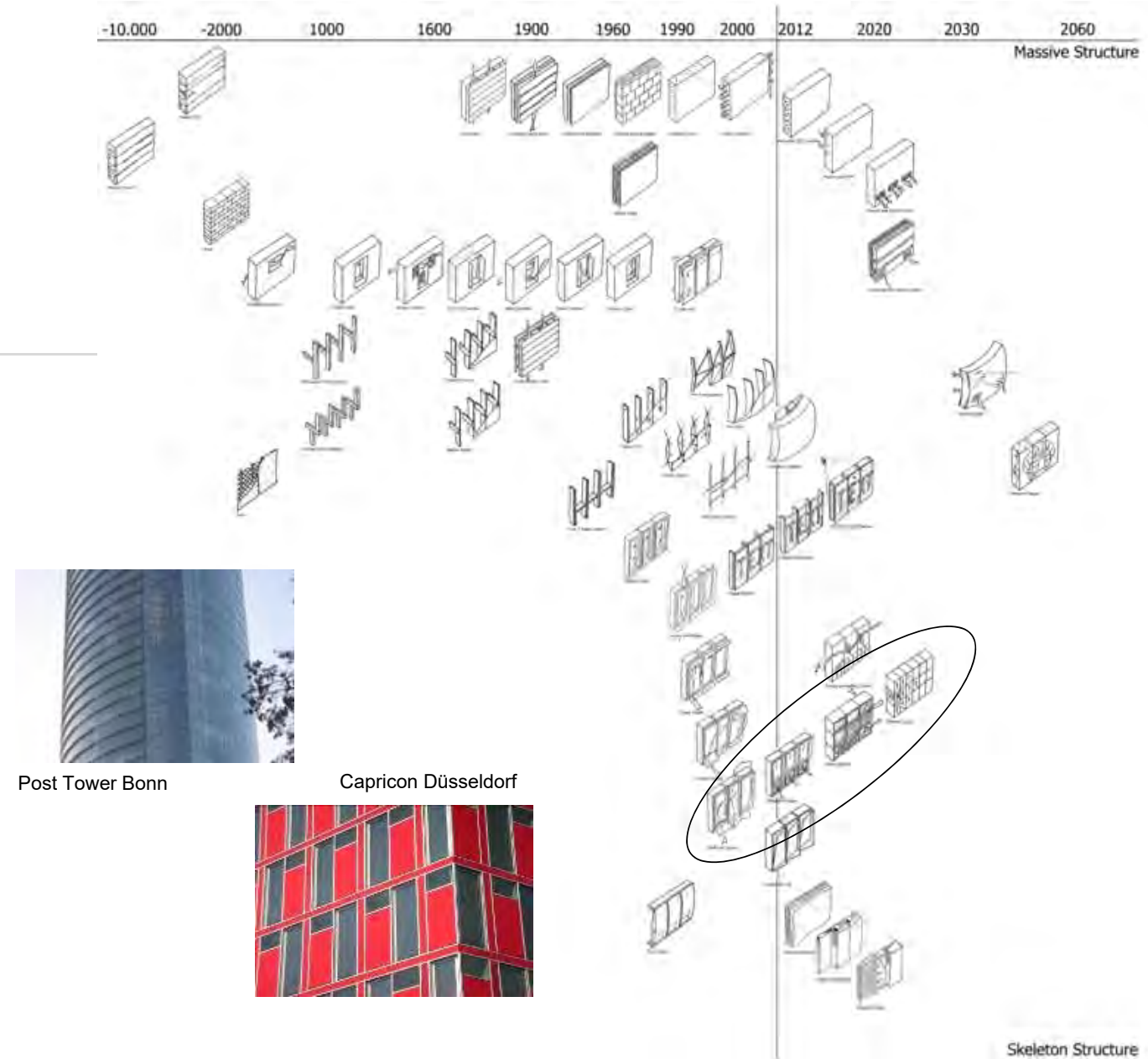


alternating facade



component facade

Façade Roadmap



Façade Roadmap
Component façade @ 2010



Posttower Bonn



T-motion facade



Capricorn Düsseldorf



SmartBox



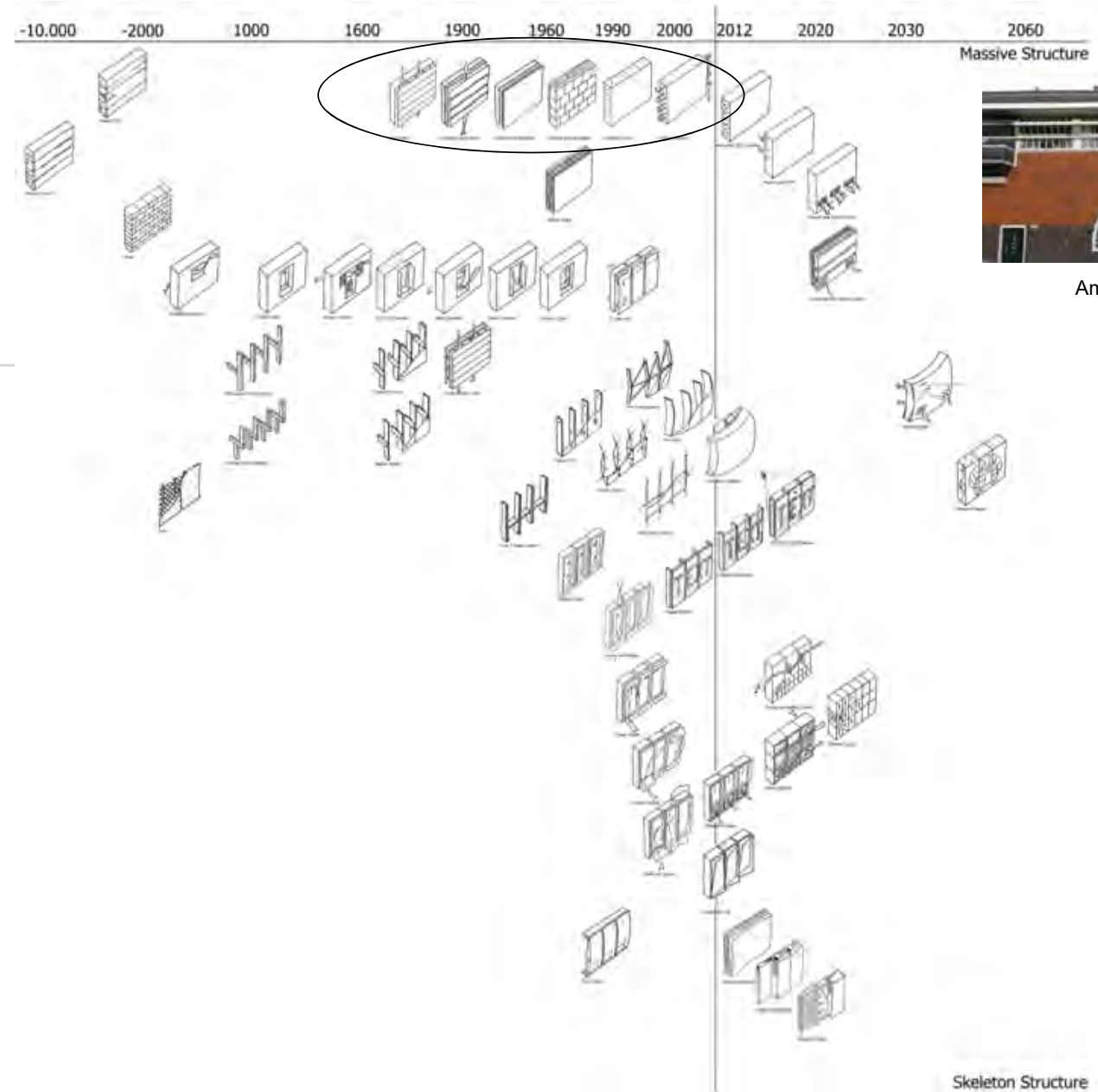
E² Fassade



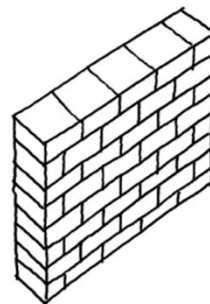
NEXT Facade



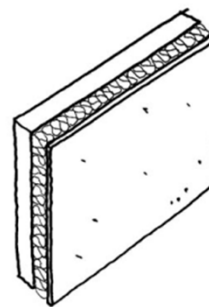
Façade Roadmap



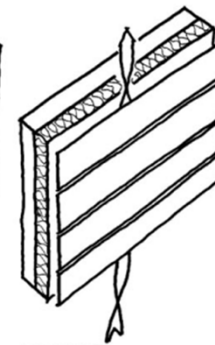
solid construction to layered solid
construction



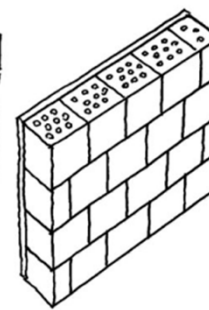
Brick



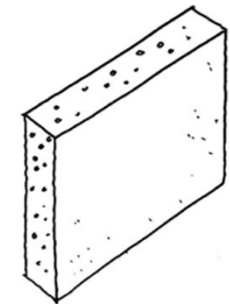
Massive insulated



Cavity wall

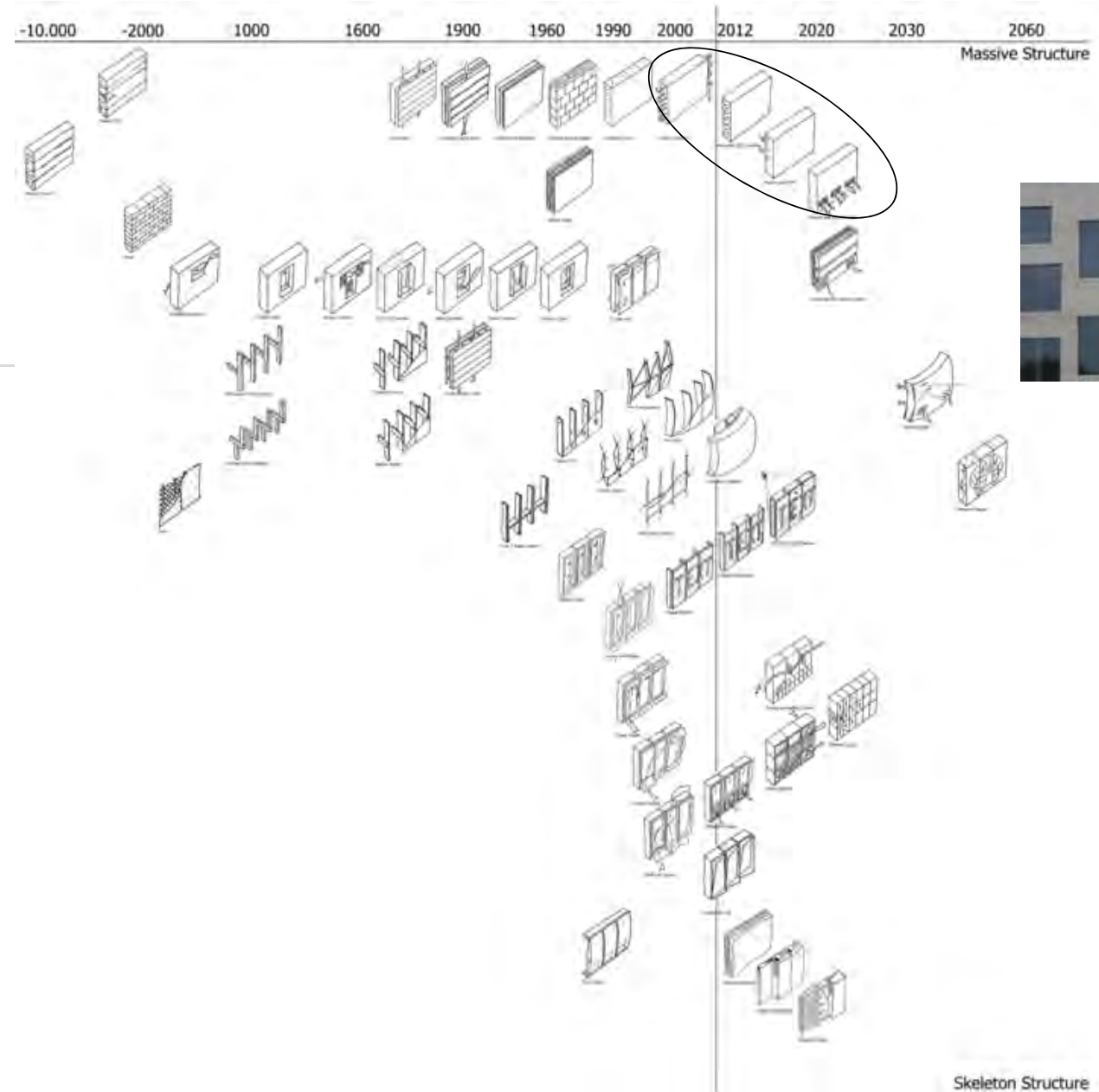


Massive brick insulated



Monolithic block

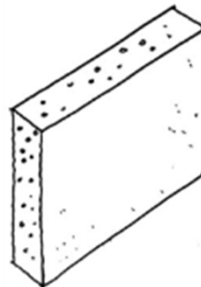
Façade Roadmap



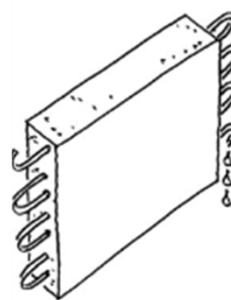
Design School Essen

Façade Roadmap

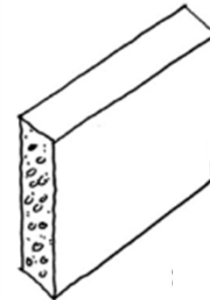
solid function integrated construction



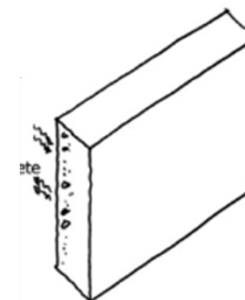
Monolithic block



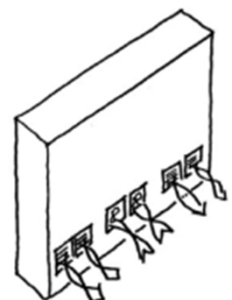
Active insulation



Monolithic light concrete



Massive and PCM



Massive and service units

Façade Roadmap

Design School Essen - SANAA / Tokyo

in collaboration with
Mathias Schuller - Transsolar and
Holger Techen - Bollinger und Grogmann



Façade Roadmap

Design School Essen - SANAA / Tokyo

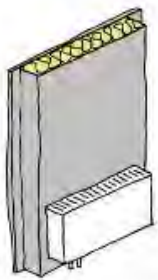
in collaboration with
Mathias Schuller - Transsolar and
Holger Techen - Bollinger und Grogmann



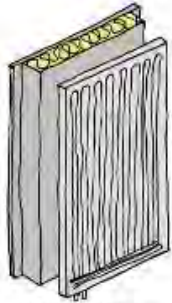
Façade Roadmap

façade heating / cooling panel

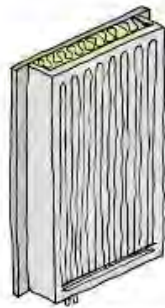
by Marcel Bilow / 2007



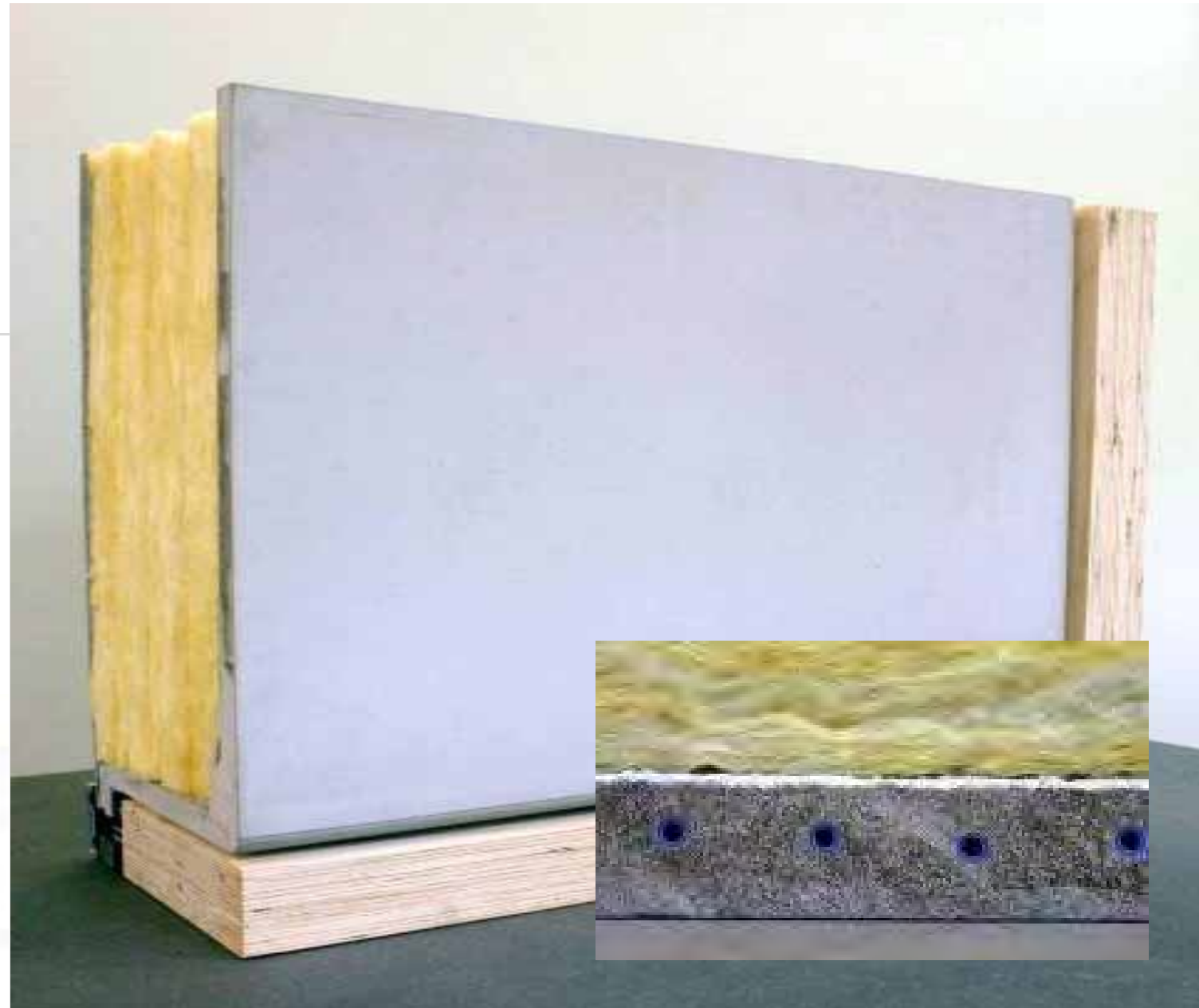
Panel mit vorgesetztem Heizkörper



Panel mit Flächenheizung additiv



Flächenheizkörper bildet Teil des Panels



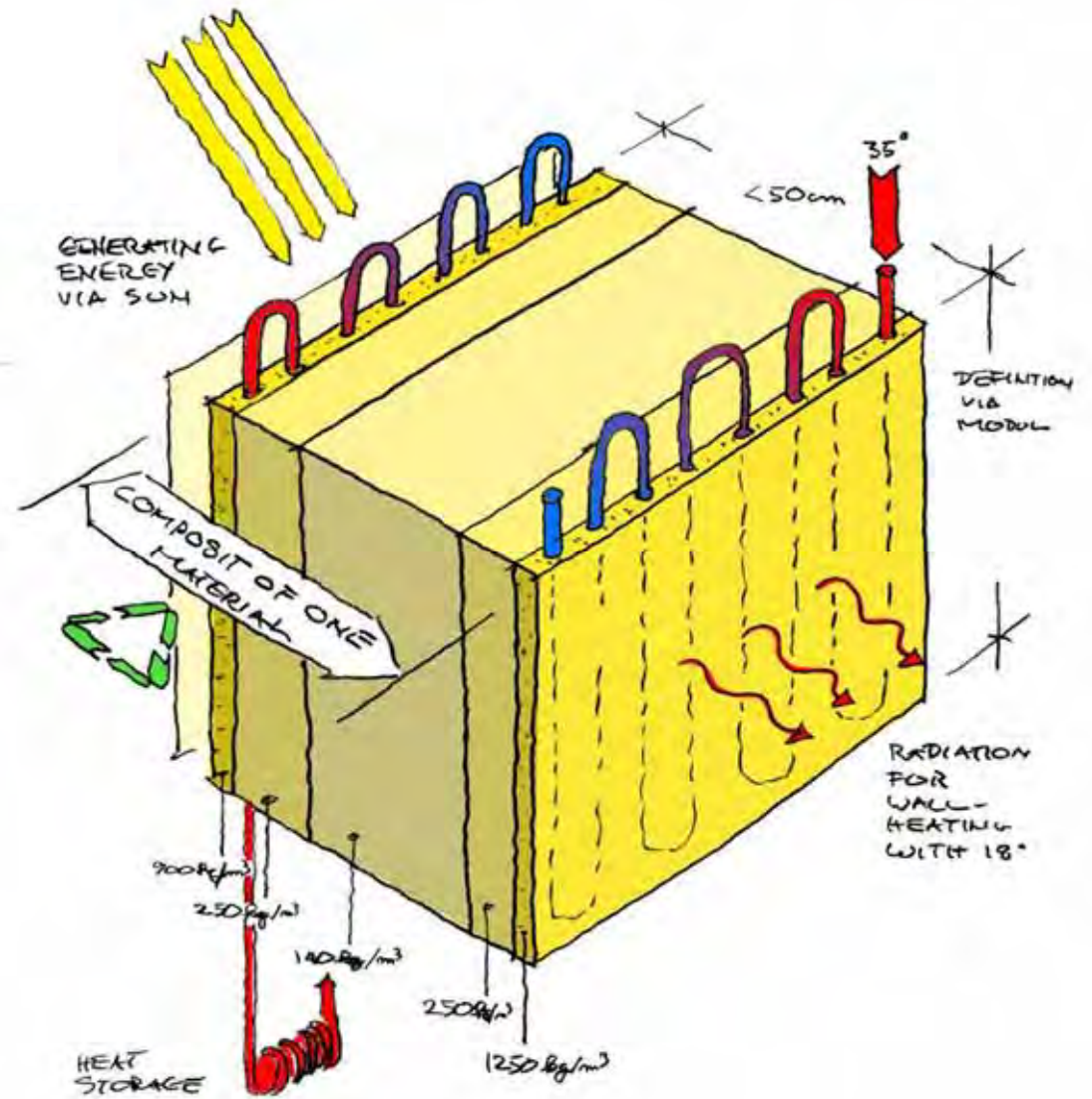
Façade Roadmap

Jackbox: integrated sandwich construction

HS OWL / 2007



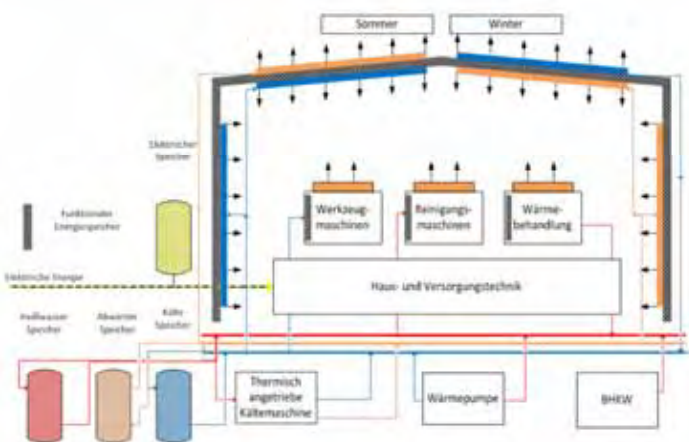
Façade Roadmap

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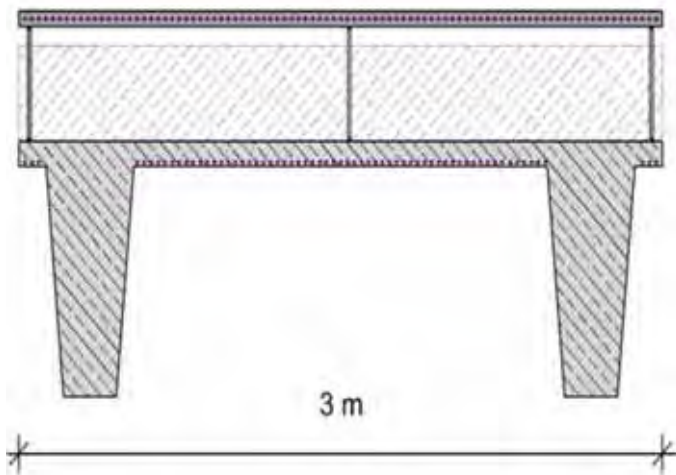
Façade Roadmap

ETA Factory / Tu Darmstadt

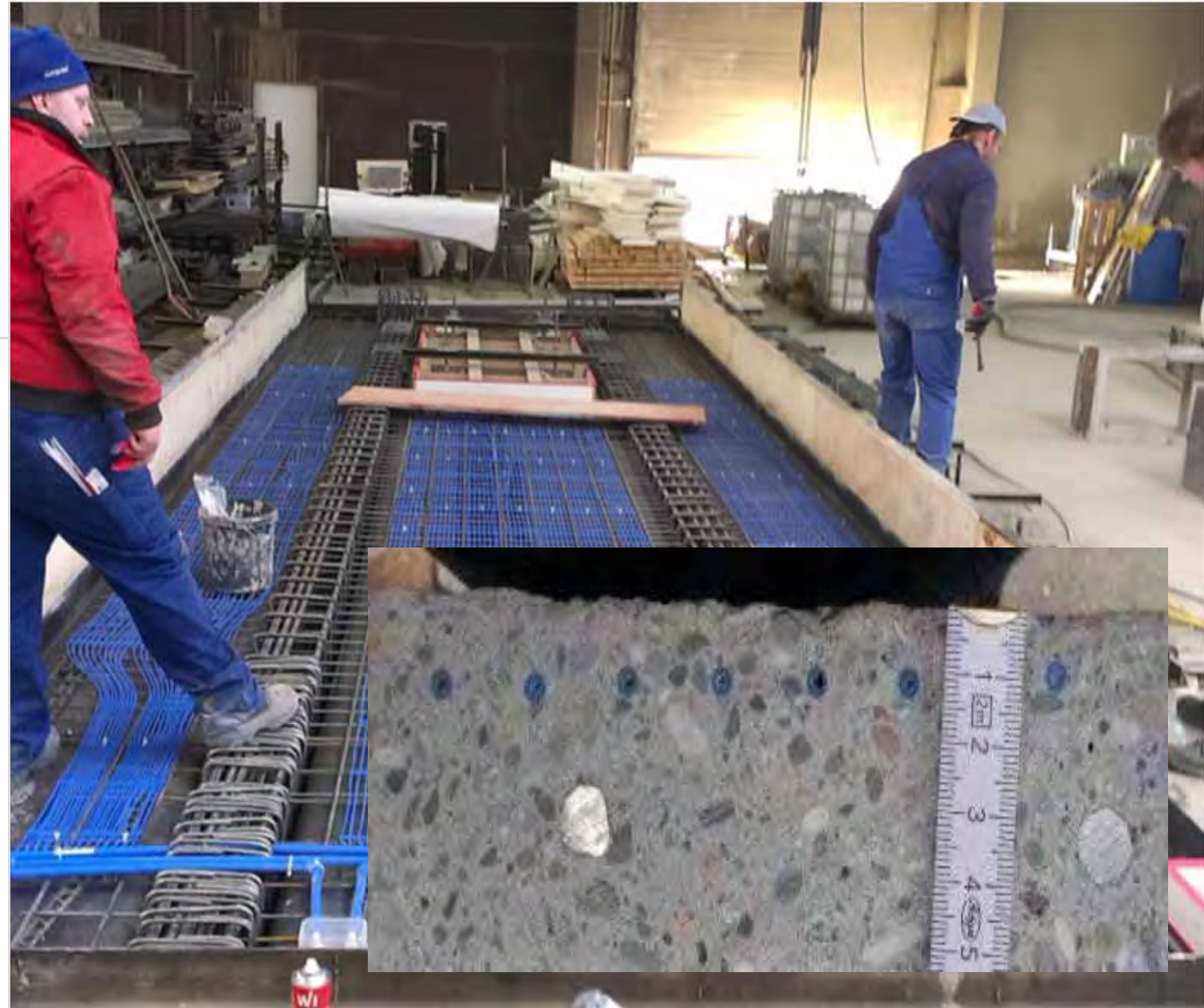
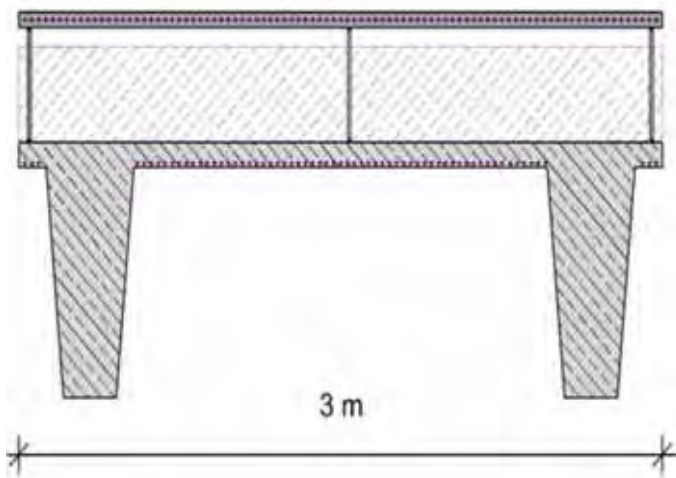
Prof Dr. Jens Schneider,
Prof Dr. H. Gerecht,
Prof Dr. E. Abele / TU Darmstadt
Prof. J. Eisele
Prof A. Joppin



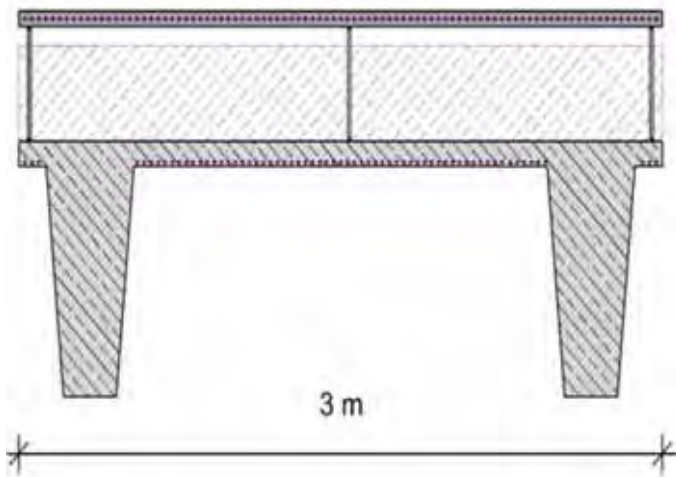
Façade Roadmap



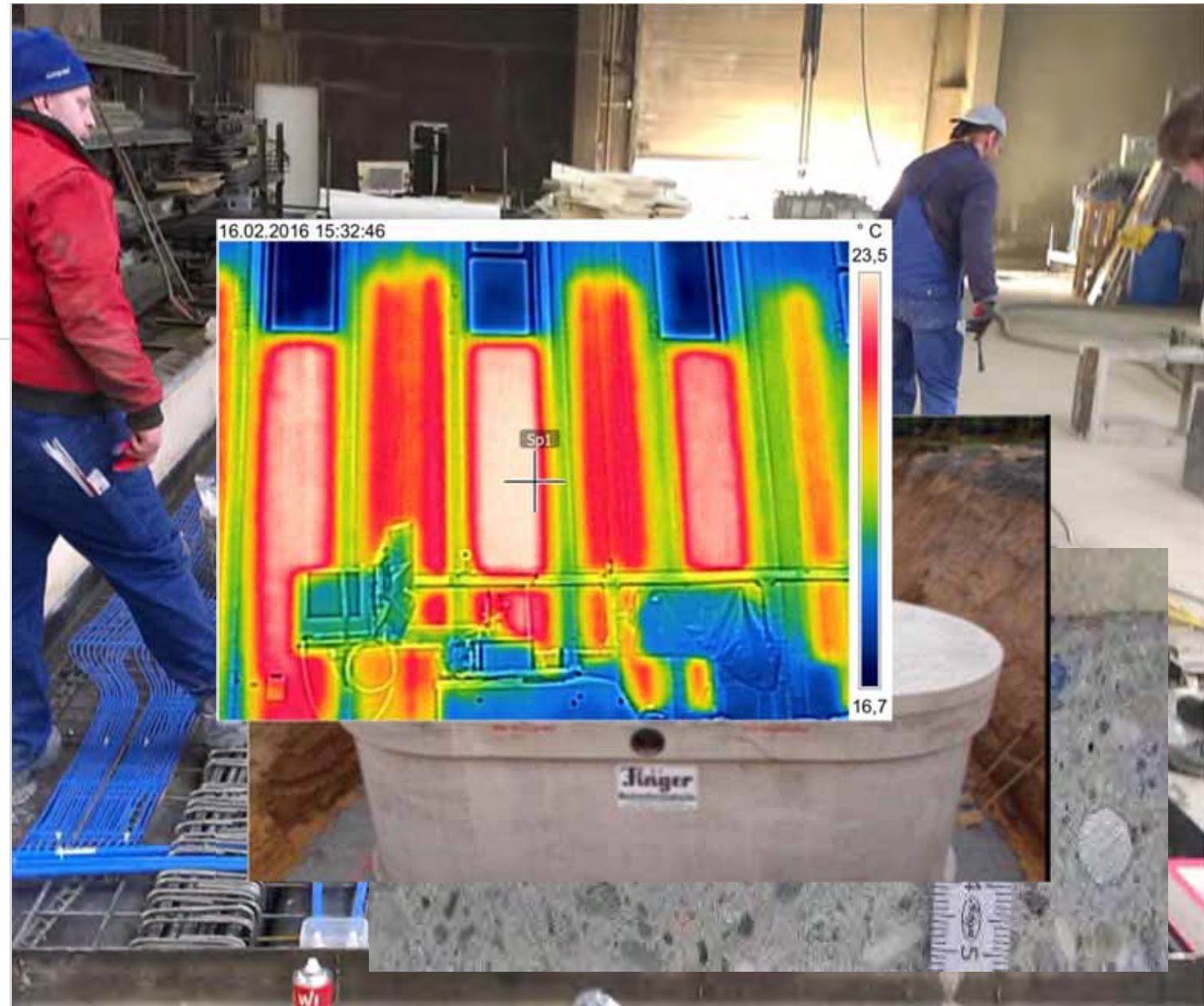
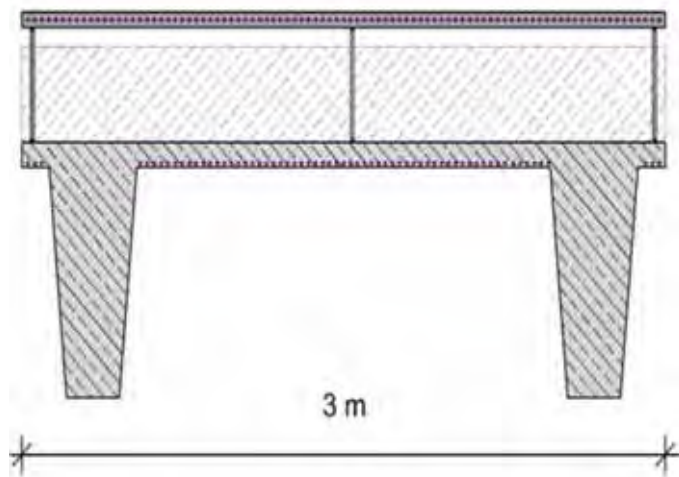
Façade Roadmap



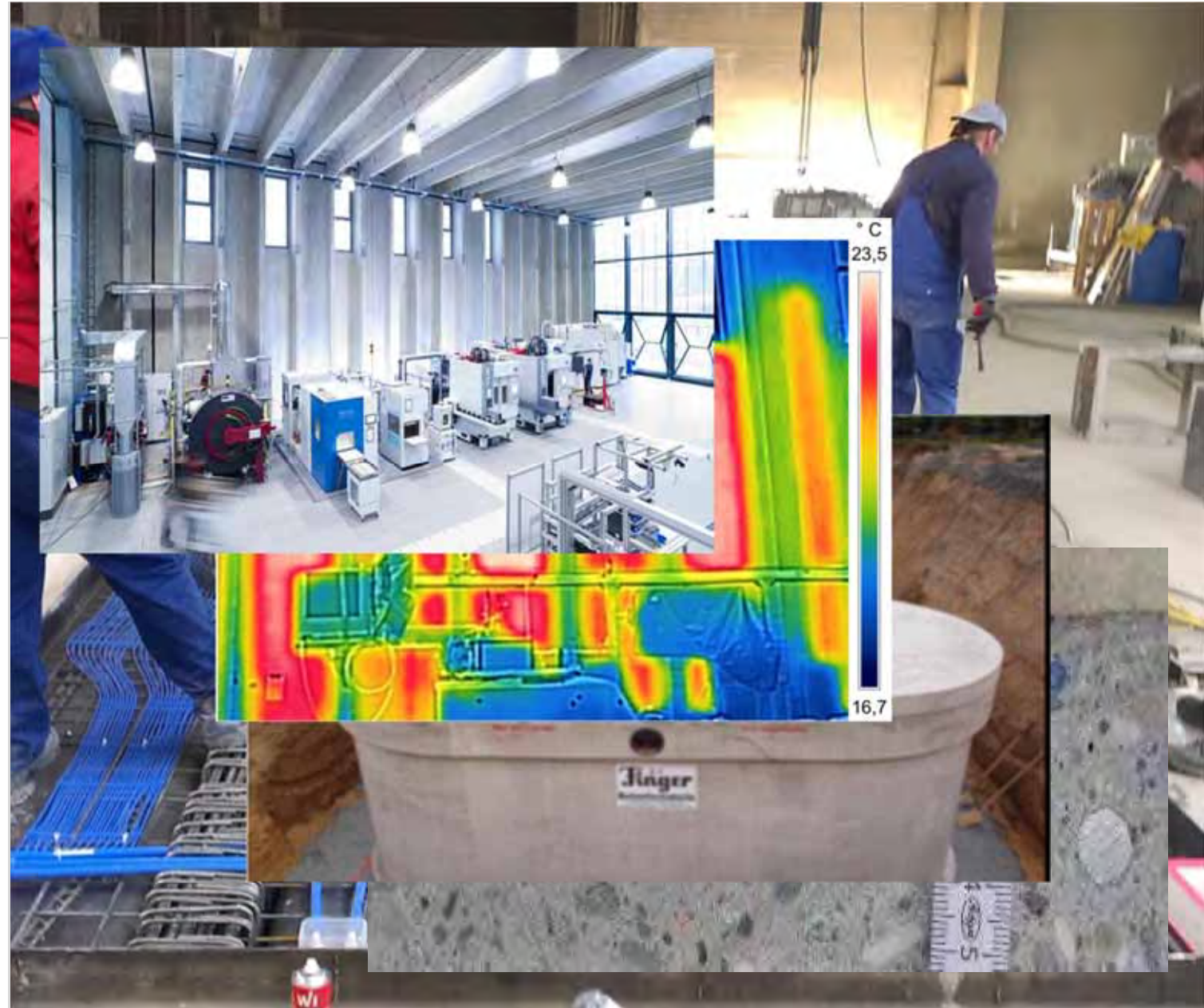
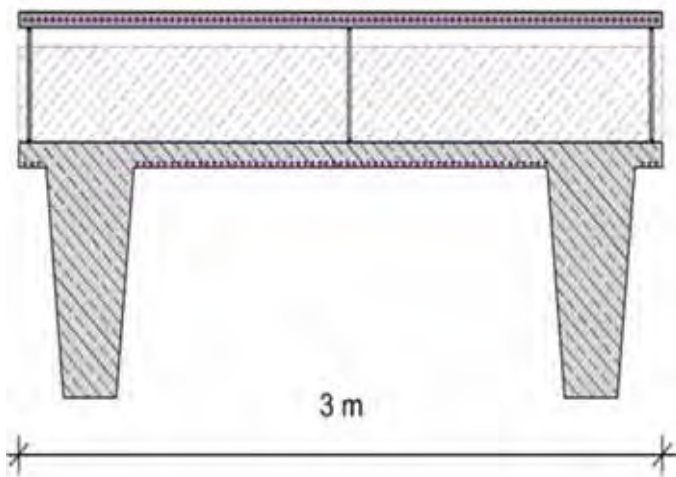
Façade Roadmap



Façade Roadmap



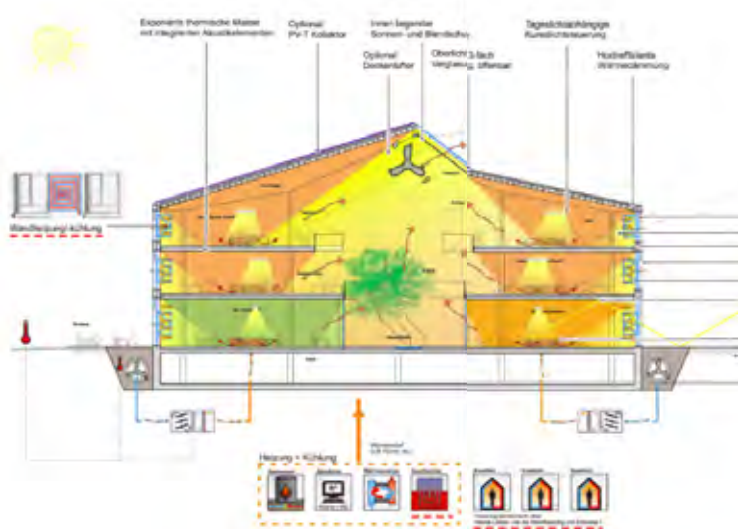
Façade Roadmap



Façade Roadmap

Alnatura / Darmstadt

Studio 2050 mit Transsolar und Knipper Helwig



Façade Roadmap



Façade Roadmap





Façade Roadmap

Green Building Innovation: Façade Research Group

Advection Based Adaptive Building Envelopes:

Component surface morphology and entropy management of a ceramic building facade

The Advection Based Adaptive Building Envelope is a ceramic based cladding system optimized to work with local climate conditions, absorbing or reflecting solar radiation by using variable surface morphology, colour and material properties, while vectoring energy via photonic advection. The ABABE is designed to use this multivalent strategy to absorb, release and redirect heat or coolth to conserve energy by managing entropy production.

Value Proposition of Managing Entropy Production
If ABABE's transport energy capacity is responsive to the dynamic loads of climate and occupation, then by controlling thermal transfer, its form and length scales by reducing photonic advection, ABABE will reduce the typical peaks and valleys of energy consumption associated with conventional building envelope strategies.

Building Envelope as Energy Transfer Function
The development of the building envelope as a transfer function for the capture, transformation, storage and distribution of energy is based on an ecological model of entropy management through the building matrix. It addresses the typical approaches of energy integration or conversion that can be characterized as derived from the First Law of Thermodynamics (e.g., conservation of energy in a closed loop of Thermodynamics (e.g., energy generation)).

Material Design Principles
The idea of passive cooling (e.g., via evaporation) and surface morphology (e.g., natural), are directly related to thermodynamic energy storage (e.g., building volume, thermal capacity, etc.) and climate (e.g., hot and cold, convective, etc.) and provide a research platform from which to investigate the potential for the performance design of a building envelope system. The principle of passive cooling (e.g., via evaporation) is the management of entropy through an advective working fluid. The principle of surface morphology is the control of the rate of energy gain or loss due to convection. By having these two principles together in the design of a facade component, we can then investigate the effects on the energy profile of the affected building system, as well as propose the facade as a functioning element whose morphology reflects its use.

Project Information

Project Name: Green Building Innovation: Façade Research Group

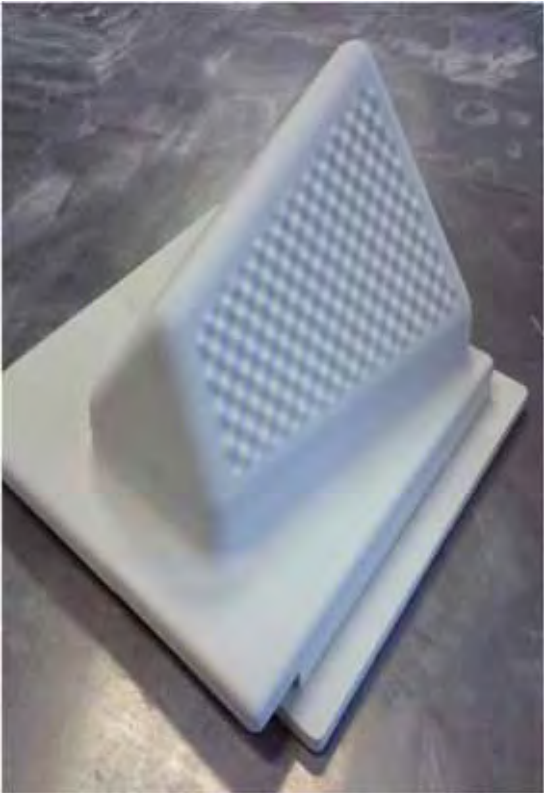
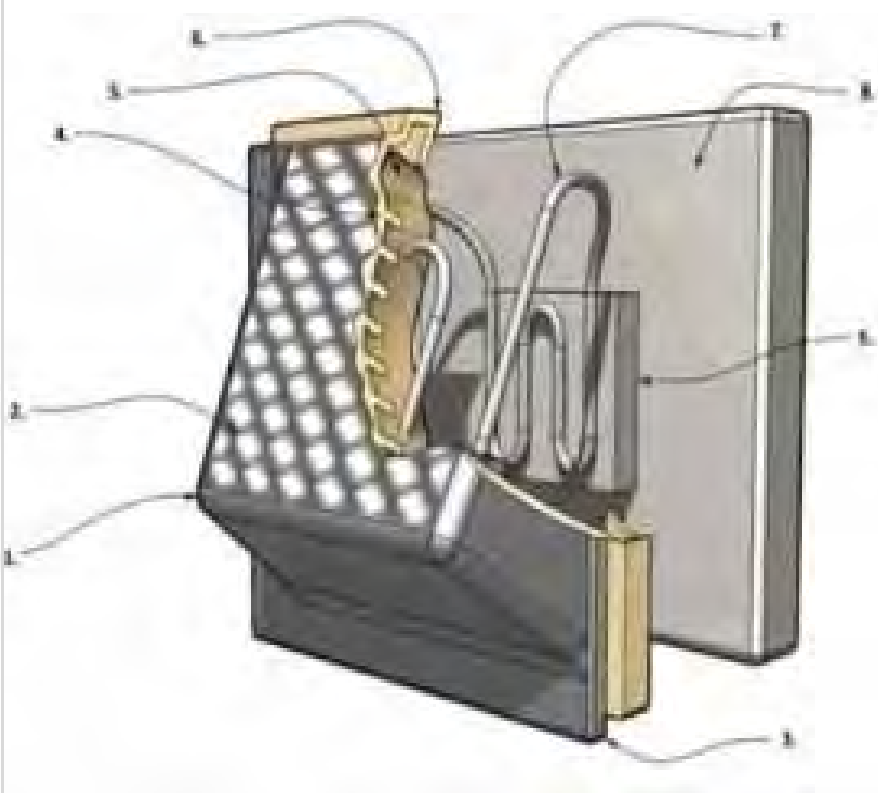
Project Lead: Dr. J. H. Kim

Project Manager: Dr. J. H. Kim

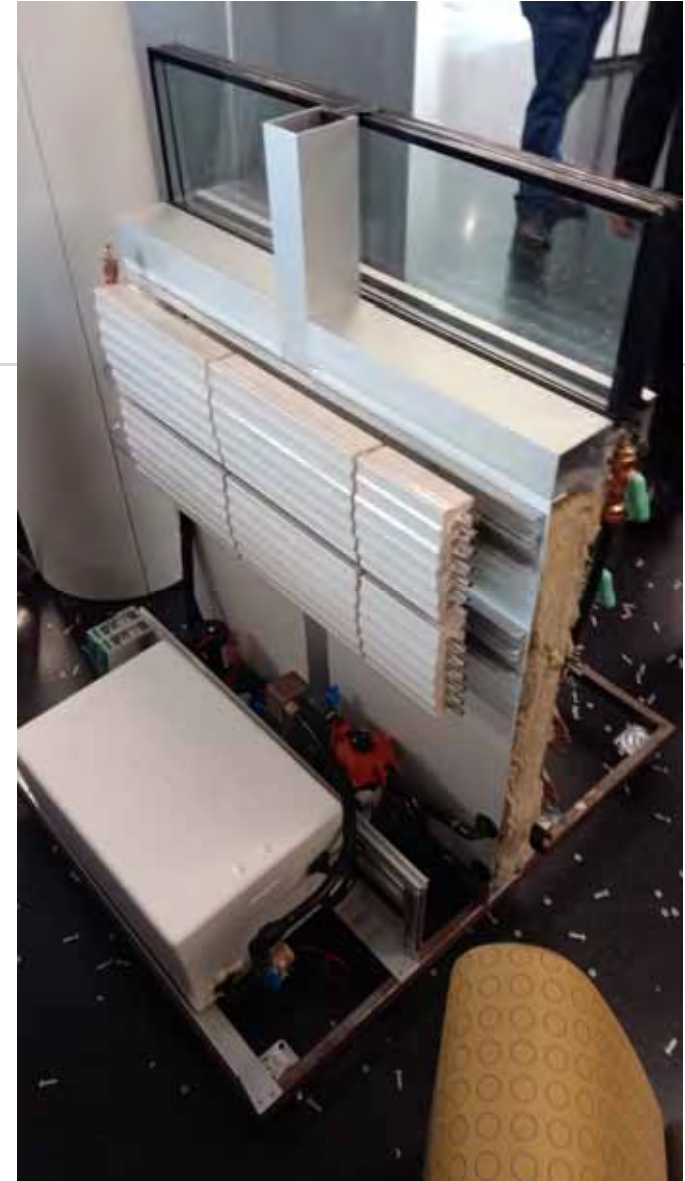
Project Status: In Progress

Project Description

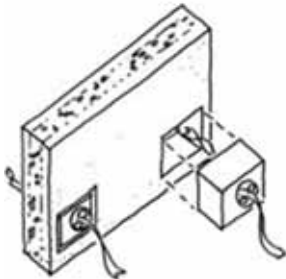
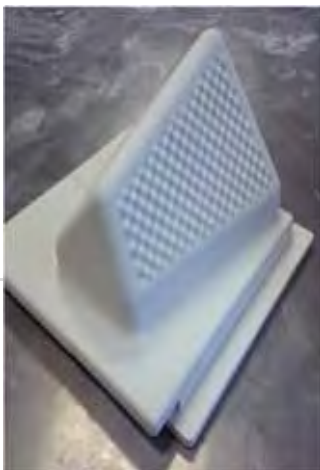
The project is a research and development project aimed at developing a new building envelope system that can adapt to changing climate conditions and occupant needs. The project is led by Dr. J. H. Kim, who is a senior research fellow at the Green Building Innovation: Façade Research Group. The project is currently in the design phase, and the team is working on developing a prototype of the building envelope system.



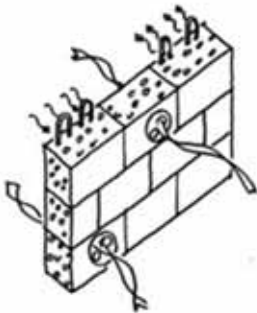
Façade Roadmap



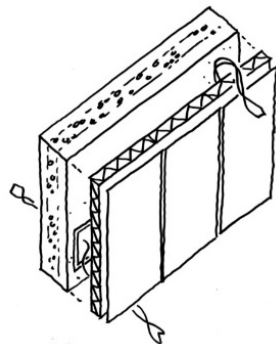
Façade Roadmap



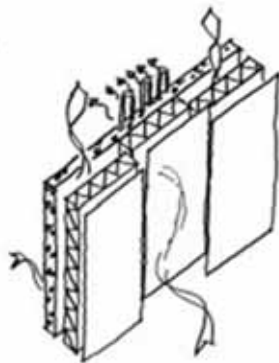
Single layered light massive
enveloper with services
integrated



Full services and energy
collection integrated in light
massive envelope

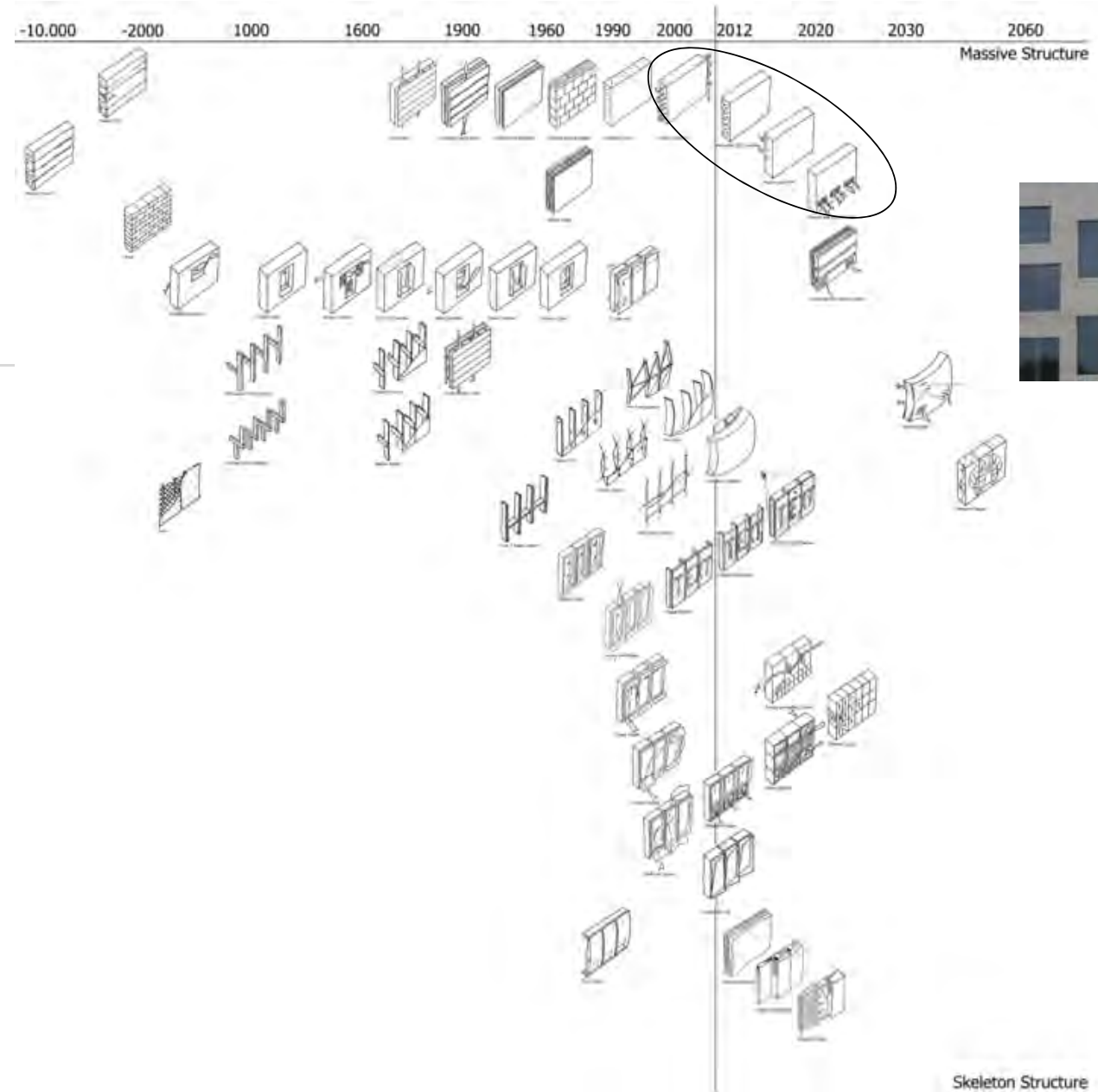


Light massive envelope
with separate and
demountable cladding



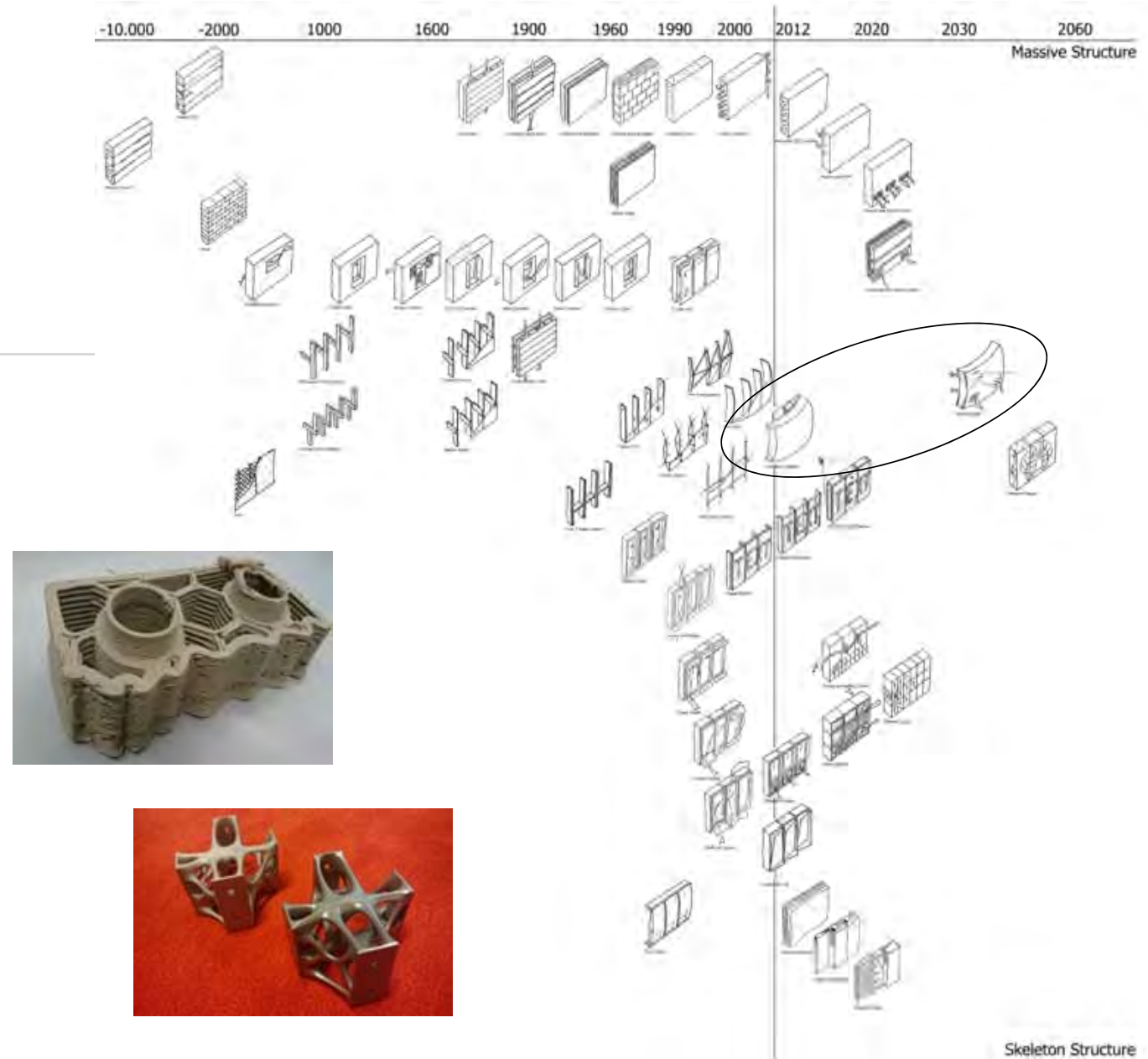
Light and fully demountable
massive envelope

Façade Roadmap



Design School Essen

Façade Roadmap



Additive Manufacturing



Polymeers



Metal



Concret



Ceramic



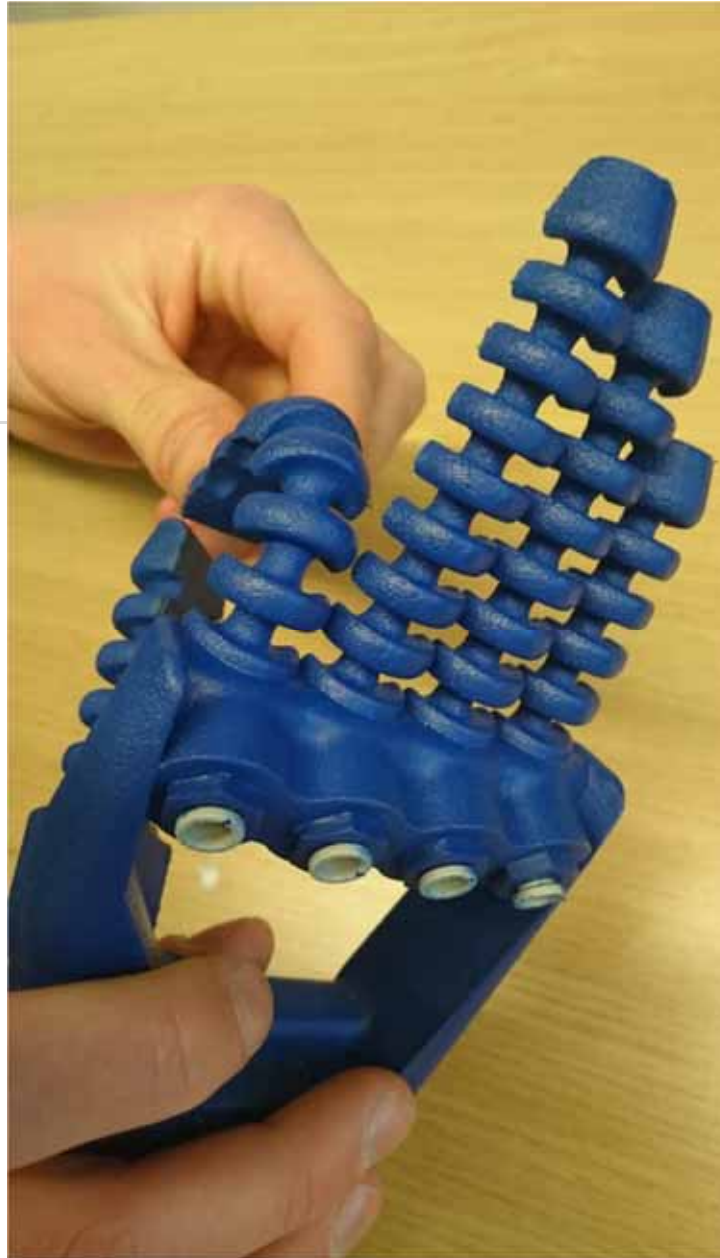
Glass



Wood / Paper



Additive Manufacturing



Additive Manufacturing

grach... x +

ngen.nl/cultuur/architectuur-cultuur/162366/dus-architects-gaat-3d-grachtenpand-printen.html

ZEIT ONLINE | Nachri... | Technology Review | facadeworld | Facade... | imagine the blog | buckylab | TU Delft: Bouwkunde | FB1: News | YouTube | Google | reich - English - Deu

Welingelichte Kringen

HOME POLITIEK ECONOMIE SPORT SAMENLEVING+ WETENSCHAP+ CULTUUR & MEDIA+ OPINIE Zoek...

DUS Architects gaat 3D grachtenpand printen



Door Chantal Caes - donderdag 14 maart 2013, 22:38 in categorie: Architectuur

In 1613, precies 400 jaar geleden, werd in Amsterdam gestart met de aanleg van de... u breekt een nieuw tijdperk aan: dat van 3D ontwerp- en

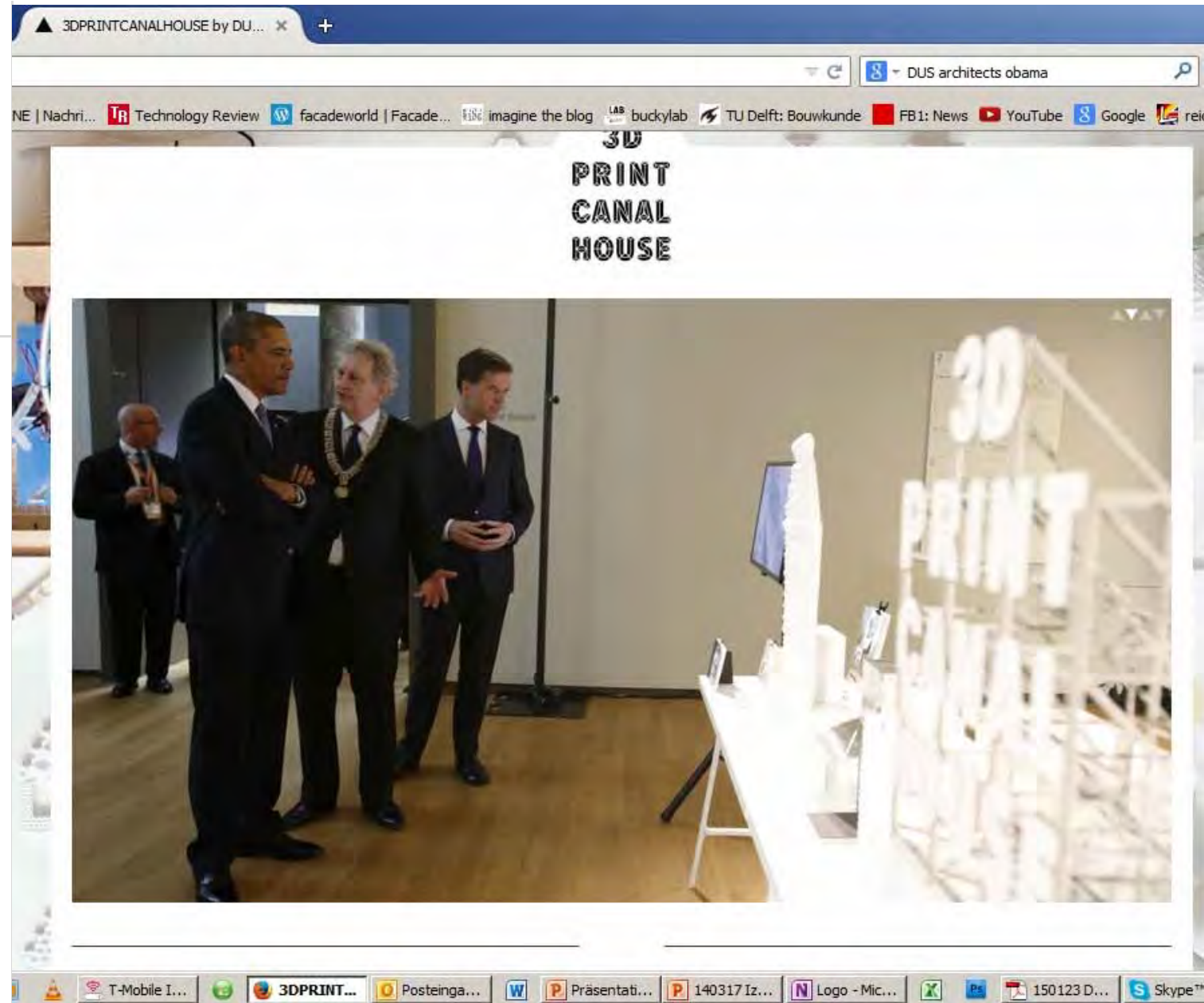
ADVERTENTIE

MEEST GELEZEN VANDAAG

-  Waarom je stuiptrekkingen krijgt voor het slapengaan
-  Veel lof voor optreden Aboutaleb op CNN
-  Islamitische geestelijke vertelt op universiteit: 'De zon draait om de aarde'
-  IS: 'We sturen 500.000 migranten in bootjes de Middellandse zee over'
-  Zo krijg je nooit meer advertenties op Facebook
-  In deze 10 landen gaan mensen het vaakst vreemd

com...

T-Mobile I... DUS Arch... Posteinga... W P Präsentat... P 140317 Iz... N Logo - Mic... 150123 D... Skype™ [...]



Additive Manufacturing

Additive Manufacturing

3D PRINT CANAL HOUSE

expectations

Internet of Things
Natural Language Question Answering
Wearable User Interfaces
Consumer 3D Printing
Cryptocurrencies
Complex-Event Processing
Big Data
In-Memory Database Management Systems
Content Analytics
Hybrid Cloud Computing
Gamification
Augmented Reality
Machine-to-Machine
Communication Services
Mobile Health Monitoring
Cloud Computing
NFC
Virtual Reality
Speech Recognition
Consumer Telematics
Enterprise 3D Printing
Active Streams
In-Memory Analytics
Gesture Control

Speech-to-Speech Translation
Autonomous Vehicles
Smart Advisors
Data Science
Prescriptive Analytics
Neurobusiness
Biochips
Affective Computing
Smart Robots
3D Bioprinting Systems
Volumetric and Holographic Displays
Software-Defined Anything
Quantum Computing
Human Augmentation
Brain-Computer Interface
Connected Homes
Virtual Personal Assistants
Digital Security
Biocoustic Sensing
Smart Workspace
Quantified Self

time

Plateau will be reached in:

- less than 2 years
- 2 to 5 years
- 5 to 10 years
- more than 10 years
- obsolete before plateau

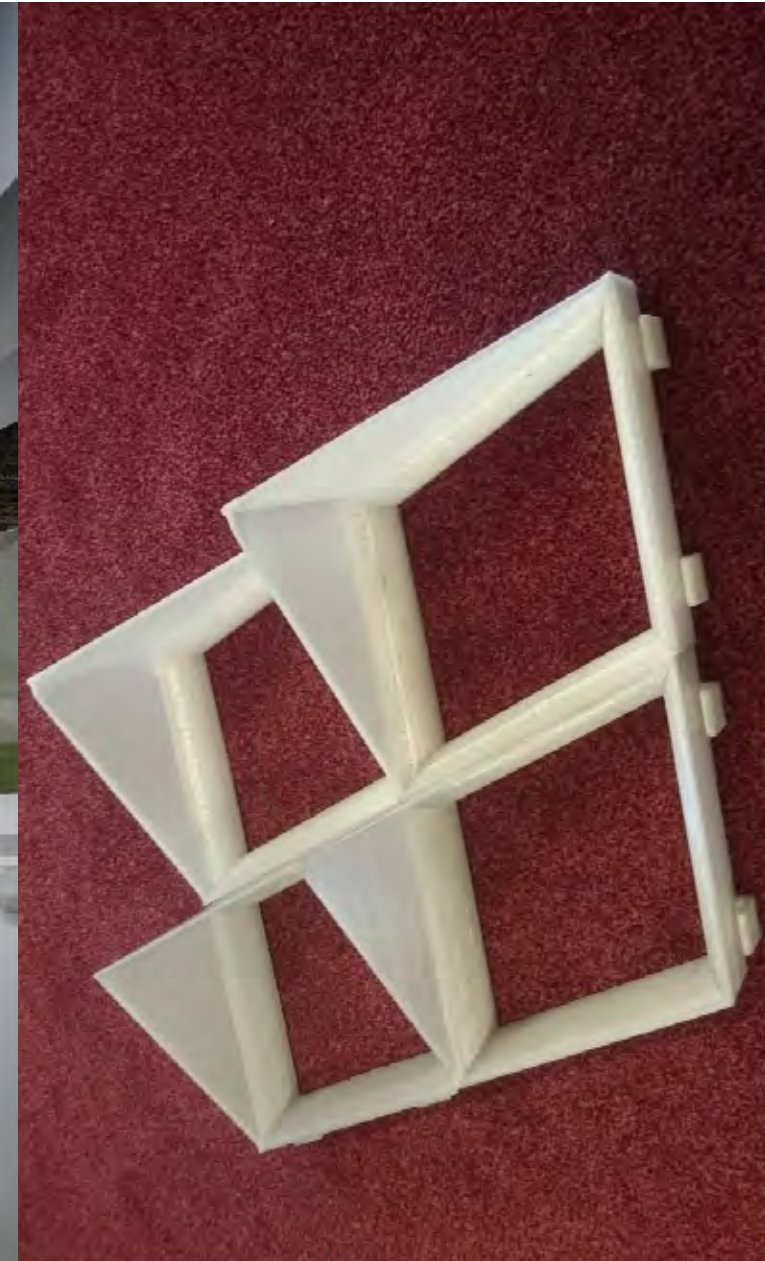
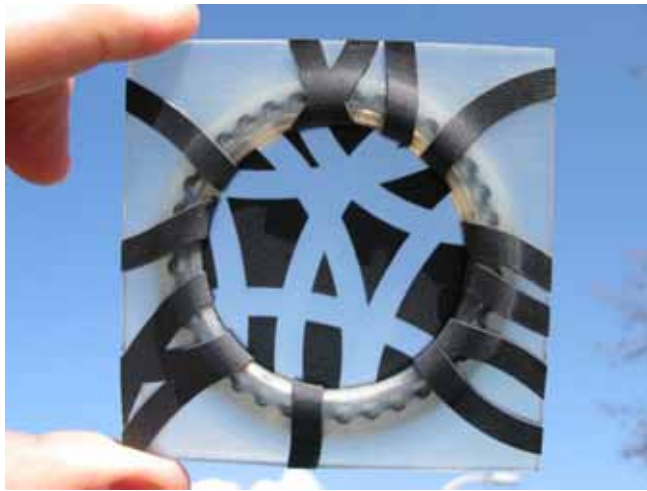
As of July 2014

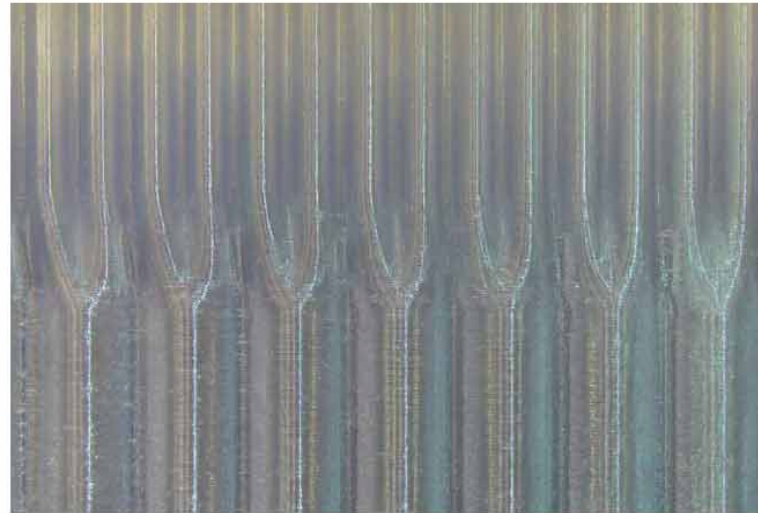
Stages of the Hype Cycle:

- Innovation Trigger
- Peak of Inflated Expectations
- Trough of Disillusionment
- Slope of Enlightenment
- Plateau of Productivity

Additive Manufacturing

Sunnhading / TU Darmstadt - TU Delft





Spong3D is an adaptive 3D printed facade system that integrates multiple functions to optimize thermal performances according to the different environmental conditions throughout the year. The proposed system incorporates air cavities to provide thermal insulation and a movable liquid (water plus additive) to provide heat storage where and whenever needed. The air cavities have various dimensions and are located in the inner part of the system. The movable liquid provides heat storage as it flows through channels located along the outer surfaces of the system (on the indoor and outdoor faces of the facade). Together, the composition of the channels and the cavities form a complex structure, integrating multiple functions into a singular component, which can only be produced by using an Additive Manufacturing (AM; like 3D printing) technology.



The aim of this research is a proof of concept of Spong3D. Spong3D is an adaptive facade system that controls the heat exchange during the year between the interior and exterior conditions of the building. It incorporates two sub-systems. The first system consists of a porous inner core with air cavities to provide thermal insulation. The second one contains a series of outer channels that enable the flowing of liquid. The liquid acts as movable thermal mass to provide adaptive heat storage. Based on necessity, the liquid can be transferred from one side of the facade to the other to absorb and release the heat. The overall adaptive system proposes an integrated component fabricated with additive manufacturing.

The development of the proof of concept was organized according to sub-goals. First, the research aimed at understanding and quantifying the thermal potentials of the 3D printed porous structures, enhancing their capacity for thermal insulation and heat storage. Moreover, the research discovered additional needed properties, specifically issues related to the 3D printing process, such as flow resistance, water tightness, structural robustness and printing time for production. Finally, the research investigates the effects of the facade system in a room environment.

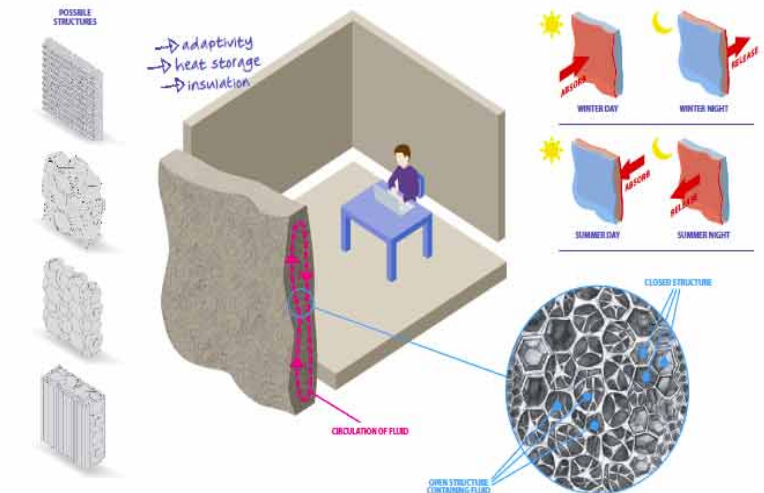
The optimization of thermal performances occurred through an iterative, cyclical process. Several samples with different geometric configurations of porous structures were designed and tested in order to maximize thermal insulation, allow appropriate heat absorption in the liquids, minimize the flow resistance, achieve acceptable water tightness and minimize the production time.

An adaptive façade system that controls the heat exchange during the year.

In order to design the test-samples, preliminary choices were made by taking into account that the porosity of the material determines the thermal resistance of the facade. The higher the porosity,

The models were produced with 3D printing, using PETG, a transparent material with relatively low thermal conductivity.

the less solid (and conductive) material there is, and therefore higher thermal resistance. Thus, the first set of samples was based on ordered cellular structures like polyhedra, which performed well for thermal criteria and structural robustness, but caused challenges with regard to the printing process. In order to reduce the time required for the printing process and the risk of possible failures during production, the size of the cells were then scaled in all directions except the ones related to the heat transfer perpendicular to the facade. The size of the insulating cavities in that direction was constrained to 15 mm in order to prevent internal convection since this would cause the thermal resistance to be reduced. As such, the geometry was adjusted to create smoothly curved cavities that remain 15 mm only in the direction of the heat transfer but are larger in the other two directions. This adjustment showed positive results not only reducing the printing time, but also to creating a stiff, yet lightweight structure. Moreover, the smoothness of the geometry allowed for a more stable printing process. The external layer (where the liquid flows) requires water-tightness and a fluid shape of the channels to allow for minimal pressure drop and uniform flow. Several samples with different configurations were tested for flow resistance and the best performing shape was selected. The current shape of the channels is inspired by natural



configurations that transfer fluids such as blood vessels, the veins of leaves and three dimensional bionic structures. Though further investigation is needed, the current shape is promising with regard to the circulation of the liquid. The channels should also allow for appropriate heat absorption into the liquid. To accommodate this need, the current models were produced with Fused Deposition Modelling (FDM) printing, using PETG, a transparent 3D printing material that has relatively low thermal conductivity. Further investigations may consider the calibrated combination of translucent and dark materials. To control the movement of the liquid through the overall system, each facade panel consist of two external layers that integrate two reversed pumps for water circulation. The water can be stored in a tank in the center of the panel. In a cooling situation, the liquid is first placed on the inside to absorb internal heat gain and is then pumped to the outside layer to discharge the heat to the cool night sky. In the alternative case, for heating purposes, the liquid is placed outside to absorb any solar heat gain during daytime and is then pumped to the inside to release this heat inside the building. The pumps are also connected with the water tank to store the water inside the tank when necessary.

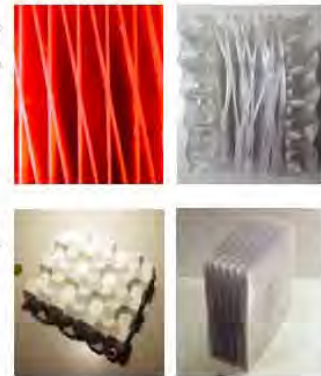
The structural behavior of the overall system was analyzed by investigating the impact of the wind load to the facade panel and calculating the deformations. The result is a curtain wall system that transfers the loads to the main structure of the building. The structural analysis did not reveal major structural challenges. However, deeper studies on the structural behavior of the 3D printed material are required especially when considering extreme thermal conditions and durability.

Finally, the thermal impact of the overall system on a room was simulated. The investigation focused on two scenarios, a summer day and a sunny

winter day. Energy simulations showed that a cooling rate of 25 W/m² could be obtained during typical summer conditions. This is more or less equivalent to 50% of the internal heat gains in a conventional office environment. Similarly, 4.8 kWh of thermal energy could be harvested for a typical 12 m² office space on a sunny winter day, which accounts for approximately 70% of the typical corresponding heating demand.

A large 1:1 (full scale) prototype was produced. One important aspect of this research was to study the feasibility to produce a facade panel within particular time constraints. This was one of the main challenges that influenced the design and the production process. The design process prioritized configurations that have low printing time and specific settings were applied to ensure a speedy printing process. The production process occurred in collaboration with KWI Solutions. The investigation of the 3D printing technology was based on the latest available production technologies, using 3D printers for larger objects and innovative materials.

In conclusion, the main outlook of this research is a proof of concept for a facade system that can adapt its thermal behavior to different environmental conditions, regulate the temperature inside the building and reduce the environmental impact through innovative production technologies. Despite the challenges faced so far, the project showed promising results regarding the development of tailored products with complex shapes by using 3D printing technology. In the case of Spong3D, it was possible to successfully generate a facade system with high complexity that achieves high levels of thermal comfort. Additionally, by using 3D printing technology the project uses material resources more strategically and minimizes waste material throughout the production process.



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KWI Solutions
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Additive Manufacturing

Maria Valentini / TU Delft



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3d printing house

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More detail on those Chinese 3D-printed houses

Lloyd Alter (@lloydalter)
Design / Modular Design
April 24, 2014

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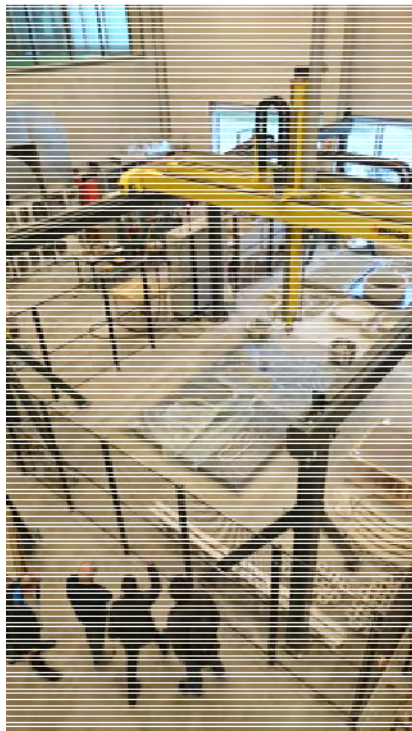
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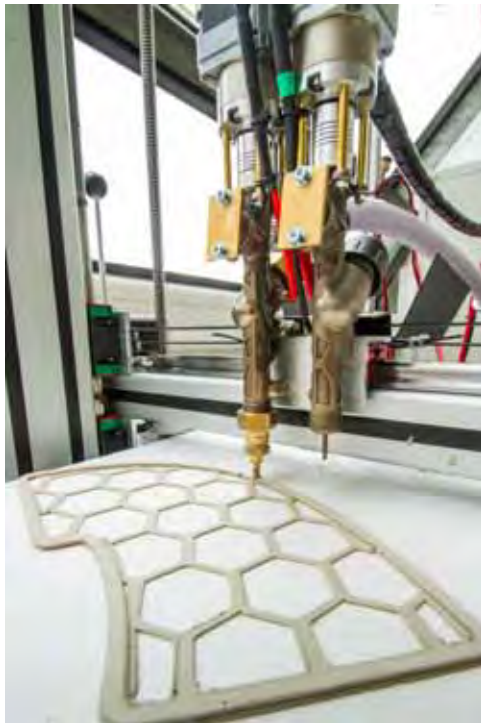
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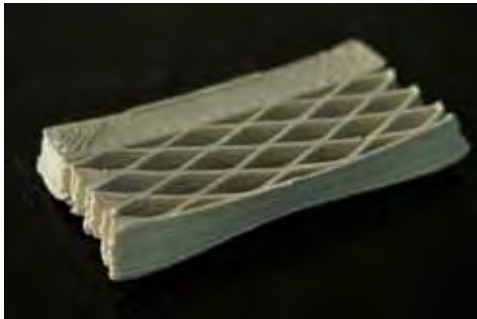
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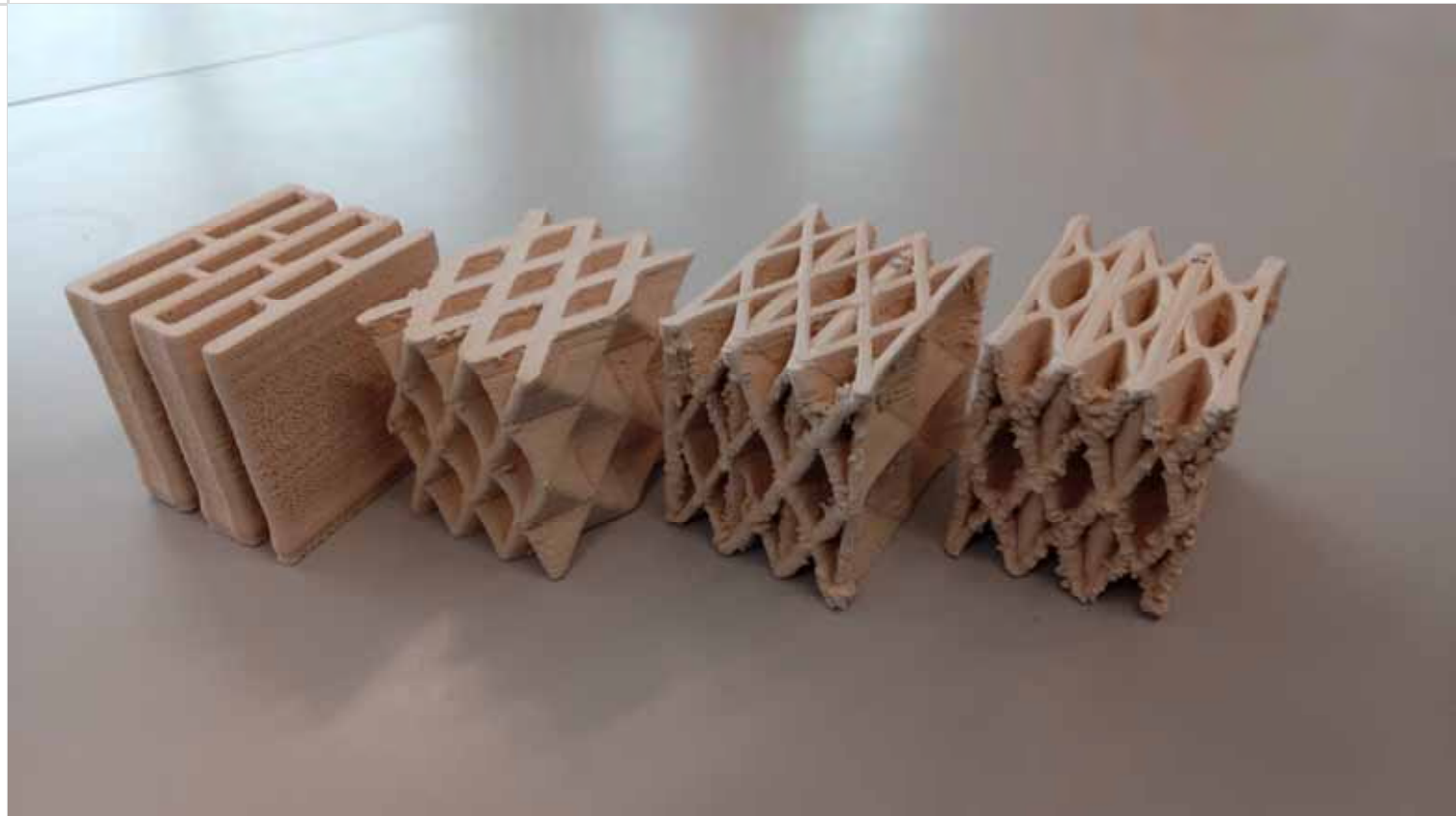
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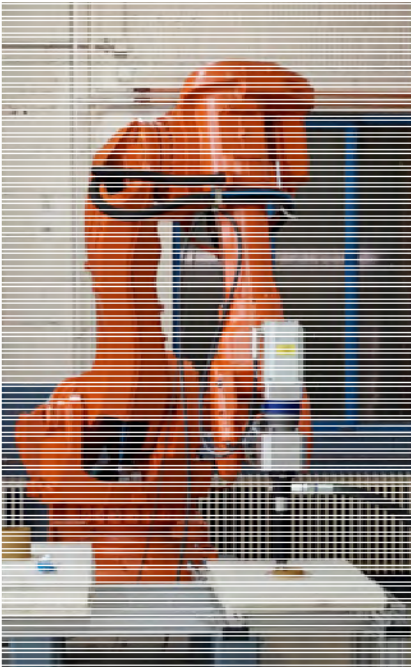
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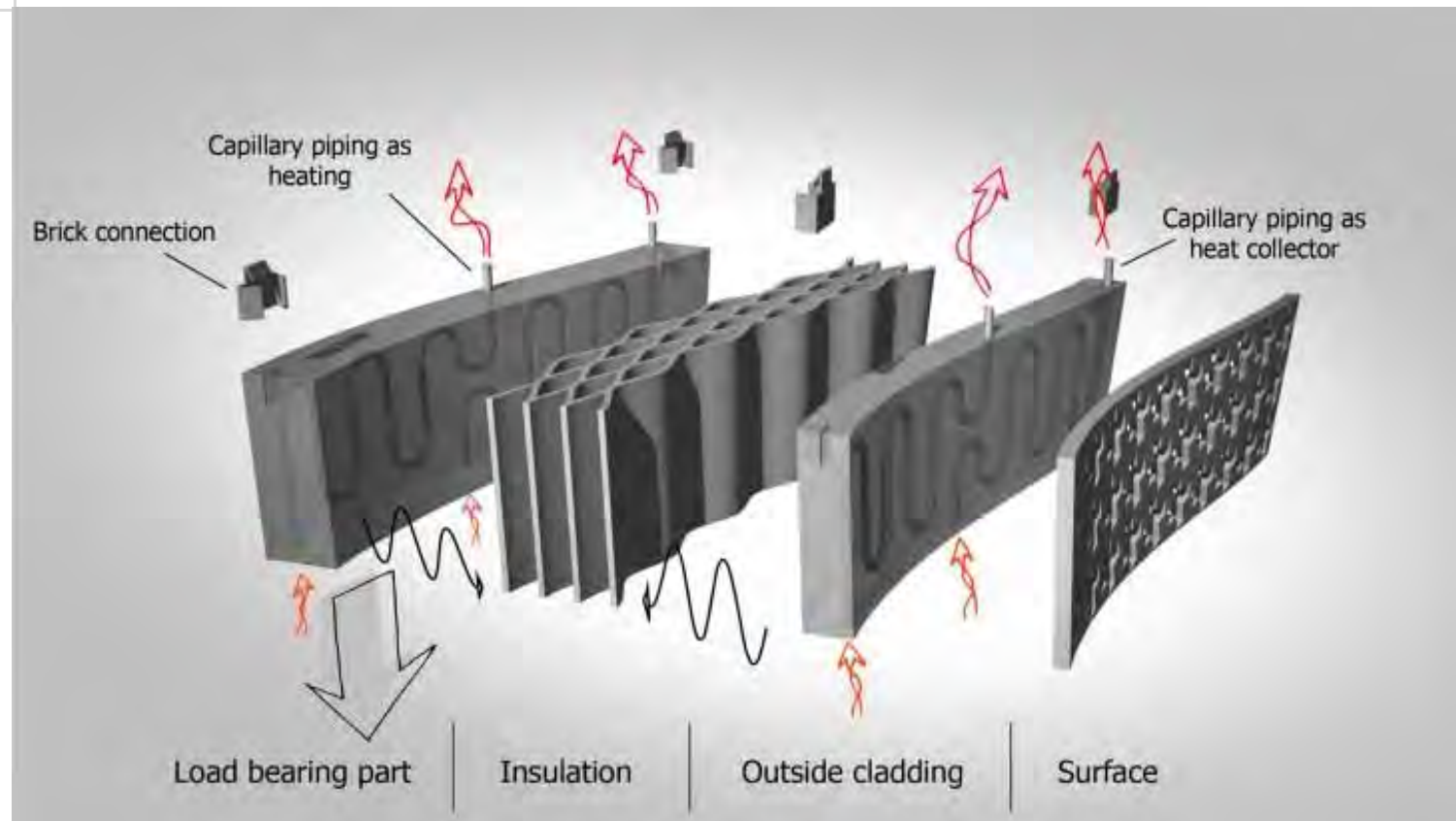
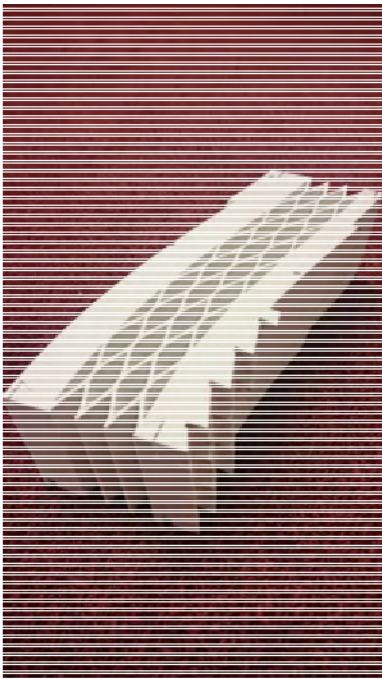
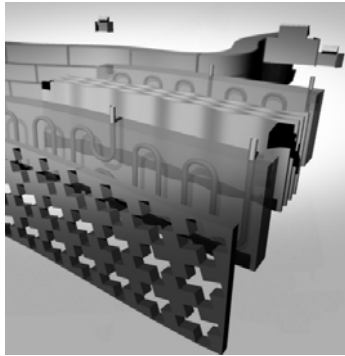
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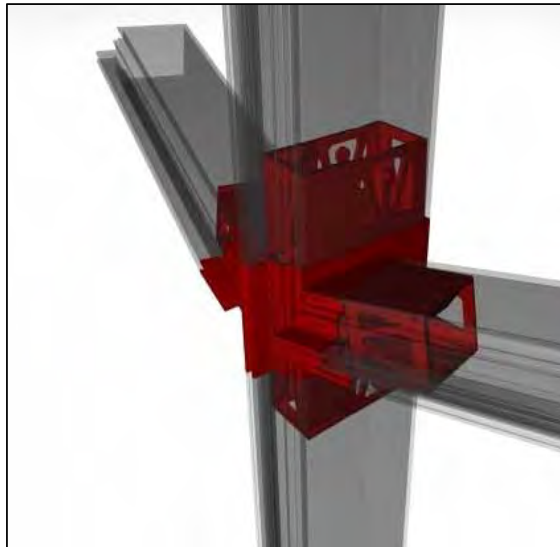
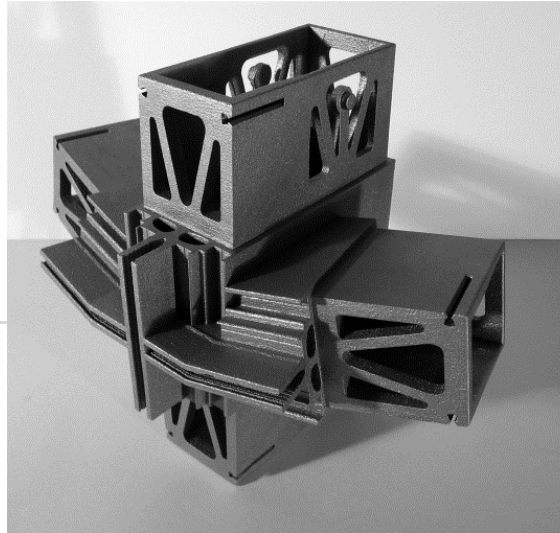
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Holger Strauss / TU Delft



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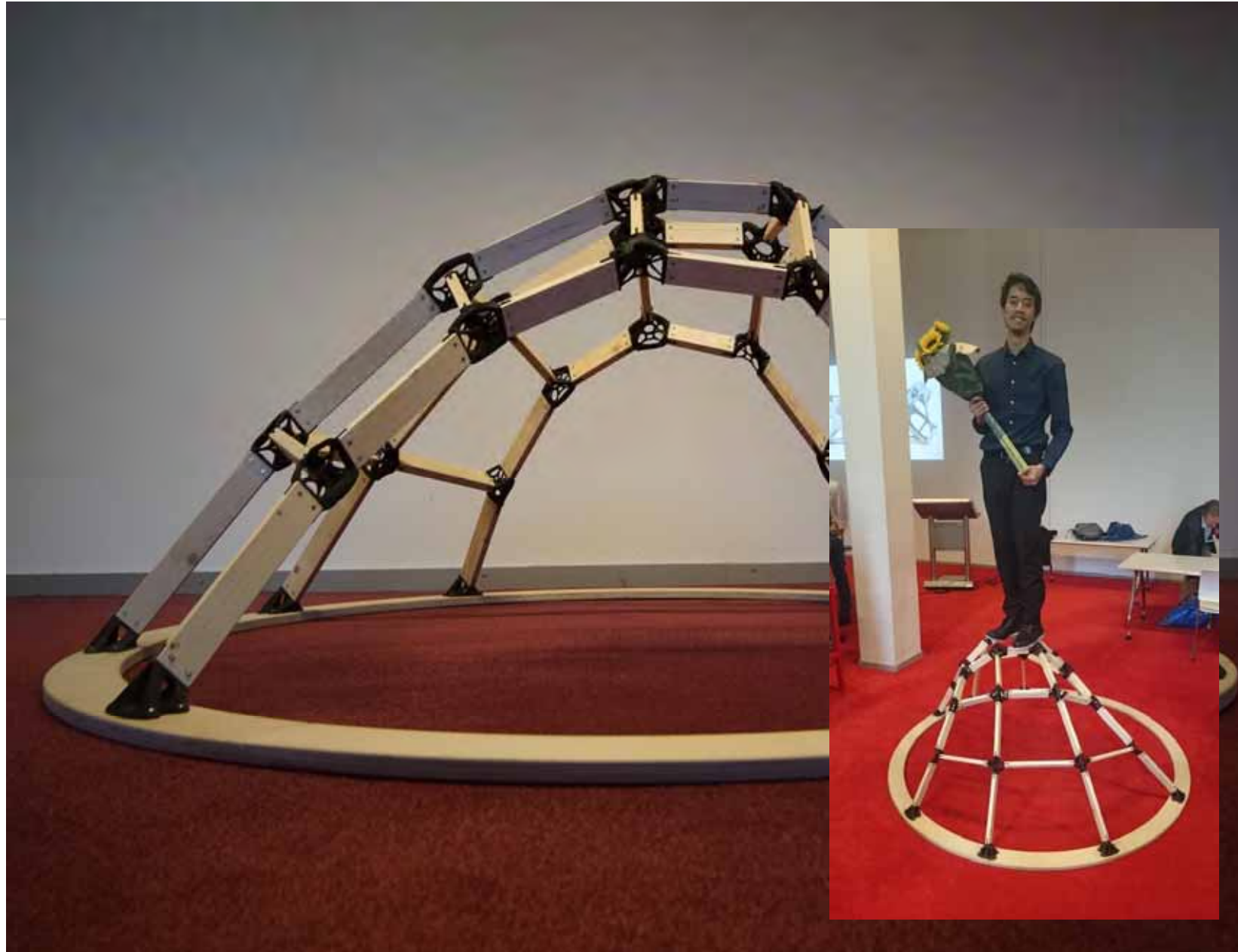
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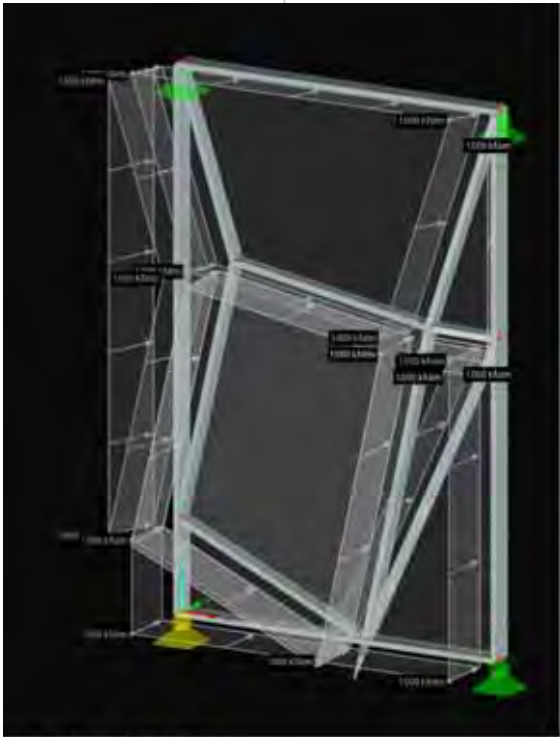
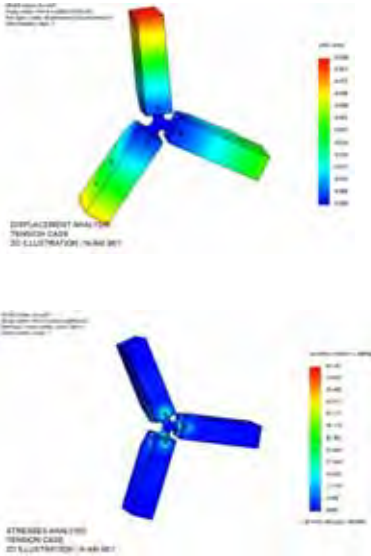
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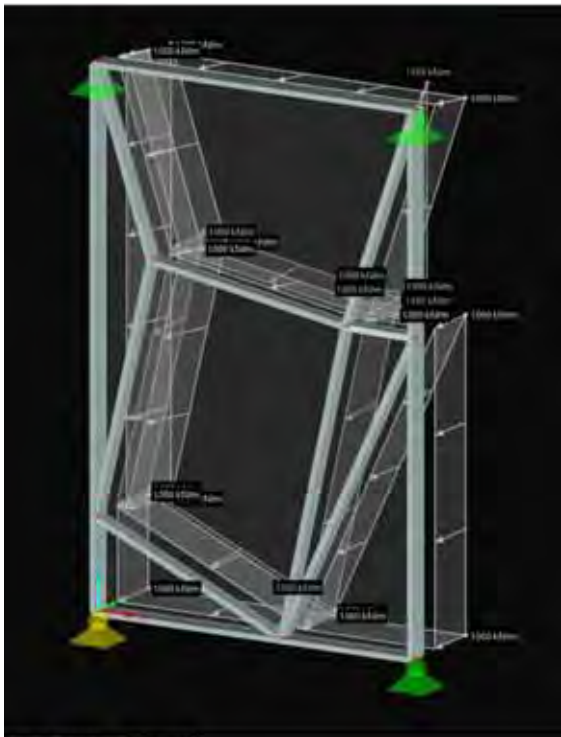


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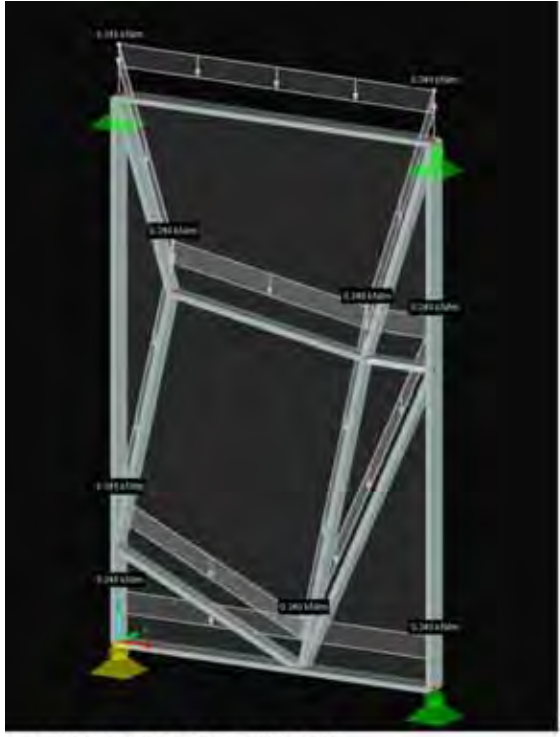
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WIND LOAD - PRESSURE



WIND LOAD - SUCTION



DEAD LOAD - WEIGHT OF GLASS PANELS

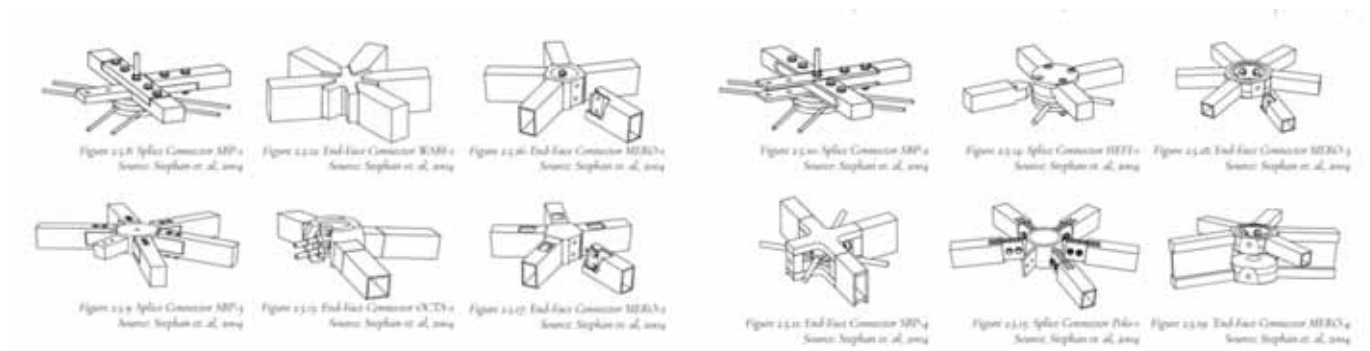
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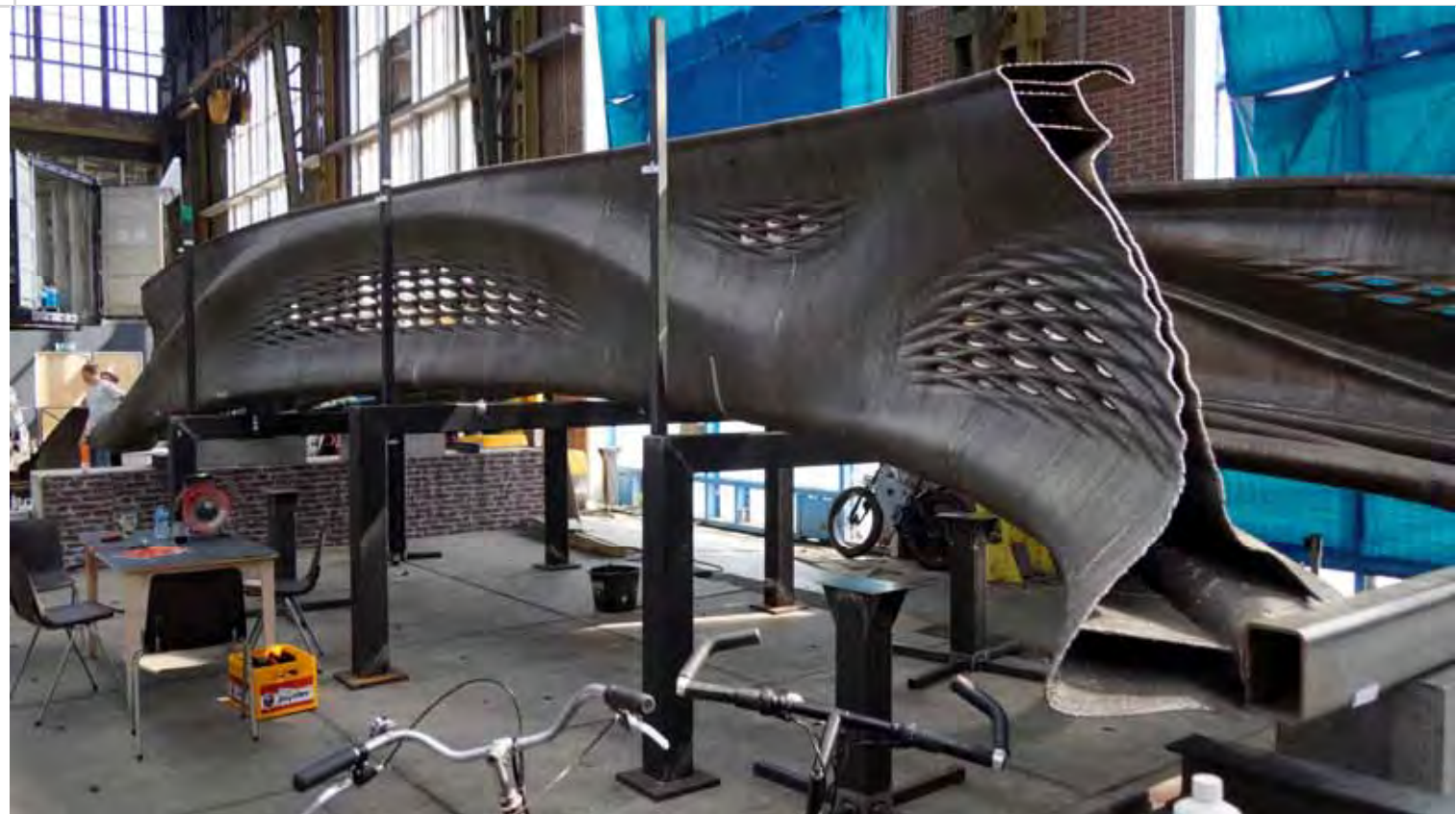
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Robotic Wire-Arc Additive Manufacturing (W.A.A.M.) in Construction

Dr. Ching Sung Chen, TU Darmstadt

Robotic Wire-Arc Additive Manufacturing (W.A.A.M.) is a novel manufacturing process allowing for a tailored buildup of metal using a computerized algorithm with the welding torch. One of the greatest advantages of such a process is the capability to generate any complex, hollow, cross-sectional profile that is not achievable using conventional techniques.

W.A.A.M.: The use of robotic wire arc additive manufacturing (W.A.A.M.) is a novel manufacturing process allowing for a tailored buildup of metal using a computerized algorithm with the welding torch. One of the greatest advantages of such a process is the capability to generate any complex, hollow, cross-sectional profile that is not achievable using conventional techniques.

Advantages of W.A.A.M.: The ability to build up a complex, hollow, cross-sectional profile that is not achievable using conventional techniques. The process is highly flexible and can be used to build up a wide range of shapes and sizes. The process is also highly accurate and can be used to build up a wide range of shapes and sizes.

W.A.A.M. Applications: The process can be used to build up a wide range of shapes and sizes. The process is highly flexible and can be used to build up a wide range of shapes and sizes. The process is also highly accurate and can be used to build up a wide range of shapes and sizes.

Summary: Robotic Wire-Arc Additive Manufacturing (W.A.A.M.) is a novel manufacturing process allowing for a tailored buildup of metal using a computerized algorithm with the welding torch. One of the greatest advantages of such a process is the capability to generate any complex, hollow, cross-sectional profile that is not achievable using conventional techniques.





Additive Manufacturing

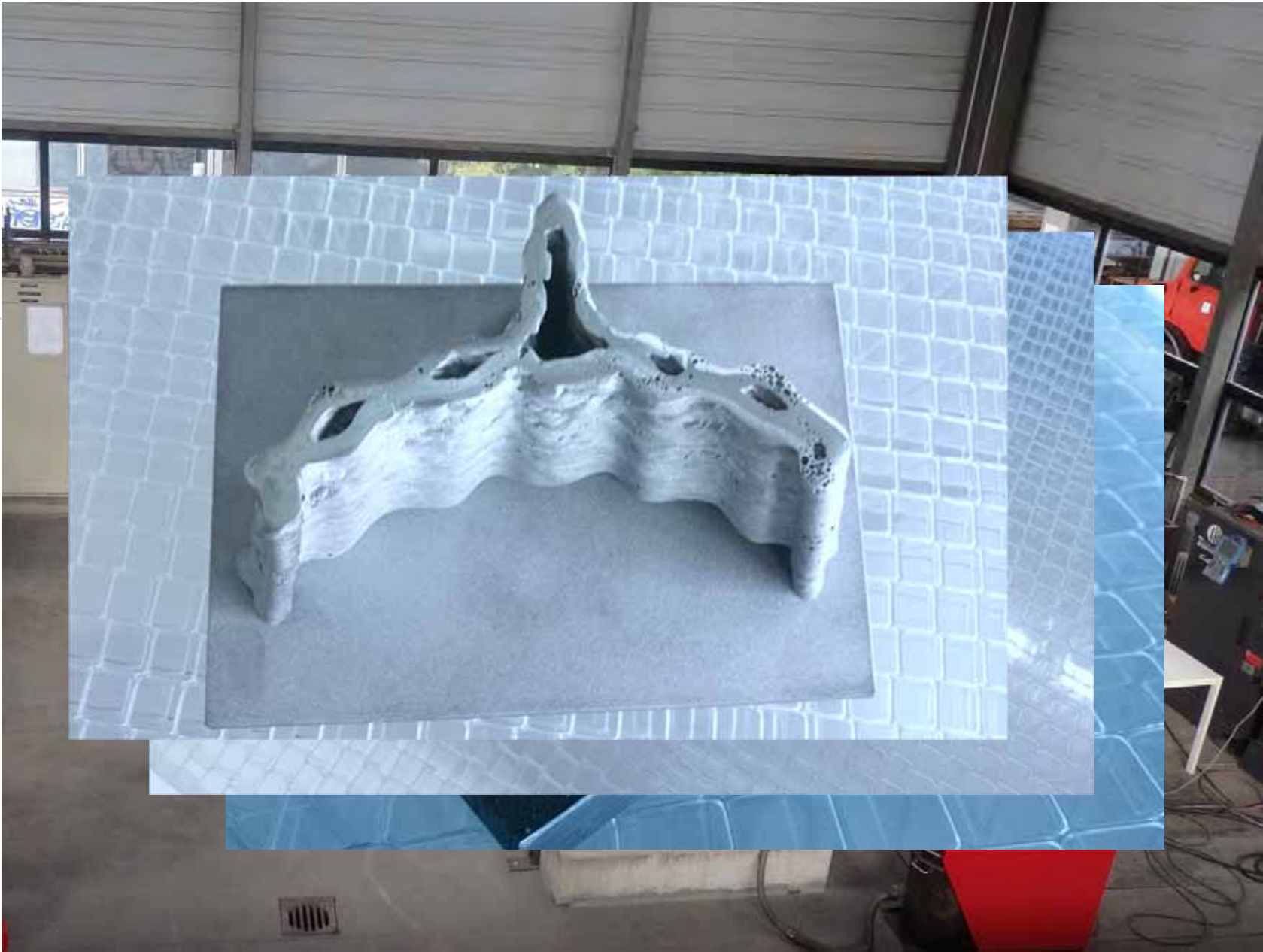
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Robotic Wire-Arc Additive Manufacturing (W.A.A.M.) in Construction

Dr. Christof Burg, Chair of Construction Management

W.A.A.M. is a new process for the construction of large-scale structures. It combines the advantages of welding and additive manufacturing. The process is based on the principle of layer-by-layer construction. The main advantage of W.A.A.M. is the ability to create complex, three-dimensional structures. This is achieved by the use of a robotic welding head, which is controlled by a computer. The welding head moves in a precise, programmed path, depositing molten metal layer by layer. This process allows for the creation of structures that are difficult to produce using traditional methods. The main advantage of W.A.A.M. is the ability to create complex, three-dimensional structures. This is achieved by the use of a robotic welding head, which is controlled by a computer. The welding head moves in a precise, programmed path, depositing molten metal layer by layer. This process allows for the creation of structures that are difficult to produce using traditional methods.





Additive Manufacturing

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Robotic Wire-Arc Additive Manufacturing (W.A.A.M.) in Construction

Dr. Christof Burg, Chair of Construction Management

Robotic Wire-Arc Additive Manufacturing (W.A.A.M.) is a novel manufacturing process allowing for a tailored buildup of metal using a computerized algorithm with the welding torch. One of the greatest advantages of such a process is the significant reduction of material waste compared to other manufacturing processes.

W.A.A.M. in Construction

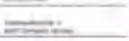
The main goal of W.A.A.M. is to build up a structure layer by layer. This is done by a robotic welding torch that is controlled by a computer. The torch is moved by a robotic arm and the welding torch is controlled by a computer. The torch is moved by a robotic arm and the welding torch is controlled by a computer. The torch is moved by a robotic arm and the welding torch is controlled by a computer.

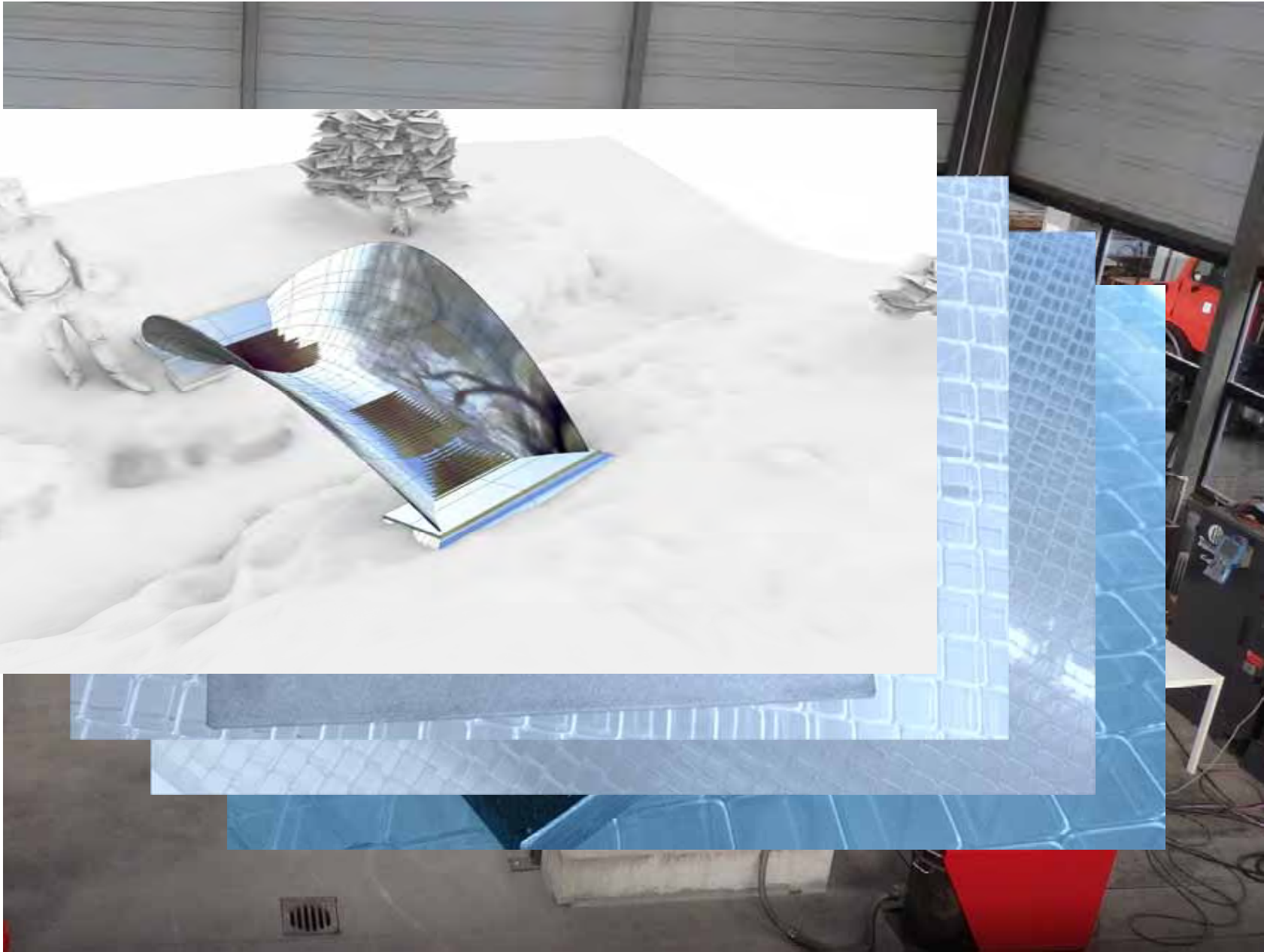
Advantages of W.A.A.M.

- Tailored buildup of metal
- Reduction of material waste
- High precision
- High speed
- High accuracy
- High reliability
- High safety
- High quality
- High efficiency
- High cost-effectiveness
- High flexibility
- High adaptability
- High scalability
- High sustainability
- High innovation
- High performance
- High durability
- High strength
- High resistance
- High stability
- High security
- High privacy
- High integrity
- High confidentiality
- High availability
- High accessibility
- High portability
- High mobility
- High flexibility
- High adaptability
- High scalability
- High sustainability
- High innovation
- High performance
- High durability
- High strength
- High resistance
- High stability
- High security
- High privacy
- High integrity
- High confidentiality
- High availability
- High accessibility
- High portability
- High mobility

Summary:

Robotic Wire-Arc Additive Manufacturing (W.A.A.M.) is a novel manufacturing process allowing for a tailored buildup of metal using a computerized algorithm with the welding torch. One of the greatest advantages of such a process is the significant reduction of material waste compared to other manufacturing processes.





Additive Manufacturing

ISMD + ISFW / TU Darmstadt



Robotic Wire-Arc Additive Manufacturing (W.A.A.M.) in Construction

By Chris Burg, Content Manager

Robotic Wire-Arc Additive Manufacturing is an Robotic Replicating Process allowing for a better construction alternative with the welding team. One of the greatest advantages of this is a significant reduction in construction costs and a significant increase in safety.

W.A.A.M. in Construction

The use of W.A.A.M. in construction is a new way of thinking about construction. It is a process that allows for the creation of complex structures that are difficult to build with traditional methods. This process is used to create structures that are difficult to build with traditional methods. This process is used to create structures that are difficult to build with traditional methods.

Advantages of W.A.A.M.

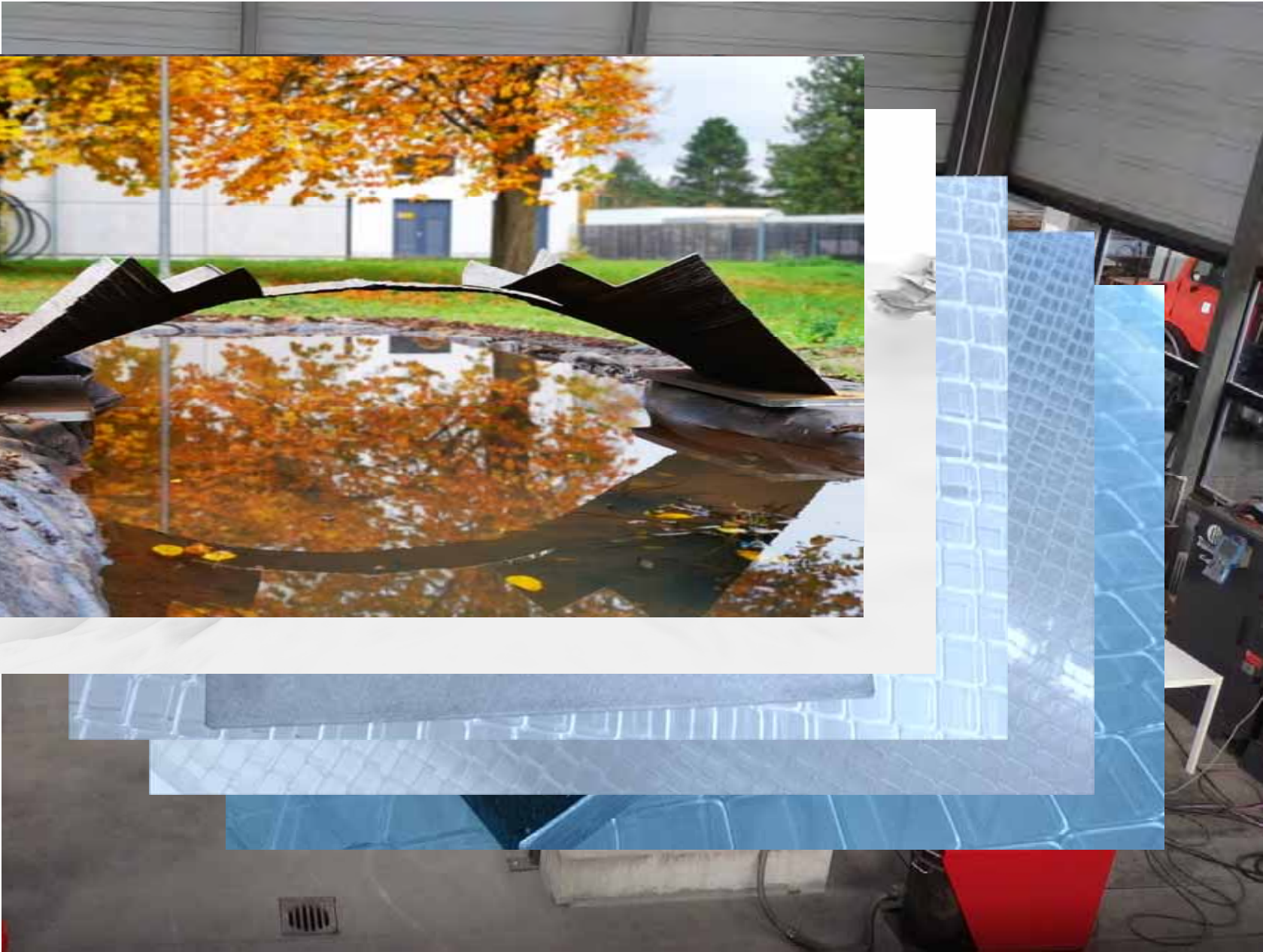
The advantages of W.A.A.M. are many. It allows for the creation of complex structures that are difficult to build with traditional methods. It also allows for the creation of structures that are difficult to build with traditional methods. This process is used to create structures that are difficult to build with traditional methods.

W.A.A.M. and Construction

W.A.A.M. is a process that allows for the creation of complex structures that are difficult to build with traditional methods. It is a process that allows for the creation of structures that are difficult to build with traditional methods. This process is used to create structures that are difficult to build with traditional methods.

Summary

Robotic Wire-Arc Additive Manufacturing is a process that allows for the creation of complex structures that are difficult to build with traditional methods. It is a process that allows for the creation of structures that are difficult to build with traditional methods. This process is used to create structures that are difficult to build with traditional methods.



Additive Manufacturing

Lisa Rammig / TU Delft + EOC

Green Building Innovation: Façade Research Group

ADDITIVE GLASS MANUFACTURING

The potential of additively fabricated glass connections for façade applications

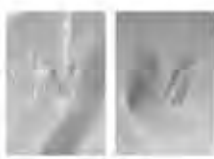
During the past two decades Additive Manufacturing (AM) which can be defined as the layered production from a 3D file, has been enhanced from a prototyping tool used mainly for product development to a fully independent production method.

Whilst the direct fabrication of materials such as plastic or metal is by now a sophisticated technology, the additive fabrication of glass, perhaps one of the most fascinating building materials, is almost unexplored.

Glass is strong and brittle, heavy and easy to shatter, and it is transparent. These properties have made glass an important component of our built environment. Several types of glass such as laminated and insulated glazing, coated, curved, and free formed glass panes have been developed lately after high heat glass process was invented.

Whilst free formed or glass production, constructions have been further developed to increase a transparent architectural appearance. Current products are heavily influenced by digital media and modelling software, giving us the possibility to create almost anything in form. This has developed the need for glass of an overall higher performance.

Free formed glass panes, each one different to the other, might fit perfectly together, but are irregularly produced. As this gives the panes an edge why not use additive fabrication methods for glass production or processing? It would give us the possibility to produce free formed transparent building components without the complexity of the layered depth of production but with a wide range of performance available by varying conditions.



Author: Lisa Rammig
Advisor: Dr. Rijkman
Advisor: Dr. Rijkman

Project: Additive Manufacturing of Glass
Project: Additive Manufacturing of Glass
Project: Additive Manufacturing of Glass
Project: Additive Manufacturing of Glass
Project: Additive Manufacturing of Glass

TU Delft

Self-organising 3D printing, Faculty of Architecture, Department of Architectural Engineering & Building
Additive Manufacturing of Glass, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 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Additive Manufacturing

MIT

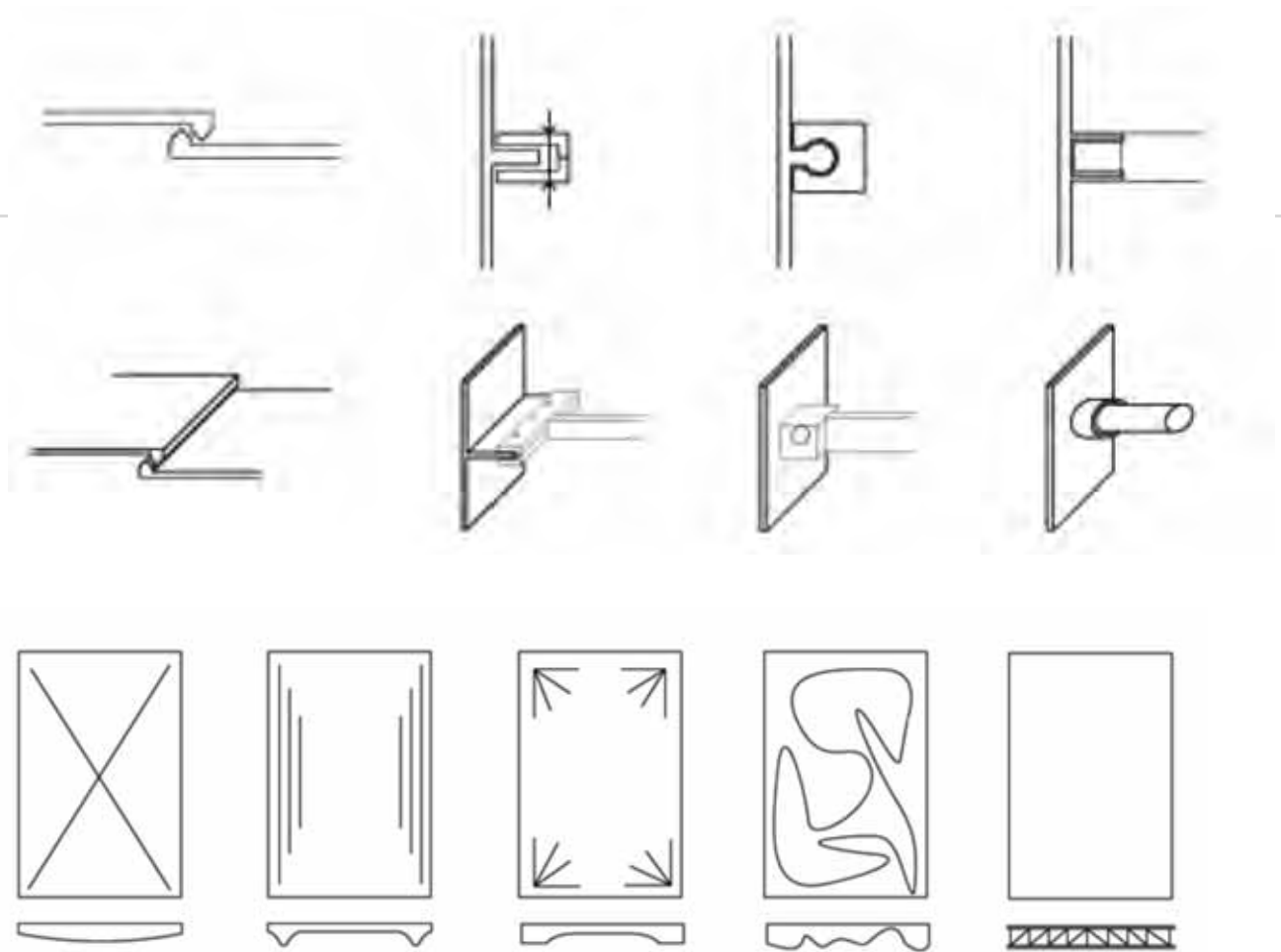


ISMD + MPA / TU Darmstadt



Additive Manufacturing

ISMD + MPA / TU Darmstadt



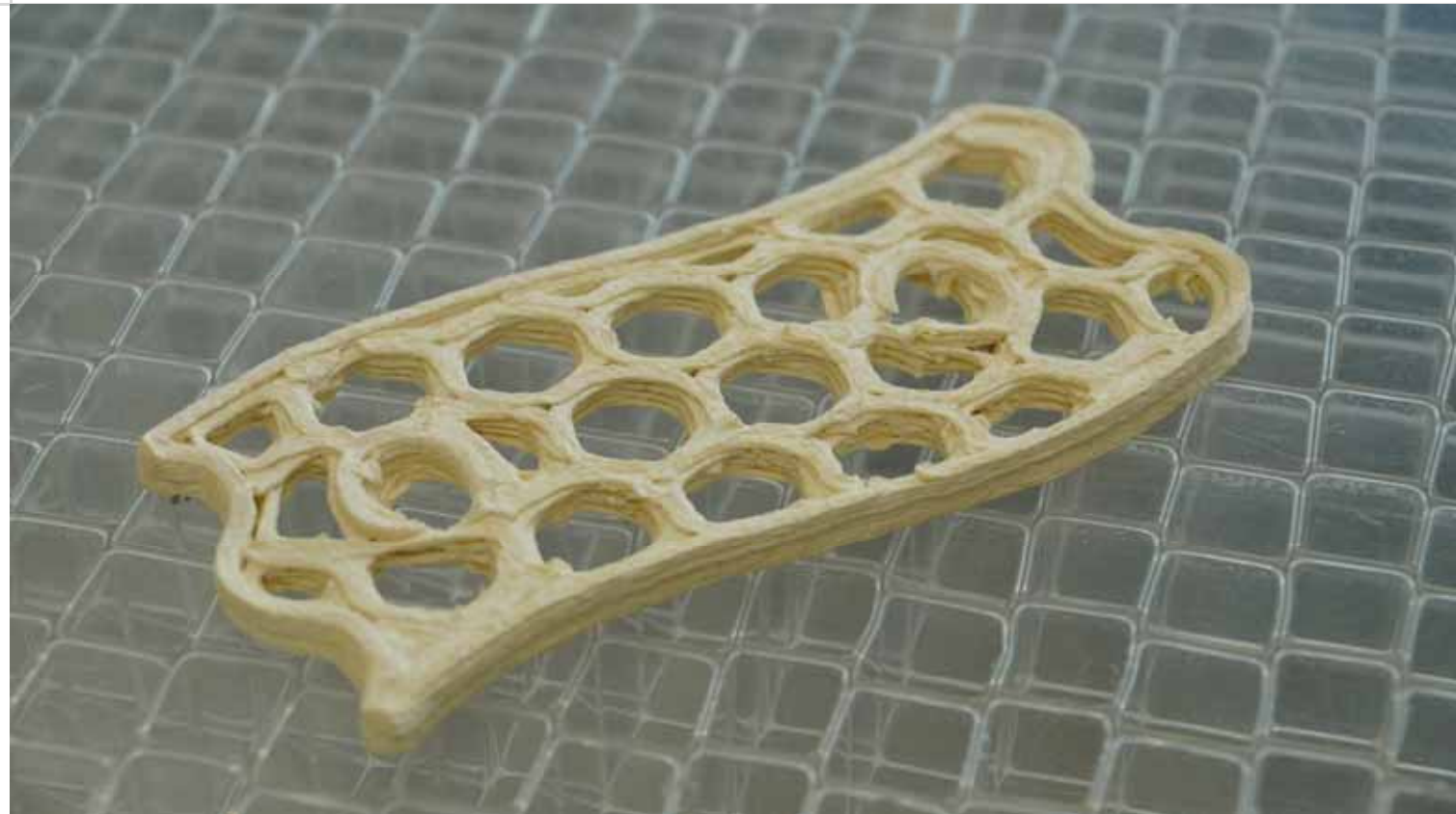
Additive Manufacturing

Next steps: adaptive Polymeere



Additive Manufacturing

Next steps: paper - BAMP Team / TU Darmstadt



Additive Manufacturing

Next steps: paper –
Seminar Fassadentechnologie + Dunia Ahag /
TU Darmstadt



Additive Manufacturing

Next steps: Wood / MSc T. Liebrand / TU Delft



Additive Manufacturing

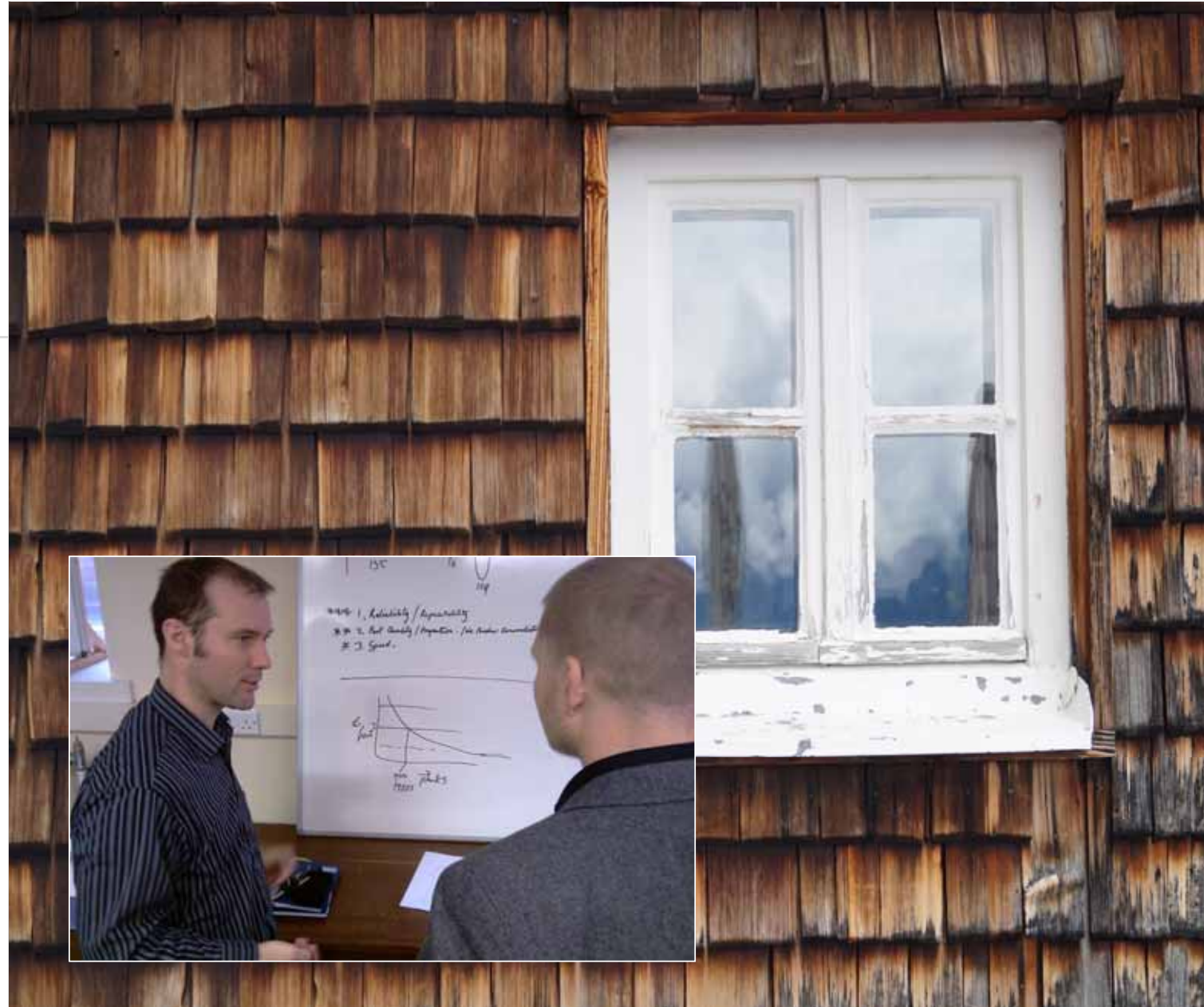
construction oriented versus function oriented thinking



Additive Manufacturing

construction oriented versus function oriented thinking

Potential for a new craftsmanship: local and low investment



Additive Manufacturing

construction oriented versus function oriented thinking

Potential for a new craftsmanship: local and low investment

The solution for refurbishment: parts and missing technology



Additive Manufacturing

construction oriented versus function oriented thinking

Potential for a new craftsmanship: local and low investment

The solution for refurbishment: parts and missing technology

Adaptive building envelopes: integrated technologies



Additive Manufacturing



Polymeers



Metal



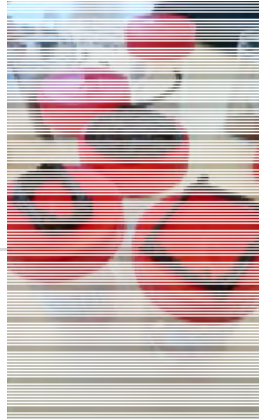
Concret



Ceramic



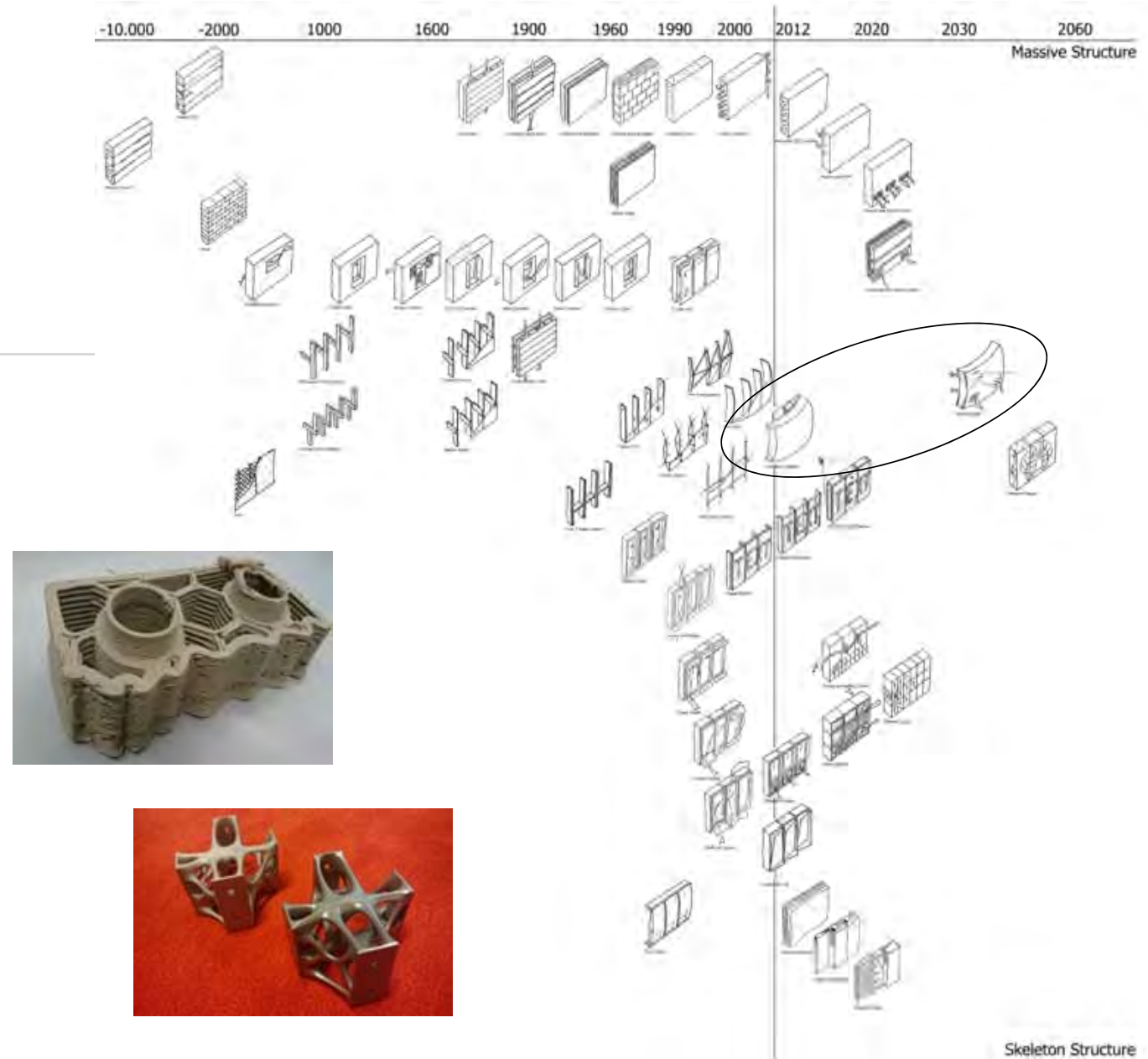
Glass



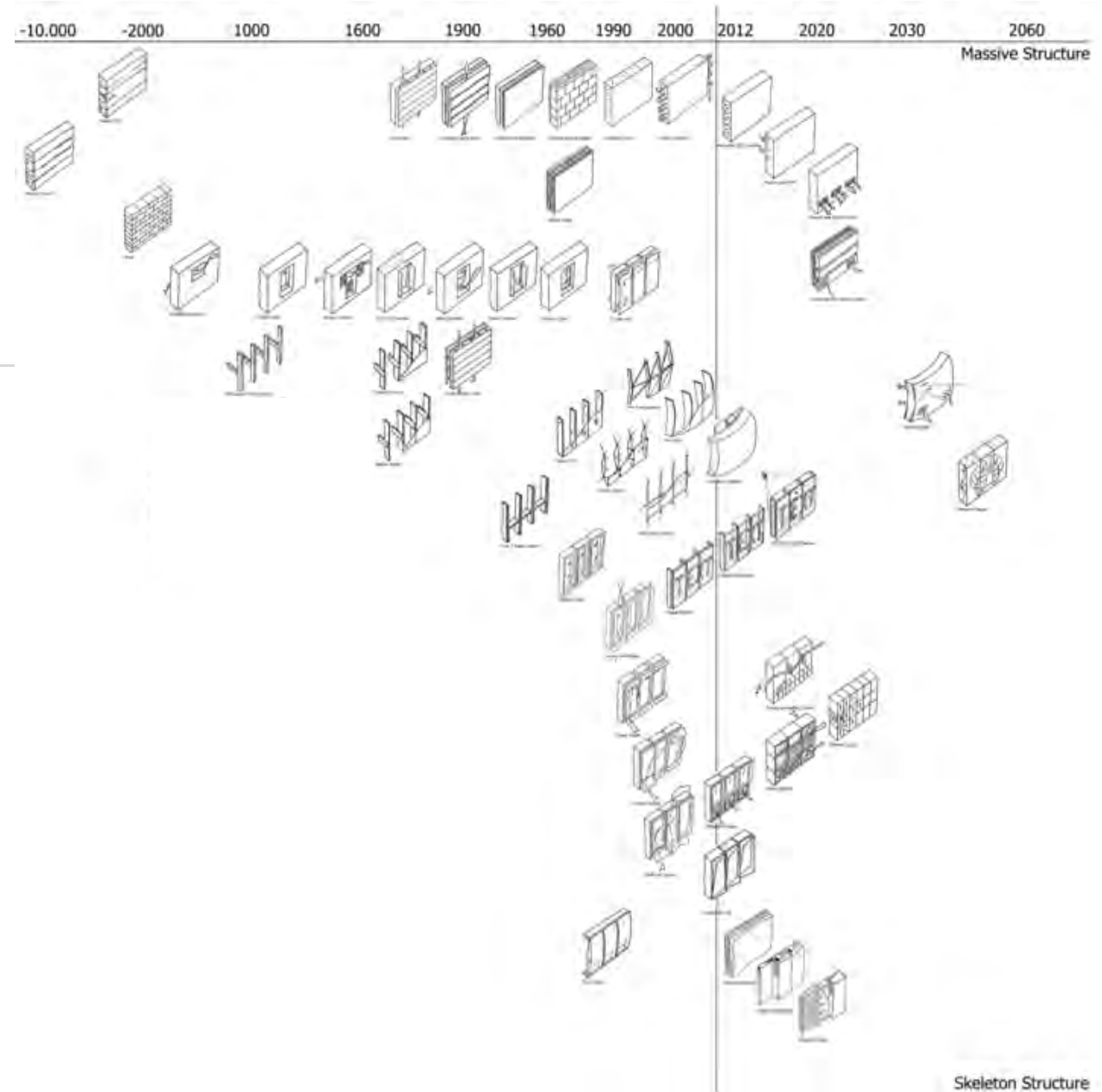
Wood / Paper

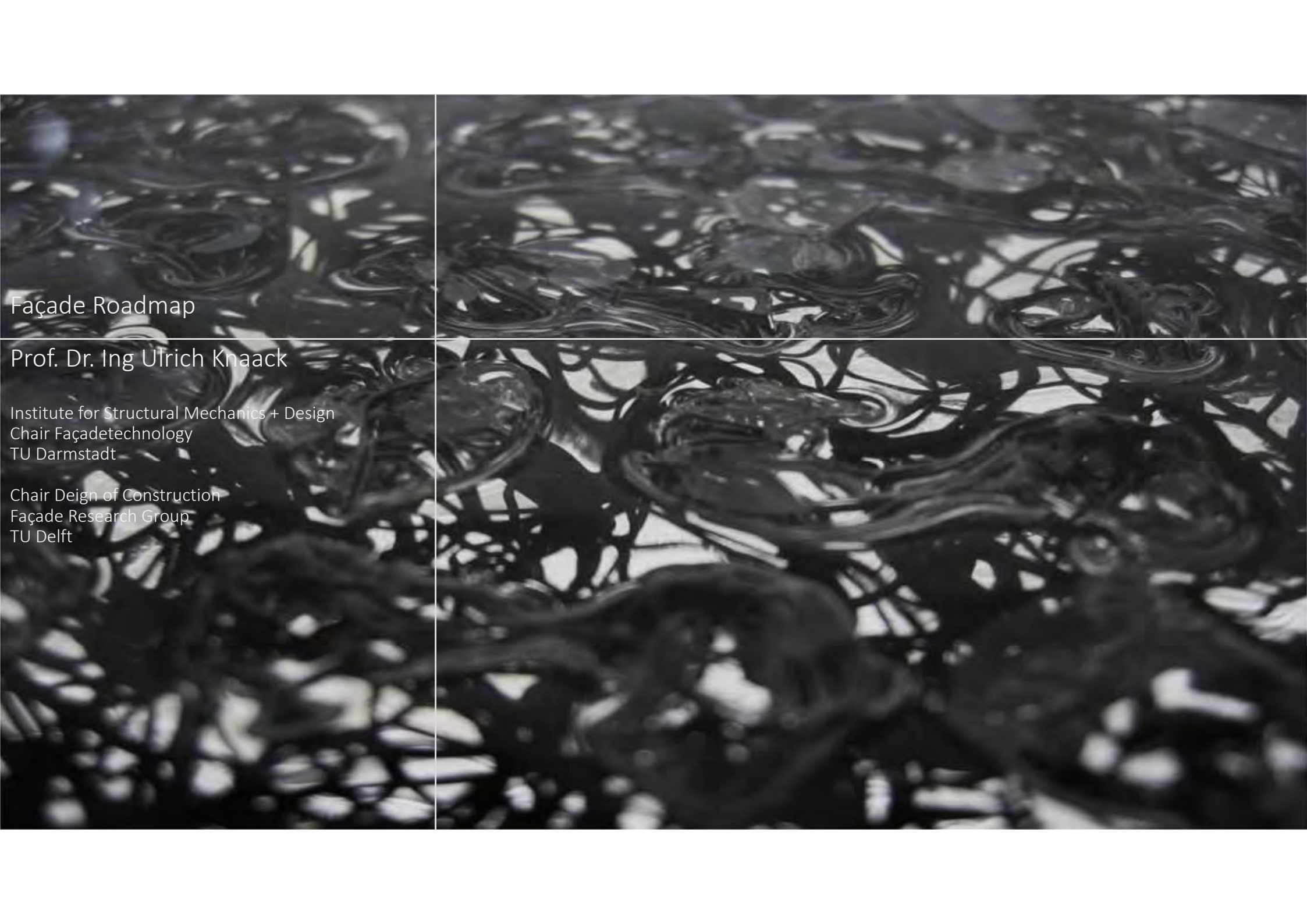


Façade Roadmap



Façade Roadmap





Façade Roadmap

Prof. Dr. Ing Ulrich Knaack

Institute for Structural Mechanics + Design
Chair Façadetechnology
TU Darmstadt

Chair Deign of Construction
Façade Research Group
TU Delft

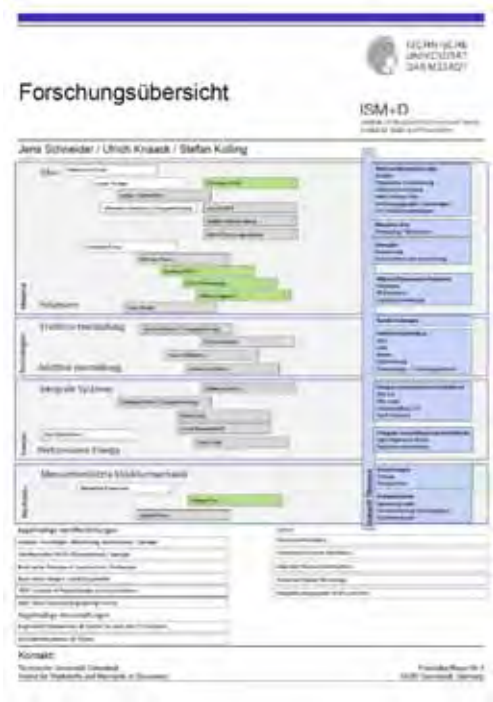
Architectural Facades & Products / Research Group TU Delft

Prof. Dr. Ing. Ulrich Knaack
Prof. Dr. Ing. Tillmann Klein



Institute for Structural Mechanics +
Design / TU Darmstadt

Prof. Dr. Ing. Jens Schneider
Prof. Dr. Ing. Ulrich Knaack





Valorisation

- South Danish University Odense / Denmark *
- TU Delft / The Netherlands *
- CWTC + University of Bristol / United Kingdom
- Hochschule OWL / Germany *
- TU Darmstadt / Germany *
- Hochschule Luzern / Swiss
- Uni Innsbruck + Bolzano / Italy
- Universidad del Pais Vasco - San Sebastian + University of Madrid / Spain
- ITU Istanbul / Turkey *
- Lisbon / Portugal



MASTER PROGRAM ARCHITECTURE, URBANISM, AND BUILDING SCIENCES, TRACK BUILDING TECHNOLOGY – DELFT

UNIVERSITY	Delft Technical University
FACULTY	Faculty of Architecture, Department Architectural Engineering + Technology
DEGREE / LANGUAGE	M.Sc. / English
DURATION	2 Years / 4 Semesters
RECOGNITION	Accredited track
ADMISSION FOR	B.Sc.
KEY COMPETENCE	Building function
COORDINATING TEAM	Prof. Dr. Ulrich Knaack, Dr. Ing. Tamara Klein, & Ana Berganza

PROFILE

The Building Technology track is one of the five tracks within the Architecture, Urbanism and Building Sciences master program. Within this track, students can specialize on Façade Design. The track focuses on research, technological design and innovation, dealing with the newest technology and interacting with the current market. This program offers a balance between applied research and design of buildings and building elements.

It encompasses a broad spectrum of engineering and architectural design skills that lead to one of the dominant professions of the future: the sustainable designer. The emphasis of this programme is on the design of innovative and sustainable building components and their integration into the built environment.

What you will learn

Through focusing on structural, façade and climate design, students learn how to contribute to smart buildings that are sustainable, comfortable and environmentally intelligent. This programme stands out internationally because of its integration of architectural design with technical disciplines, filling the niche between architecture and engineering. Rather than focusing on one or two specialisations, students investigate the whole breadth of building technology: looking at climate design, façade design and structural design, producing designers that know how engineers work.

Prospective students must show both technical and architectural skills, interest and understanding. The programme is well suited to architectural graduates looking to strengthen their technical qualifications and those with a technical background that want to strengthen their design abilities.

JOB PROSPECTS

Building technology graduates and façade specialists are in high demand as the construction industry is lacking designers that bridge the gap between the architectural and engineering disciplines. Given that graduates can make decisions based on calculations and integrate them into architecture, they can direct structural engineers and manage complex processes. Graduates are sought after for architectural offices, engineering offices and specialised façade manufacturers.

Graduates of the Building Technology programme can expect to find generalist and specialist positions in engineering and architectural firms, and excellent opportunities in the business supply, contracting and project development sectors. Others opt to begin their own businesses or to pursue further studies at the doctoral level.

MASTERPROGRAM GLASS & FAÇADE STRUCTURES – DARMSTADT

UNIVERSITY	Technische Universität Darmstadt
FACULTY	Faculty of Civil and Environmental Engineering
DEGREE / LANGUAGE	M.Sc. / English
DURATION	2 Years / 4 Semesters
SPECIALIZATION	Civil Engineering with a focus on Glass and Façade Engineering
ADMISSION FOR	B.Sc.
KEY COMPETENCE	Façade materials, structural performance
COORDINATING TEAM	Prof. Dr. Ulrich Knaack, Prof. Dr. Ing. Jens Schneider

PROFILE

As part of the Civil Engineering track of the Faculty of Civil and Environmental Engineering MSc program a specialisation of façade engineering is made available. Within this track, students can specialize on Façade Engineering. The track has a broad intake with a standard civil engineering MSc program and is focusing in the specialisation "glass + façade structures" at materials, structural and computational engineering as well as facades and glass construction. Problem solving at an engineering level, combined with a close understanding of technical and physical parameters of facades are in the focus of the education. Engineering and design skills are trained in an project oriented program. The program is closely linked to research within the faculty and interacts with the partner programs within the European network.

What you will learn

Façade as one of the most complex parts of a building act as the border of indoor and outdoor environment. An education to engineer the requires a deep understanding of the mechanical, material and building physics related aspects. In this program these aspects are integrated in theoretical and experimental courses. Project related parts of the program will train the understanding of engineering and design processes.

JOB PROSPECTS

Civil engineering graduates do have a large variety of job opportunities: working in the engineering and construction industry as well as being active in the manufacturing industry are general opportunities. But due to the lack of skilled people in the façade industry the specialization "Glass and Façade Structures" will allow alumni's to become active as specialist in consulting, engineering and manufacturing / construction within the field of façade.

Graduates of the "Glass and Façades structure" program can expect to find engineering or specialist positions in engineering or manufacturing firms as well as contracting and project development sectors. The program also allows to continue further studies at the doctoral level.

Valorisation

TU Delft / The Netherlands

MSC Program Building Technology
Subtract Façade Design and Engineering
Cooperation with the Dutch Façade Association

TU Darmstadt / Germany

MSC Program Civil Engineering
Subtract Glass and Façade Structures

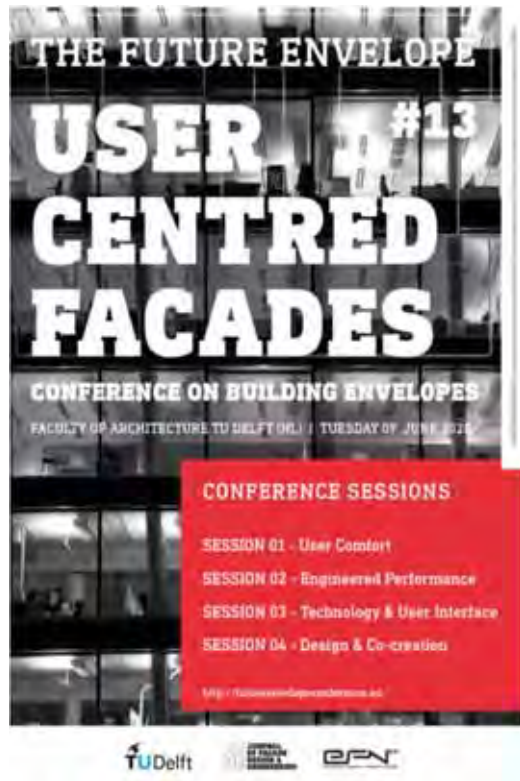
Valorisation

The Future Envelope / Delft

PowerSkin / BAU München

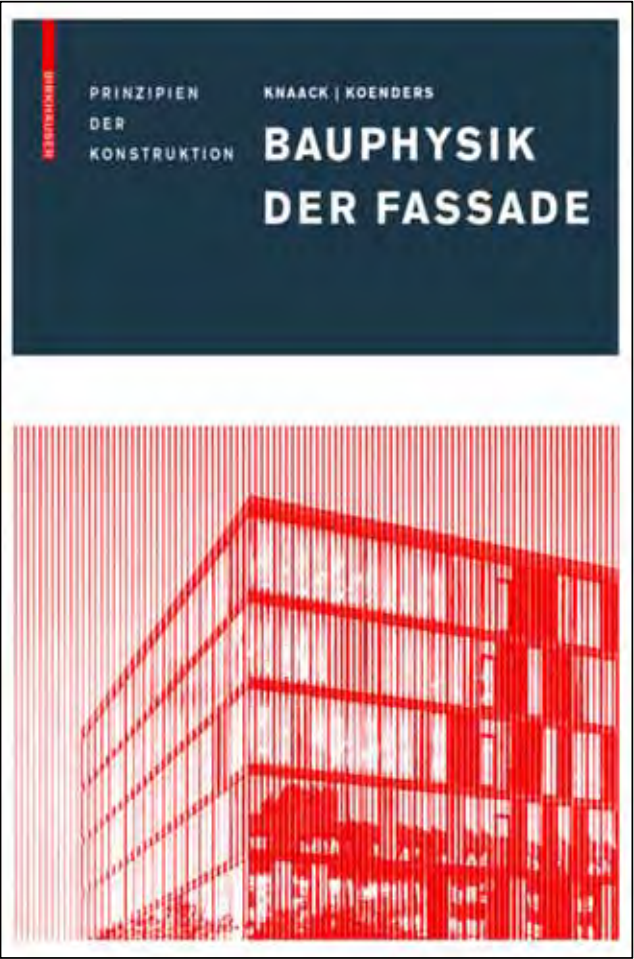
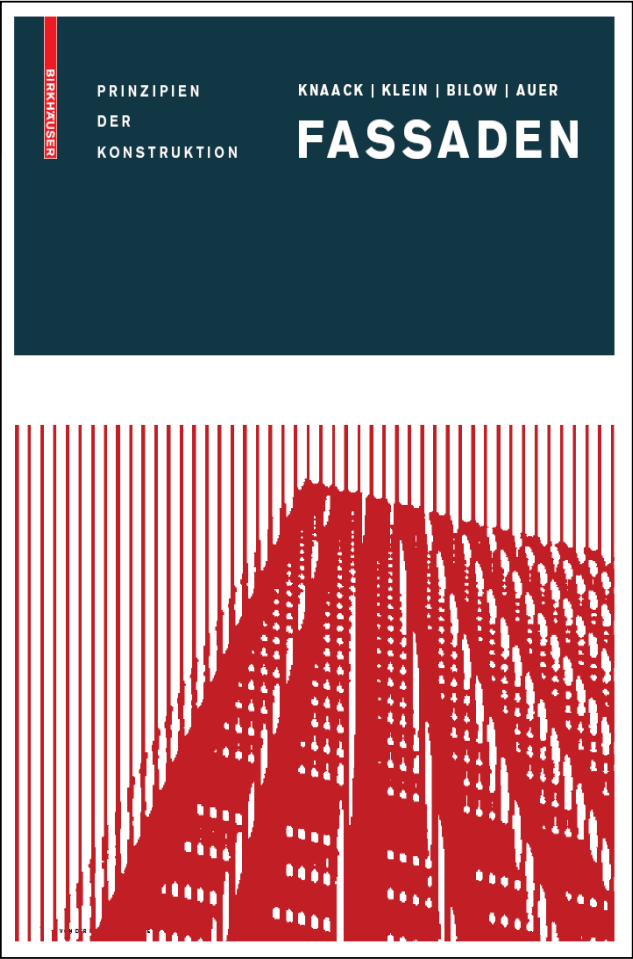
BE-AM / FormNEXT Frankfurt

glass technology live / Düsseldorf



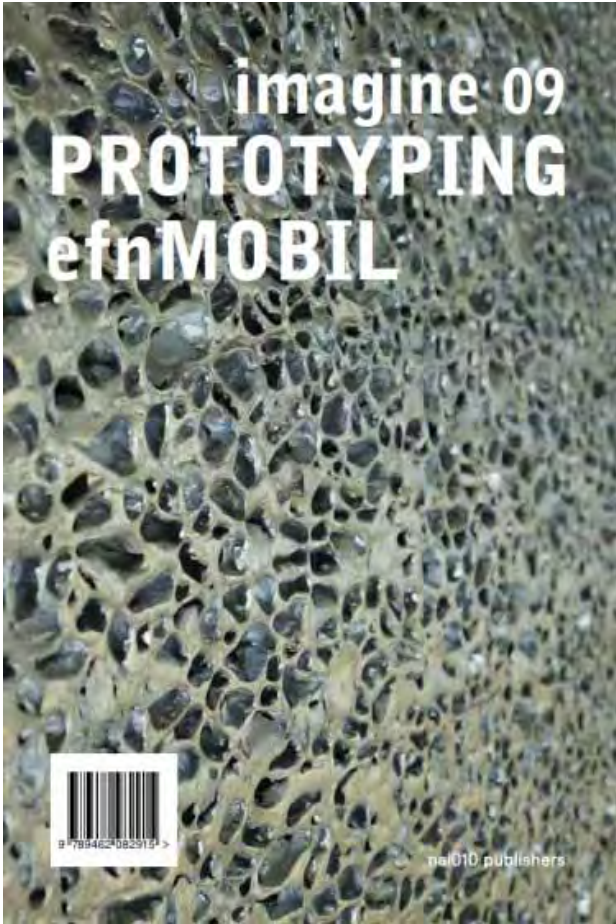
Valorisation

Books



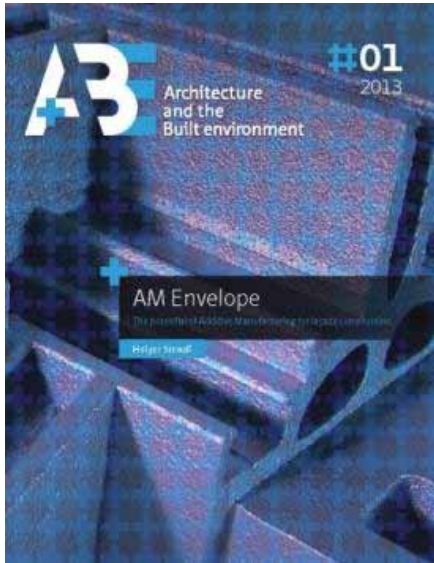
Valorisation

Books



Valorisation

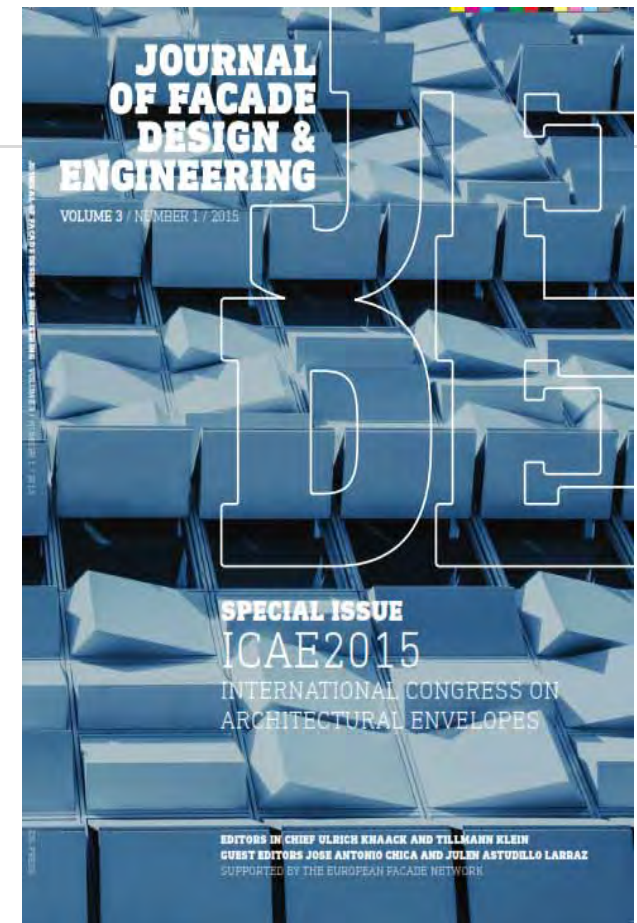
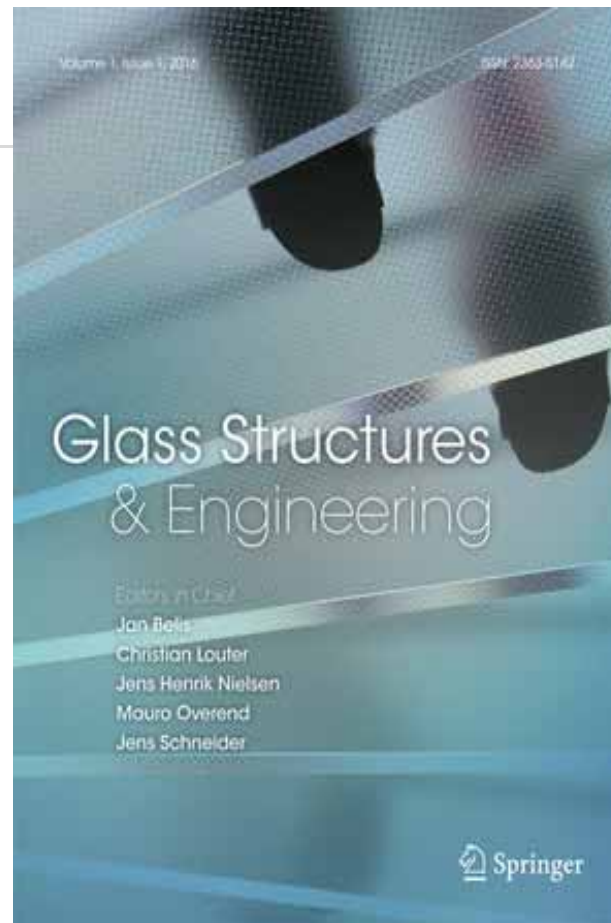
PhD's
TU Darmstadt: Springer
TU Delft: BKBOOKS – open access



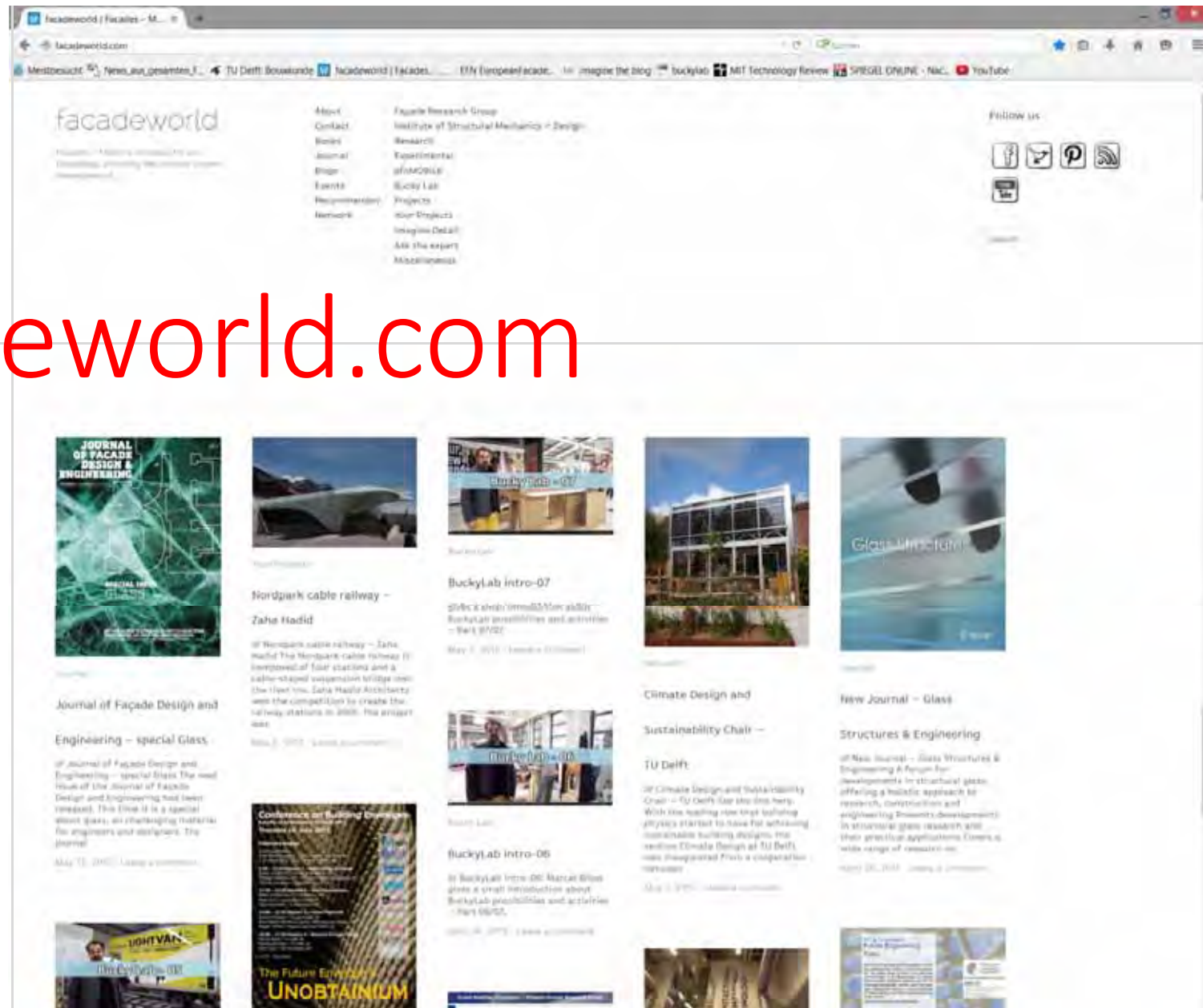
Valorisation

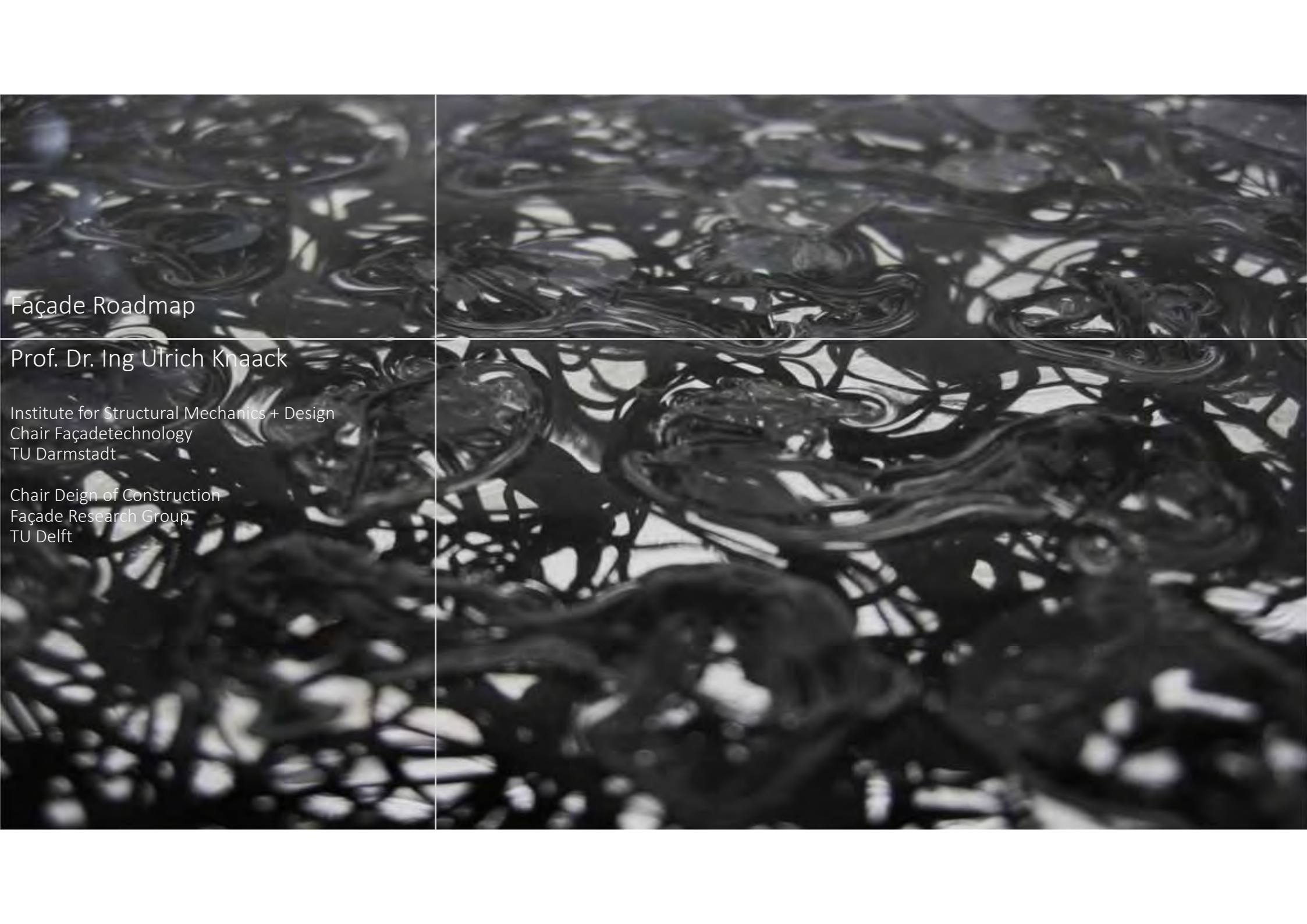
Journals

Glass Structures & Engineering / Springer
Journal of Façade Design & Engineering /
BKBOOKS – open access



www.facadeworld.com





Façade Roadmap

Prof. Dr. Ing Ulrich Knaack

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