The Next Big Thing
The Dutch government aims for a climate-neutral built environment in 2050. Renovation of the existing building stock is essential in realizing this ambition as the market needs to prepare for delivering 200,000 high performance renovations per year. This requires, among others the development of affordable renovation solutions, enabling the transition toward a fully sustainable energy supply and a fast renovation process.

Adapting the building envelope is an important element for this transition. This implies improving the thermal performance of the envelop (lower energy losses through better insulation, better windows, etc.) as well actively utilizing the envelop for the production of renewable energy.

Various smart solutions for the building envelope were developed in the last couple of year and the key question is: how can we scale up these projects to contribute to delivering 200,000 high performance renovations per year?

At this symposium we will discuss:
- What are promising concepts and developments?
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- What process innovation do we need in the construction chain?
Façade Roadmap
Façade Roadmap
Façade Roadmap

double facades @ 2000
Façade Roadmap

Post Tower Bonn

Capricon Düsseldorf
Façade Roadmap
Component façade @ 2010

Posttower Bonn
T-motion facade
Capricorn Düsseldorf
SmartBox
E² Fassade
NEXT Facade
Façade Roadmap
solid function integrated construction
Façade Roadmap

Design School Essen - SANAA / Tokyo

in collaboration with
Mathias Schuller - Transsolar and
Holger Techne - Bollinger und Grogmann
Façade Roadmap

Design School Essen - SANAA / Tokyo

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Façade Roadmap

facade heating / cooling panel
by Marcel Bilow / 2007
Façade Roadmap

Jackbox: integrated sandwich construction

HS OWL / 2007
Xella Technologie und Forschung
Systembausteine Energie Plus

The project aim is to develop concepts that will be used as a basis to develop a new multifunctional product system. These concepts are then focused on development use of specific technical and environmental implications on the product performance, manufacturing as well as on the market scale of the product industry strategies for sales and variance.

Different compositions of products have been analysed in terms of their product limits, then simple elements to whole wall or building units, their technical properties and constructional concepts then receive basis to complete multifunctional packages, their functionality.

A number of product strategies for the new generation of products have been developed and evaluated according to development trends, success potential and implementation effort.
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 returning energy via
photonic advection. The ABABE is designed to use this inherent strategy to absorb, release,
and redirect heat or cold to conserve energy by managing entropy production.

Video Presentation of Managing Entropy Production
ABABE’s transport entropy power is critical to the
dynamic flow of heat and evaporation. From the
maximizing a network of microchannels, the
temperature control is manipulated to
achieve the thermal gains and losses of the
typical peaks and troughs of energy consumption
associated with conventional building envelope typologies.

Building Envelope as Energy Transfer Function
The characteristic of the building envelope as a transfer station for the entropy, transportation, storage and
conversion of energy, is achieved by maintaining the
total entropy of energy in the building envelope. This
enhances the typical approach to energy related
management that can be characterized as derived from the
feedback of the ambient energy storage or from Second Law Thermodynamics (e.g. entropy
generation).

SteadyState Design Principles
The total concept of variable current heat exchange (e.g.,
interface, and evaporation mass, energy) are
directly related to thermodynamic process, leading to
interface, evaporation mass, energy, and ambient
material properties (e.g., thermal conductivity and
ambient, etc) and provide a robust platform
from which to investigate the potential for the performance
optimization of these systems. The control of variable
current heat exchange is the storage or return
through an effective and efficient system. The principle of
surfacing variable mass is the variable of the rate of energy gain or
loss due to entropy. By taking these two principles
into consideration, this new technology will have a
significant effect on the energy profile of the effective
building envelope, as well as the passive facade in
a functioning system whose morphology evolves over
ben.
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

3 m
Façade Roadmap

3 m
Façade Roadmap
Façade Roadmap

Alnatura / Darmstadt

Studio 2050 mit Transsolar und Knipper Helwig
Façade Roadmap
Façade Roadmap

- Single layered light massive envelope 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 Solid Construction
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Powerskin 2019
Powerskin 2019
Session Envelope

Parametric Poetry-Integrated Solutions for Complex Geometries with Structure and Skin

Ragunath Vasudevan¹, Till Schneider⁵, Kai Otto⁶, Klaus Bollinger⁷, Andreas Rutechmann⁸

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⁶Bollinger + Grohmann Ingenieure GmbH, Frankfurt am Main, Germany
Session Envelope

4D Adaptive Textile Building Skin

Jan Steude1, David Schmelzeisen1, Philip Engelhardt1, Sabine Baumgarten1, Tiber Lohmann1, Thomas Gries2

1Institut für Textiltechnik (ITA), RWTH Aachen University, Aachen, Germany; email jan.steude@ita.rwth-aachen.de
2Institut für Textiltechnik (ITA), RWTH Aachen University, Aachen, Germany
3Institute of Building Technology (IBT), RWTH Aachen University, Aachen, Germany
4Clinic of Ophthalmology, RWTH Aachen University, Aachen, Germany
Impacts on the Embodied Energy of Rammed Earth Façades During Production and Construction Stages

Lisa Nanz¹, Martin Rauch², Thomas Honermann³, Thomas Außer⁴
Chair of Building Technology and Climate Responsive Design, Technical University of Munich, Munich, Germany,
lehrstuhl.klima@tum.de
Lehar Ton Ride Baukunst, Sankt, Austria
Materiality and Embodied Carbon Considerations in Contemporary Curtainwall Systems

Mic Patterson, PhD, LEED AP (BD+C)
Schlumberger USA, Facade Technologies Institute, Simi Valley, Canada. Email: mpatterson@facadetechnology.org
The next big thing - facades

RESEARCH
2014 – 2017

Lighthouse Projects
PDEng Projects
Research to Reality Projects
The next big thing - facades

RESEARCH
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PDEng Projects
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EXPLORATION OF BUILDING INTEGRATED PHOTOVOLTAICS

Within the EU, ensuring the stock of buildings, about 50% of the embodied materials and 30% of all energy is consumed in the built environment. To have coherent environmental impacts, the EU has set a target to reduce 7% energy efficiency improvement, 30% share of renewable energy, and 65% (60%) emissions reduction by 2030. This has been translated into the concept of nearly zero energy buildings (NZEBs).

To realize a NZEB, two measures are typically applied, resulting in a decrease of operational energy demand mainly by adding building components such as insulating packages, and an increase of energy generation, mainly by adding or integrating energy generating devices. Consequently, material-based environmental impact might cause a substantial improvement to the NZEBs, which is not yet addressed in current assessment methods.

The aim of this research is to develop a framework for environmental impact assessment and certification of integrated photovoltaics, focusing on the impact on varying capacity based on theoretical data collected from a NZEB field test. The objective is to apply the framework for a NZEB field test and to develop an optimized PV setup element for this specific case based on assessment and possibly selecting a generated set of alternatives.
CONVective CONCRETE

CONVective CONCRETE is about a novel design strategy of an innovative internal space cooling system. Its goal is to improve building energy efficiency by using a convective heat transfer mechanism in buildings. This is achieved by using a special concrete mixture that has high thermal conductivity and high thermal storage capacity. This lightweight, conductive concrete provides a unique solution to the problem of high energy consumption in buildings. The convective heat transfer mechanism is used to cool the building by inducing natural convection currents that carry heat away from the building's interior, thereby reducing the need for mechanical cooling systems.

Benefits of Using Convective Concrete:
1. **Energy Efficiency**: The convective heat transfer mechanism reduces the need for mechanical cooling systems, leading to significant energy savings.
2. **Sustainability**: By reducing energy consumption, convective concrete contributes to a more sustainable and environmentally friendly building design.
3. **Comfort**: The natural cooling effect of convective concrete provides a more comfortable indoor environment, especially in warm climates.
4. **Cost-Effectiveness**: Over the long term, the energy savings make convective concrete a cost-effective solution compared to traditional cooling systems.

Applications of Convective Concrete:
- **Commercial Buildings**: Large office spaces can benefit from convective concrete's ability to manage indoor temperatures effectively.
- **Residential Buildings**: New houses and retrofitting existing homes with convective concrete can improve energy efficiency and comfort levels.
- **Industrial Facilities**: Effective cooling of industrial buildings can lead to increased productivity and worker satisfaction.

Conclusion:
Convective concrete offers a promising future for sustainable and energy-efficient building solutions. As research and development continue, we can expect to see more widespread adoption of this innovative technology in various applications.
DOUBBLEFACE

The Doubleface project aimed at developing a new product that could potentially revolutionize the field of solar and energy harvesting devices. The concept of using double-sided solar panels not only increases the efficiency of energy absorption but also acts as a unique architectural feature. The design was inspired by the principle of light and shadow, creating dynamic and engaging spaces.

The project focused on creating a solar panel that could not only generate electricity but also serve as a shading device. This dual functionality would make the panels highly appealing for both residential and commercial buildings. The design incorporated the latest materials and technologies to ensure maximum efficiency and durability. The panels were designed to be easily integrated into existing structures, making them a viable option for retrofitting as well as new construction.

The Doubleface panels were tested in various conditions to ensure their performance under different weather and light intensities. The results showed promising outcomes, with the panels performing efficiently in both sunny and cloudy conditions.

DOUBBLEFACE

PVH as a material was a game-changer. Not only it can adapt to different climates but also it can be easily integrated into various architectural designs. The panels can be定制化定制 to fit specific needs, making them a versatile option for designers and architects.

The project's success was not only limited to the technical aspects but also highlighted the potential for innovation in the field of renewable energy. The Doubleface project was a testament to how technology and design can be combined to create sustainable and aesthetically pleasing solutions.

The project was also a significant milestone in the development of solar and energy harvesting technologies. It opened up new possibilities for the future of sustainable energy solutions.
The development of the concept was inspired by the shape of a sponge, which is a porous material that can absorb and release water. The design concept focused on creating a material that could absorb and release water, similar to a sponge. The concept was based on a series of interconnected channels that could absorb and release water, allowing the material to mimic the behavior of a sponge.

The optimization of thermal performance involved the selection of appropriate materials and the design of the channels. The channels were designed to maximize thermal efficiency, allowing the material to absorb and release water. The channels were also designed to enhance the overall thermal performance of the material. The design was optimized to ensure that the channels were evenly distributed and that they were connected to each other, allowing for efficient water absorption and release.

The materials used in the design were lightweight and had a high thermal conductivity. The channels were designed to be flexible, allowing them to absorb and release water efficiently. The design was also optimized to ensure that the channels were evenly distributed and that they were connected to each other, allowing for efficient water absorption and release.

The final design of the material was tested in a laboratory setting to evaluate its performance. The material was tested in a variety of conditions, including different temperatures and moisture levels. The results showed that the material was able to absorb and release water efficiently, mimicking the behavior of a sponge. The design was also able to maintain its thermal performance under varying conditions, making it a viable option for a variety of applications.
DOUBLE CURVED 3D CONCRETE PRINTING

This is an excellent project that explores some new advancements in the field of concrete-based manufacturing. However, one of the major drawbacks of this technology seems to be that it cannot meet the complex forms required for architectural printing. While more research could potentially demonstrate some successes, alternative strategies must be explored.

This project employs the possibilities of creating unique additive manufacturingwithin a precast concrete framework. The use of this new concrete, more intricate generation, to form natural-based prototyped surfaces has not been fully explored but the possibilities for complex curved and concrete-based manufacturing and casting are still not fully explored.

In order to verify the proposed manufacturing strategy, a shell structure consisting of dynamic stressing geometry was designed and printed. The basic principle of creating the design of the two-layer single span of the structure and parameters, such as the required print stability as well as the ability to form thin and precise layers, was explored by the print technology. The design could not be printed using the typical printer settings due to the constraints on the material thickness and the height of the print.

Fabrication Process

Both the 2D and the 3D prototypes were able to meet the overall requirements of the final structure. The 2D and the 3D prototypes both met the overall requirements of the final structure. A total of 15 layers of concrete were printed to form the final structure. The final structure was printed using a single layer of concrete and a total of 15 layers of concrete were used to form the final structure. The final structure was printed using a single layer of concrete and a total of 15 layers of concrete were used to form the final structure. The final structure was printed using a single layer of concrete and a total of 15 layers of concrete were used to form the final structure.

This was carried out because printing was not done sequentially for the final structure to ensure that the final structure that was carrying more weight was on the solid and the concrete structure was on the solid. The final structure was not carried out because printing was not done sequentially for the final structure to ensure that the final structure that was carrying more weight was on the solid and the concrete structure was on the solid. The final structure was not carried out because printing was not done sequentially for the final structure to ensure that the final structure that was carrying more weight was on the solid and the concrete structure was on the solid.
**Optimising 3D Concrete Printing**

**Content**

Lubomir Fridrich's work explores the employment of numerical techniques, including numerical modeling, in the optimization of 3D printing processes. The focus lies on improving the accuracy and efficiency of 3D printing, particularly in the context of concrete printing. By exploring the interaction between computational design and experimental work, the research develops advanced optimization techniques for 3D printing, aiming to improve the quality and reliability of the printing process.

**Preprint**

- The 3D printing process is shown as a complex, iterative process that requires careful optimization to achieve desired results.
- Advanced numerical techniques are employed to optimize the printing parameters, including layer thickness, print speed, and supports, to ensure higher quality and efficiency.
- The optimization process involves the use of simulations and experimental validation to refine the printing parameters.

**Key Tools**

- Advanced numerical simulation software for modeling the printing process.
- Experimental testing to validate the simulation results.

**Future Directions**

- Further development of optimization algorithms for different printing materials and conditions.
- Integration of machine learning techniques to automate the optimization process.

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**Optimising 3D Concrete Printing**

- The implementation of novel concrete-displacement modeling techniques, digital fabrication, and additive manufacturing technologies in the construction industry is expected to bring significant benefits, driven by advancements in 3D printing technologies and the simplification of traditional construction methods. These advancements are making 3D printing a viable alternative for the construction industry.

**Benefits**

- Reduced material waste due to precise printing.
- Increased design freedom and customization.
- Faster construction times compared to traditional methods.

**Challenges**

- Cost considerations, particularly in the initial investment for 3D printing equipment.
- Sustainability concerns, including the environmental impact of 3D printing.

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**Minimal prerequisites**

The printing process involves the manipulation of the material properties of the printing component, affecting the printing velocity and the accuracy of the printed part. Understanding the material properties is crucial for achieving optimal printing results. The optimization process requires a deep understanding of the printing machinery in order to achieve the desired outcomes.

**Optimisation**

- The research aims to develop a computational framework for the optimization of the printing process, integrating both experimental and numerical methods.
- The framework is validated through a series of case studies, demonstrating its effectiveness in improving the quality and efficiency of the printing process.

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**Key Takeaways**

- Numerical optimization techniques are essential for improving the fidelity and efficiency of 3D printing processes.
- Integrating experimental validation is crucial for ensuring the accuracy of the optimization methods.
- Future work will focus on expanding the scope of the optimization framework to include a wider range of printing materials and conditions.
The Building Envelope as a Potential Field of Application

Building envelopes play a crucial role in energy efficiency and sustainability. Improving the energy performance of buildings is essential to meet the growing demand for energy and reduce greenhouse gas emissions. The envelope, which includes windows, doors, insulation, and facade, significantly impacts the energy efficiency of a building. By optimizing the building envelope, we can achieve significant energy savings and contribute to a more sustainable future.

Polycarbonate Coating Technologies

Polycarbonate is a versatile polymer with a range of applications, including coatings for building envelopes. Polycarbonate coatings offer excellent durability, weatherability, and energy efficiency. They can be tailored to meet specific performance requirements, making them suitable for a variety of applications.

Potential Environmental Performance and Longevity

Polycarbonate coatings are designed to enhance the environmental performance of building envelopes. They offer improved durability, reduced maintenance requirements, and lower energy consumption, resulting in cost savings and environmental benefits.

Conclusion and Outlook

As technology and materials continue to evolve, the building industry is poised for significant advancements. By adopting new technologies, such as polycarbonate coatings, we can create more sustainable and energy-efficient buildings. The future of building envelopes is promising, with continued innovation driving the development of more efficient and environmentally friendly solutions.

The Poly ARCH Project is a research initiative aimed at investigating polymeric materials and coatings for building envelopes. Through a collaborative approach, the project aims to explore new possibilities and contribute to the advancement of sustainable building solutions.

Acknowledgments

The Poly ARCH Project acknowledges the support of various partners and institutions. Their contributions have been instrumental in advancing the research and development of polymeric coatings for building envelopes.
PD LAB

While architects and engineers work already actively to make our buildings more sustainable, they still lack a tool to design buildings which ensure the contribution of each building component towards the sustainability of the whole building. This paper presents the design and development of the PD Lab, a computer tool that can help architects and engineers create sustainable buildings.

The building performance simulation tool is based on the concept of potential and energy flows inside the building. This approach allows for a comprehensive analysis of the building's performance, including energy consumption, water usage, and other environmental impacts. The tool uses advanced algorithms to simulate the interactions between different building components, enabling architects and engineers to make informed decisions about the design and construction of sustainable buildings.

Conclusion

The PD Lab tool is a powerful tool for architects and engineers to analyze and optimize the sustainability of building designs. It helps ensure that buildings are designed to be energy-efficient, water-conserving, and environmentally responsible. With the increasing demand for sustainable building practices, the PD Lab offers a valuable resource for architects and engineers to create a more sustainable built environment.

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FACADE LEASING

FACADE LEASING

Facade Leasing explores a dynamic interaction in the construction industry, where a facade is treated as a service rather than an individual component. This approach integrates the concept of valuing, leasing, and maintaining the facade as a part of the building's lifecycle management, offering a new perspective on façade design and sustainability.

Consider Economics

The principle of marginal economic development and materials with high initial costs of installation or maintenance can be utilized to create a positive return on investment, encouraging the use of advanced materials and technologies that are cost-effective over time.

Consider Business Models

A dynamic business model based on ongoing maintenance and performance delivery could increase the value and adaptability of building facades, integrating the concept of life-cycle management into the design and construction process. This approach can help in addressing the challenges of sustainability and cost-effectiveness in the construction industry.

Tucked away in the materials, with notable suppliers, and real-time price changes:

- [Supplier Name]
- [Price Breakdown]
- [Real-Time Price Tracking]
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Symposium “High Performance Building Envelopes”

New Technologies
New Materials
Energy collection / Energy storage
Innovation processes

Adaptation of the technologies: who wins what?
Façade Roadmap

Prof. Dr. Ing Ulrich Knaack

Institute for Structural Mechanics + Design
Chair Façade Technology
TU Darmstadt

Chair Design of Construction
Façade Research Group
TU Delft

The Next Big Thing