

University of Stuttgart
Visualization Research Center (VISUS)



Visualization for Architecture, Engineering, and Construction: Shaping the Future of Our Built World

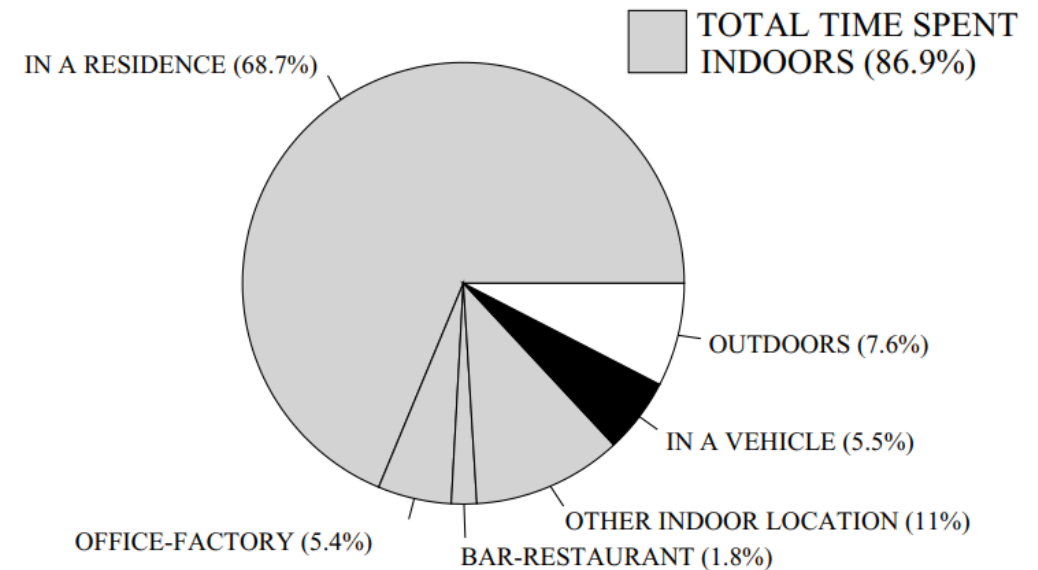
Moataz Abdelaal, Felix Amtsberg, Michael Becher, Rebeca Duque Estrada, Fabian Kannenberg, Aimee Sousa Calepso, Hans Jakob Wagner, Guido Reina, Michael Sedlmair, Achim Menges, and Daniel Weiskopf



Architecture

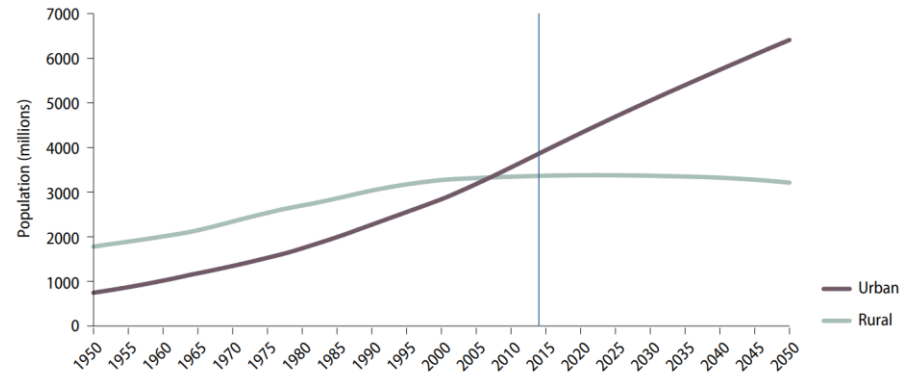
NHAPS - Nation, Percentage Time Spent

Total n = 9,196



Architecture, Engineering, and Construction (AEC) Demand

Urban and rural population of the world, 1950–2050



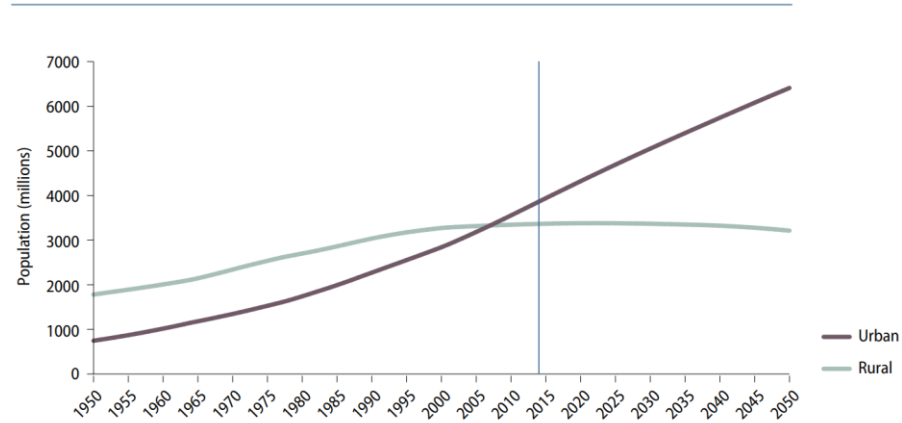
United Nations, Department of Economic and Social Affairs, Population Division (2015). World Urbanization Prospects: The 2014 Revision.

AEC industry needs to build housing and infrastructure for over 2.5 billion people by 2050

Architecture, Engineering, and Construction (AEC)

Demand, Productivity

Urban and rural population of the world, 1950–2050



United Nations, Department of Economic and Social Affairs, Population Division (2015). World Urbanization Prospects: The 2014 Revision.

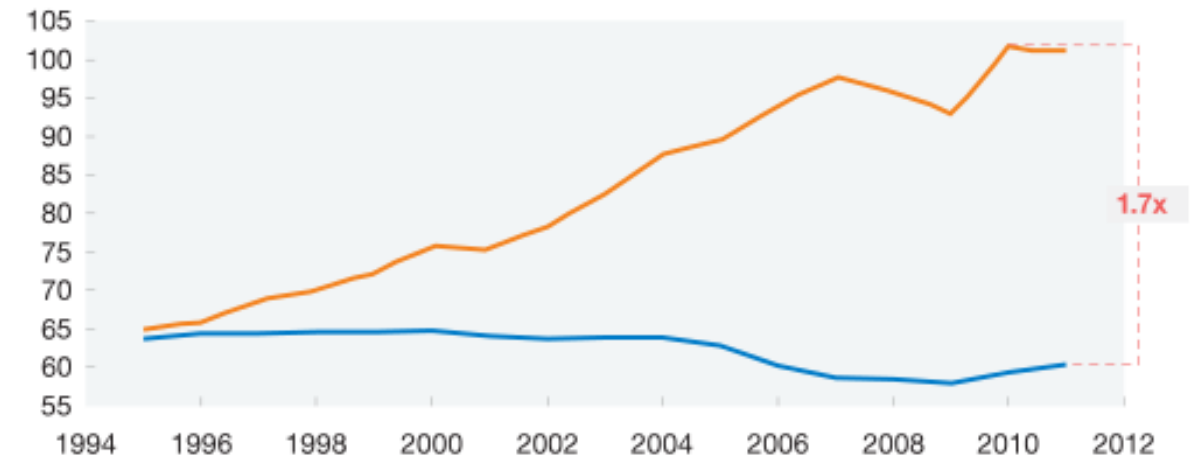
AEC industry is characterized by decreasing level of productivity over the last three decades

Productivity in manufacturing has nearly doubled, whereas in construction it has remained flat.

Overview of productivity improvement over time

Productivity (value added per worker), real, \$ 2005

\$ thousand per worker



Source: Expert interviews; IHS Global Insight (Belgium, France, Germany, Italy, Spain, United Kingdom, United States); World Input-Output Database

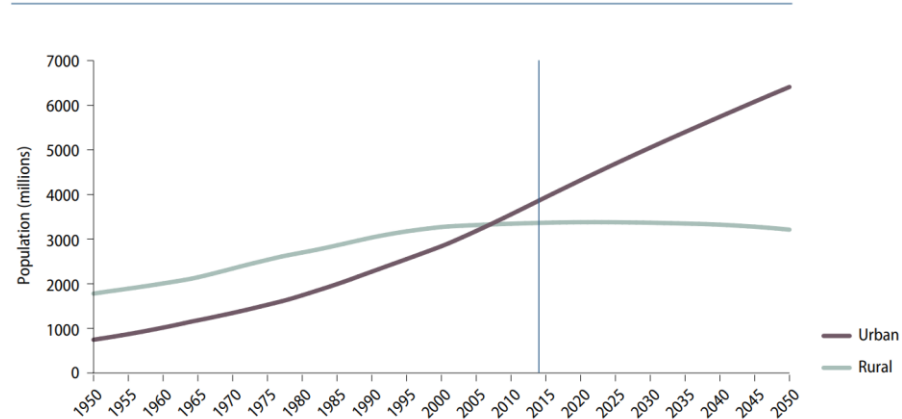
McKinsey&Company

S. Changali, A. Mohammad, and M. Van Nieuwland, "The construction productivity imperative," McKinsey & Company, New York, NY, USA, Tech. Rep., 2015

Architecture, Engineering, and Construction (AEC)

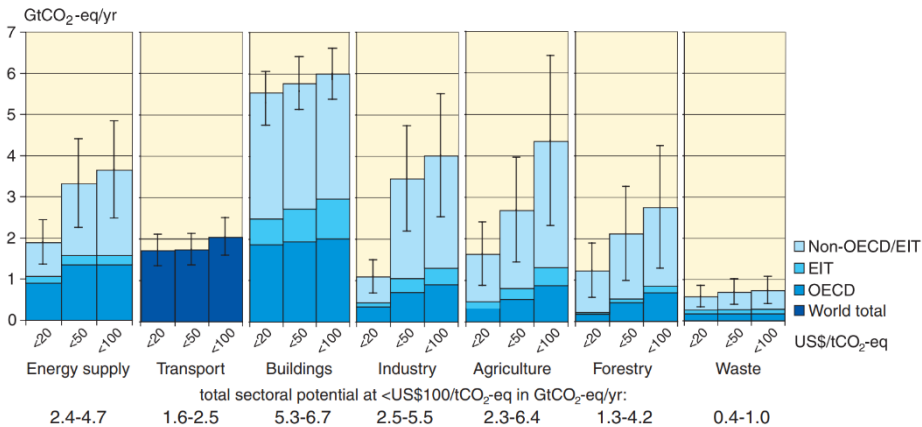
Demand, Productivity and Climate Change

Urban and rural population of the world, 1950–2050



United Nations, Department of Economic and Social Affairs, Population Division (2015). World Urbanization Prospects: The 2014 Revision.

Economic mitigation potentials by sector in 2030 estimated from bottom-up studies



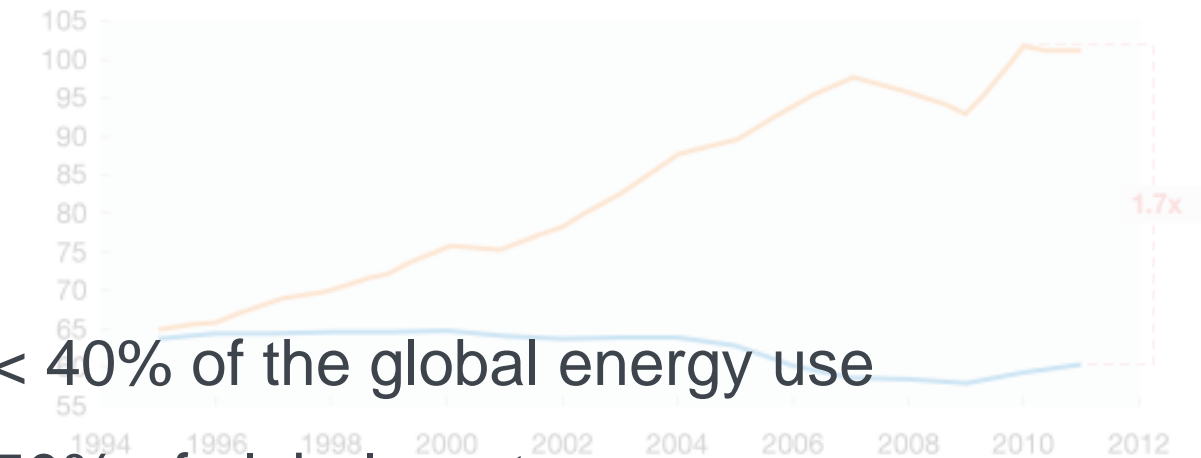
IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Productivity in manufacturing has nearly doubled, whereas in construction it has remained flat.

Overview of productivity improvement over time

Productivity (value added per worker), real, \$ 2005

\$ thousand per worker



< 40% of the global energy use

50% of global waste

30% of global greenhouse gases

S. Changali, A. Mohammad, and M. Van Nieuwland, "The construction productivity imperative," McKinsey & Company, New York, NY, USA, Tech. Rep., 2015

Solution Strategies

Researching new building materials

Reducing the consumption of building materials

Making use of the Cyberphysical systems

Solution Strategies

Researching new building materials

Reducing the consumption of building materials

Making use of the Cyberphysical systems



BUGA Fiber Pavilion



BUGA Wood Pavilion

Solution Strategies

Researching new building materials

Reducing the consumption of building materials

Making use of the Cyberphysical systems

Can we do more?

What kind of buildings can we build with these materials?

What are their structural properties?

BUGA Fiber Pavilion

What about the aesthetics?

What is the design space?

BUGA Wood Pavilion

Solution Strategies

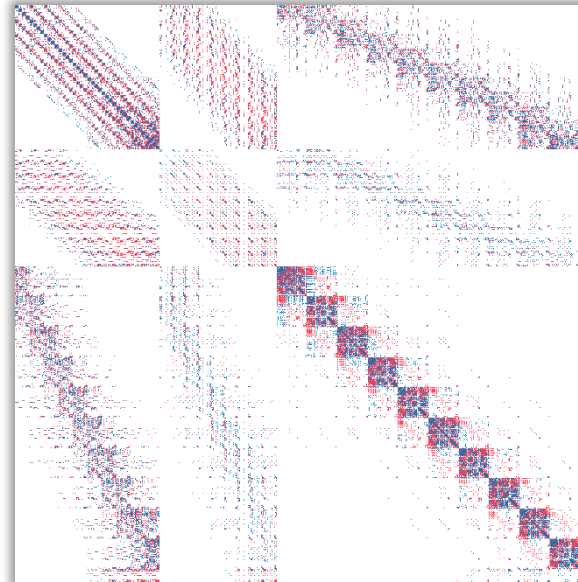
Researching new building materials

Reducing the consumption of building materials

Making use of the Cyberphysical systems



Building Actuators



Redundancy Matrix



An Adaptive High-Rise Building

Solution Strategies

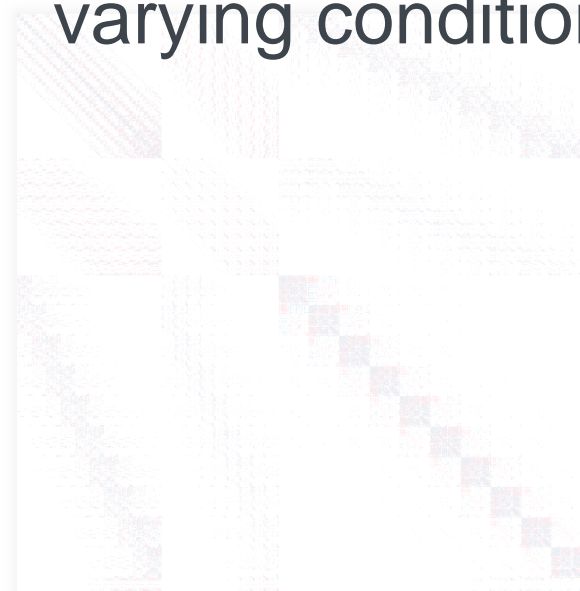
Researching new building materials

Reducing the consumption of building materials

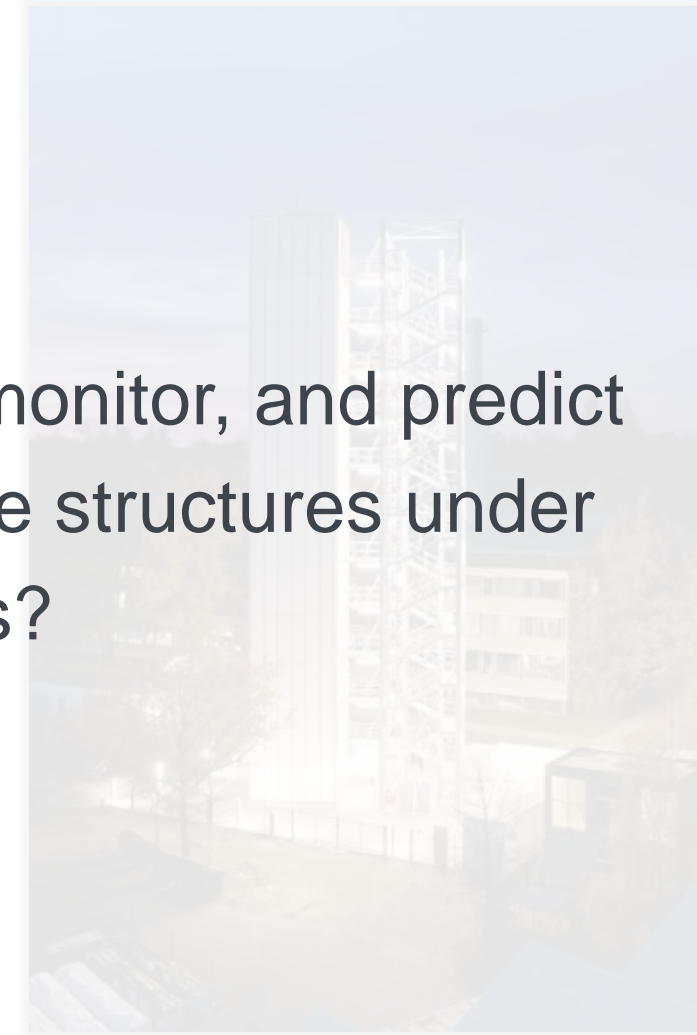
Making use of the Cyberphysical systems

Can we do more?

How to analyze, monitor, and predict the behavior of the structures under varying conditions?



Redundancy Matrix



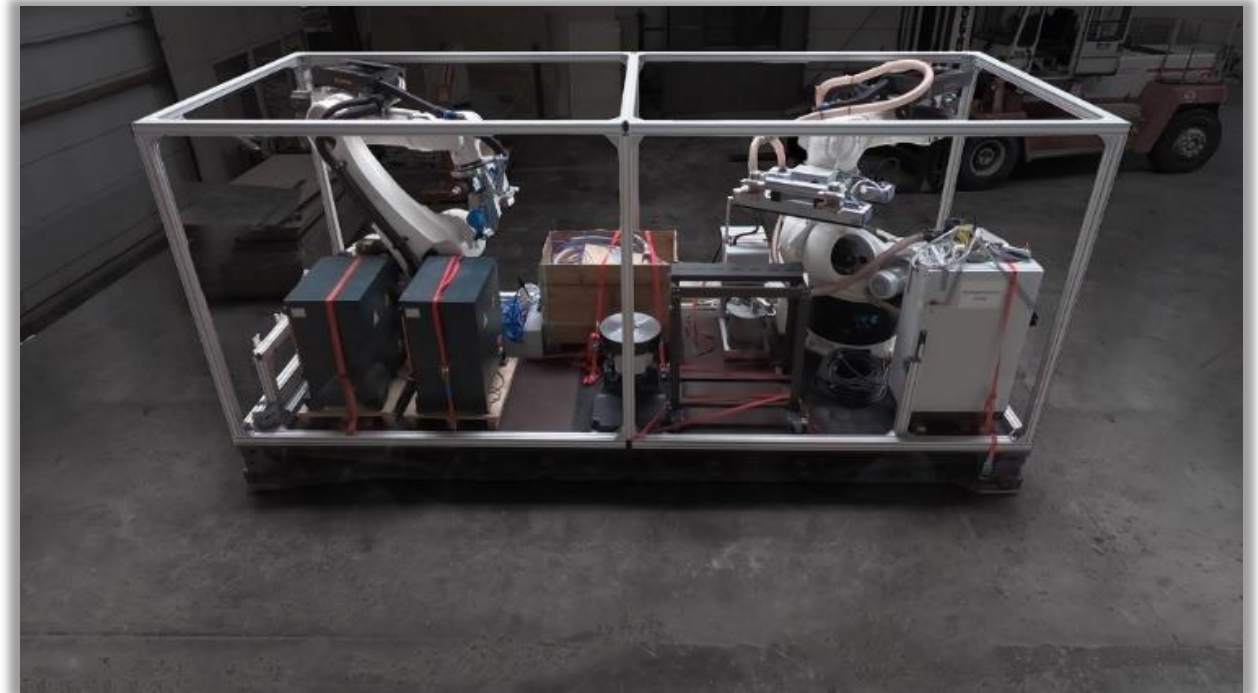
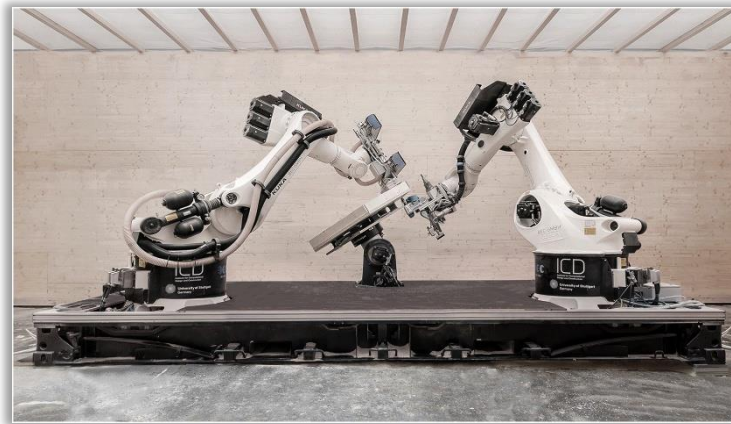
An Adaptive High-Rise Building

Solution Strategies

Researching new building materials

Reducing the consumption of building materials

Making use of the Cyberphysical systems



Transportable Robotic Fabrication Unit (TIM)

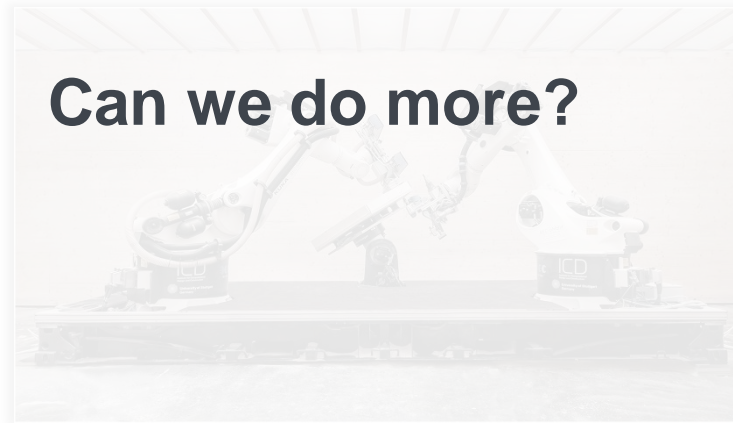
Solution Strategies

Researching new building materials

Reducing the consumption of building materials

Making use of the Cyberphysical systems

Can we do more?



How to monitor and coordinate the human-robot collaborative fabrication?



Transportable Robotic Fabrication Unit (TIM)

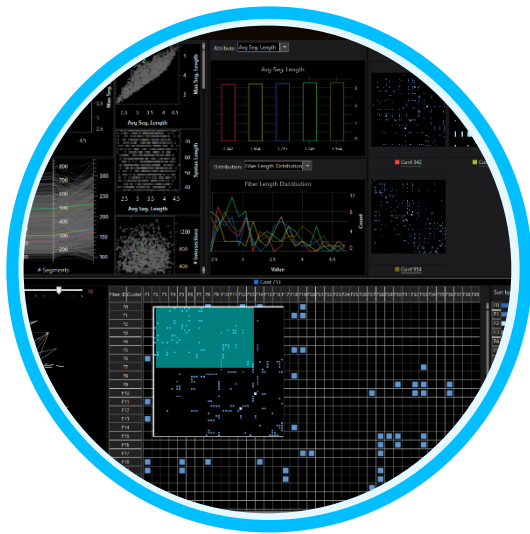
We argue that interactive data visualization and immersive technology will be the vehicle to support the transition of the building industry to a more data-driven and digital environment

”

AEC Characteristics

1. The inherent need for human judgment
2. The lack of standardization and/or the lack of data
3. Co-design and breadth of relevant domains

How Visualization Could Help?



Visual analytics systems
for domain experts



AR for Human-robot
Collaboration (HRC)



Situated visualizations of
adaptive buildings

Takeaways

- Visualization research could play a vital role in the digital transformation of the AEC sector
- Designing and building visualization solutions for AEC comes with challenges
- Visualization and Architecture could benefit from each other