

# Revisiting Folded Forms with Digital Fabrication

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**National Centre of Competence  
in Research  
Digital Fabrication**

# Revisiting Folded Forms with Digital Fabrication

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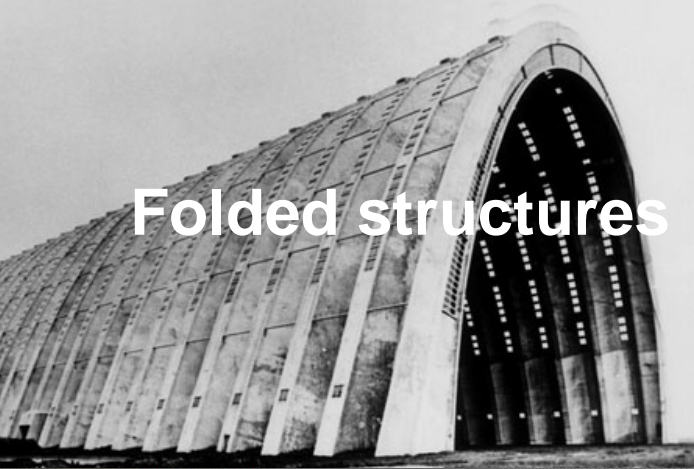
# Revisiting Folded Forms with Digital Fabrication

- **Introduction**
- **Smart Dynamic Casting**
- **Prototypes and discussion**
- **Conclusions and outlook**

# Revisiting Folded Forms with Digital Fabrication

- **Introduction**
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# Folded structures

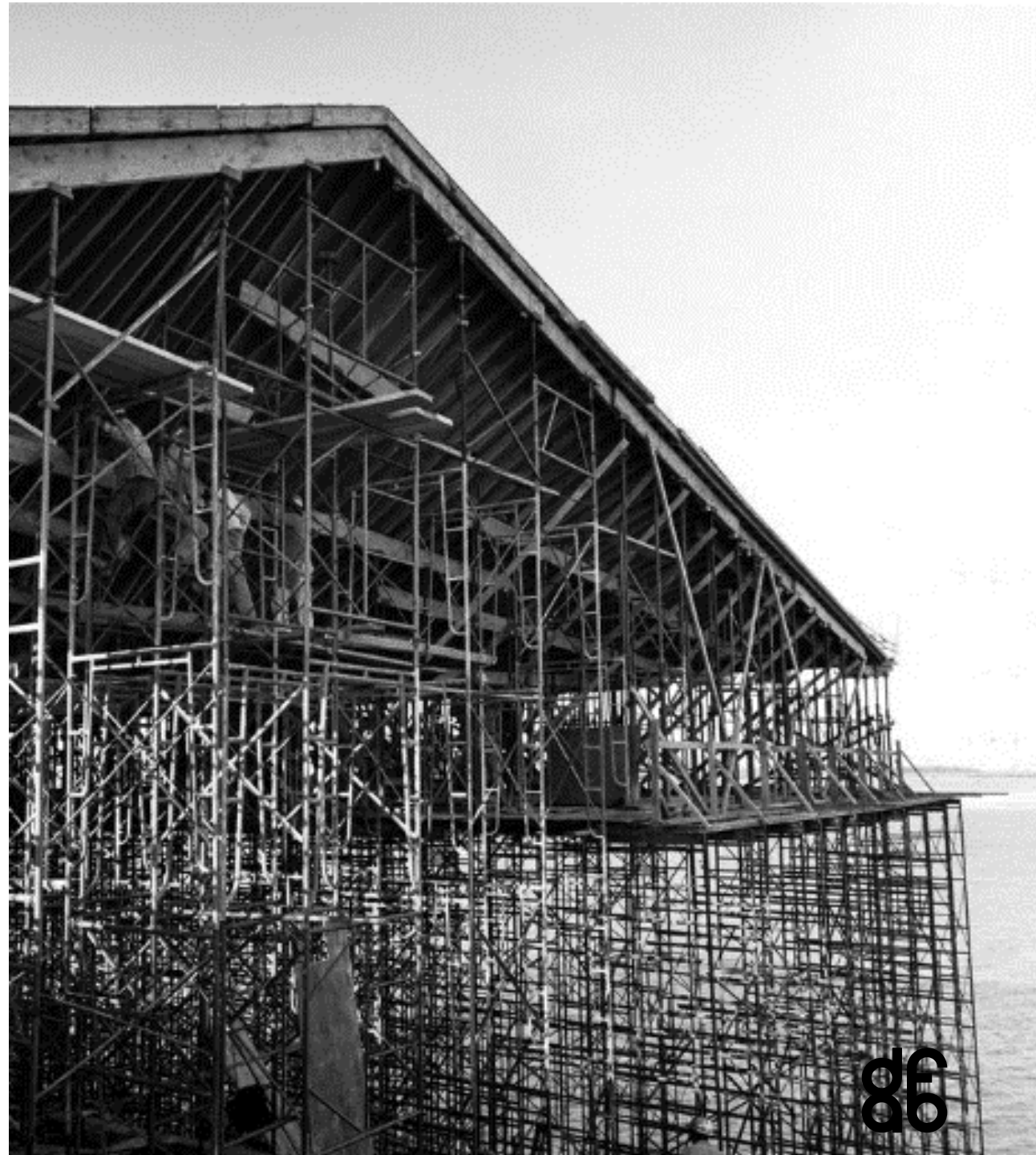


# Folded structures



Miami Marine Stadium, Hilario Candela, 1963

Gramazio Kohler Research  
ETH Zurich

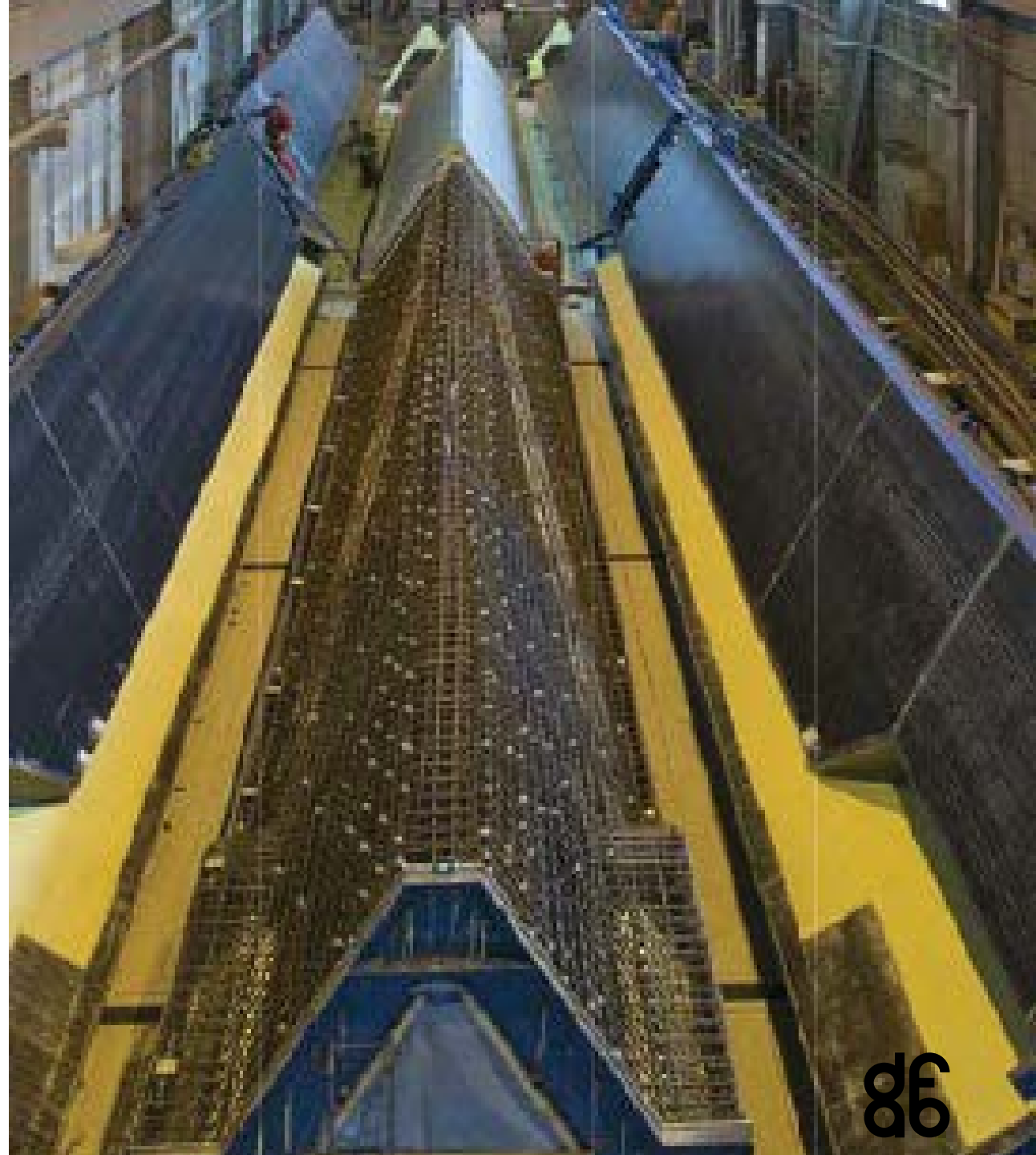


# Contemporary folded structures



Mülimatt Sports Centre, Studio Vacchini Architetti, 2010

Gramazio Kohler Research  
ETH Zurich





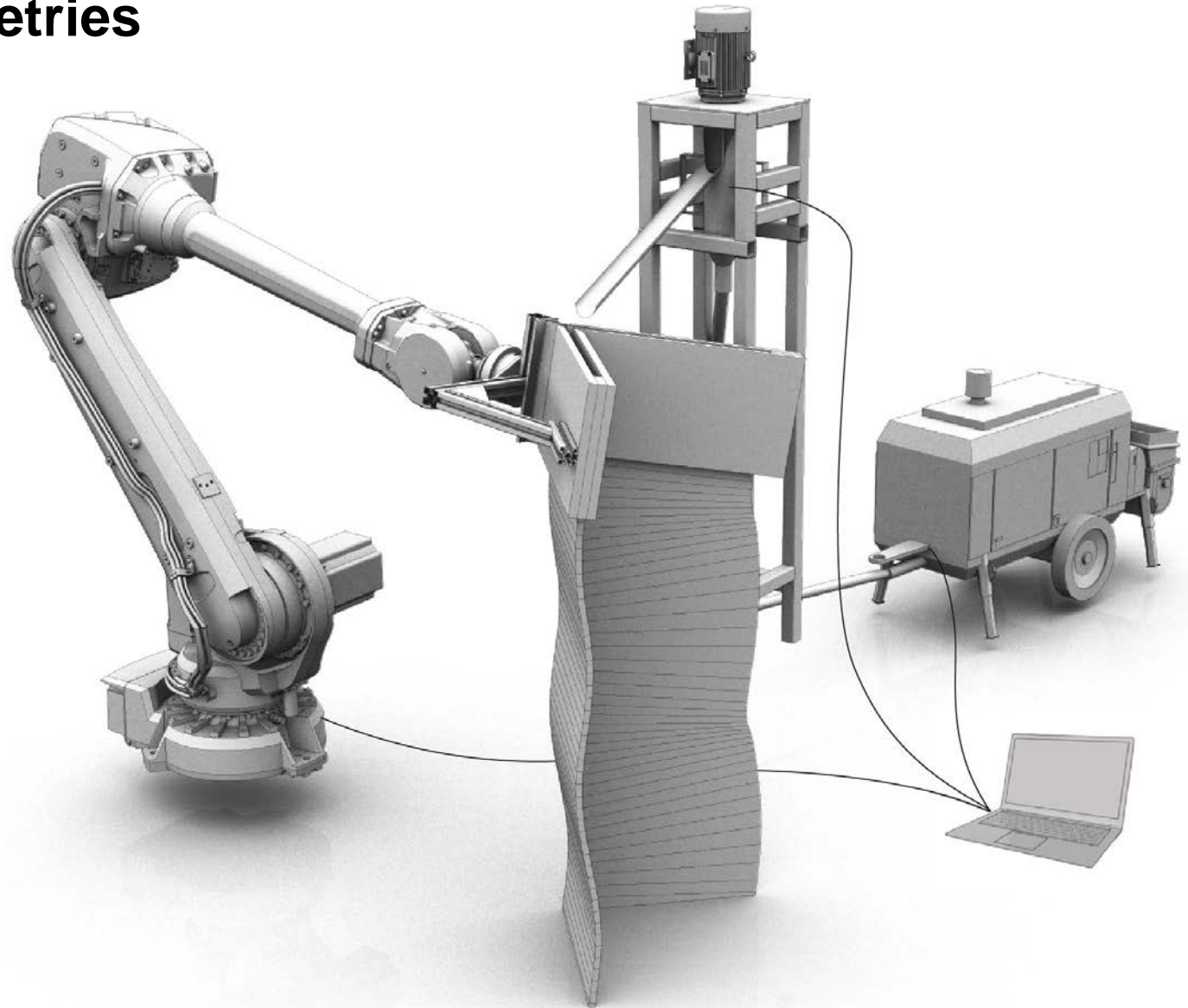
# Revisiting Folded Forms with Digital Fabrication

- Introduction
- **Smart Dynamic Casting**
- Prototypes and discussion
- Conclusions and outlook

# Setup for thin folded geometries

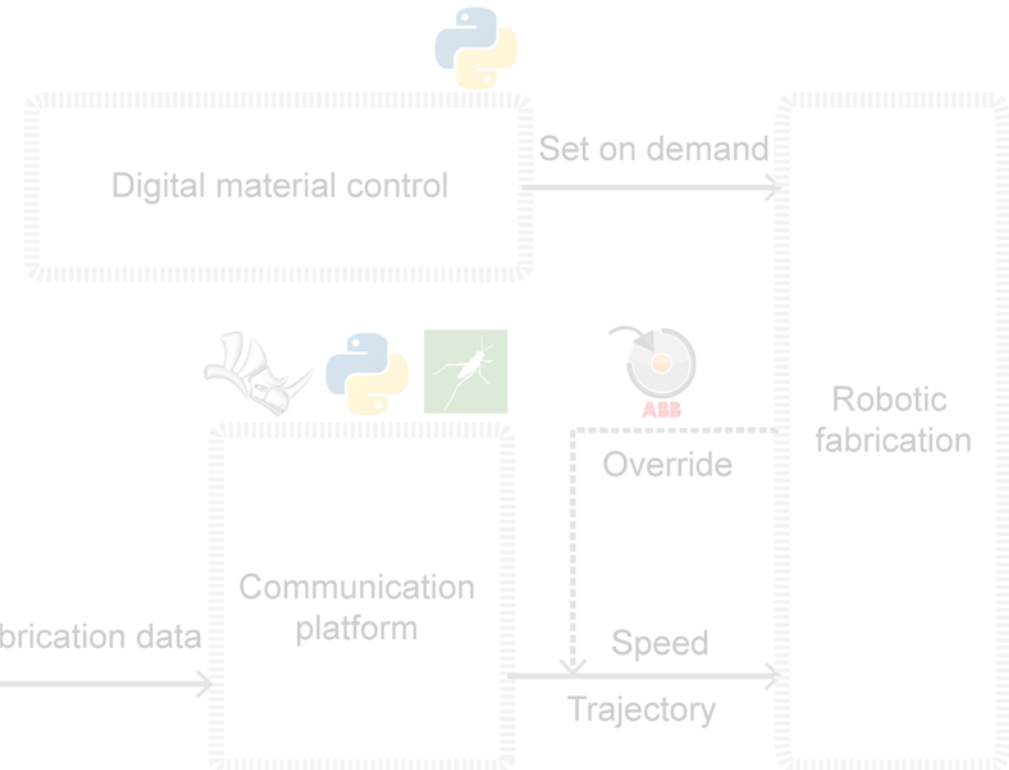
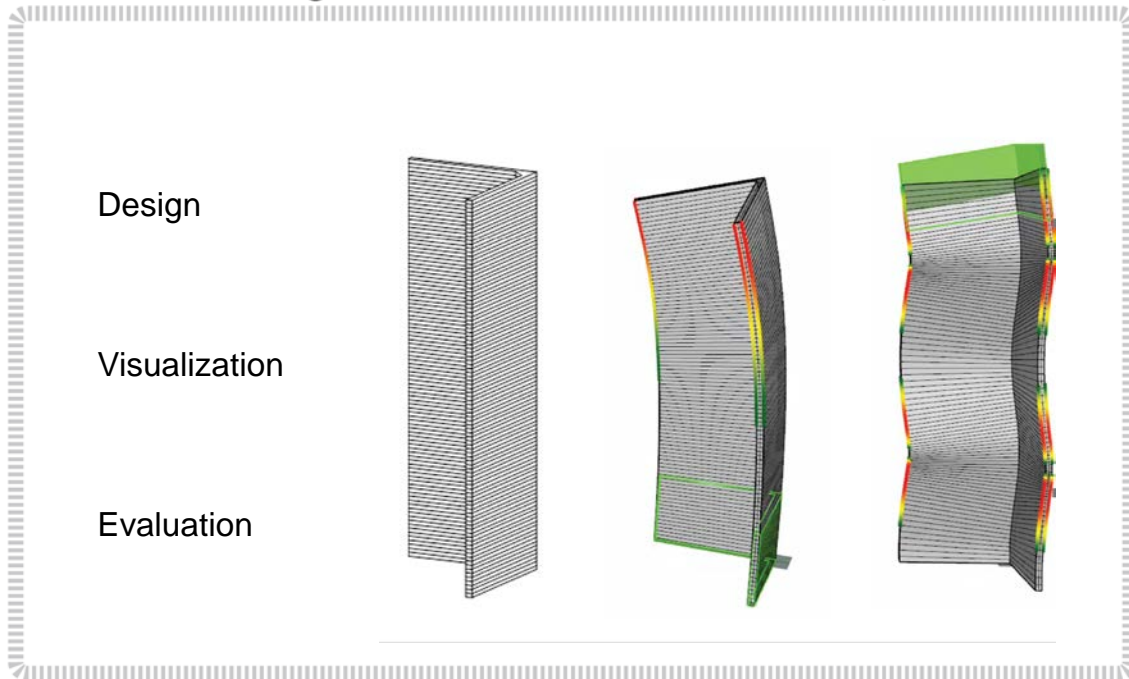
## Smart Dynamic Casting

- Robotic slipforming
- Rigid folded formwork
- Digital trajectory
- Set on demand concrete
- Shaping
- Process window



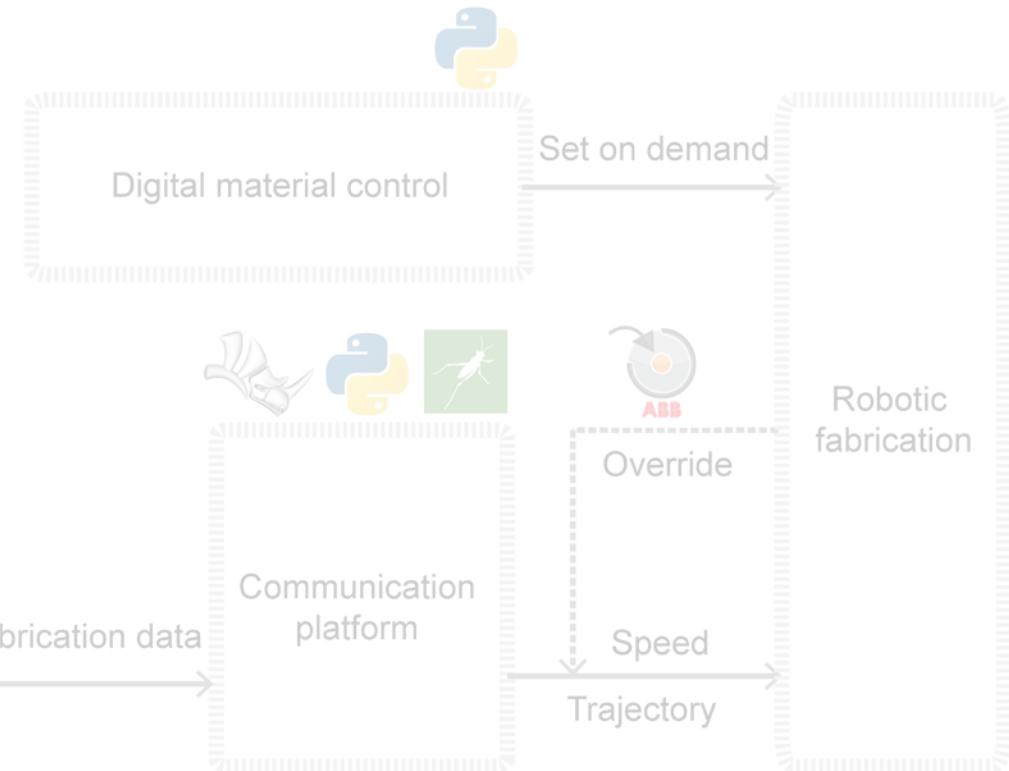
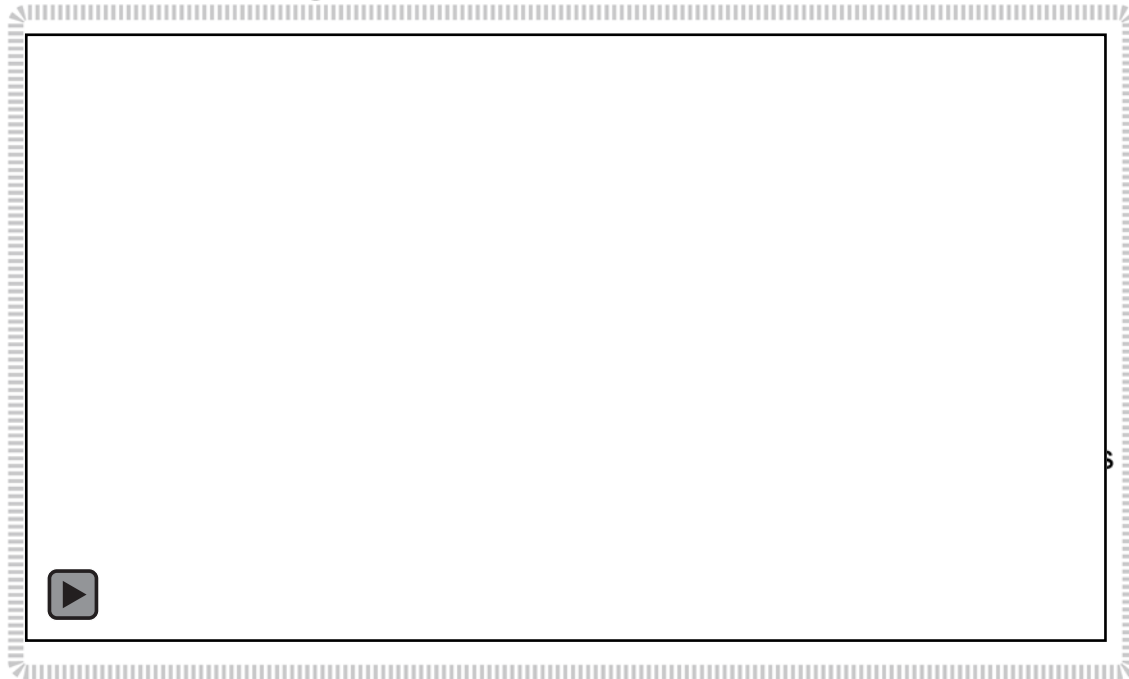
# Digital control

Design and fabrication tool  
for thin folded geometries



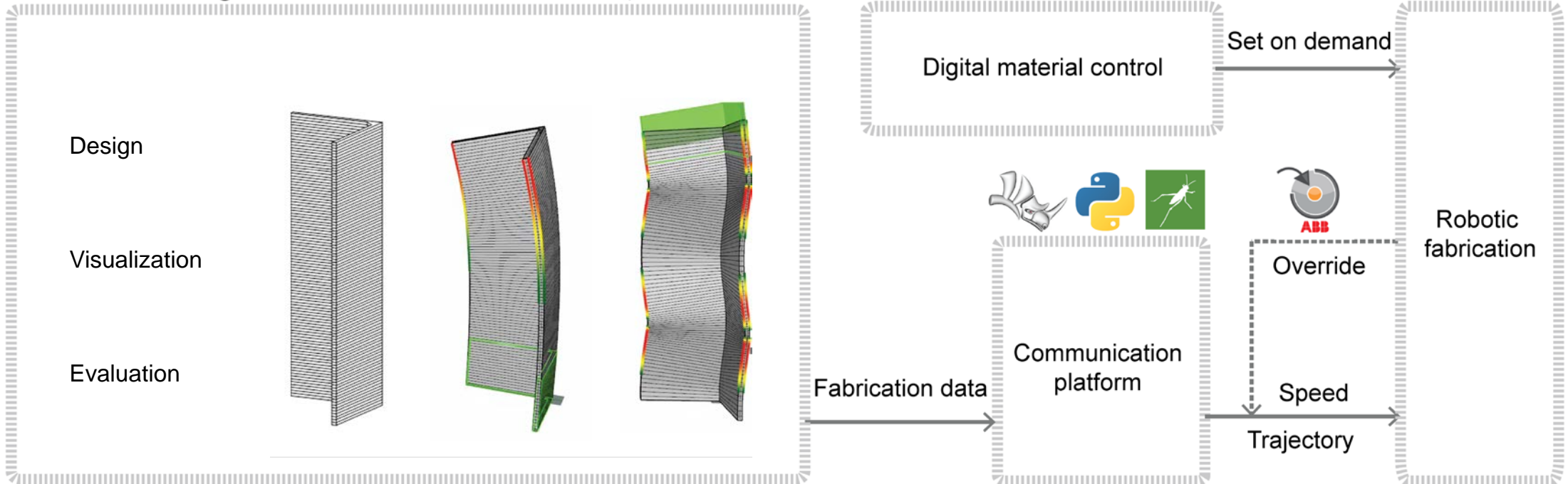
# Digital control

Design and fabrication tool  
for thin folded geometries



# Digital control

Design and fabrication tool  
for thin folded geometries



# Material engineering

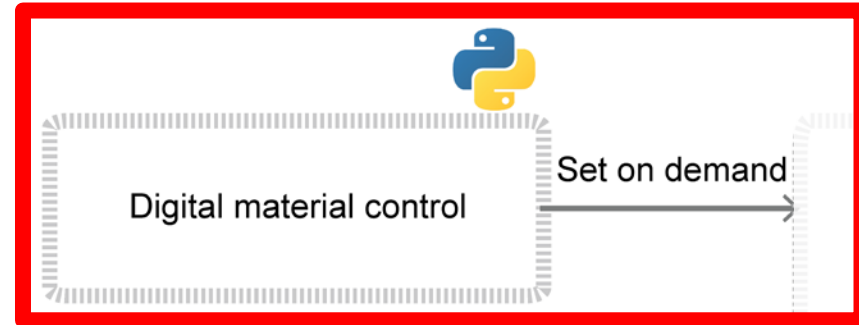
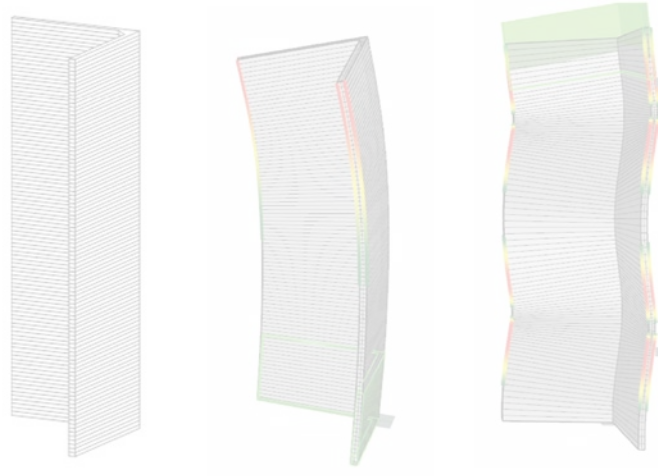
Design and fabrication tool  
for thin folded geometries



Design

Visualization

Evaluation



Fabrication data

Communication  
platform



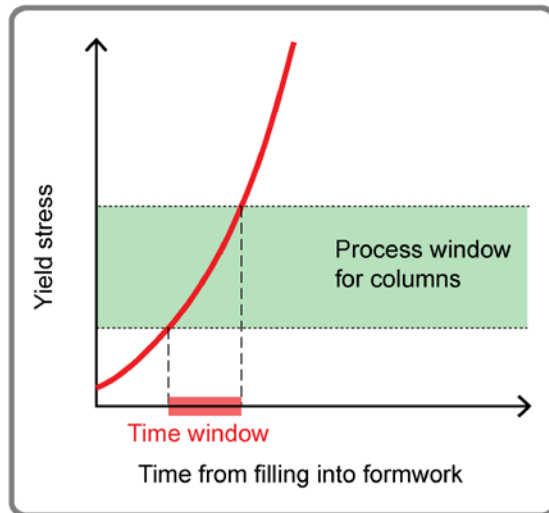
Override

Speed

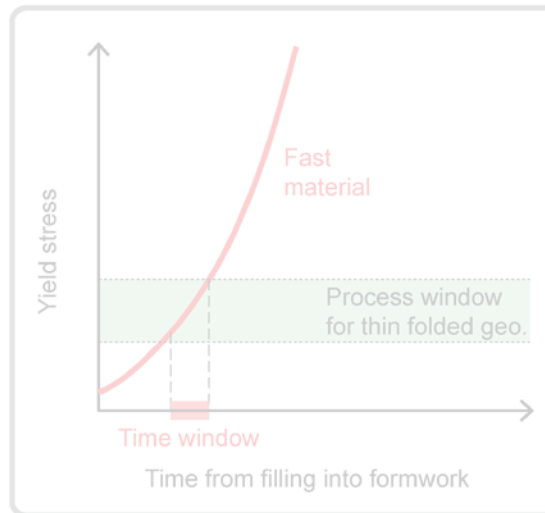
Trajectory

Robotic  
fabrication

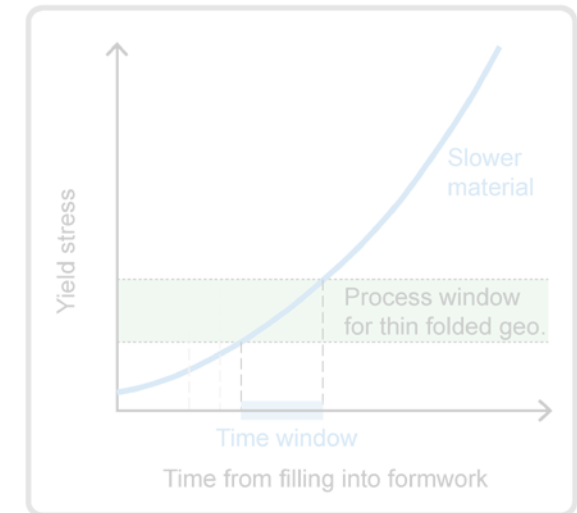
# Material engineering



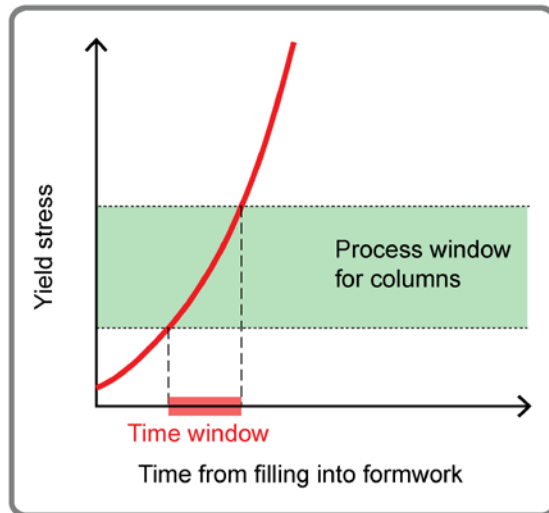
Thin folded formwork



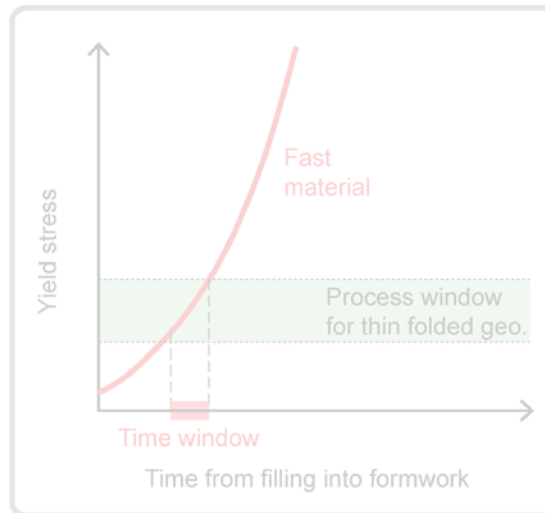
Material adaptation



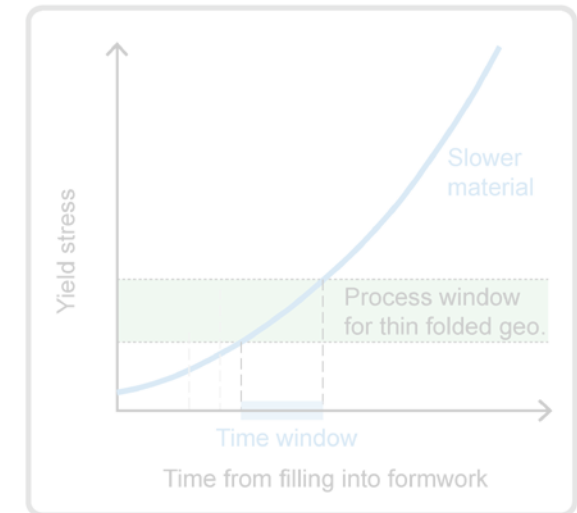
# Material engineering



Thin folded formwork

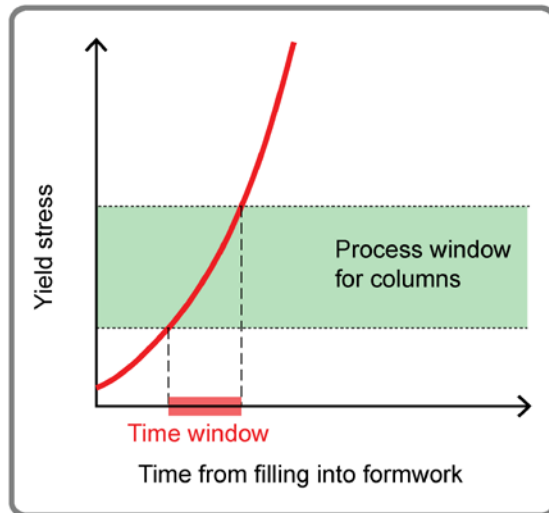


Material adaptation

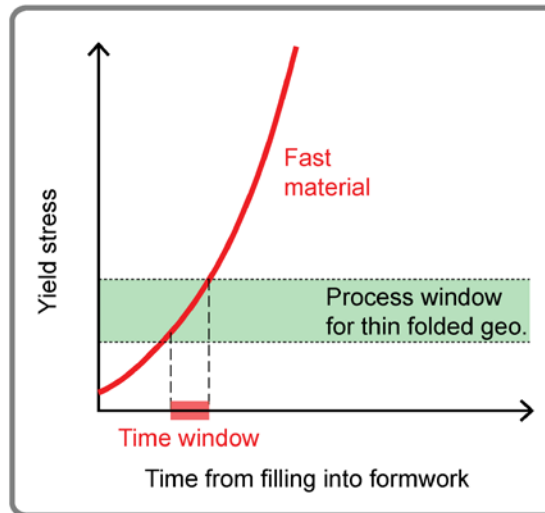




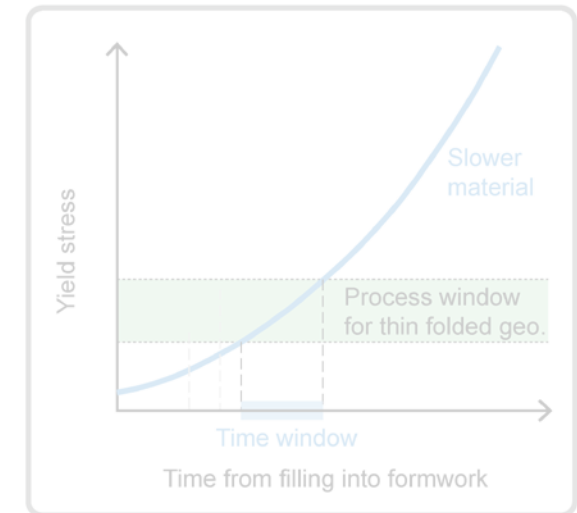
# Material engineering



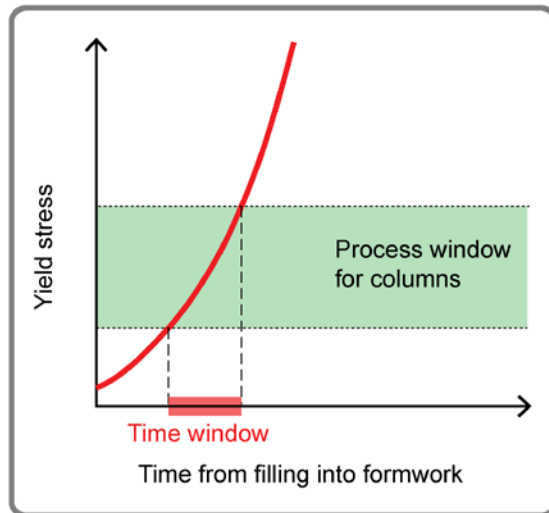
Thin folded formwork



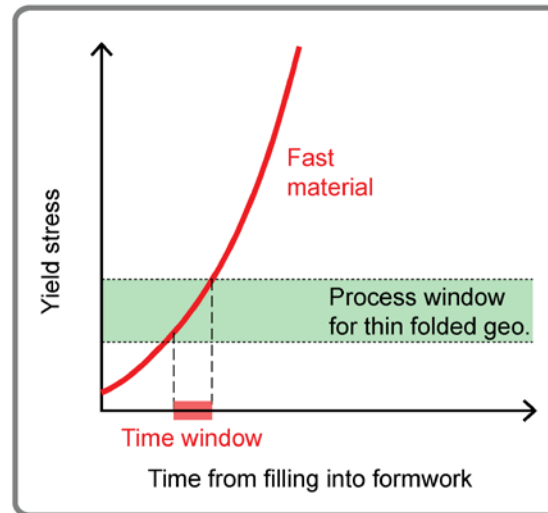
Material adaptation



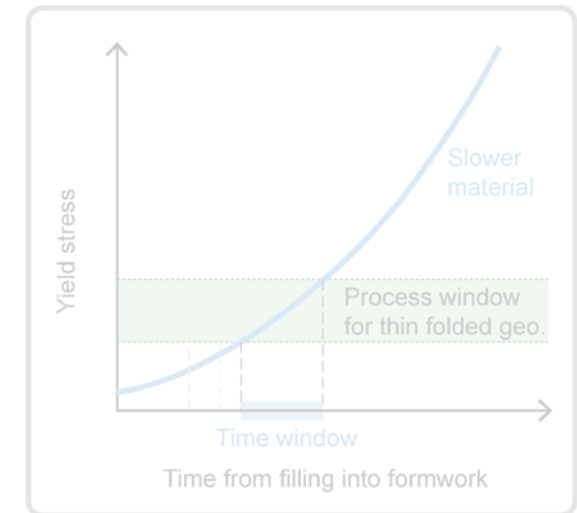
# Material engineering



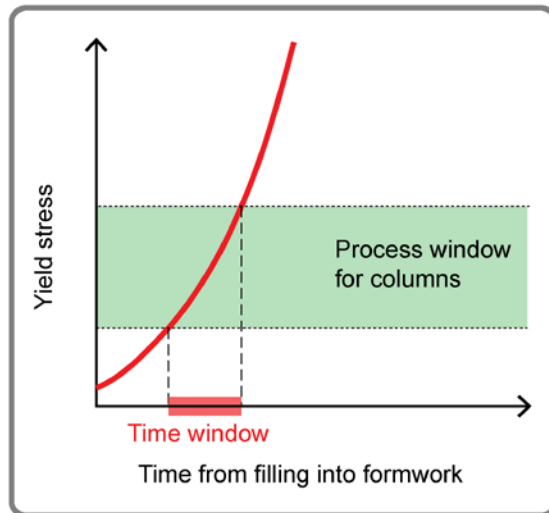
Thin folded formwork



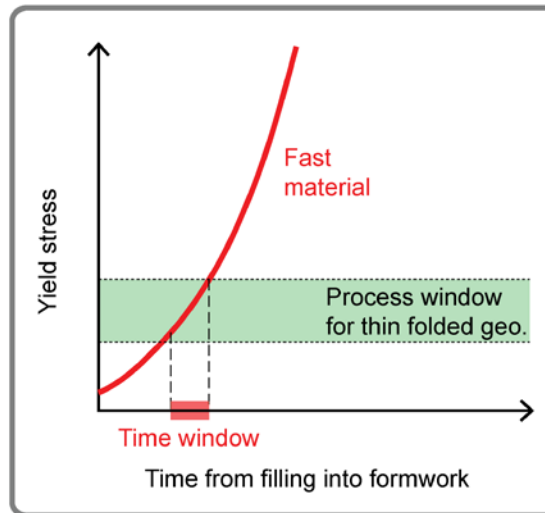
Material adaptation



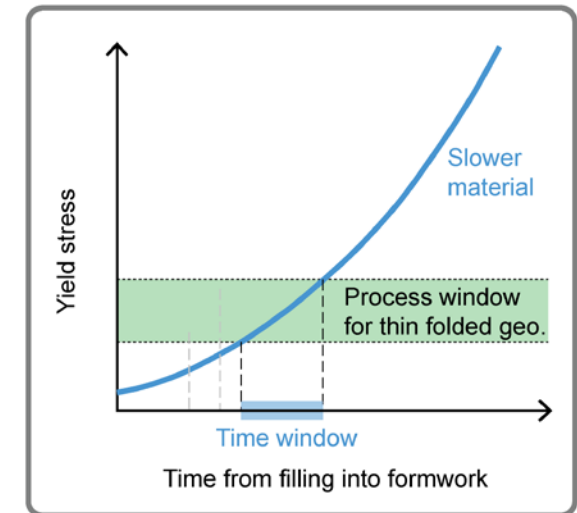
# Material engineering



Thin folded formwork



Material adaptation



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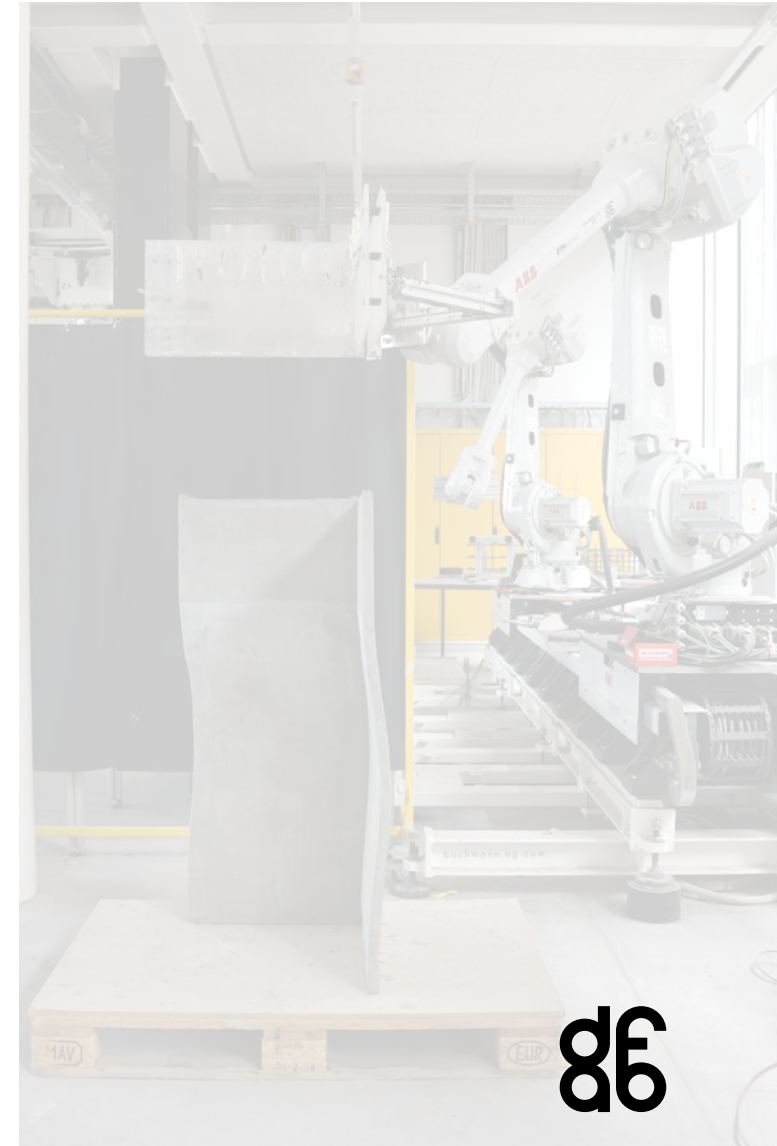
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- **Prototypes and discussion**
- Conclusions and outlook

# Prototypes



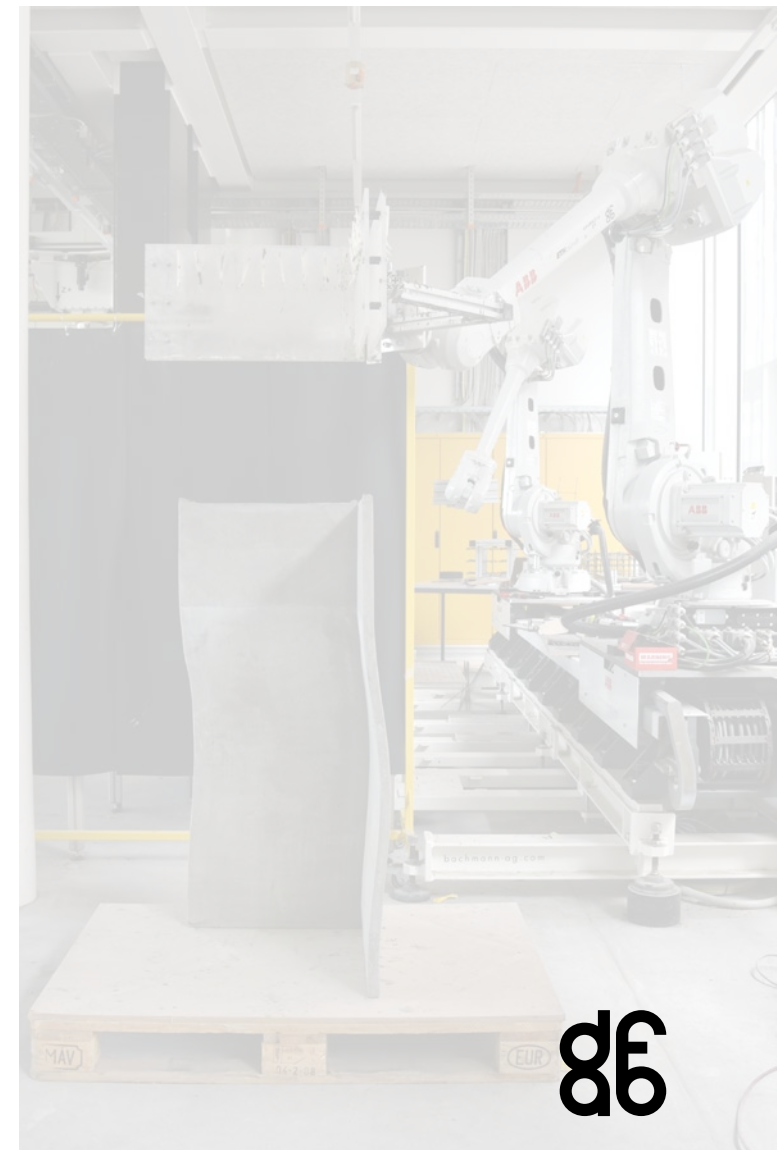
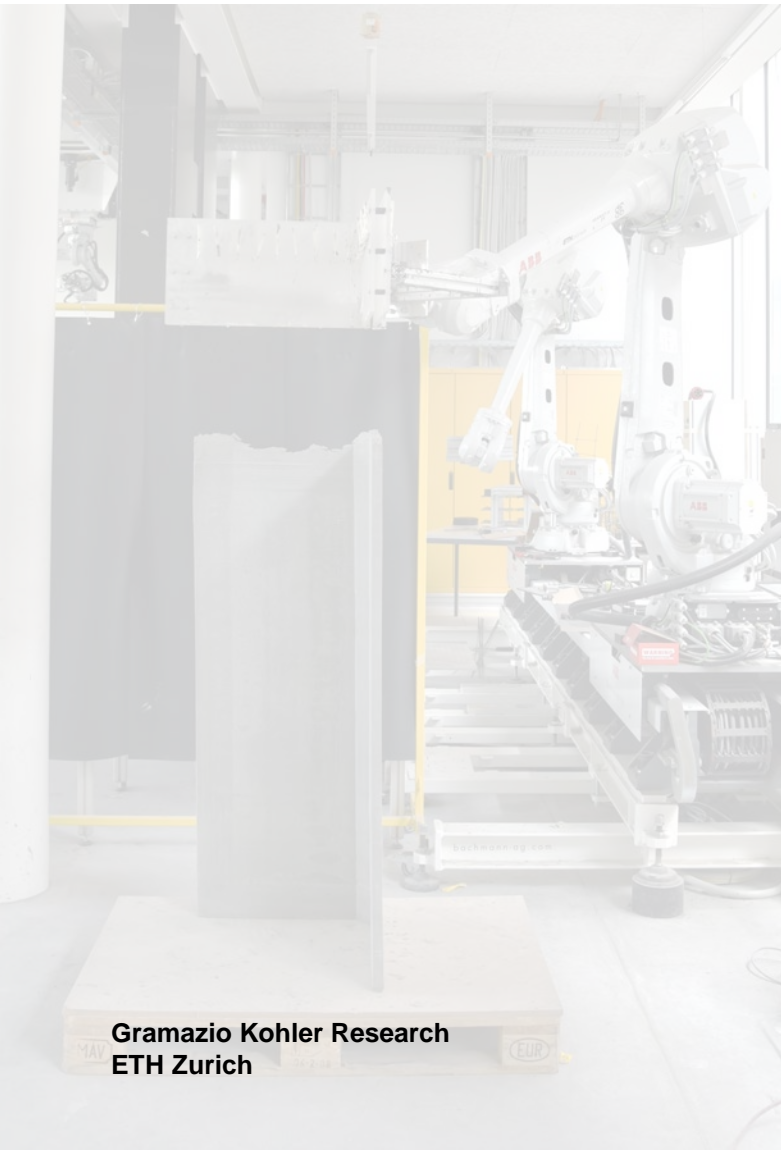
# Prototypes

- Straight trajectory
- Material validation

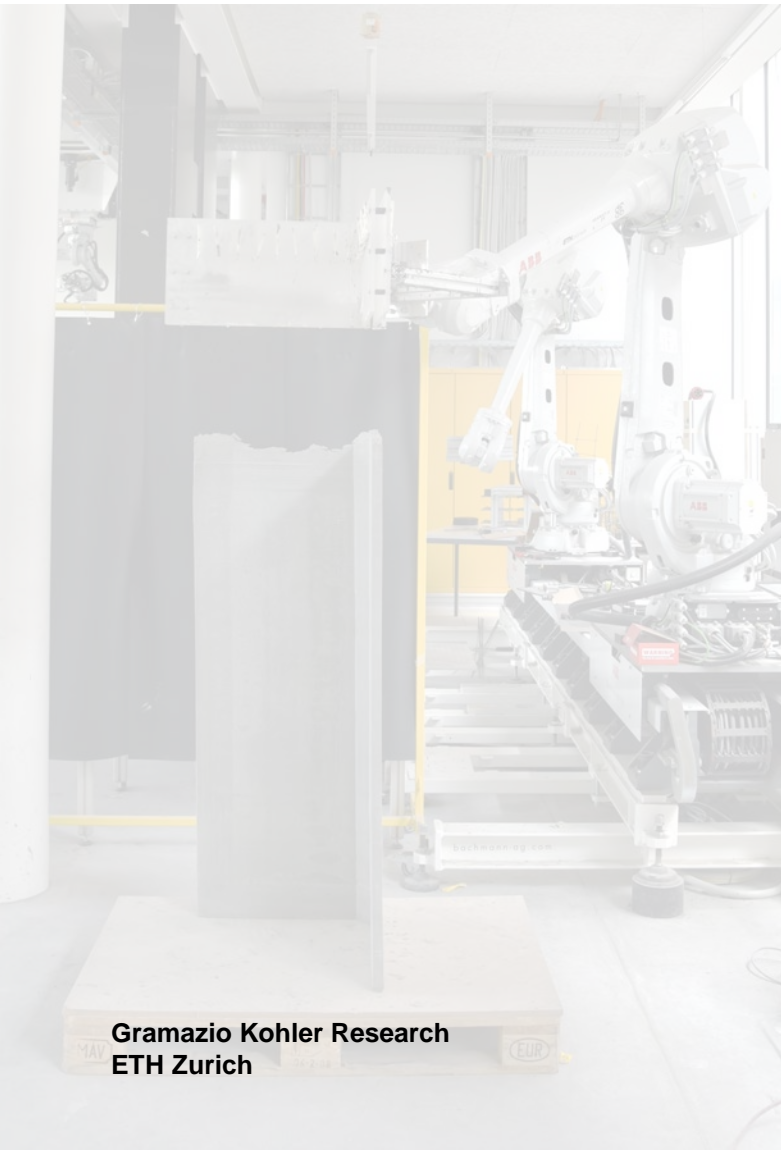


# Prototypes

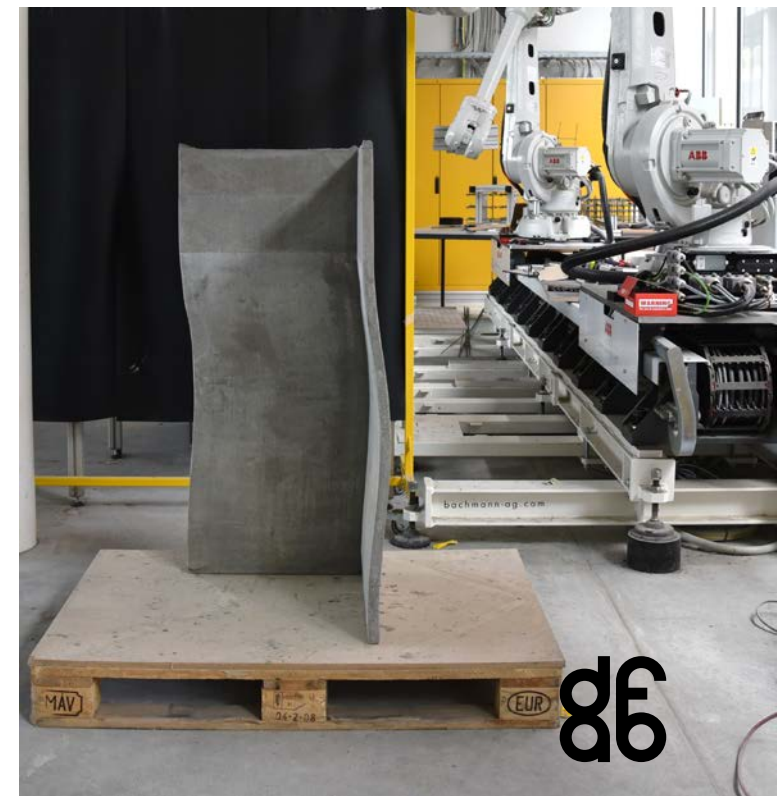
- Curved trajectory
- Cantilevering study



# Prototypes



- Sine curve trajectory
- Buckling study





# Results

- 6-8mm/min robot speed
- 110-140cm height and only 2.5 cm thickness
- ~20cm inclination for curved
- ~6cm inclination for sine curved
- Smooth surface
- Reproducibility



# Fabrication

# Revisiting Folded Forms with Digital Fabrication

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# Conclusion and outlook

- Geometry dependent process adjustments
- Risk of buckling
- Limitations of height
- Robustness within a narrow range

# Conclusion and outlook

- Geometry dependent process adjustments
- Risk of buckling
- Limitations of height
- Robustness within a narrow range

## Next steps:

- Smart Dynamic Casting -> Digital Casting
- Less constrained process
- Additional possible geometries
- Increased production speed
- Integrated reinforcement



# Thank you for your kind attention!

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**Co-Supervisors:** Prof. Dr. Robert J. Flatt, Prof. Dr. Rafael Pileggi, Dr. Nicolas Roussel

**Collaborators:** Dr. Ena Lloret-Fritschi , Dr. Timothy Wangler, Dr. Lex Reiter, Fabio Scotto, Andi Reusser, Heinz Richner, Michael Lyrenmann, Philippe Fleischmann, Tom Mundy, Lukas Sigrist, Lukas Fuhrmann, Lukas Esser, Pascal Küng, Alan Colmant, Marius Graf, Nicolas Neff

