



Lithium Designers
GmbH

Jan. 2022

“Parametric Planning of Complex Facades and shell-structures”
Automation of engineering and manufacturing Data

Presented by **Dr.-Ing. Alamir Mohsen**

Introduction

Problem statement - Projects

- Munch Museum, Oslo
- Mainzero, Frankfurt
- Hangar 8, Salzburg



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Introduction

- Stick system.
 - High technical demands.
- Highly customized.
- Highly engineered.

Munch Museum



Munch Museum, Oslo © Bollinger + Grohmann Ingenieure, Frankfurt

Introduction

- Geometrical challenges.
 - Load cases challenges.
- Customized solution.

Munch Museum



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Introduction

- Unitized system.
 - High technical demands.
- Highly customized.
- Highly engineered.

Mainzero



Mainzero, Frankfurt © Bollinger + Grohmann Ingenieure, Frankfurt

Introduction

- Design challenge.
 - Assembly challenge.
- Customized solution.

Mainzero



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Introduction

- Dome structure.
 - High geometrical demands.
- Highly customized.
- Highly engineered.

Hangar 8



Hangar 8, Salzburg © Bollinger + Grohmann Ingenieure, Frankfurt

Introduction

- Geometrical challenge.
- Manufacturing challenge.
- Customized solution.
- Intense amount of labor in planning and realization.

Hangar 8

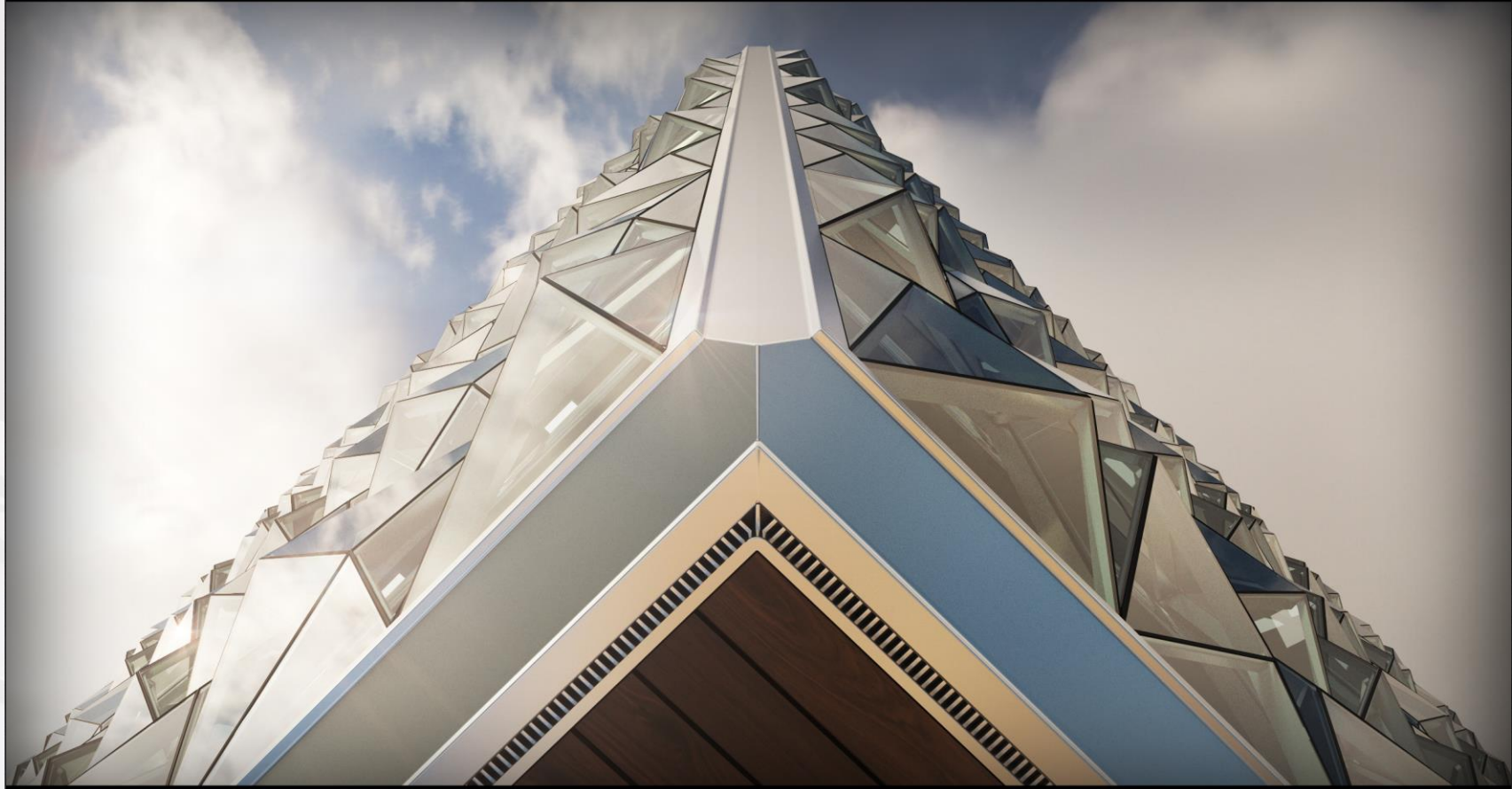


Hangar 8, Salzburg © Bollinger + Grohmann Ingenieure, Frankfurt

Li3 Vision

- Crystalized Architecture.
- Utilization of Standard Façade Systems.
- Expanding Architects' vision.
- More Transparency.
- Economical unique solutions.
- 3D printed Façade Node "N-AM_Li3".

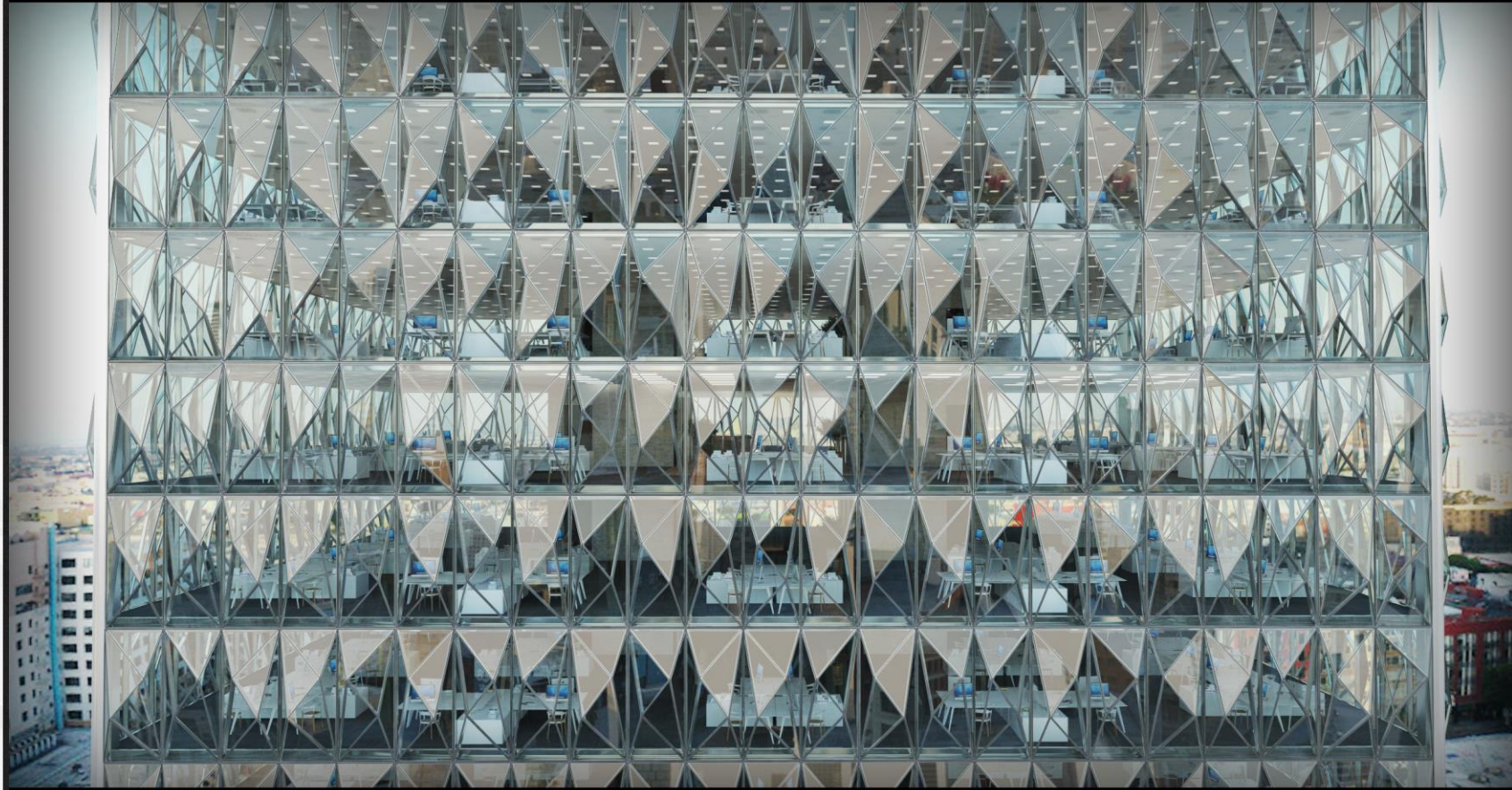
Application in Architecture



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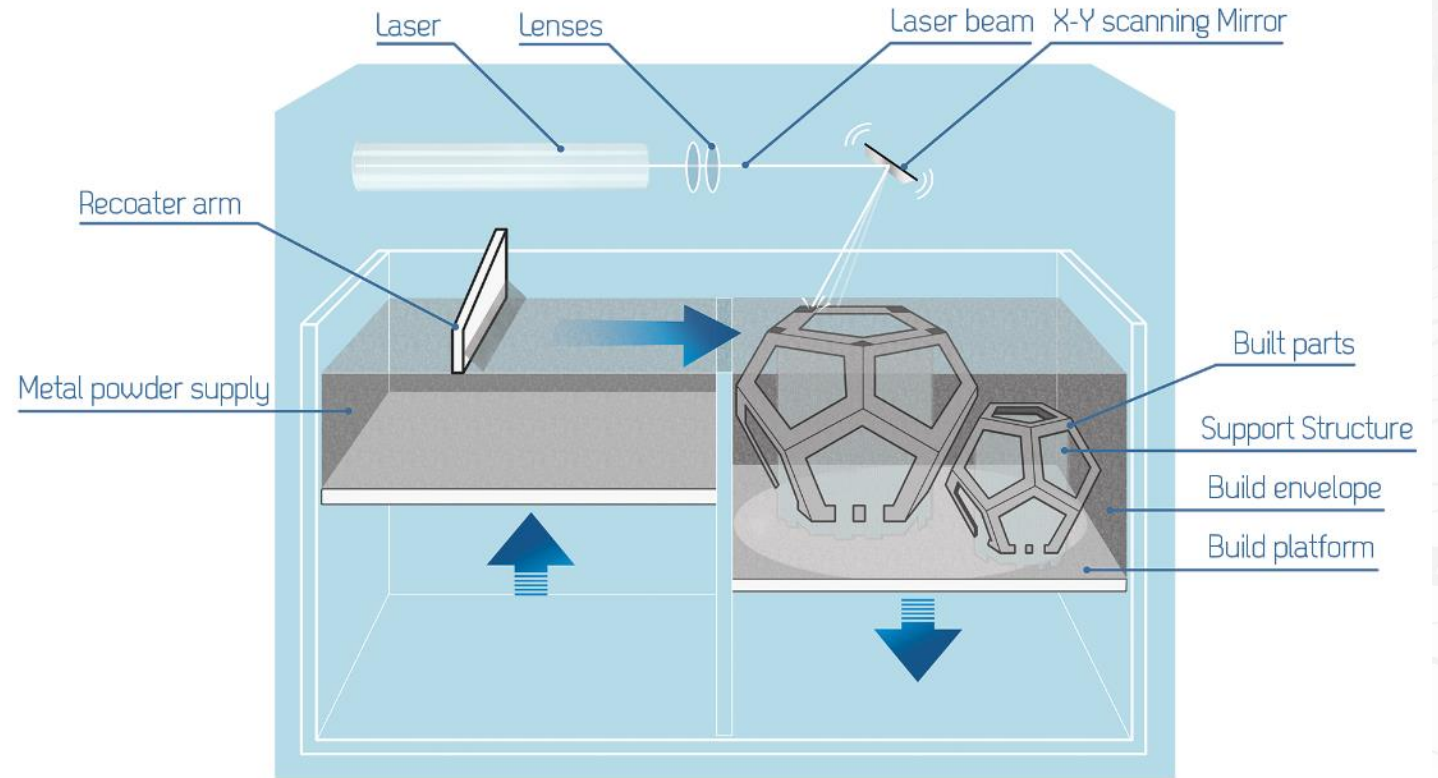
Application in Architecture



State of the Art

- Additive Manufacturing of Metals (SLM).
- Direct Modelling vs. Parametric Modelling.

Additive Manufacturing of Metals

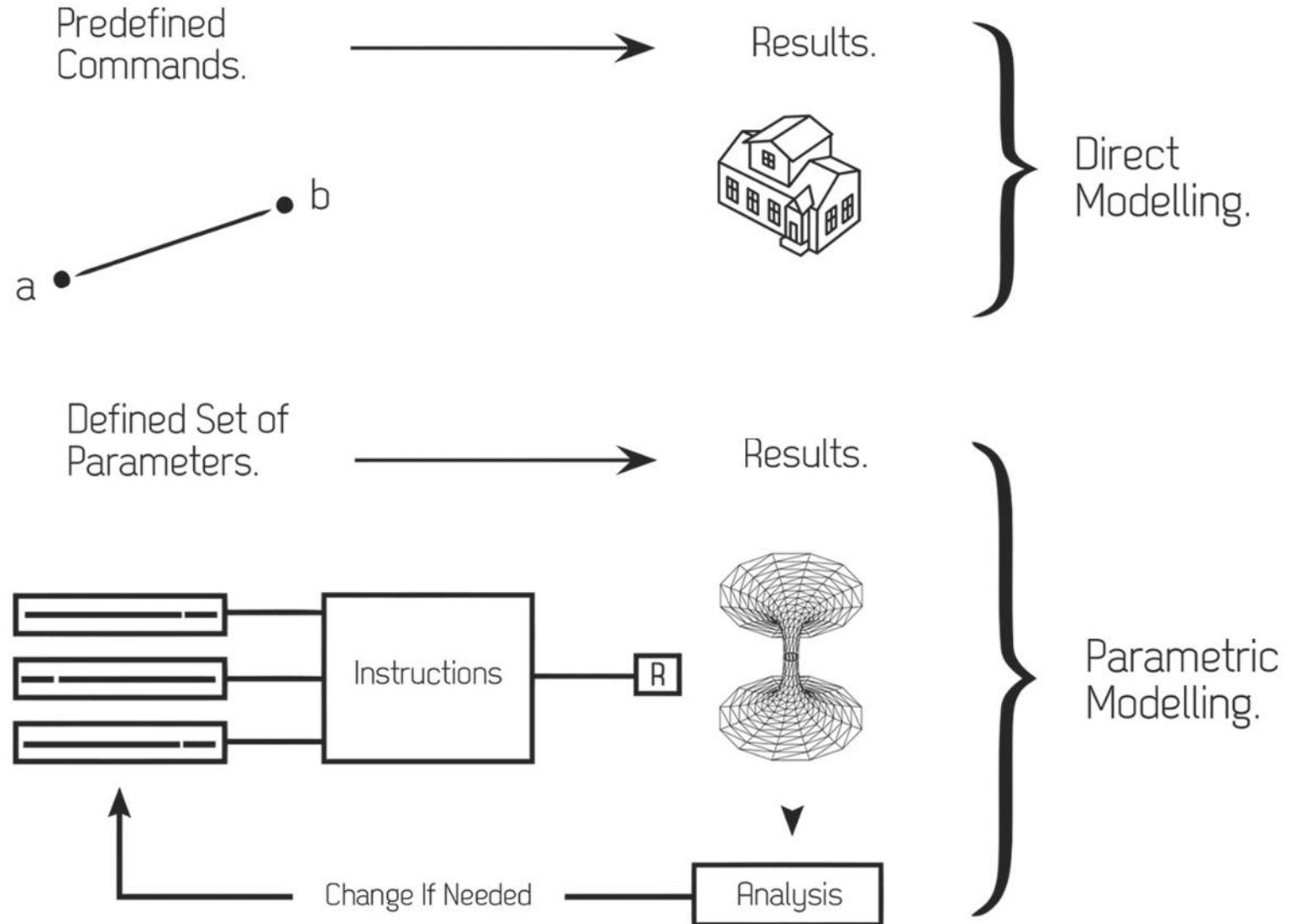


Selective Laser Melting (SLM).

State of the Art

- Additive Manufacturing of Metals (SLM).
- Direct Modelling vs. Parametric Modelling.

Direct- vs. Parametric-Modelling



Proof of Concept

- **Li3_Method:**
 - > Digital Planning concept.
 - > Manufacturing Planning concept.
 - > N-AM_Li3

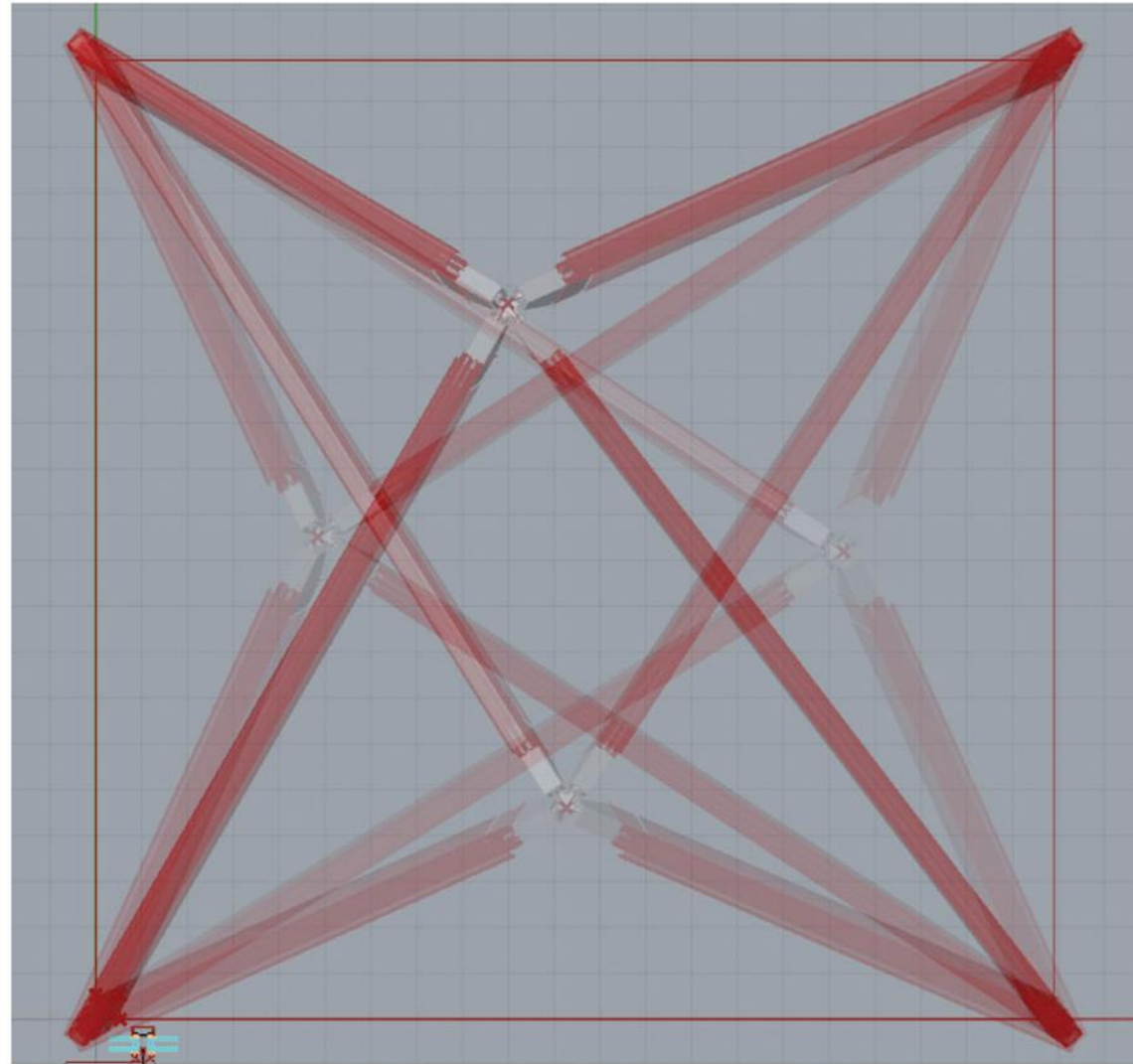
Digital Planning concept

- N-AM 1st Generation
- N-AM 2nd Generation
- Voronoi Facade
- Paneling Free-form
- Voronoi Shell Structure

Li3-Method

- Global Geometric/Structural Phase.
- Local Geometric/Structural Phase.
- Validation of Manufacturing Phase.
- Façade erection Phase.

N-AM 1st generation



Design scenarios of N-AM 04.

Li3-Method

- Global Geometric/Structural Phase.
- Local Geometric/Structural Phase.
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N-AM 2nd generation

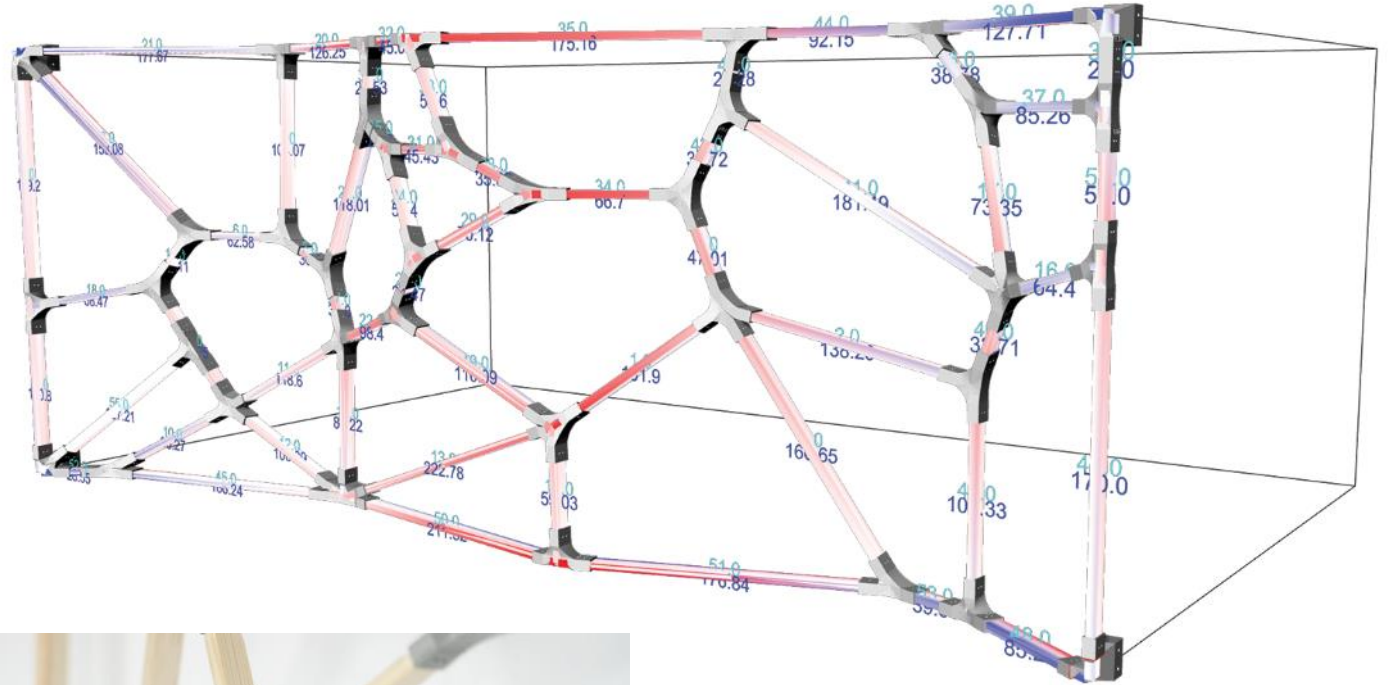


N-AM 10 – Topology optimized Steel Node.

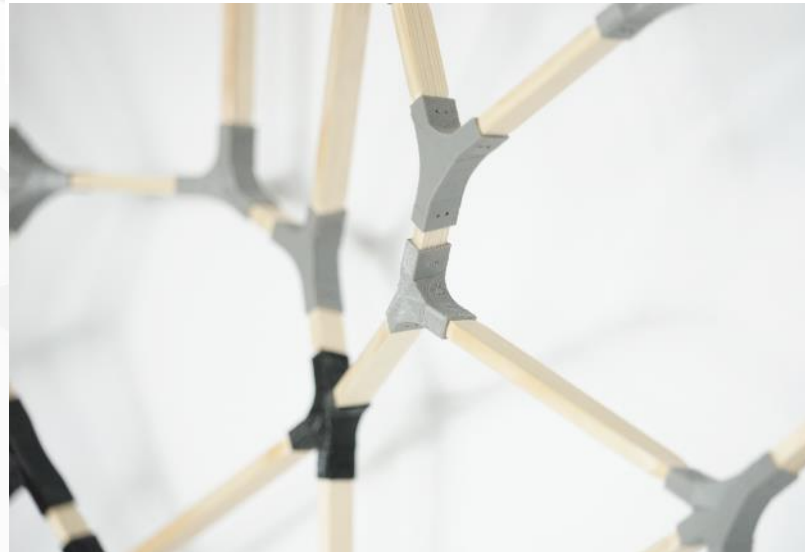
Li3-Method

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Voronoi Facade



Structural Model of Voronoi Facade

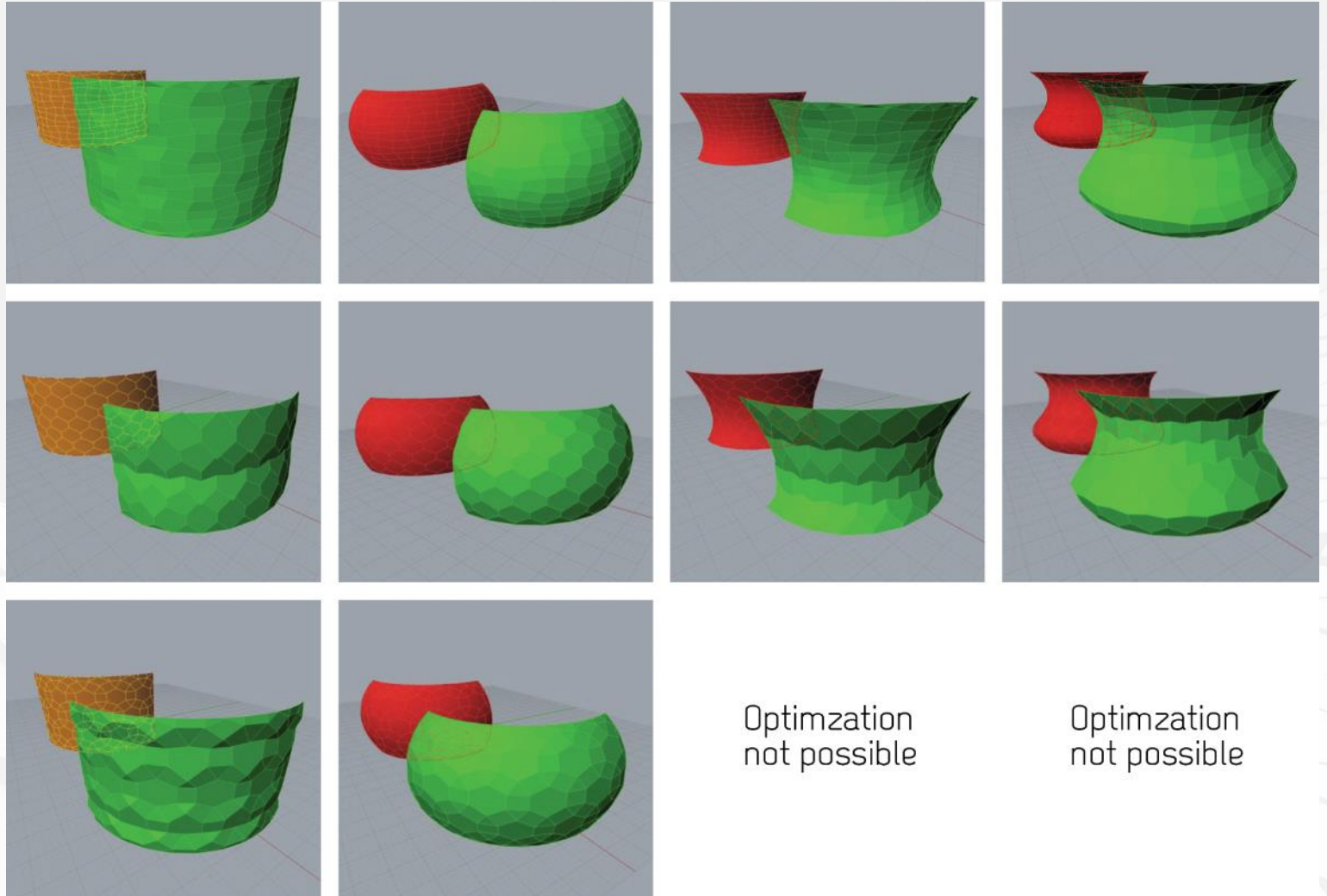


Zoom-In of the 1:20 model. The model is made of wooden sticks and 3D-printed FDM plastic nodes.

Li3-Method

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Paneling Free-Form

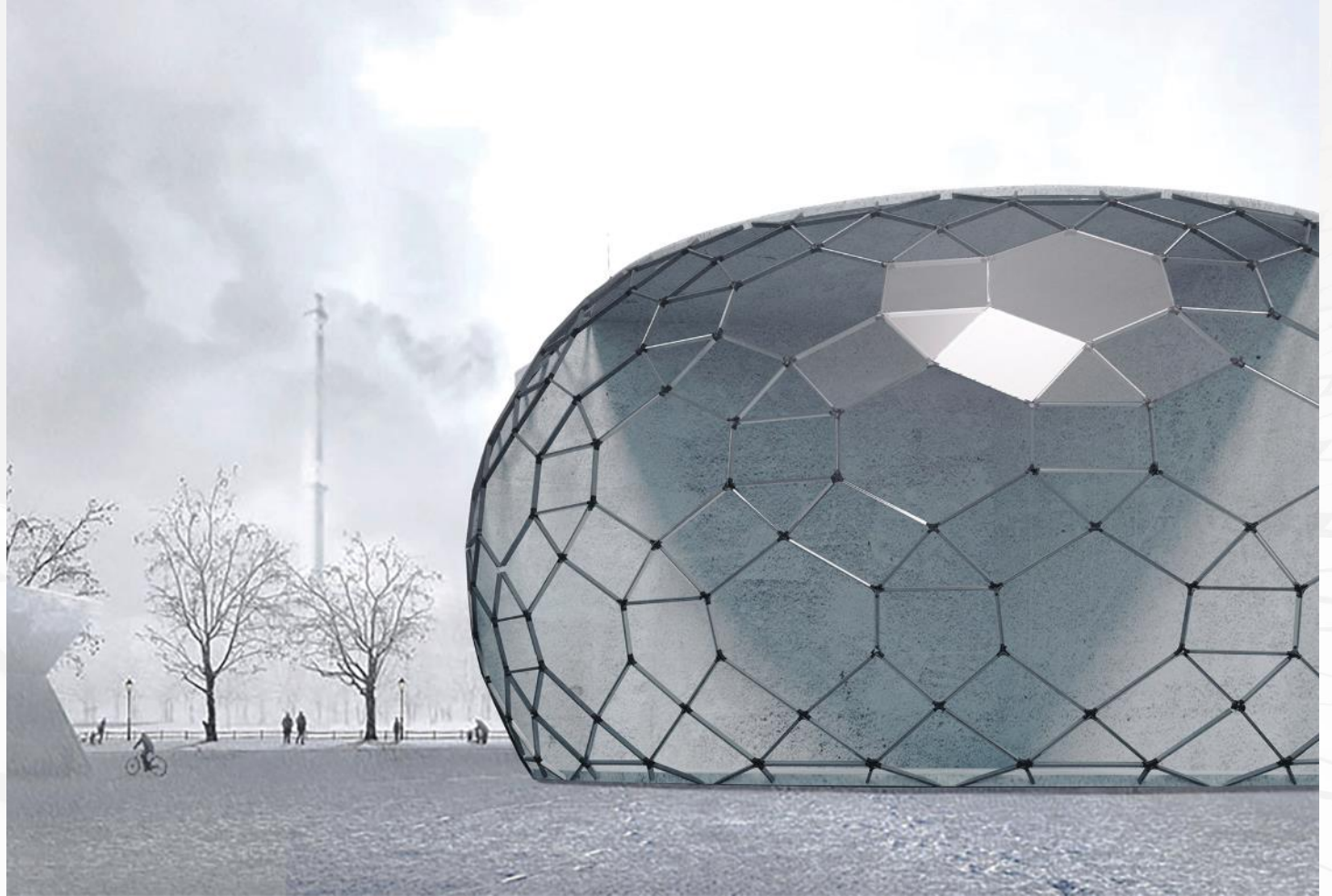


Form finding of planar glass surfaces out of Free-Form surface.

Li3-Method

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Paneling Free-Form

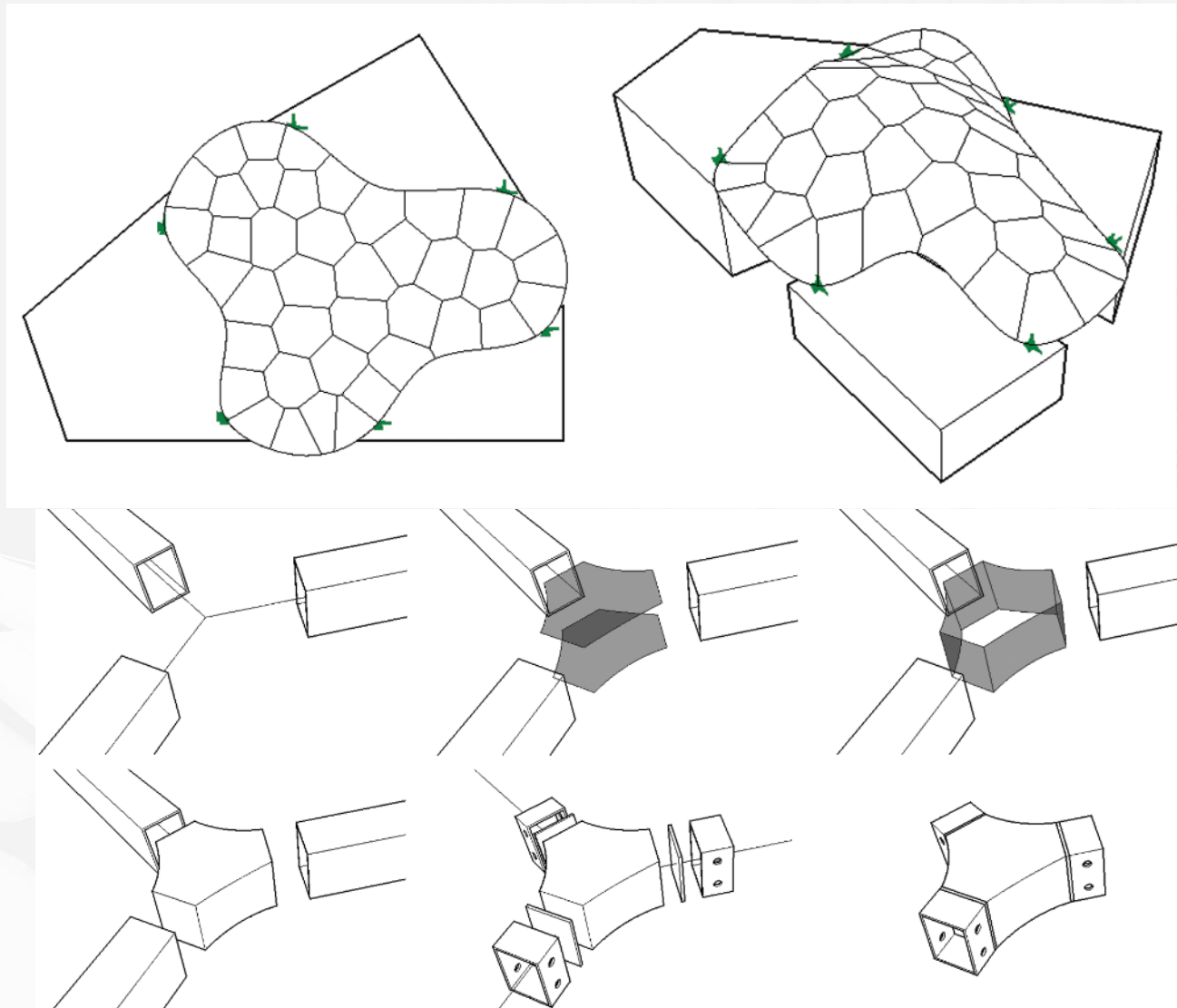


Visualization of an optimized Dome that is made of planar glass surfaces, straight profiles and 3D-printed nodes.

Li3-Method

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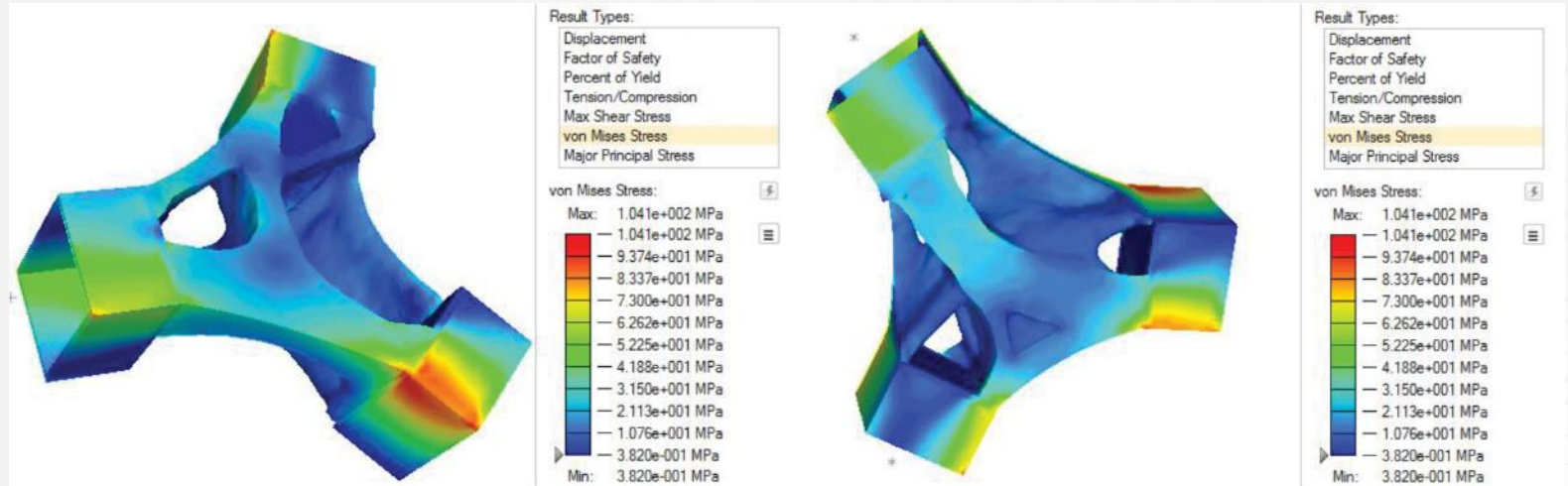
Voronoi Shell Structure



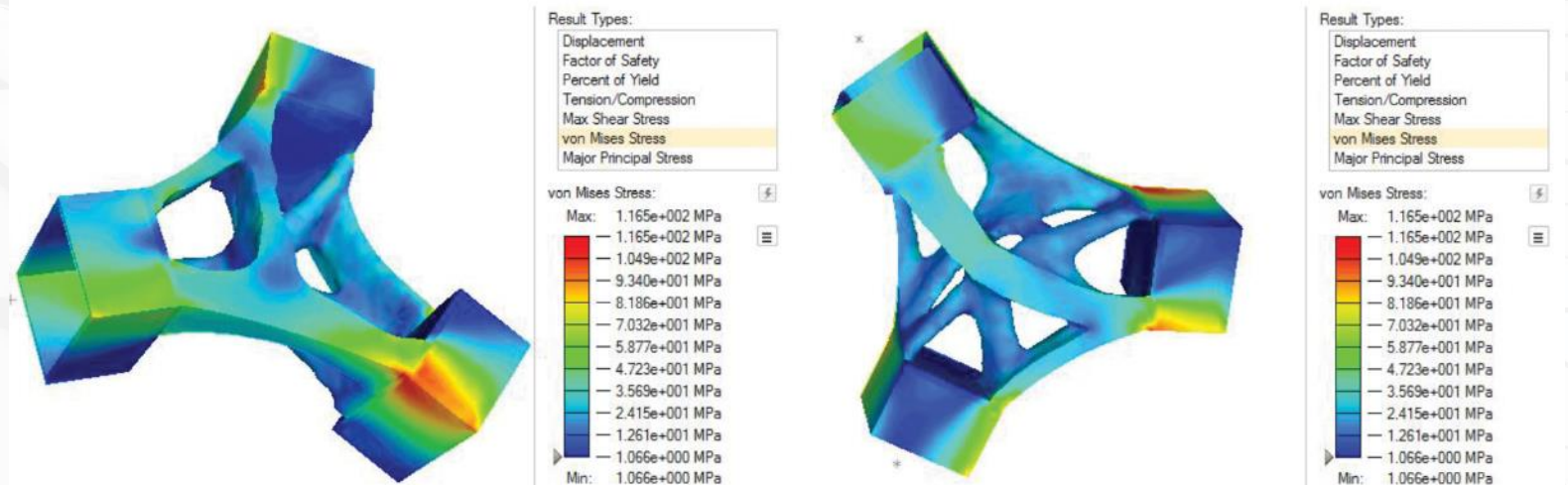
Li3-Method

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Voronoi Shell Structure



Topology optimization of a Welded connection at 30% Mass target.



Topology optimization of a Welded connection at 20% Mass target.

Proof of Concept

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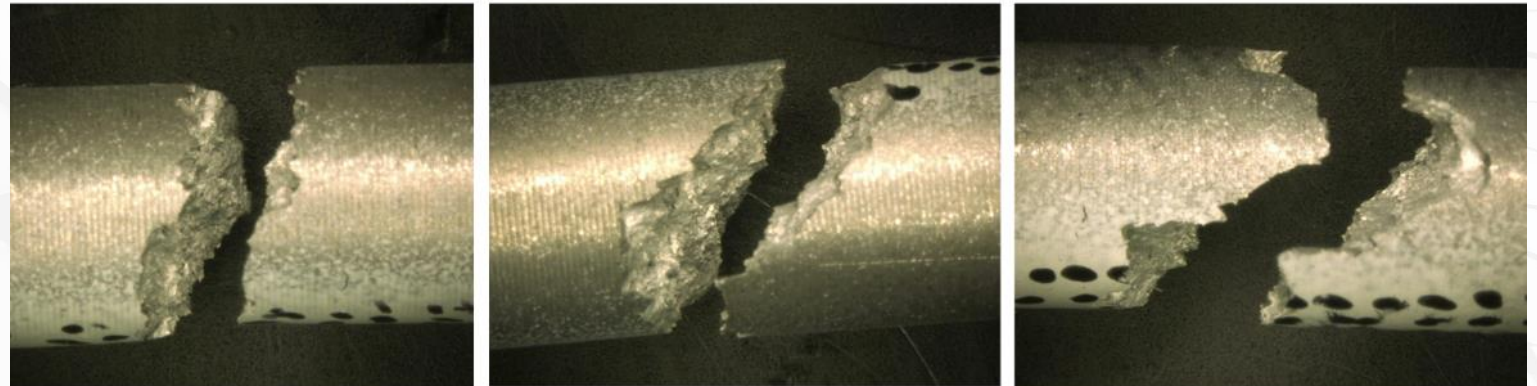
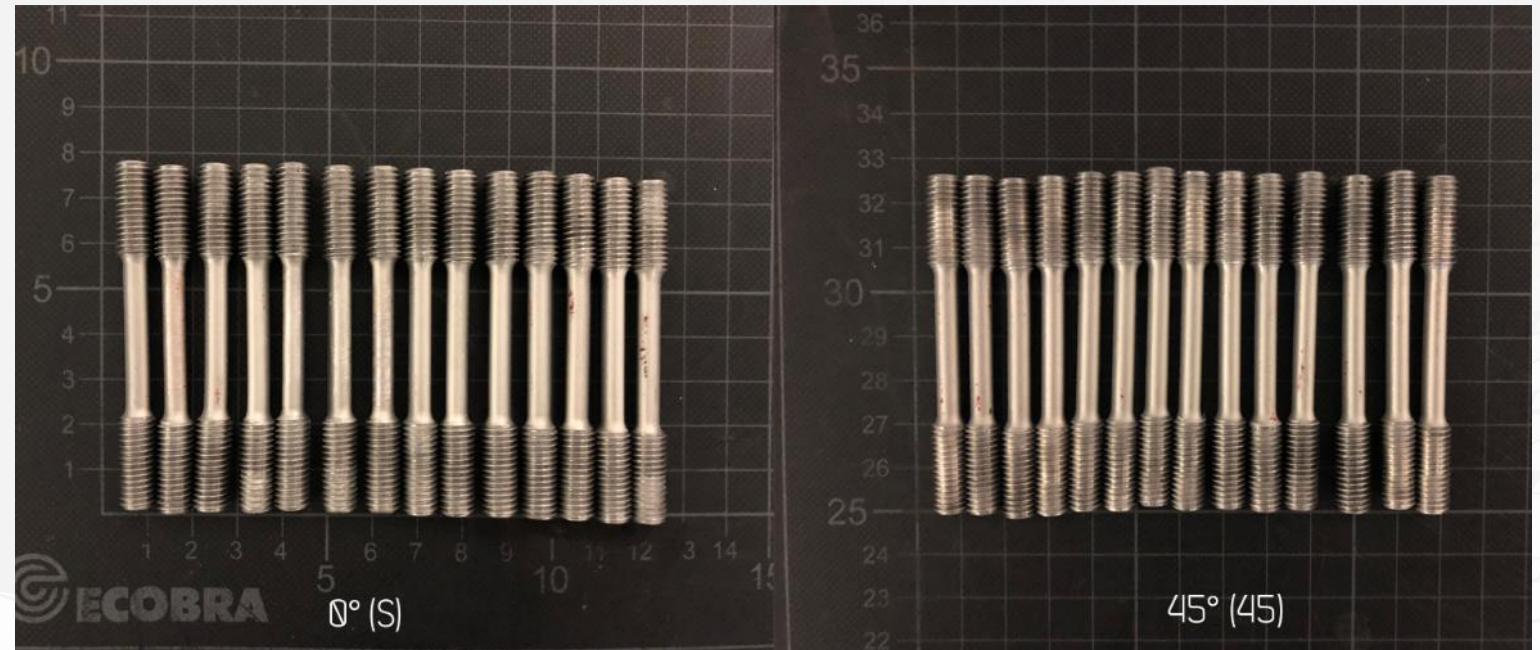
Manufacturing Planning Concept

- Tensile Tests
- Validation Tests

Li3-Method

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Tensile Tests

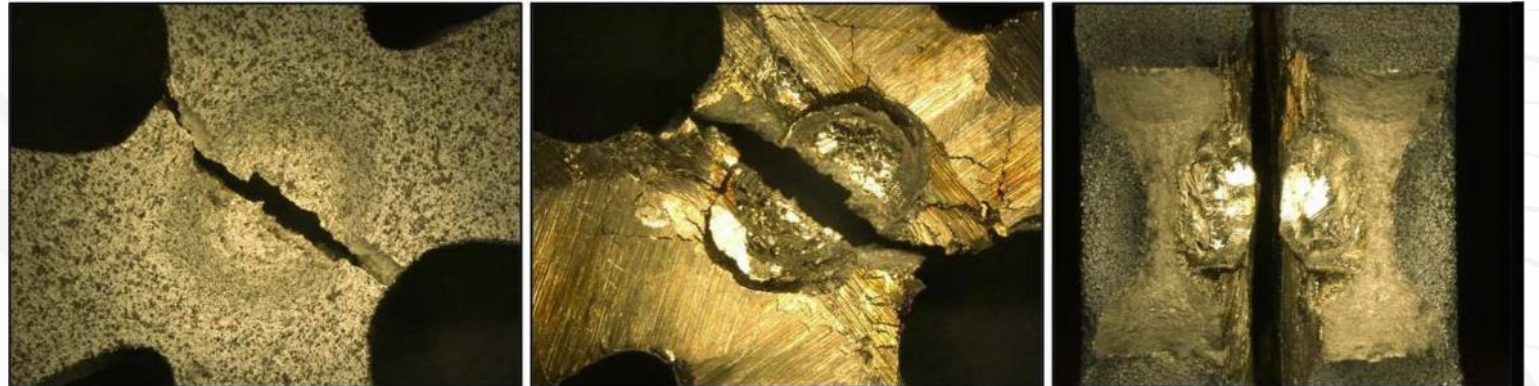


Tensile specimens and breaking pattern of ALSi10 Mg

Li3-Method

- Global Geometric/Structural Phase.
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Validation Tests



Validation Tests of X-form specimens made of Stainless-steel 316L

Proof of Concept

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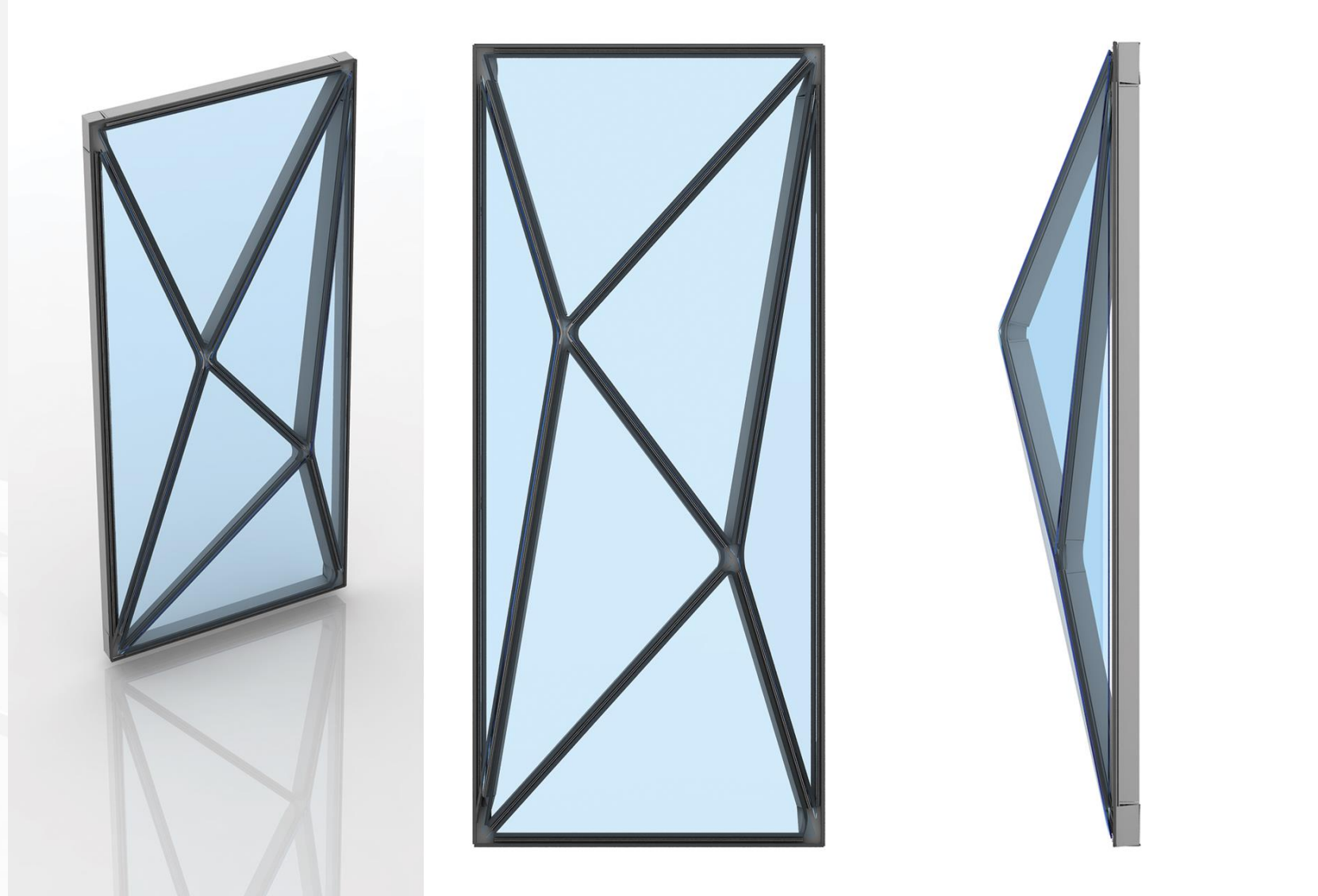
N-AM_Li3

- Façade Element Design.
- Structural Analysis.
- Connection design.
- Topology optimization.
- Building Component test.

Li3-Method

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Façade Element Design

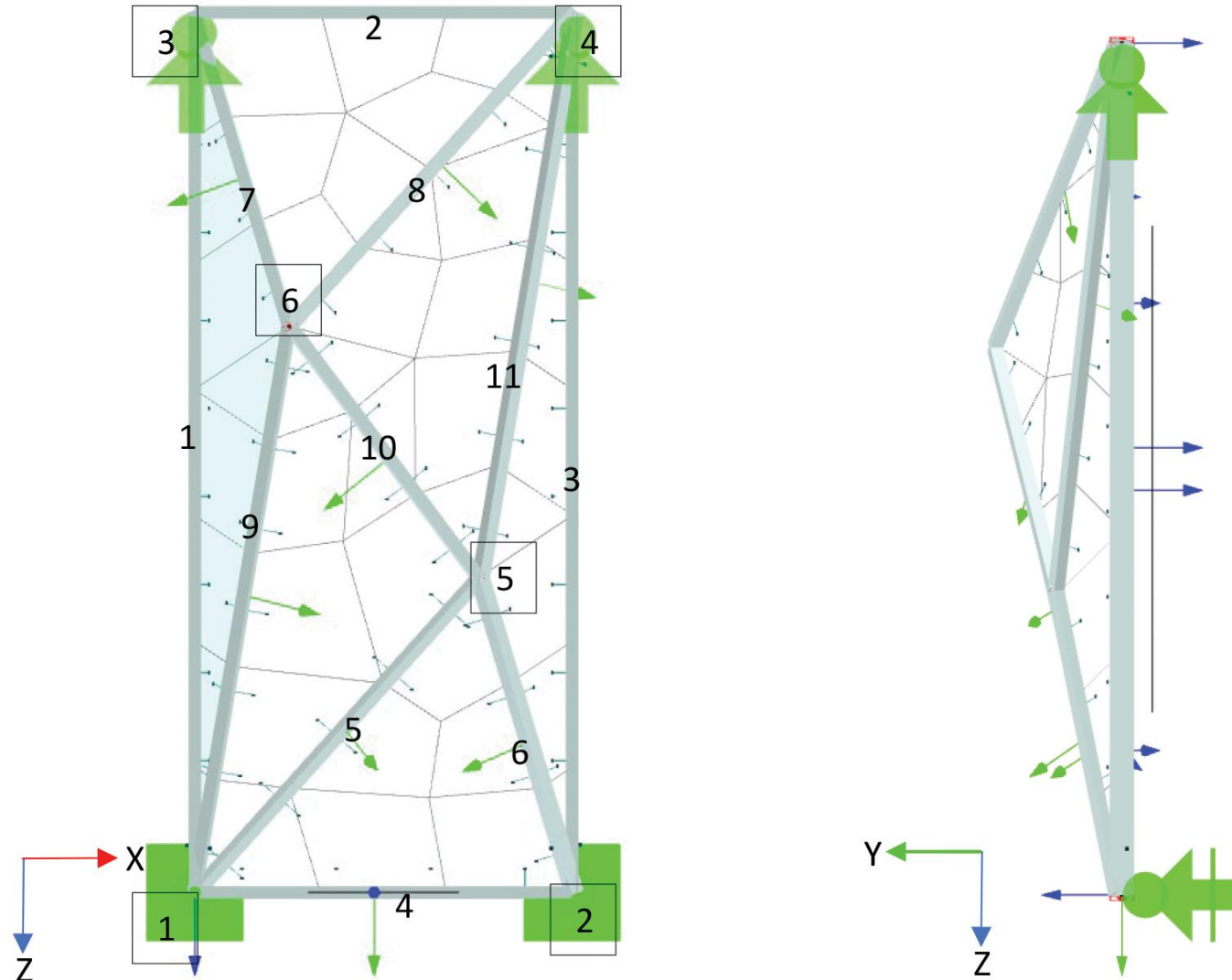


Conception of 1:1 Mockup (1,5*3,0 m Façade element)

Li3-Method

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Structural Analysis

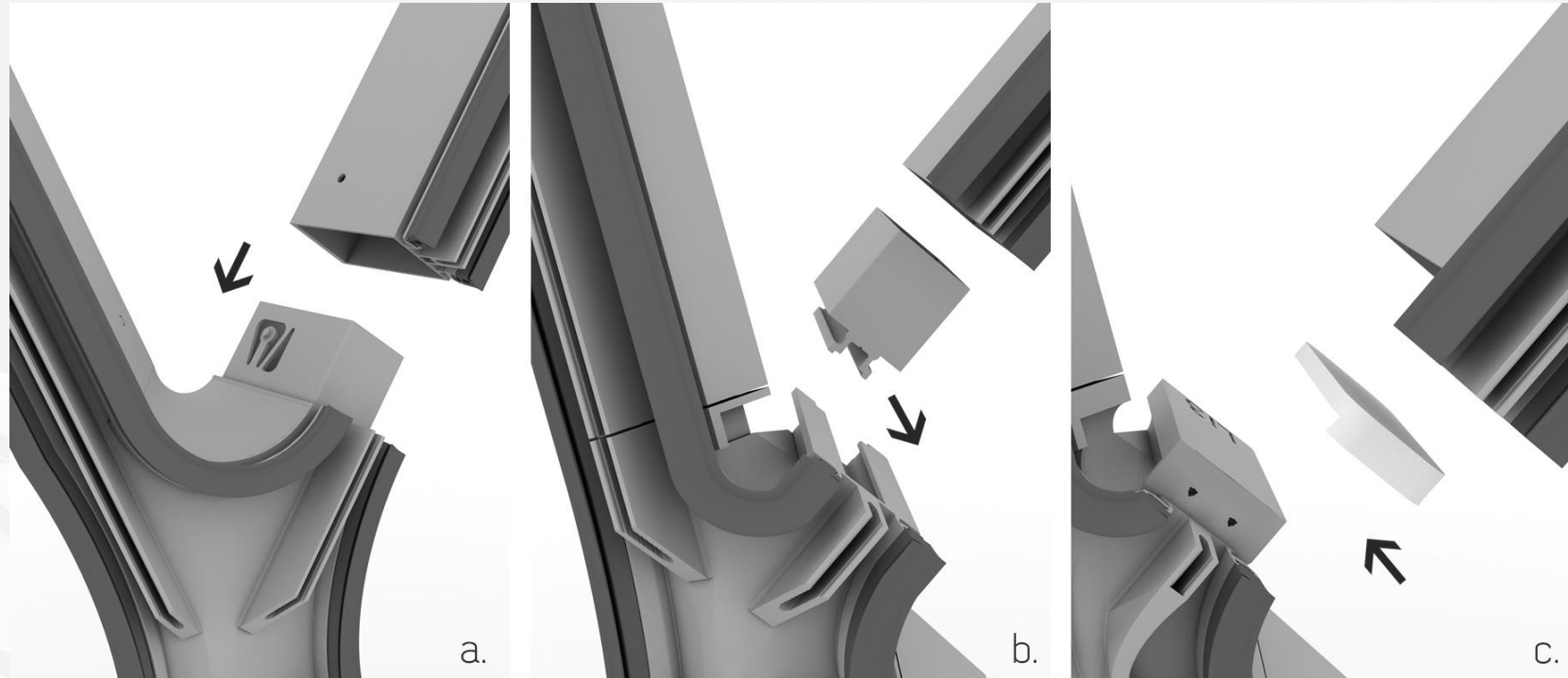


Load cases analysis and support definition of the façade element. 26

Li3-Method

- Global Geometric/Structural Phase.
- Local Geometric/Structural Phase.
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Connection Design

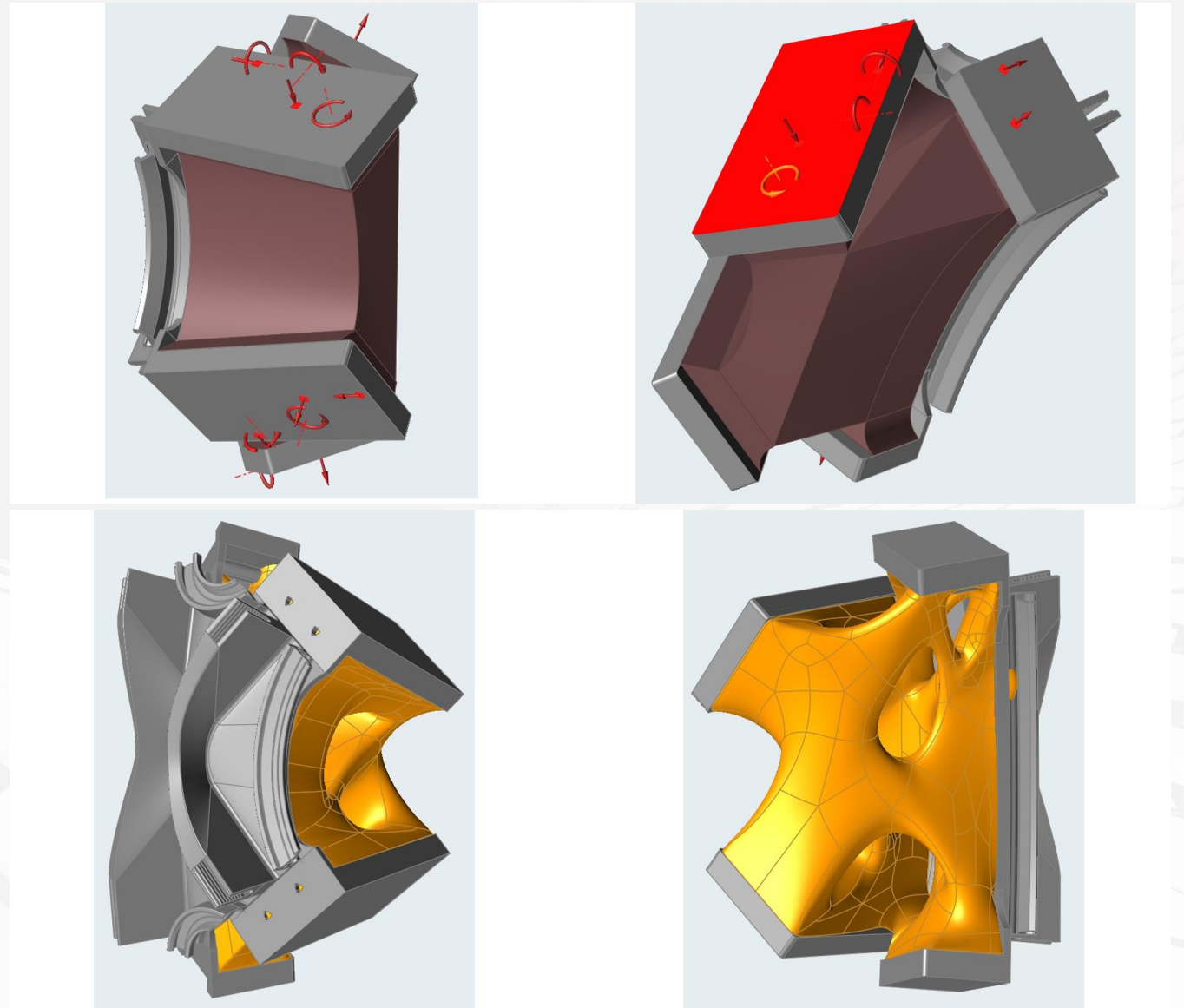


Investigating possible ways of connecting.

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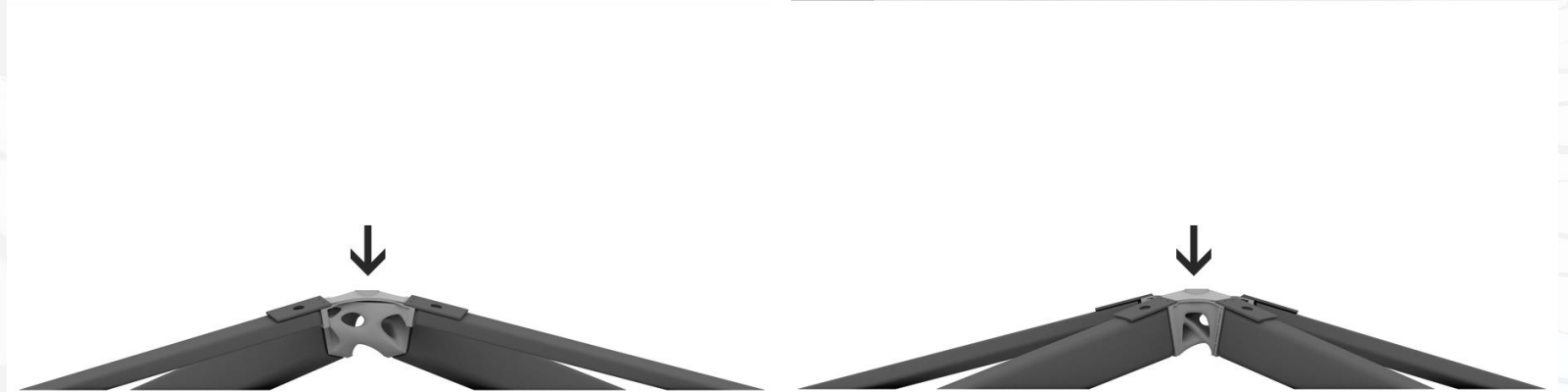
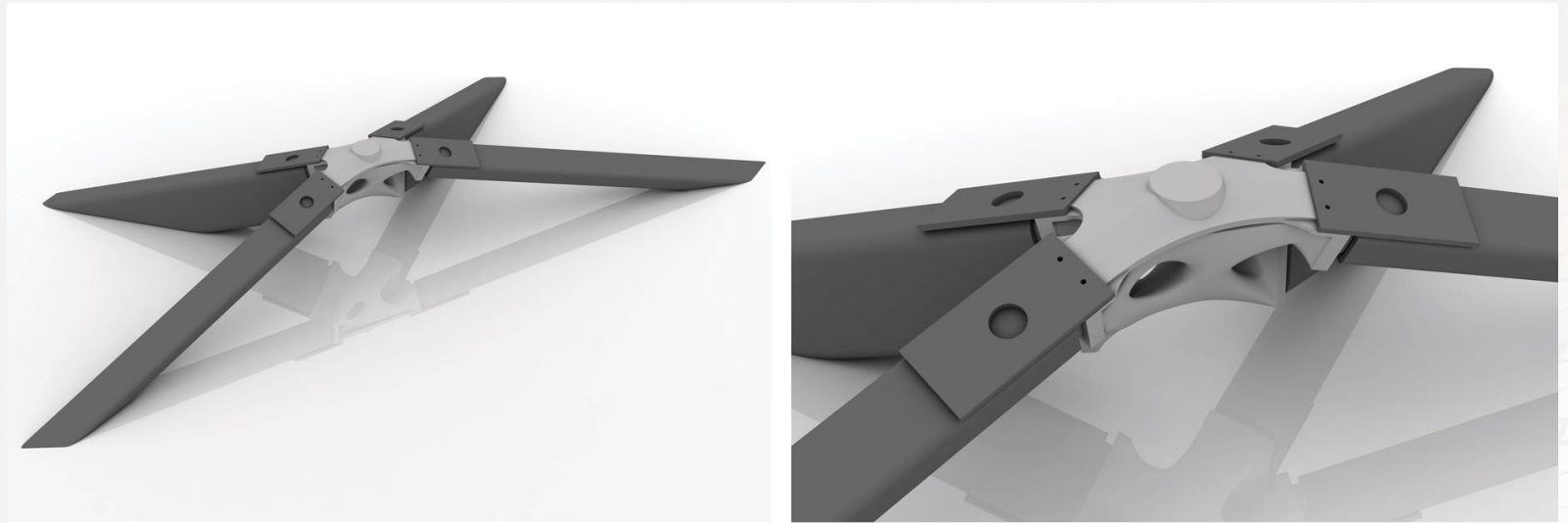
Topology Optimization



Li3-Method

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Building Component Test



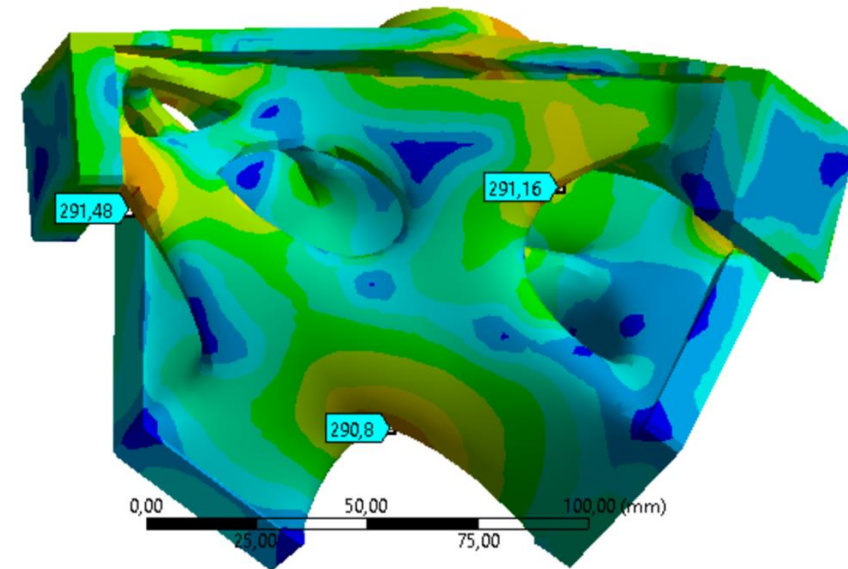
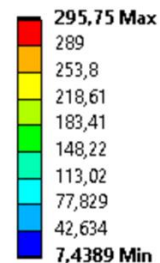
Conception of Building Component Test

Li3-Method

- Global Geometric/Structural Phase.
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- Façade erection Phase.

Building Component Test

B: Statisch-mechanische Analyse
Vergleichsspannung 2
Typ: Vergleichsspannung (von Mises)
Einheit: MPa
Zeit: 0,857
03.08.2019 15:31

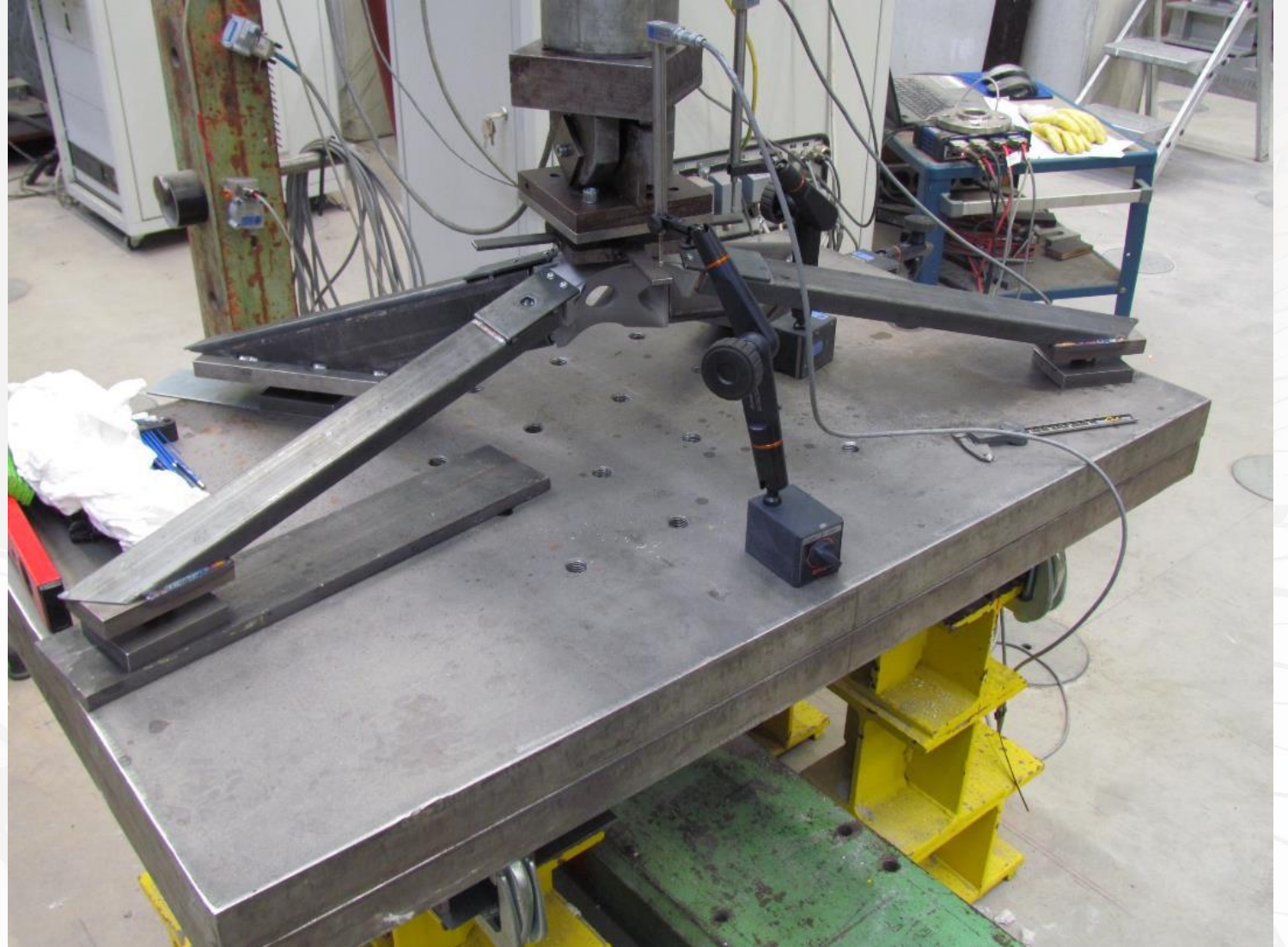


Simulative evaluation for the node structural behavior

Li3-Method

- Global Geometric/Structural Phase.
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Building Component Test



Building component test physical construction

Li3-Method

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Building Component Test



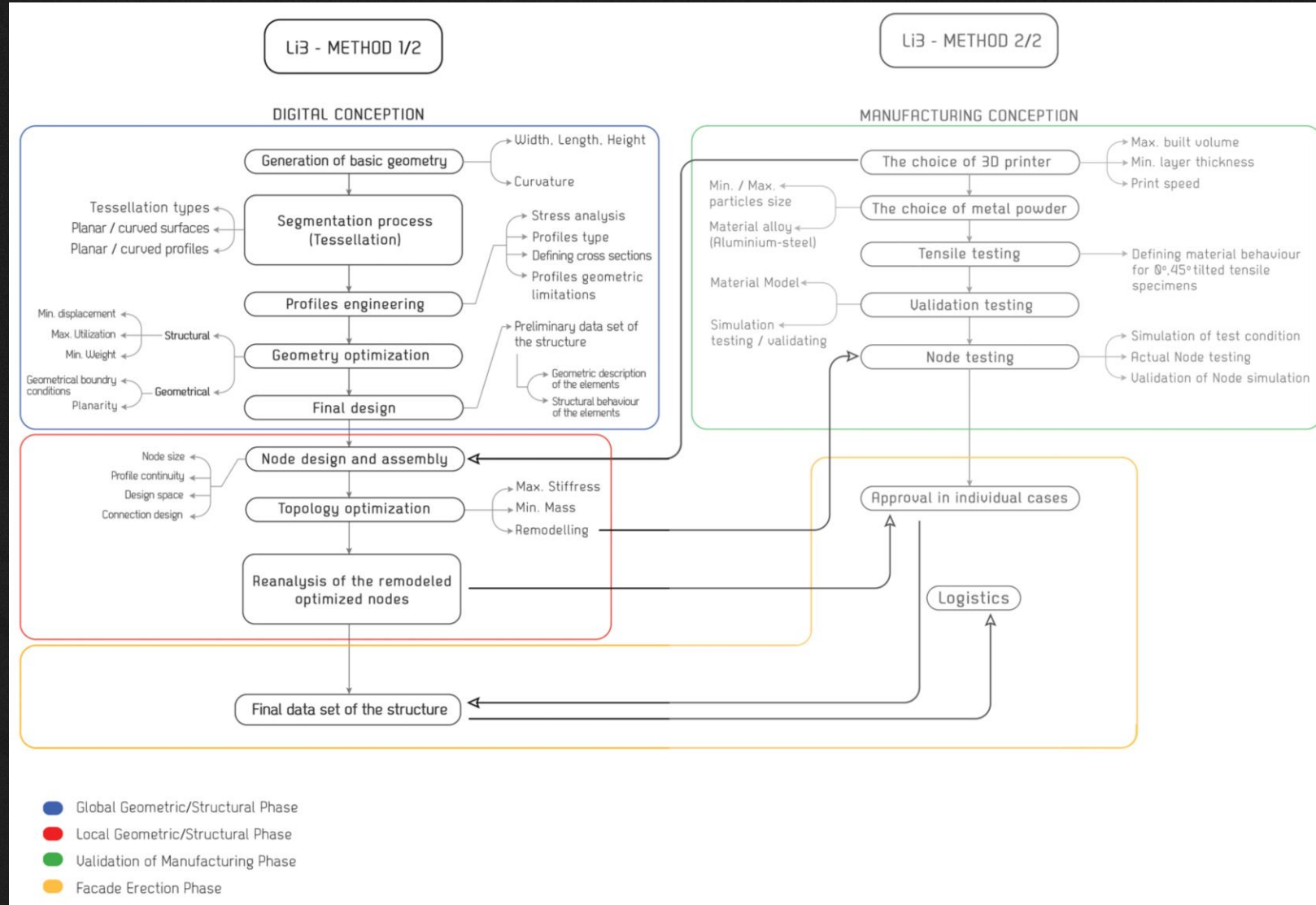
Building component test physical construction

Proof of Concept

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Li3_Method



HivE

- First Free-Form façade in the world to be constructed out of standard façade systems and 3D Printed Façade node N-AM_Li3.
- N-AM_Li3 will be the first worldwide 3D printed façade node that is certified to be used in Building industry for the German market.
- Project completion is June 2021.

HivE



Day time visualization of HivE

HivE

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HivE



Night time visualization of HivE

THANK YOU!



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Thanks for being here.