The virtual mockup

parametric design and optimisation of complex façade panels in virtual reality

Chris van der Ploeg (ABT bv) — Computational design specialist

Sandra Hombergen (ABT bv) — BIM-specialist

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AUTODESK. UNIVERSITY

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Chris van der Ploeg

Computational design specialist

Chris is heavily devoted to helping advance the use of computational design in daily practice, not limited to the field of structural design only. He has a strong interest in new digital technologies as amongst others virtual reality and he is constantly looking for opportunities to integrate new technologies in design projects. He is especially interested in the field of parametric design and optimisation strategies that help to increase insight into complex projects and achieve more efficient solutions. He regularly shares his knowledge in meetings and conferences and has published on the subjects of BIM, parametric design, and optimisation.

Sandra Hombergen

BIM-specialist

She started as a structural draftsman in 1999, then modeller and developed herself to a BIM-specialist. Currently she is working as a BIM-manager, -coordinator and is part of the group Computational Solutions at ABT. This group consist of a couple of people with advanced knowledge about BIM, Computational Design and data and the ambition to create digital solutions with an integrated approach for projects and processes. She is involved in improving the quality of the workflow and products, including BIM-models, within her company and increase the knowledge level of her colleagues.

www.abt.eu

Consulting engineers

Every client, every architect, wants 'something' – aspires, desires and requires. Whatever their wishes, we take care of the technical realisation. With energy and passion - as we have been doing for the past 60 years.

Integrated solutions that are makeable and - particularly - feasible. Irrespective of the extent or complexity of the question. Breaking new ground if necessary, but at all times sound. Making the seemingly impossible possible.
ABT builds ambitions.

What to expect?

INTRO

Key learning objectives

Why a mock up?

Why a virtual mock up?

Why VR for mock ups?

PROJECT NATURALIS

TECHNICAL ELABORATION MOCK UP AND VR

Glass crown elements

Concrete panels with relief

Distribution of panels over the building

RESUME

Key learning objectives

LEARN HOW A VIRTUAL MOCKUP CAN REPLACE A PHYSICAL MOCKUP

LEARN HOW VIRTUAL REALITY CAN BE USED FOR DESIGN OPTIMISATION

LEARN HOW TO LINK PARAMETRIC DESIGN MODELS TO VIRTUAL REALITY EXPERIENCES

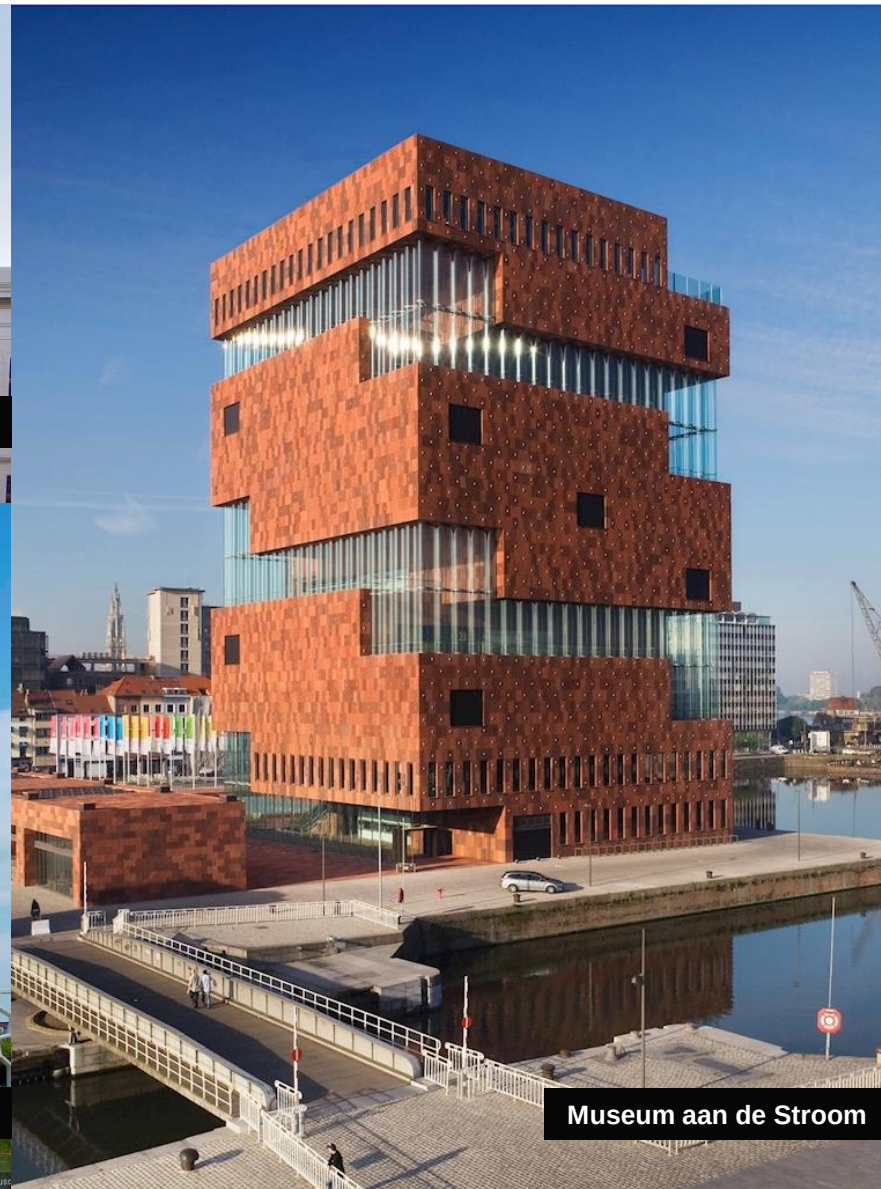
DISCOVER MULTIPLE WAYS OF CREATING VIRTUAL REALITY MODELS

Why a mock up?

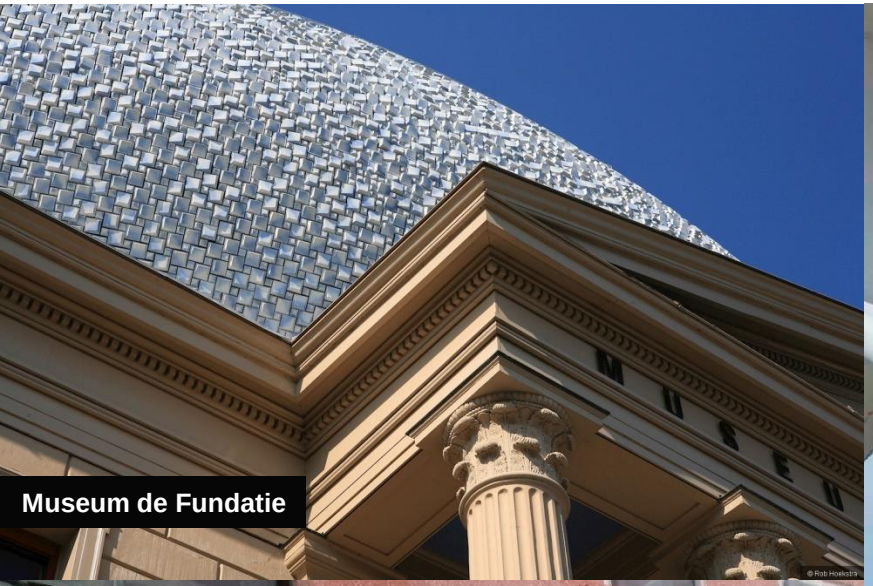
Crystal House P.C. Hooftstraat

Museum de Fundatie

Parkpergola Maximapark

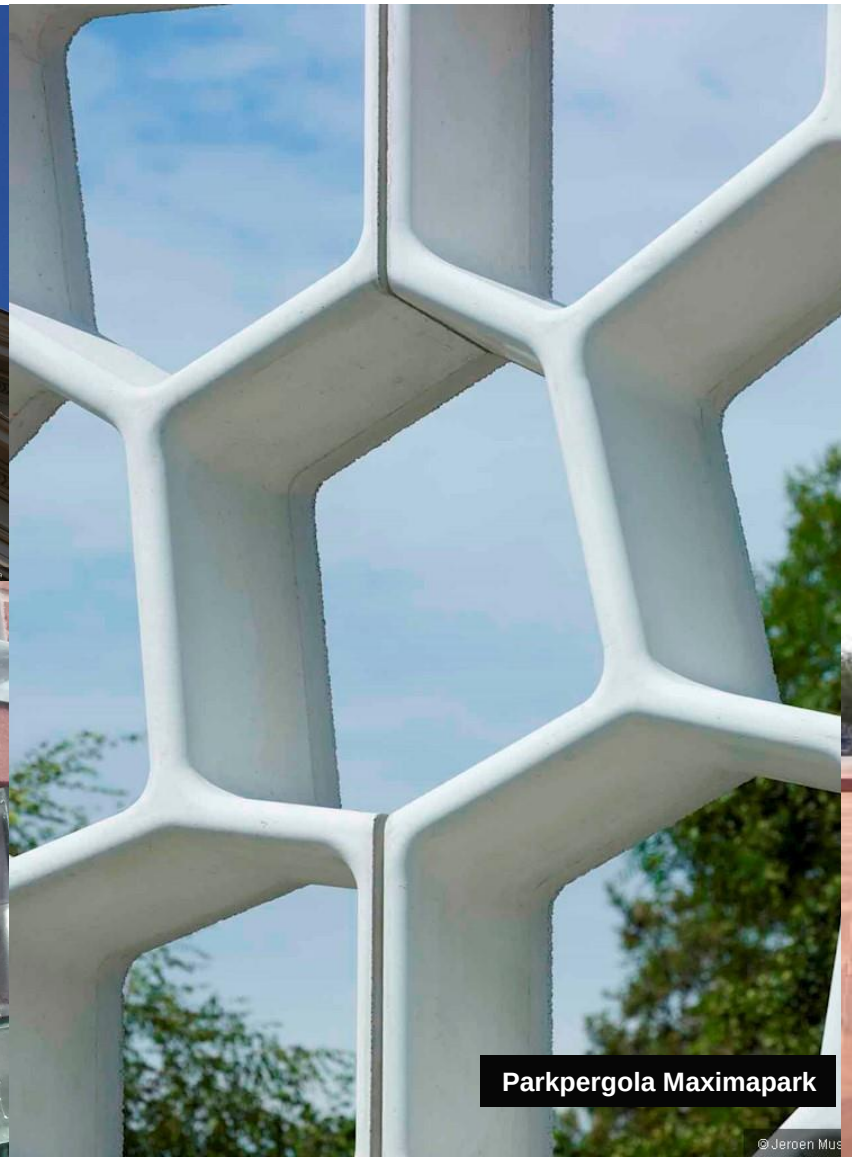

Museum aan de Stroom

Why a mock up?



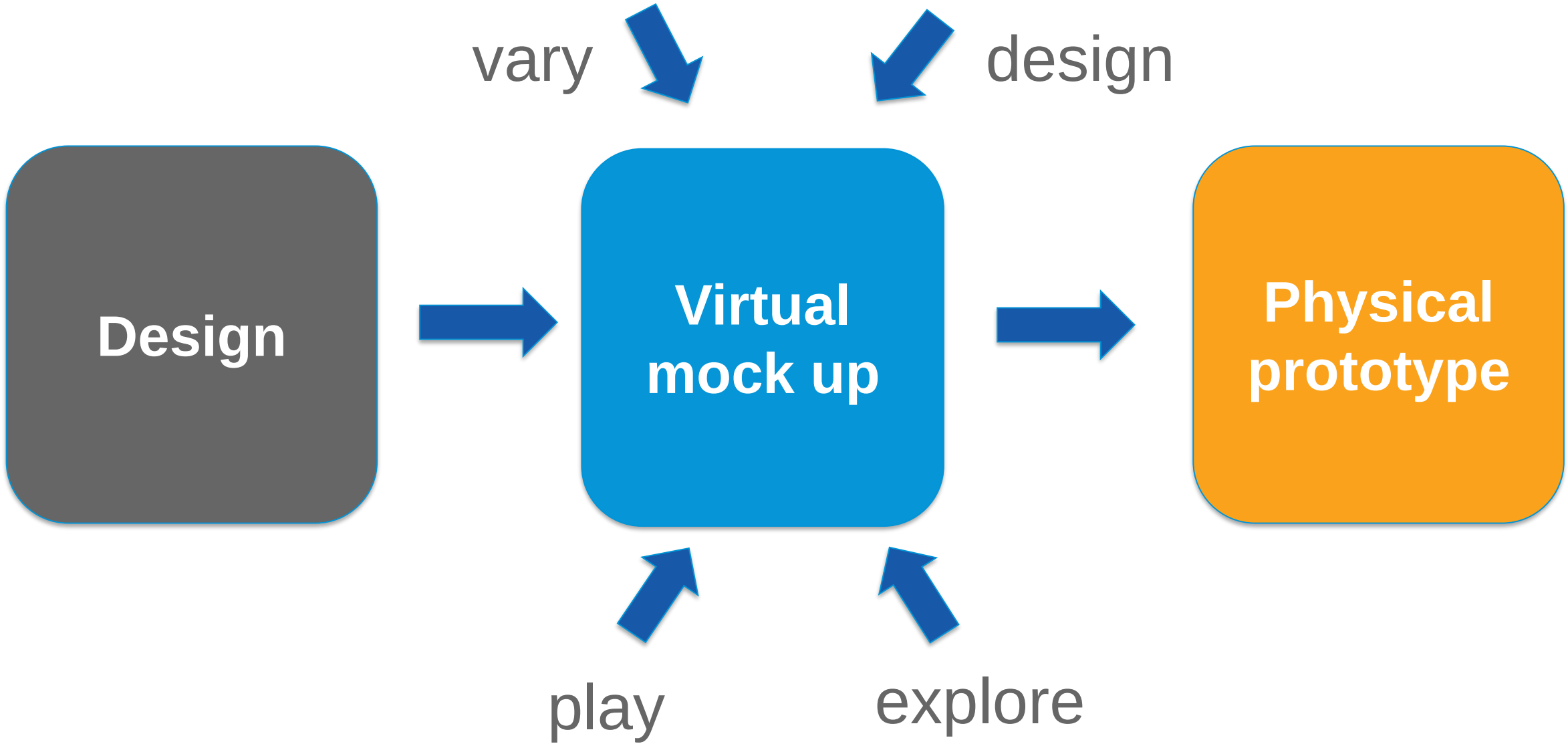
Museum de Fundatie


Crystal House P.C. Hooftstraat


Parkpergola Maximapark


Museum aan de Stroom

Why a virtual mock up?



Why a virtual mock up?

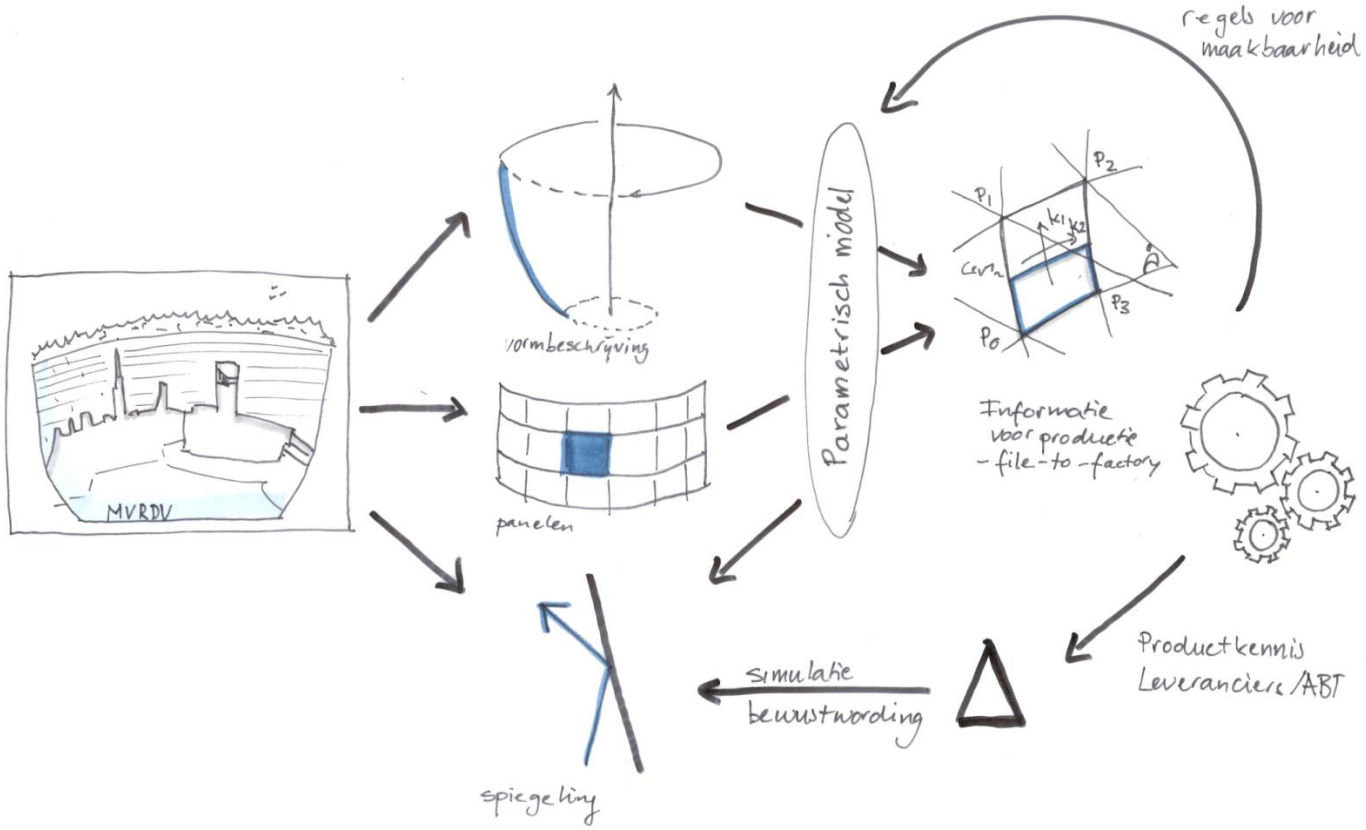
Editable digital 3D models

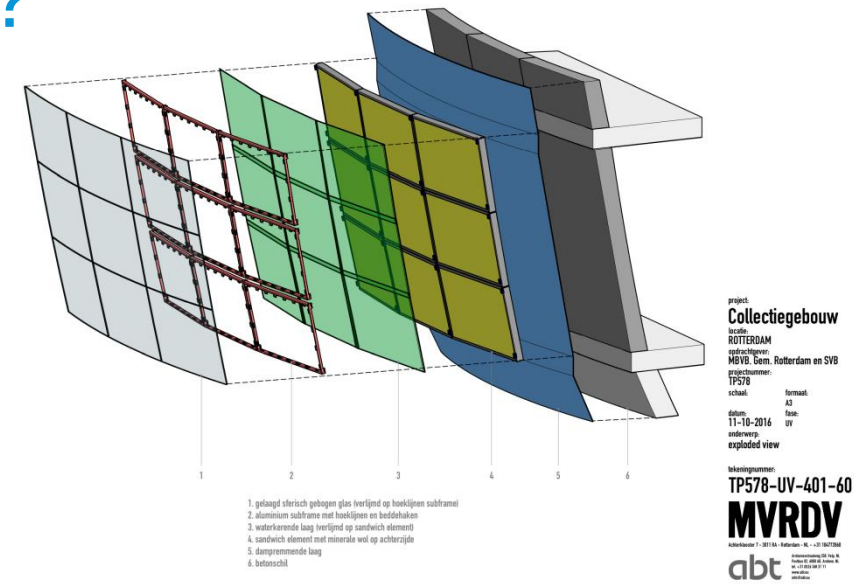
Collection Building Boijmans van Beuningen
Architects MVRDV

Why a virtual mock up?

Possibility to play with patterns in your design

Managing and adjusting for aesthetics





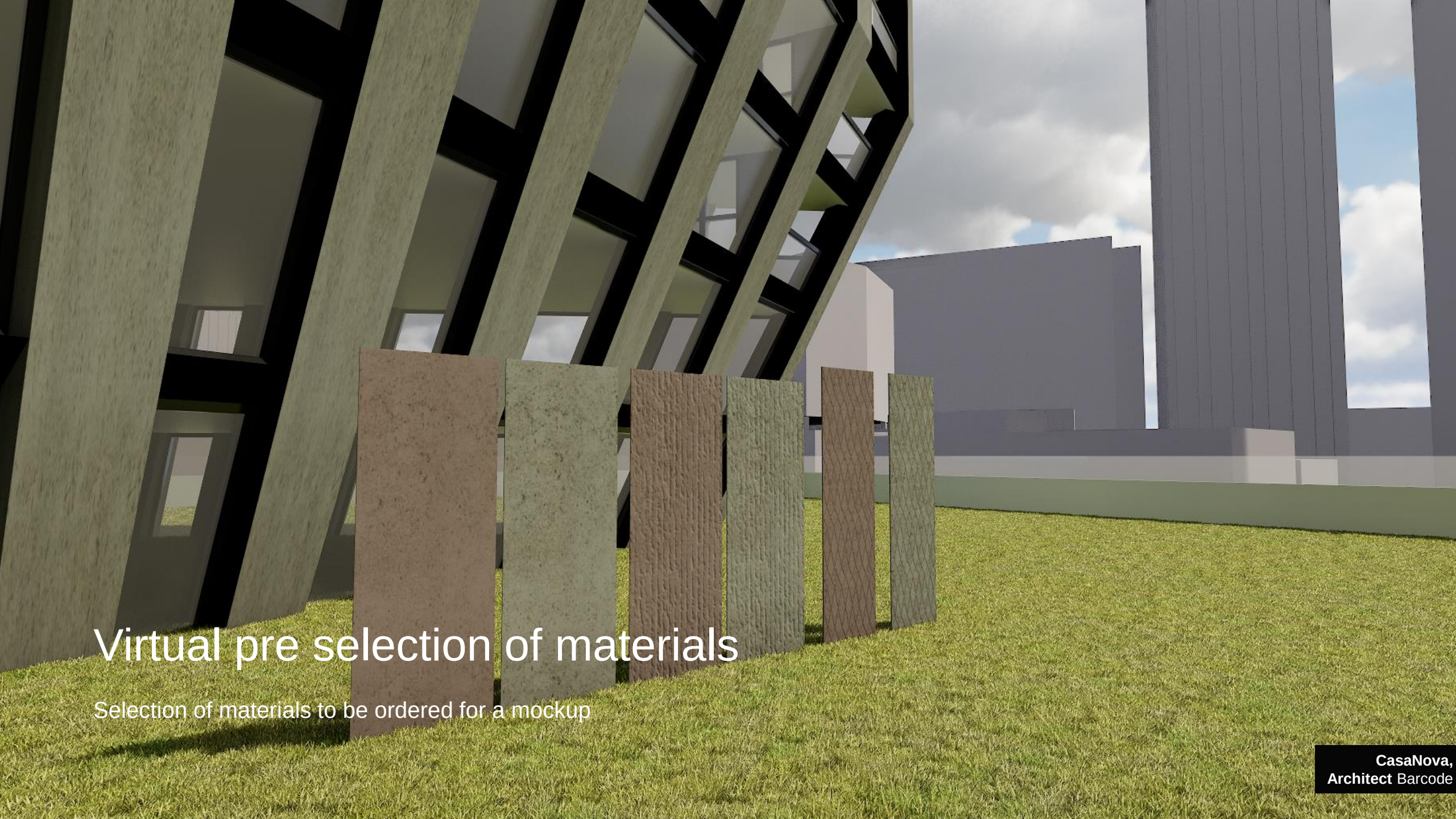
Why VR for mock ups?

- Scale 1:1
- No restriction in size
- Easy to vary
- No delivery time
- No waste
- Easy movable or sharable
- Cheaper

VR for mock ups

Understand and experience what you are buying.

Prins Claus bridge
Architect René van Zuuk Architekten



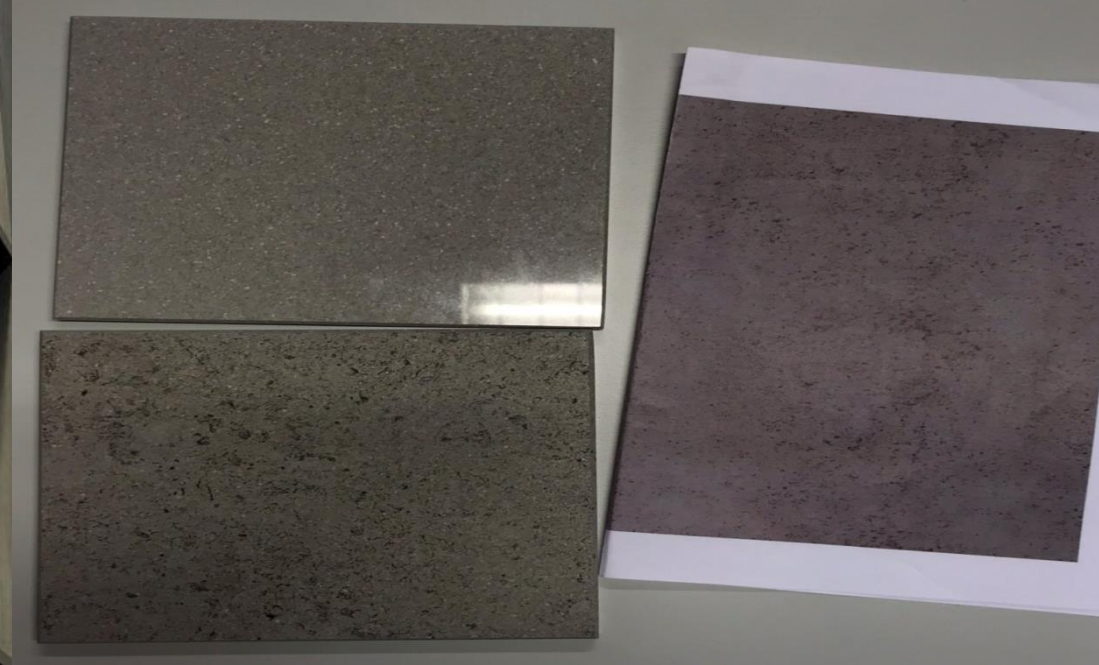
Virtual pre selection of materials

Selection of materials to be ordered for a mockup

CasaNova,
Architect Barcode

Virtual pre selection of materials

Selection of materials to be ordered for a mockup

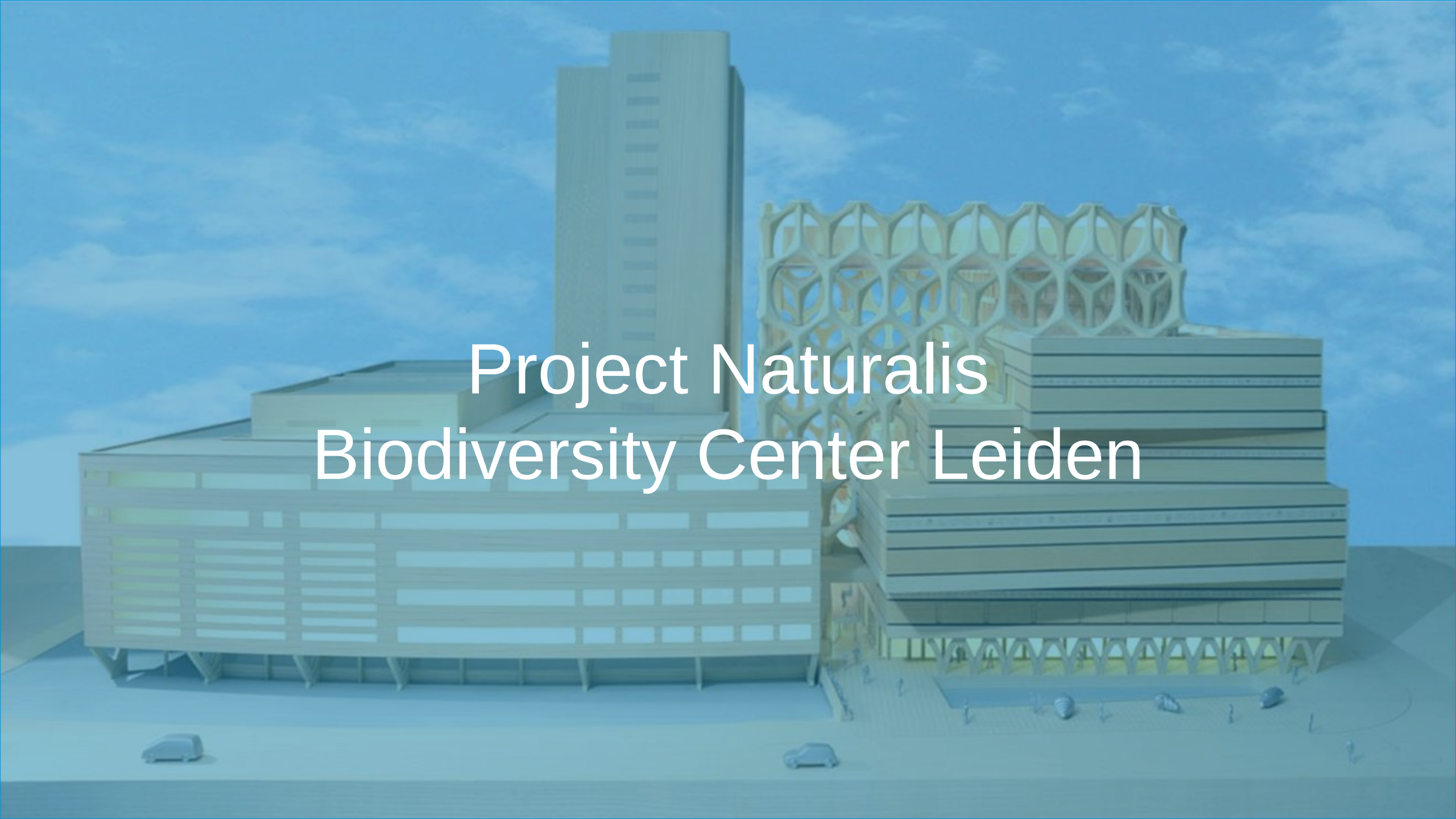


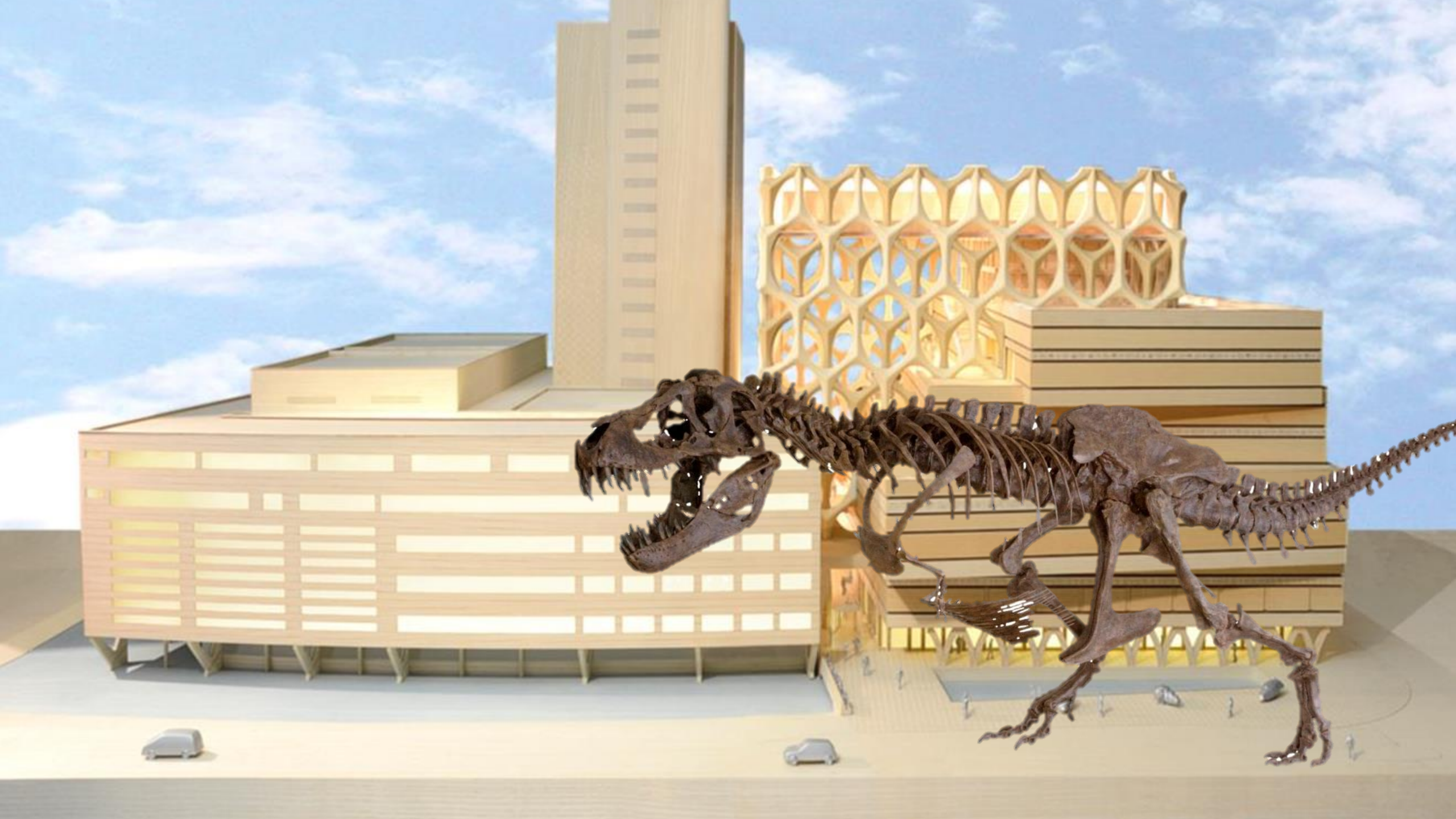
CasaNova,
Architect Barcode

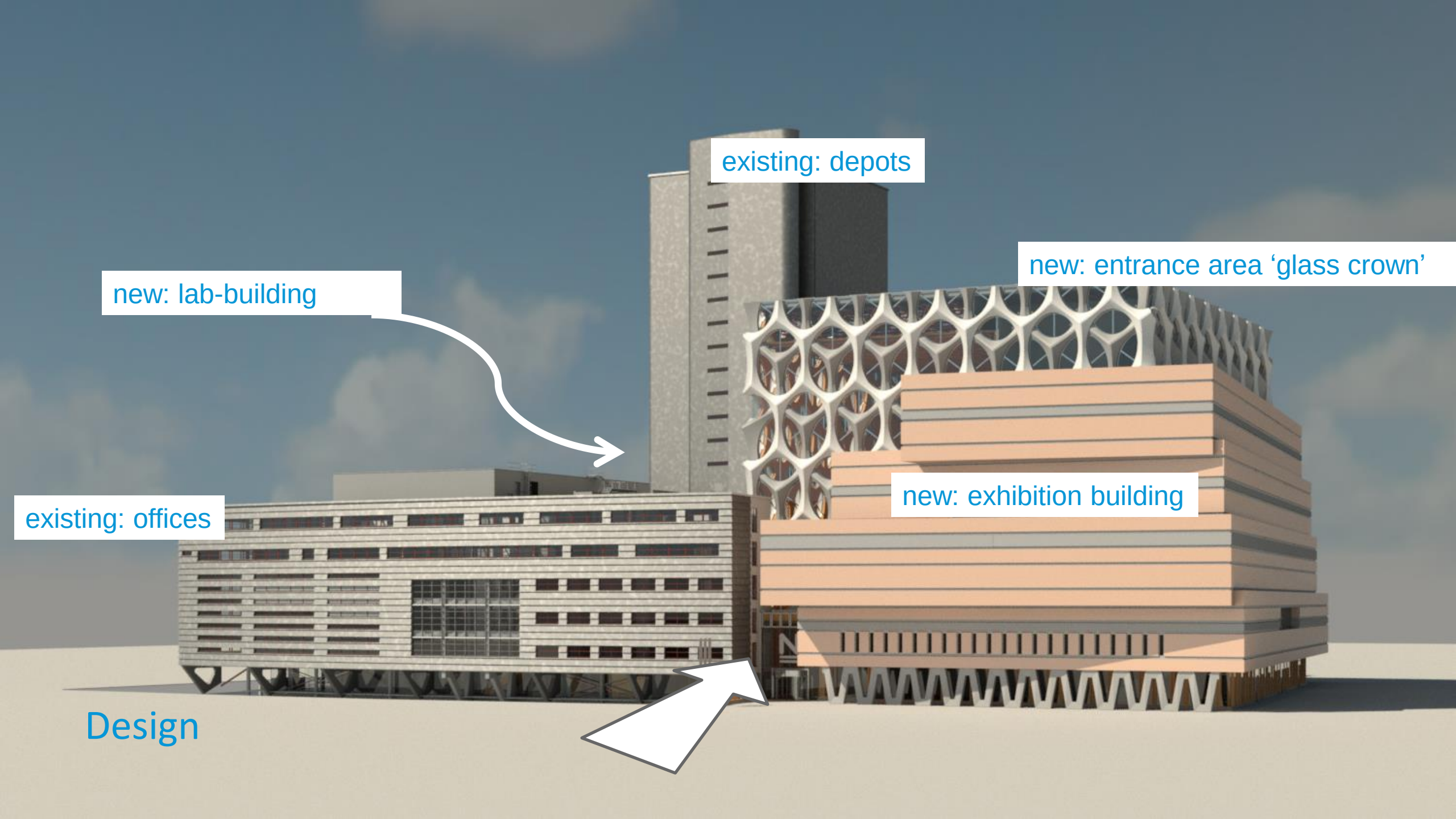
abt / VR-lab

VR@ABT

As an addition to our advice and accessible for everyone.


Project Naturalis
Biodiversity Center Leiden




existing: depots
new: entrance area ‘glass crown’
new: lab-building
new: exhibition building
existing: offices

Design

NEUTELINGS RIEDIJK ARCHITECTS

abt

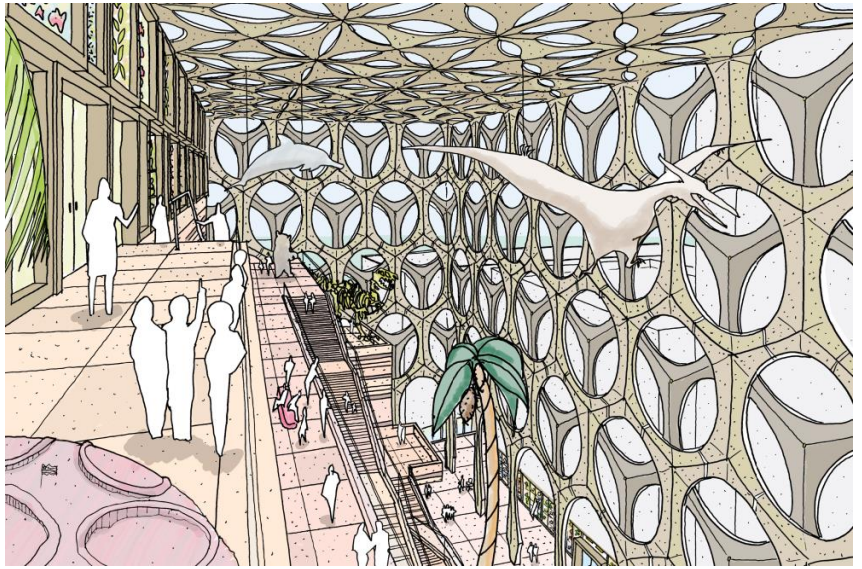
Aronsohn consulting engineers

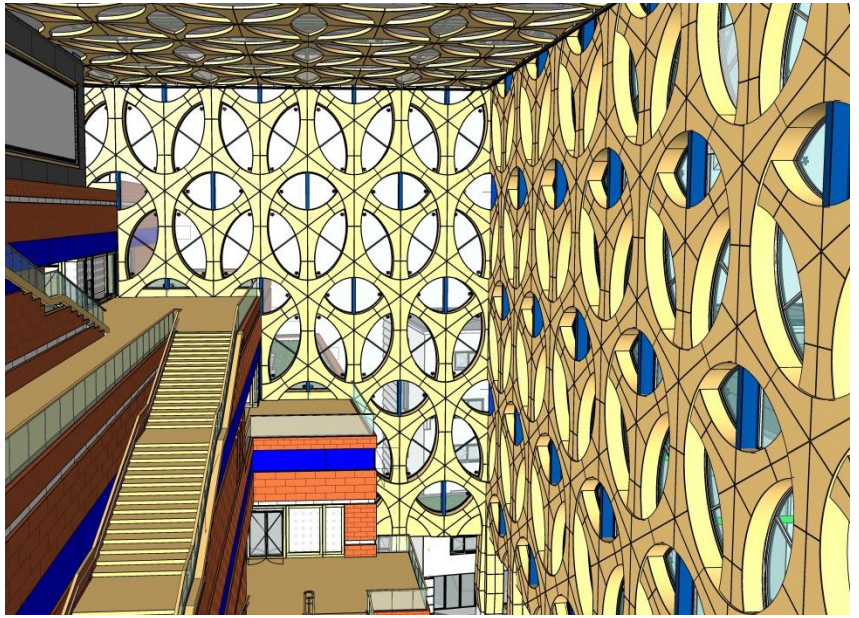
huisman & van muijen installatieadviseurs

igg bouweconomie. bointon de groot

dGmR

Naturalis Biodiversity Center

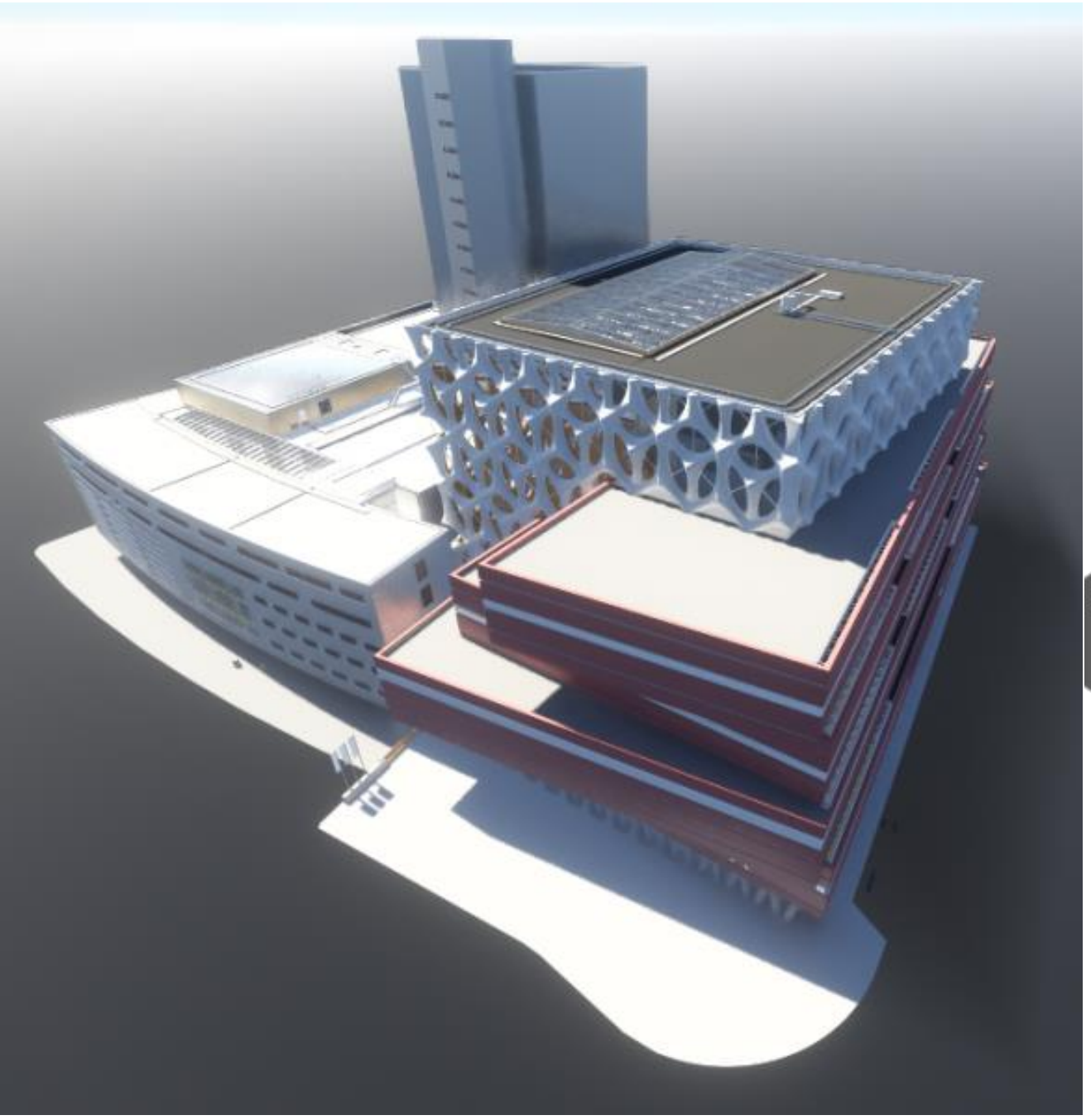


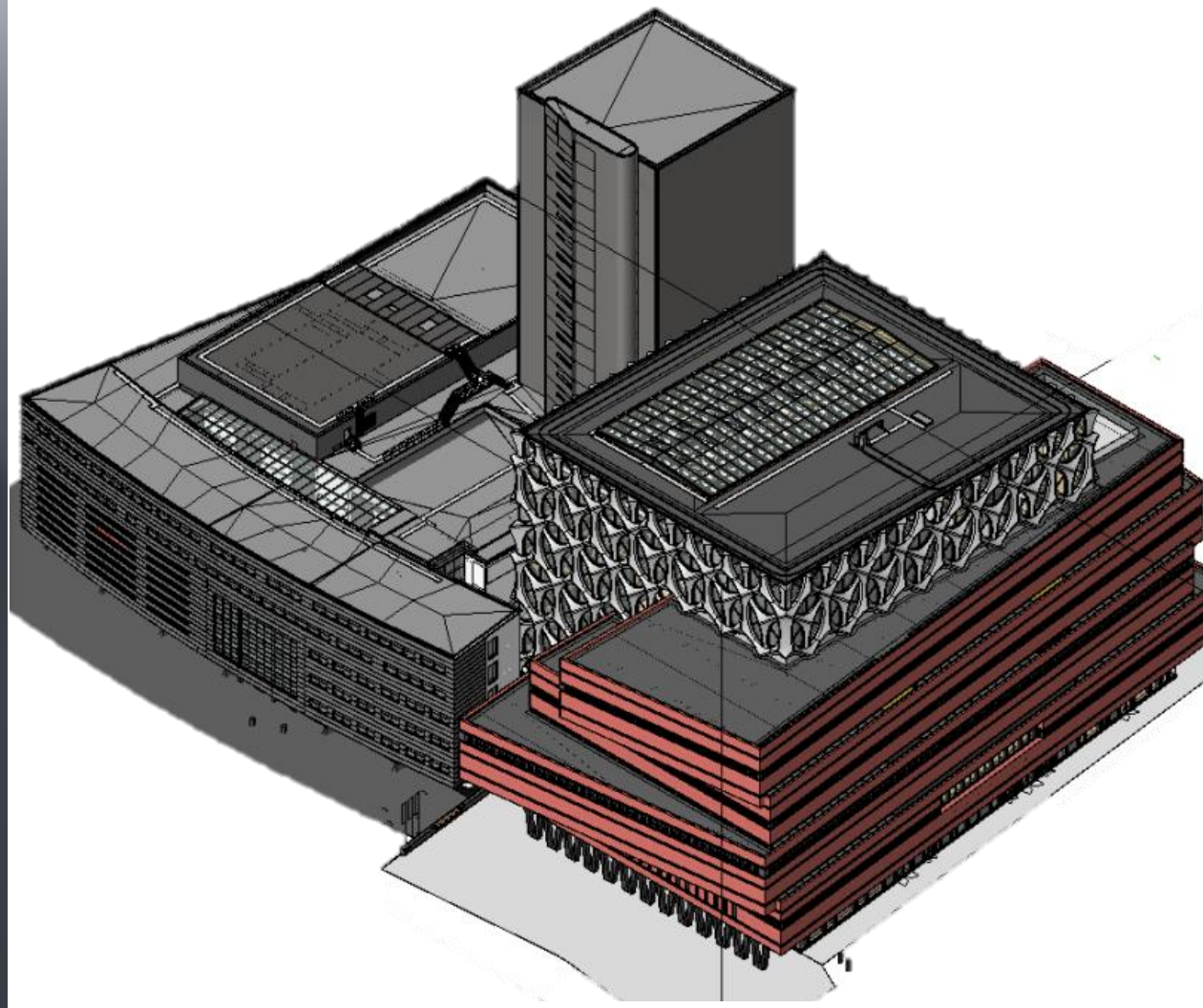


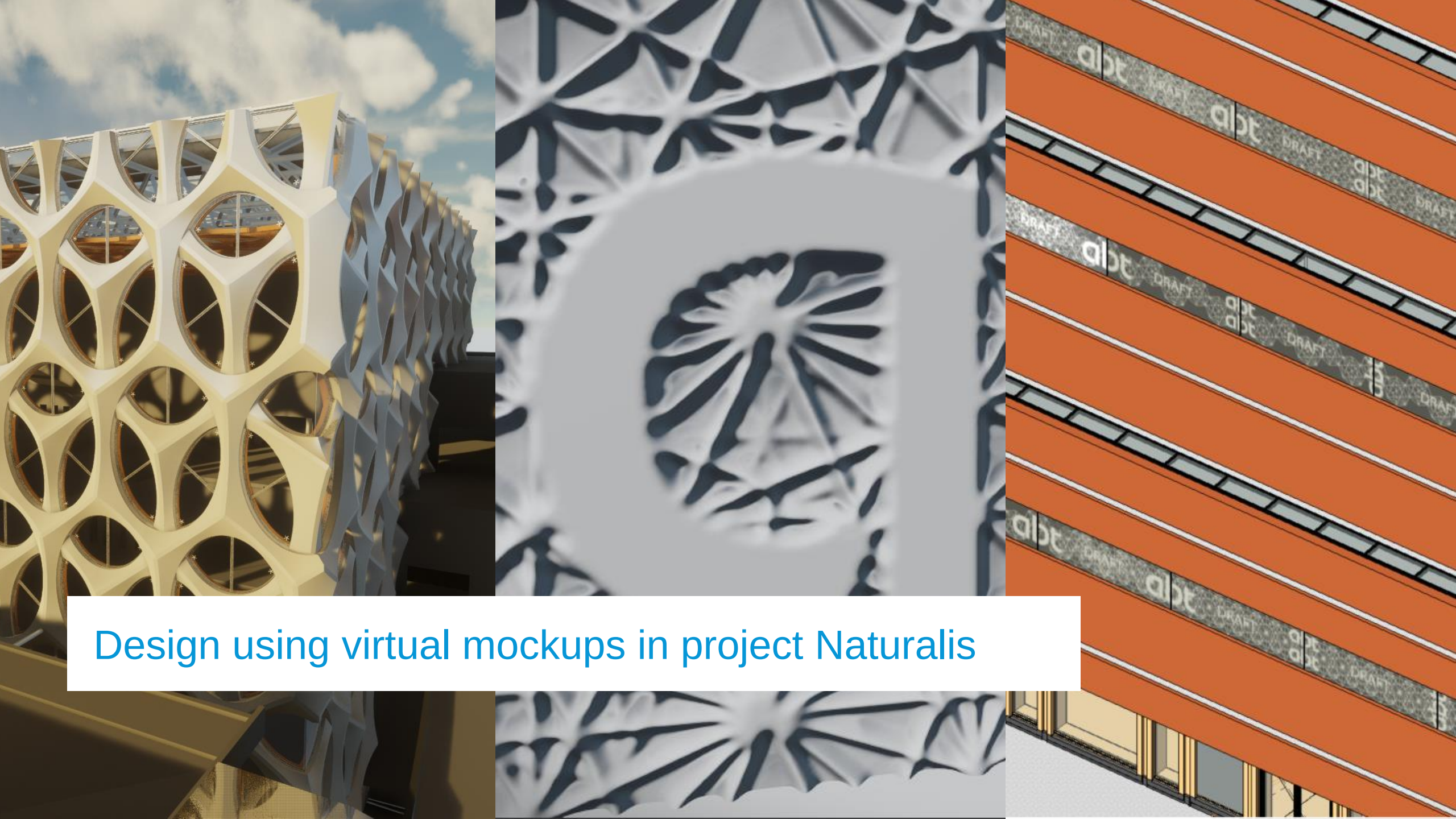
jp van eesteren

HIBEX

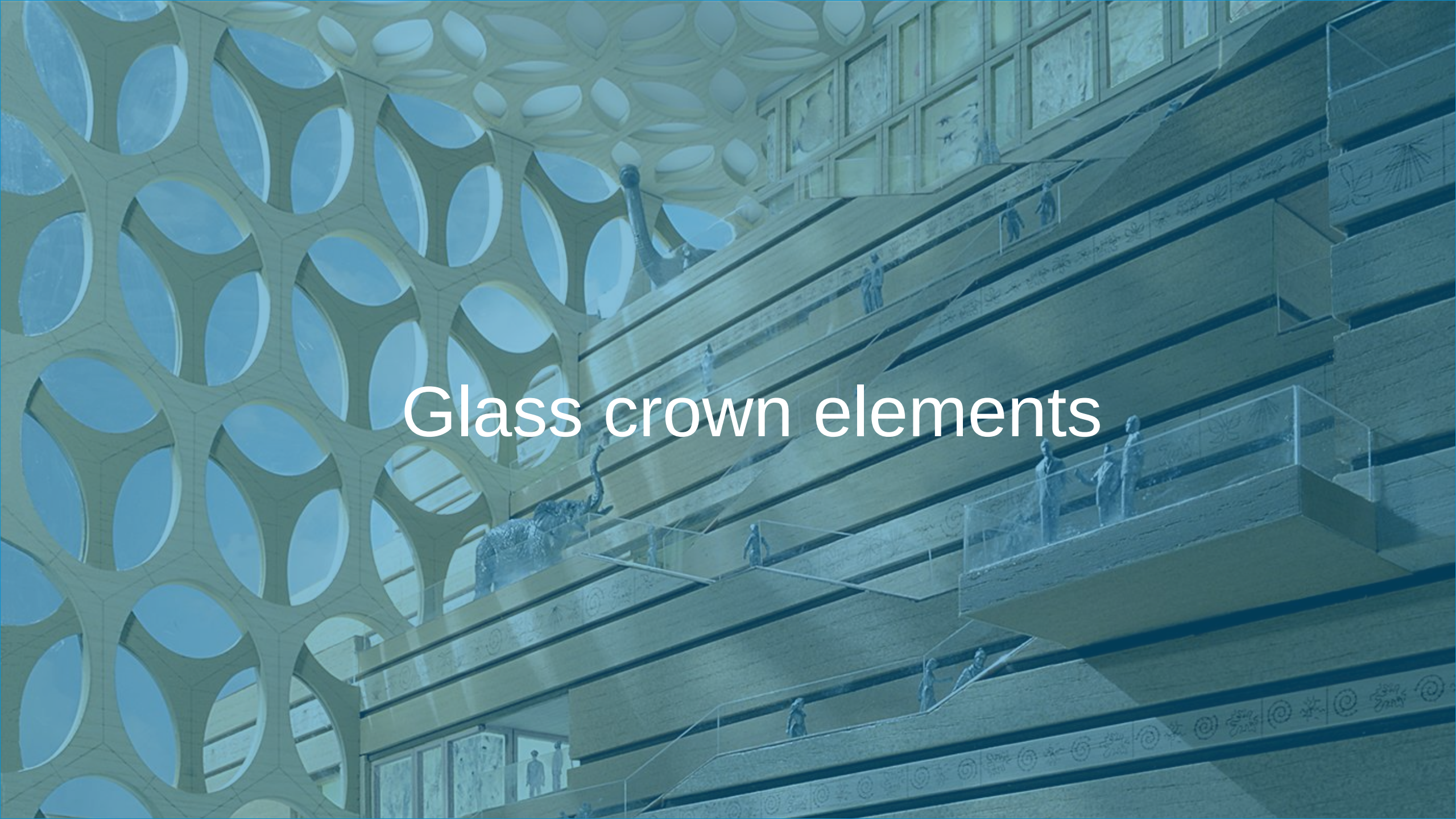
HARRYVAN® SINDS 1930 INTERIEURBOUW



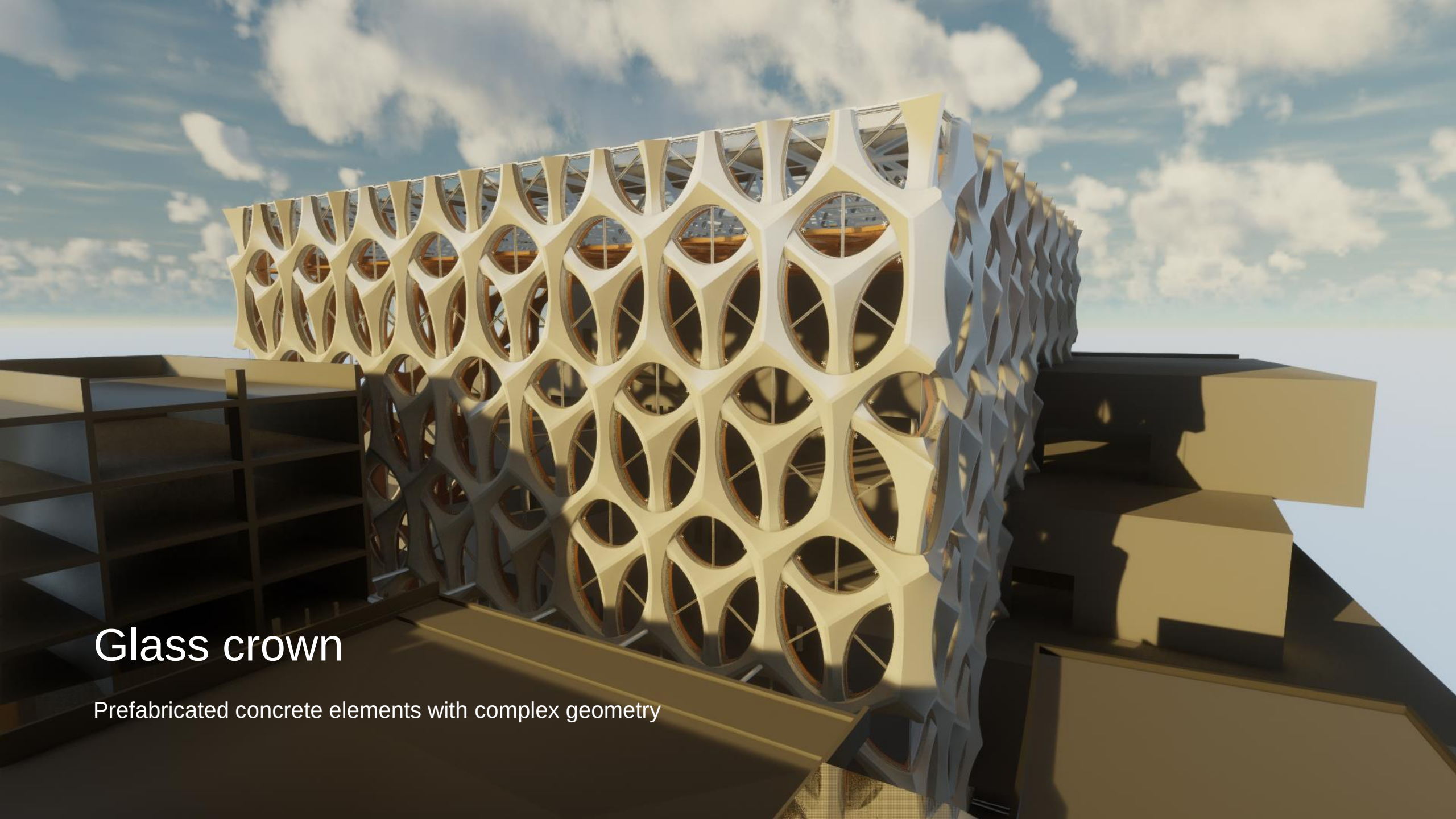




Design using virtual mockups in project Naturalis



Glass crown elements



Glass crown

Prefabricated concrete elements with complex geometry

Savings proposal

- 2 elements / truck instead of 1
- Number of transports: -200
- Panel depth 1m → 0.6m
- Material reduction

Impact on aesthetical quality

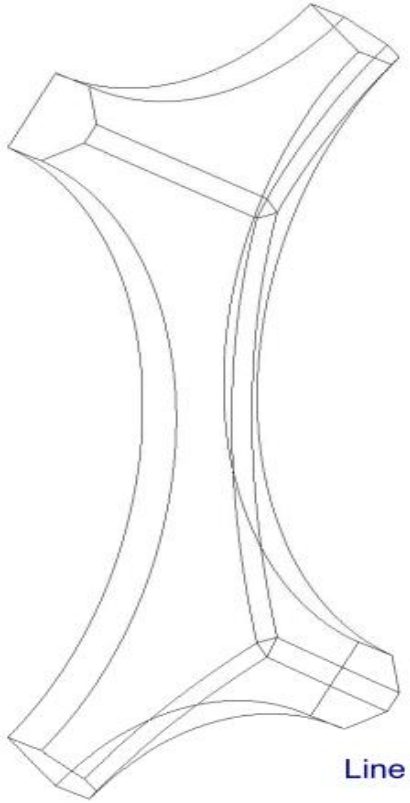
Use of scale models for design

Neutelings Riedijk Architects

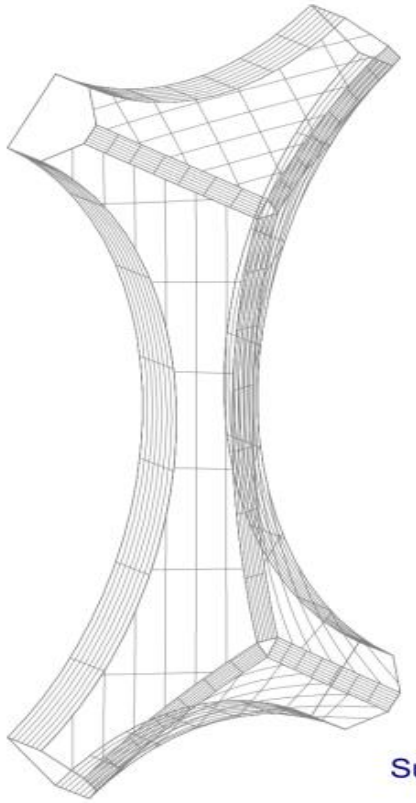
Use of scale models for design

Naturalis Biodiversity Center
Neutelings Riedijk Architects
Fragment Naturalis bouwt #1
https://www.youtube.com/watch?v=l-jnfKJ7Jlk

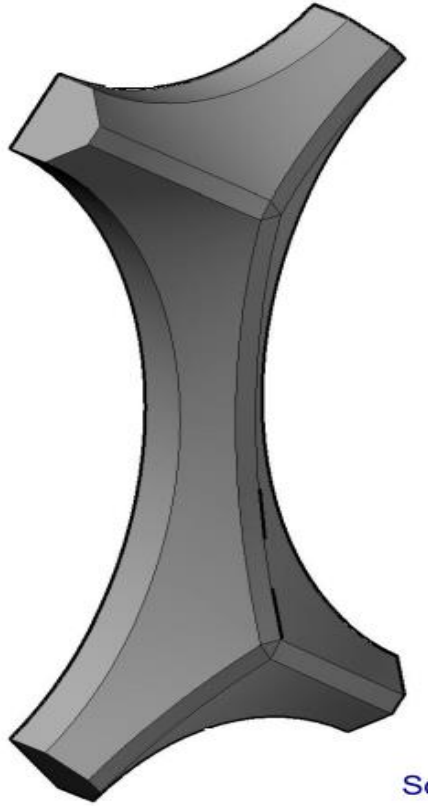
De centrale hal van het gebouw



Line



Surface

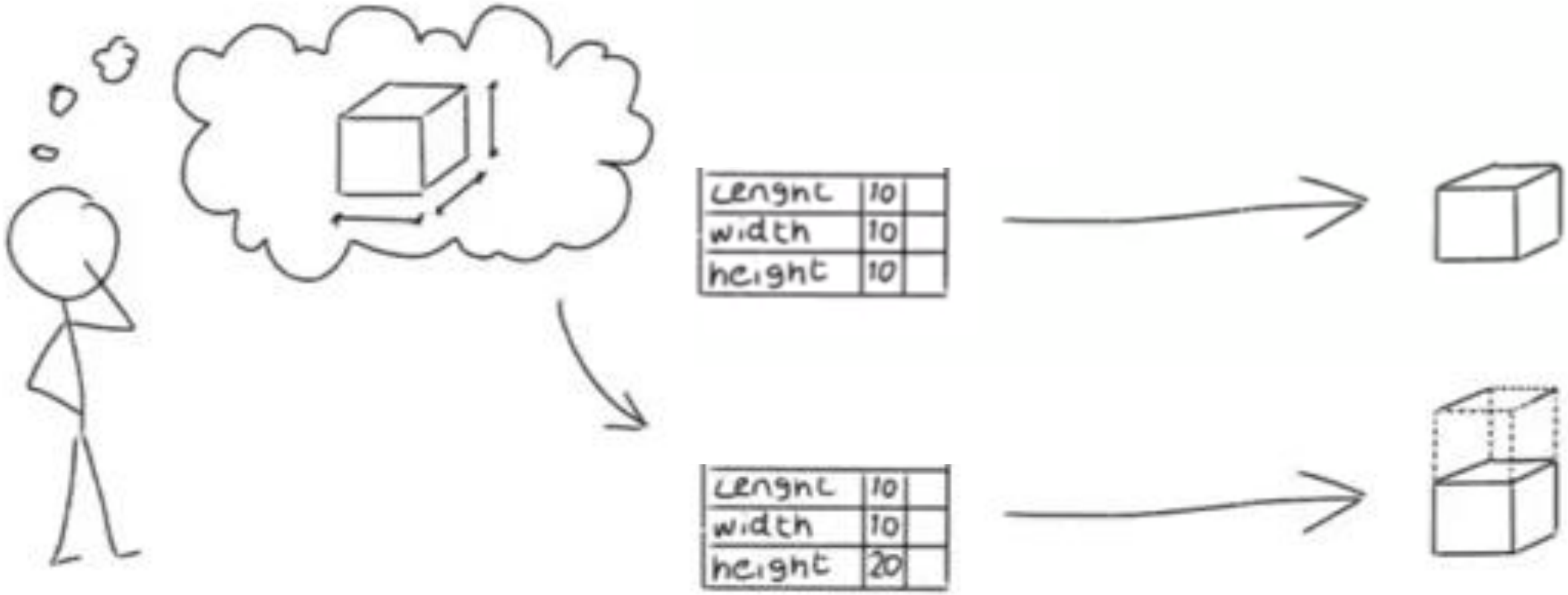


Solid

2014: “Good old” Autocad

Ewoud – December 8, 2016 at 4:06pm

Voor Naturalis zijn wij op zoek naar iemand met meer kennis van 3D Autocad,

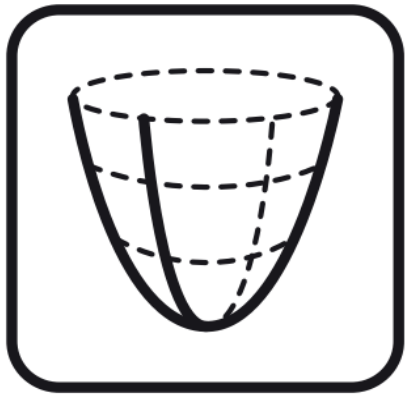


Parametric approach

Mindset

Think

Make the rules



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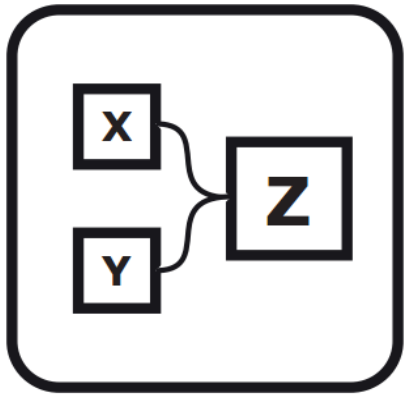
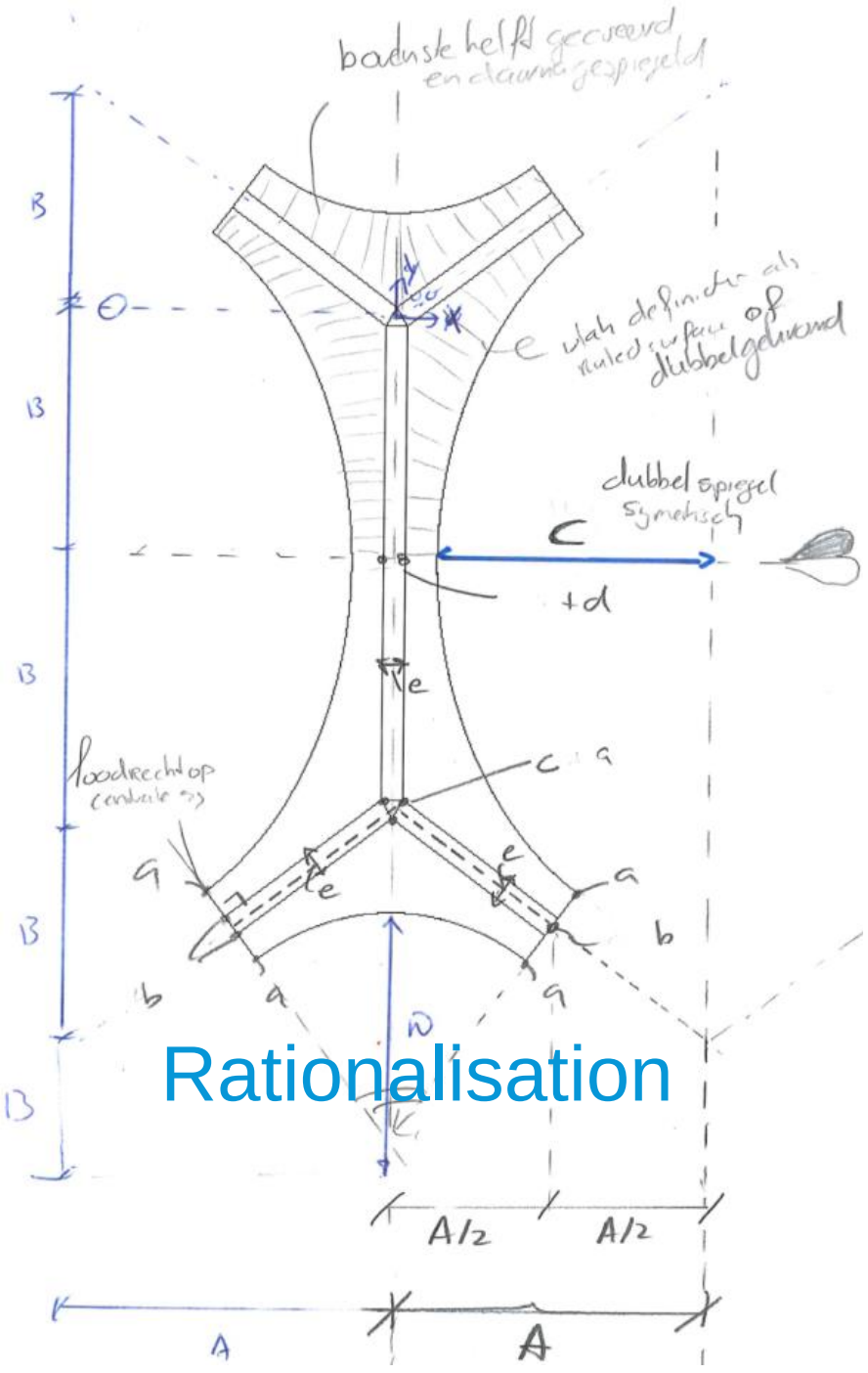
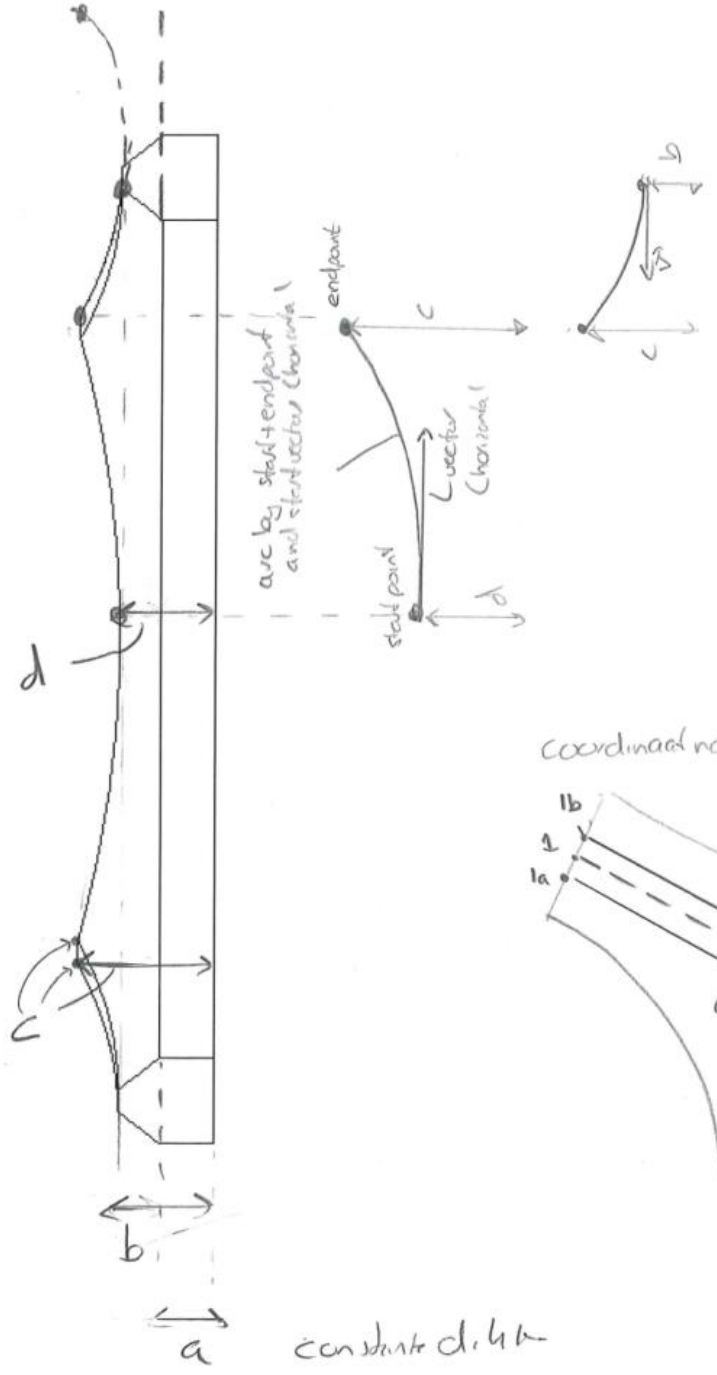
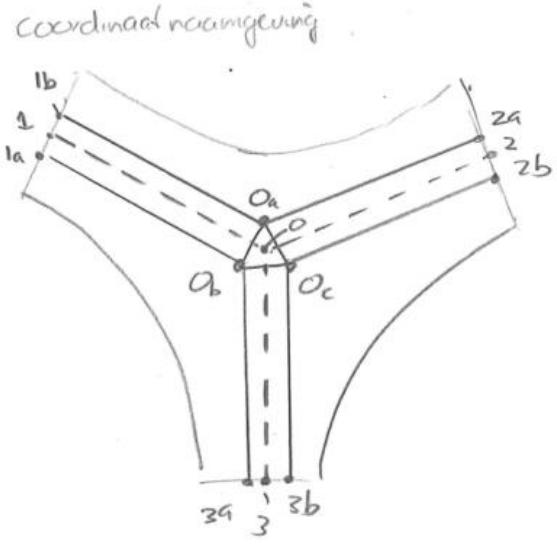


Press Enter

Rationalisation

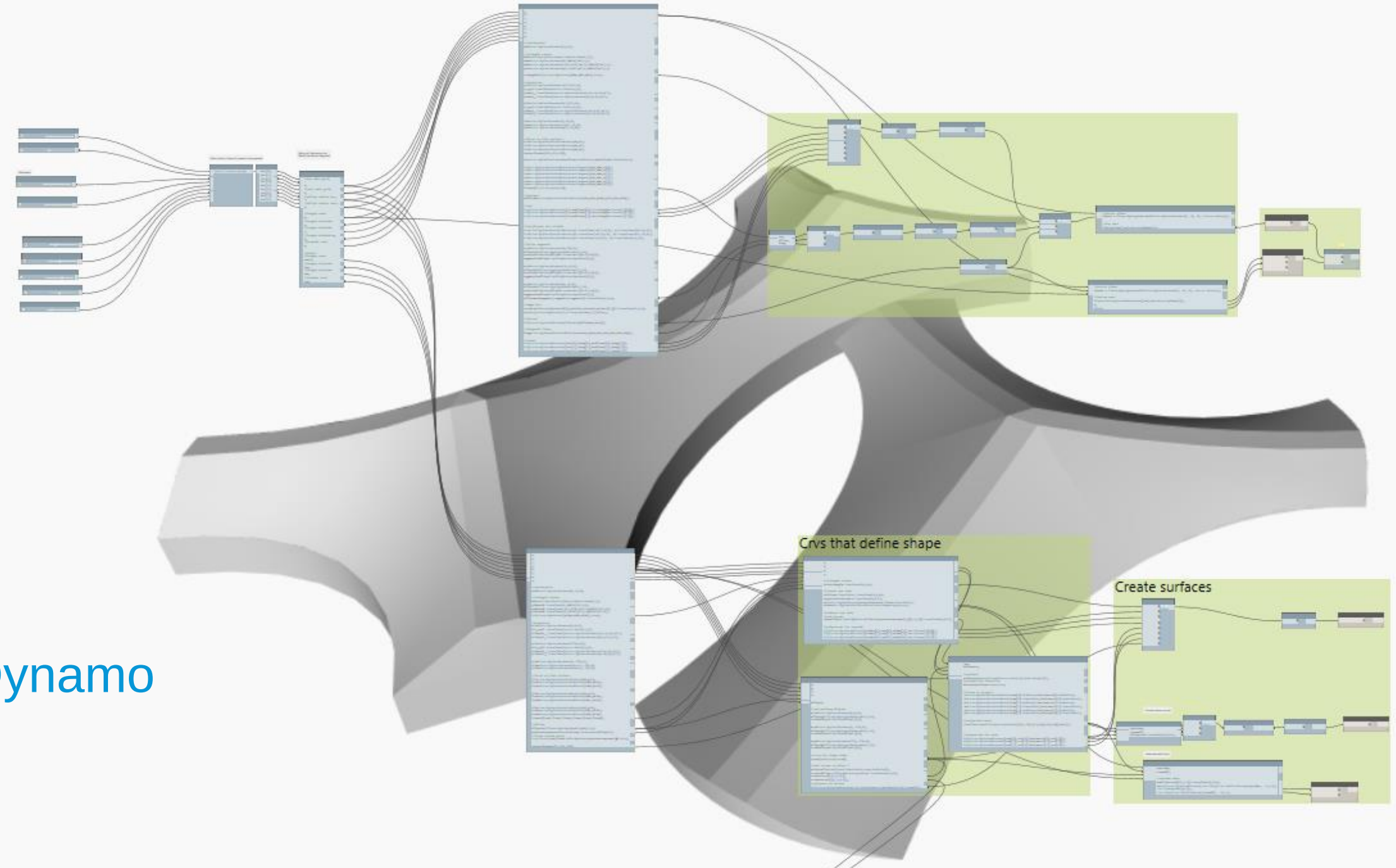


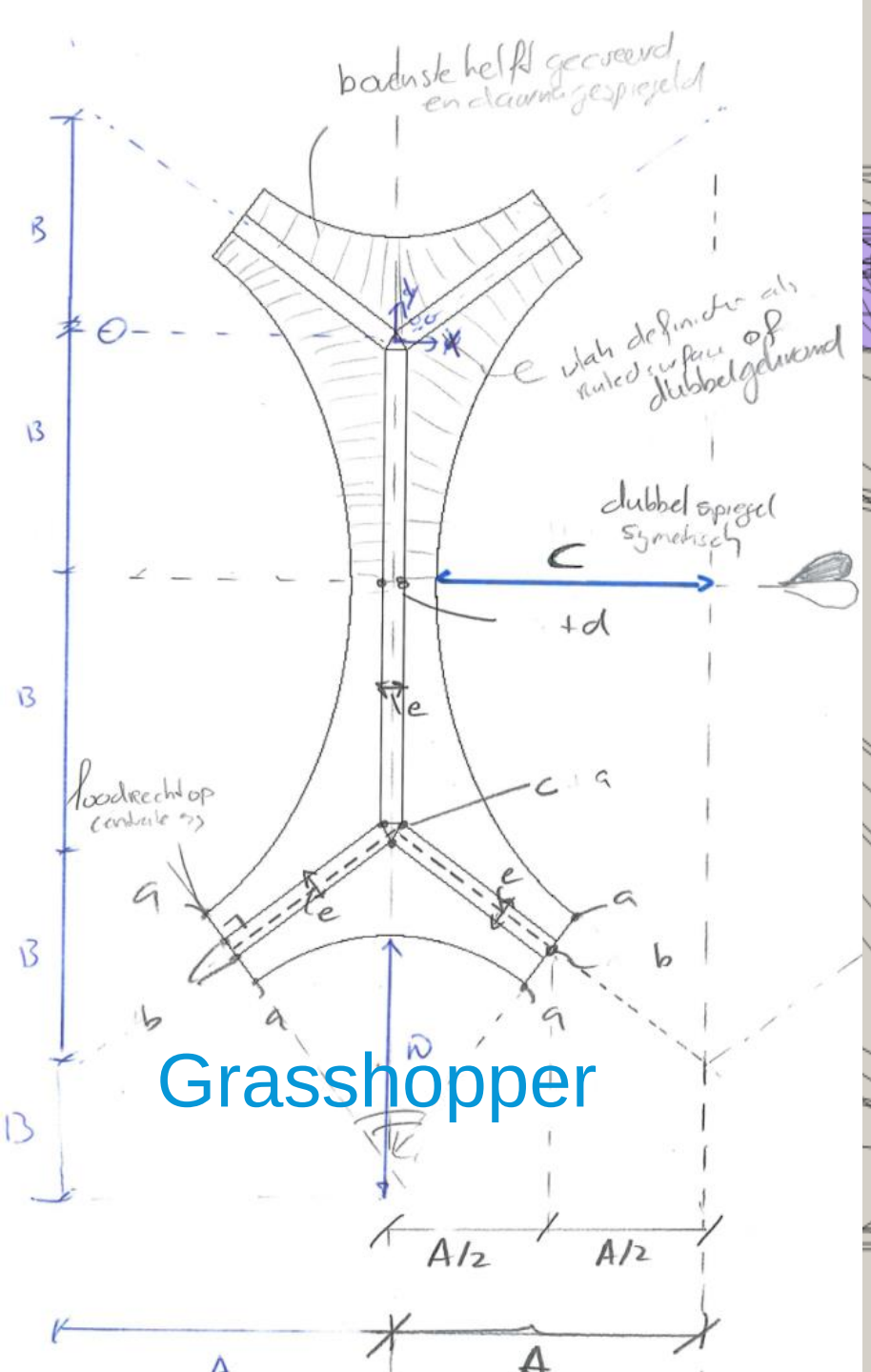




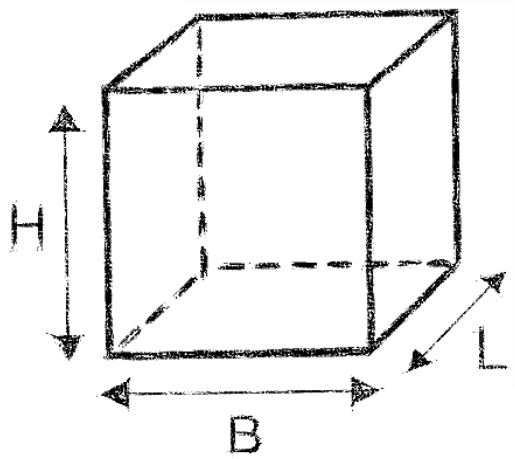
Complex shapes are not difficult
if you understand their rules of creation

Dynamo





Grasshopper

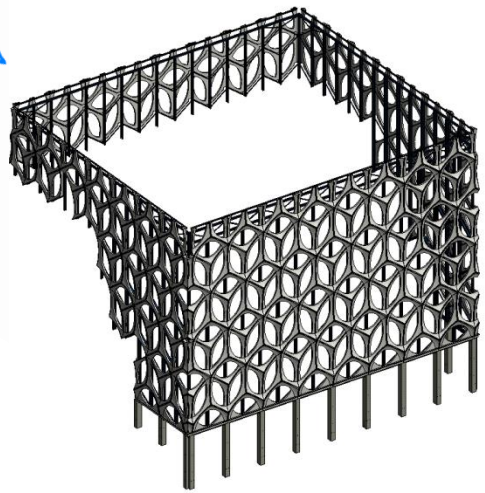


Rhinoceros

FLUX.IO

Dynamo

AUTODESK
REVIT



Data Flow

KEYS (4)

- TShaped <1 min ago
- IShaped <1 min ago
- Iteration <1 min ago
- ParameterValues <1 min ago

ParameterValues Raw

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  3000,
  2250,
  2600,
  3500,
  200,
  300,
  600,
  300
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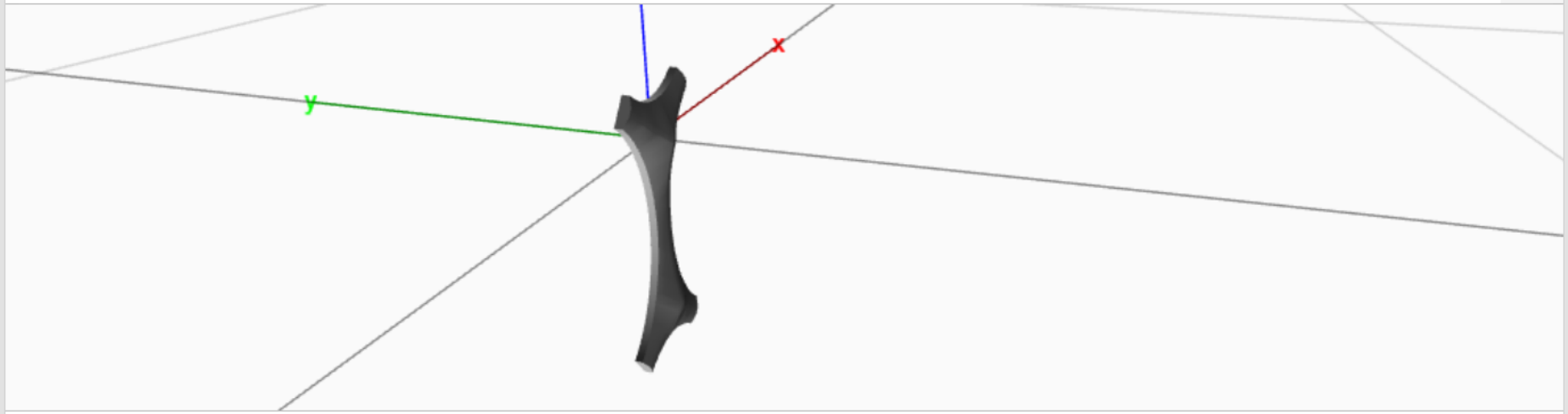
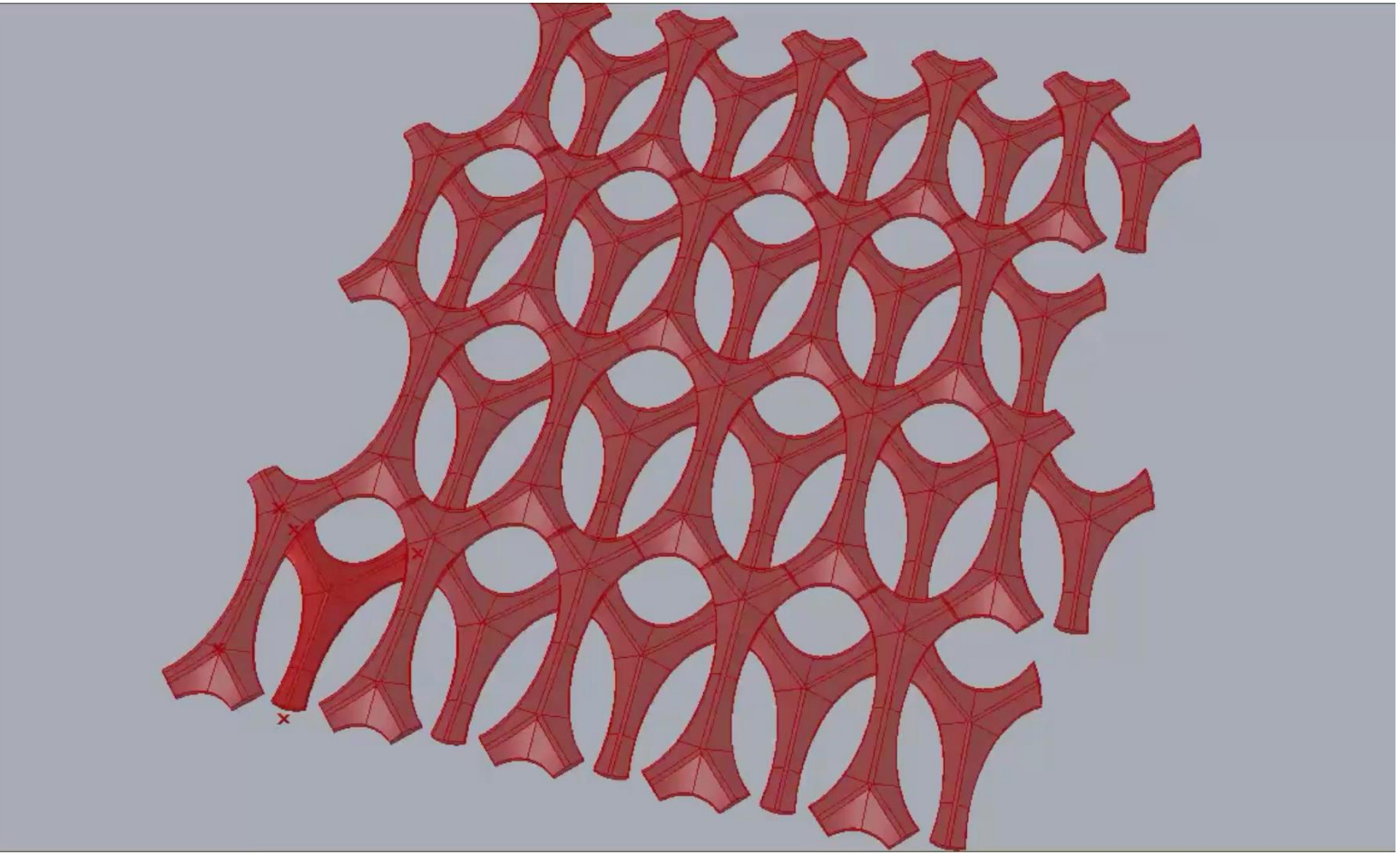
Array - (12) Chris v. Mon Mar 27 2017

IShaped 3D | Raw

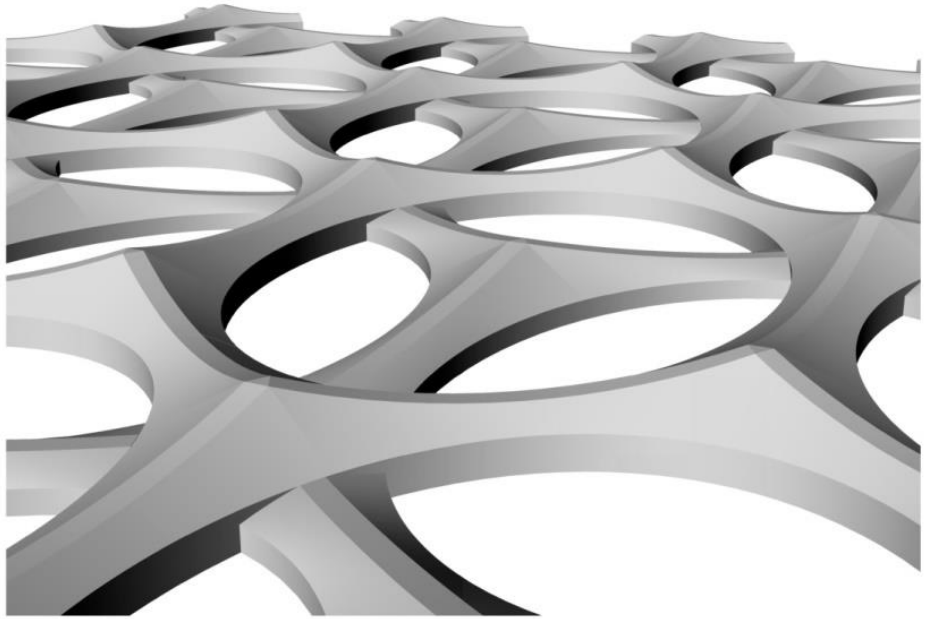


Array - Geometry (1) Chris v. Mon Mar 27 2017

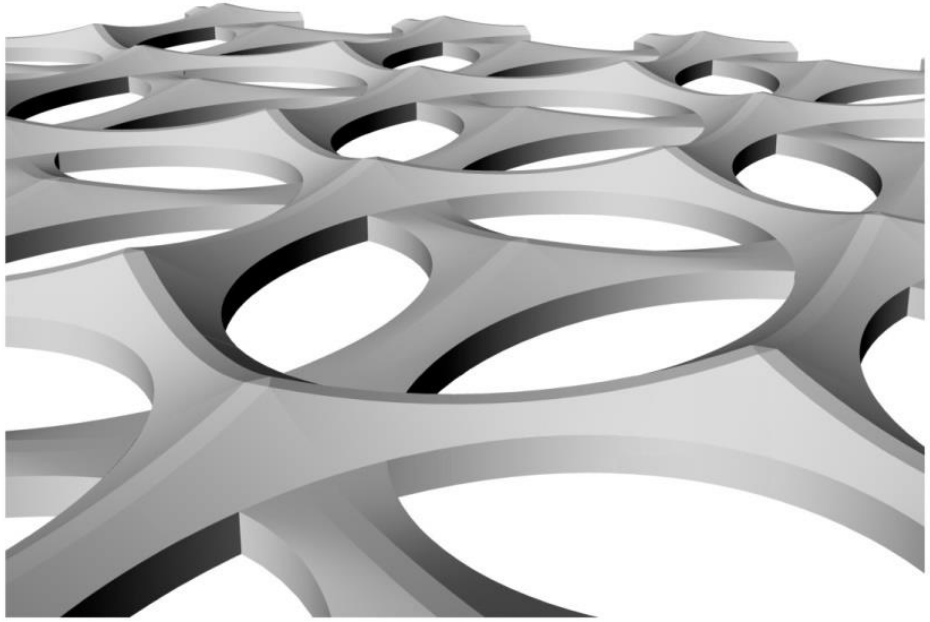
FLUX



Variant 15/02/2017

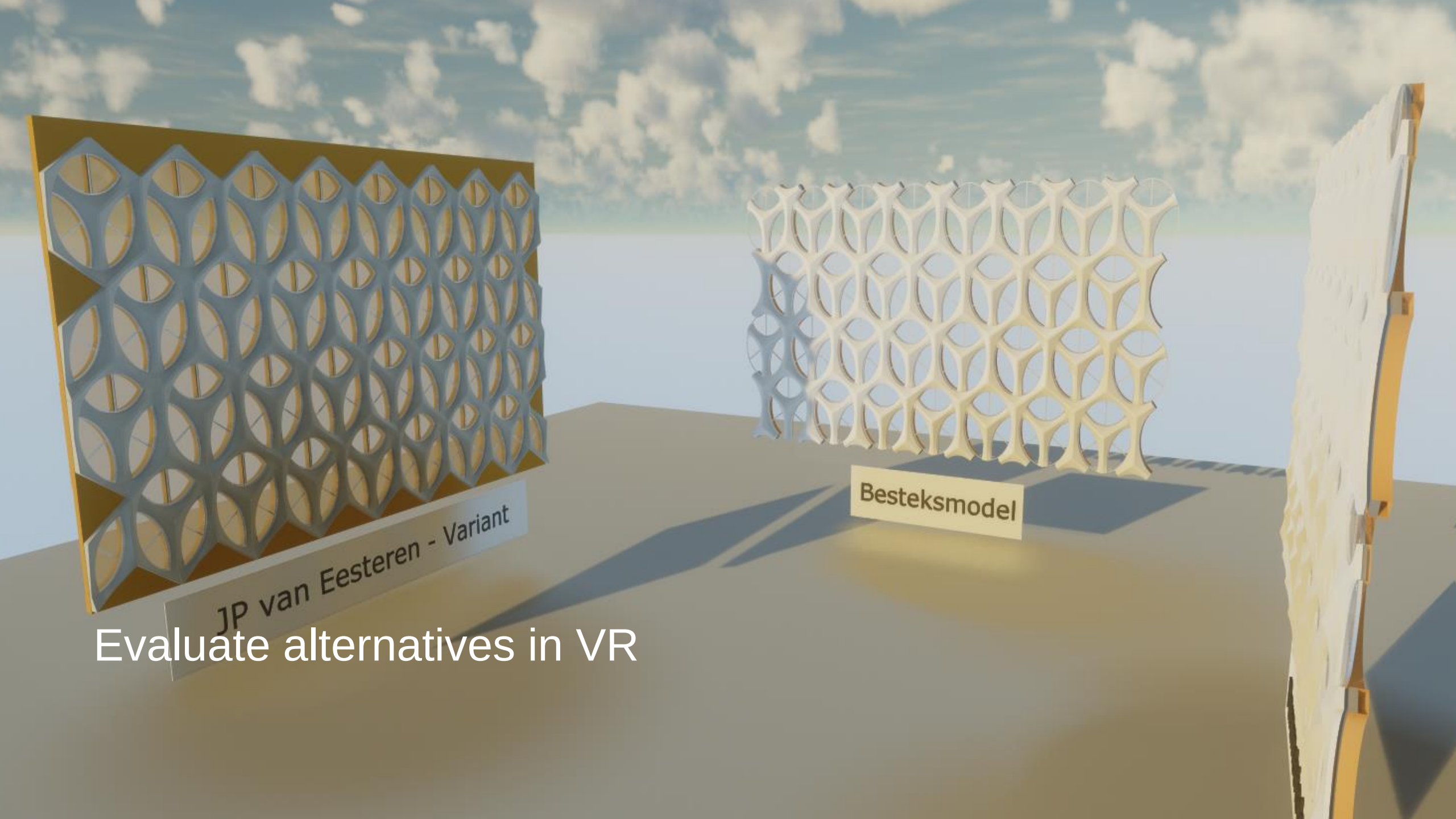


Variant 15/02/2017 met l=m=300mm

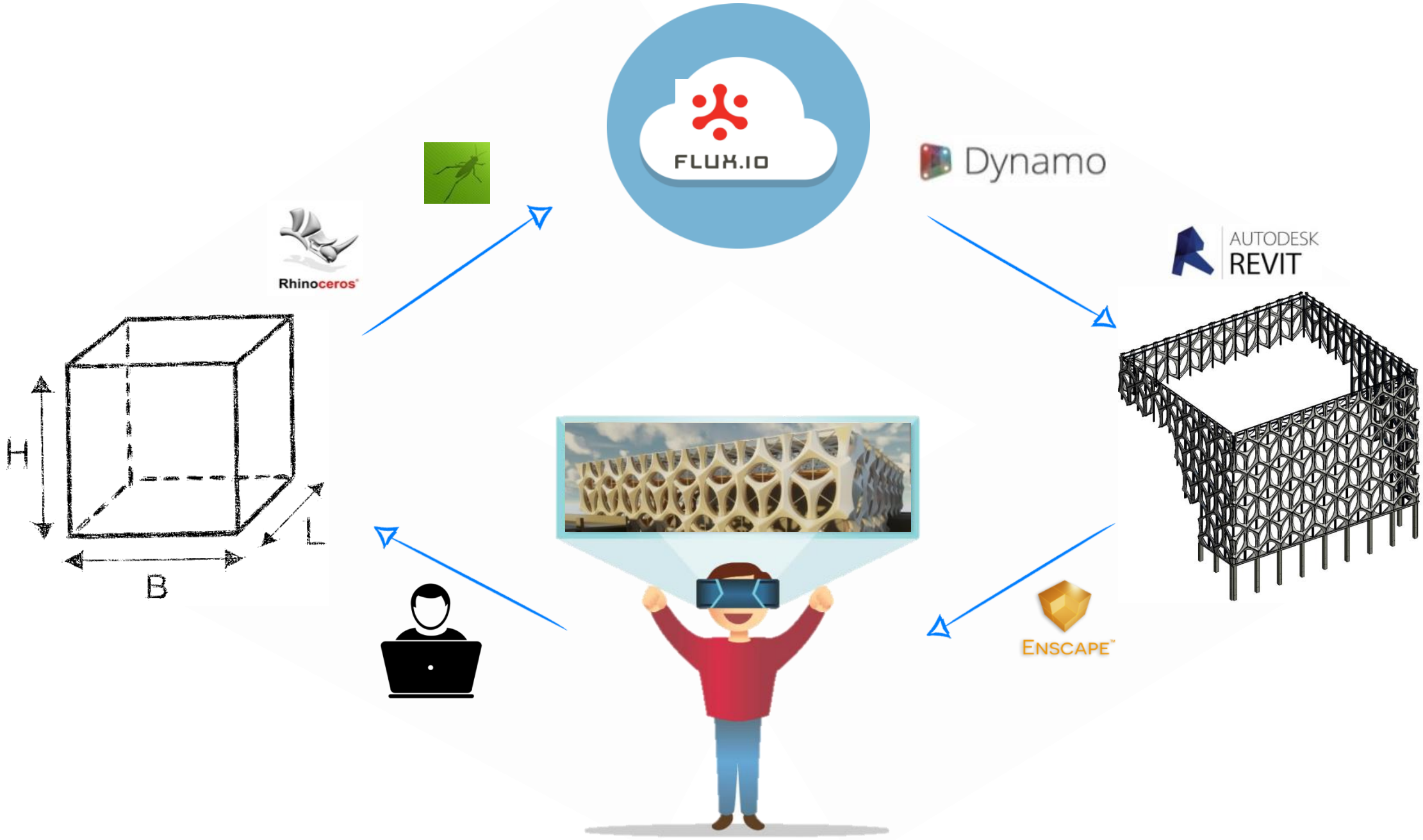


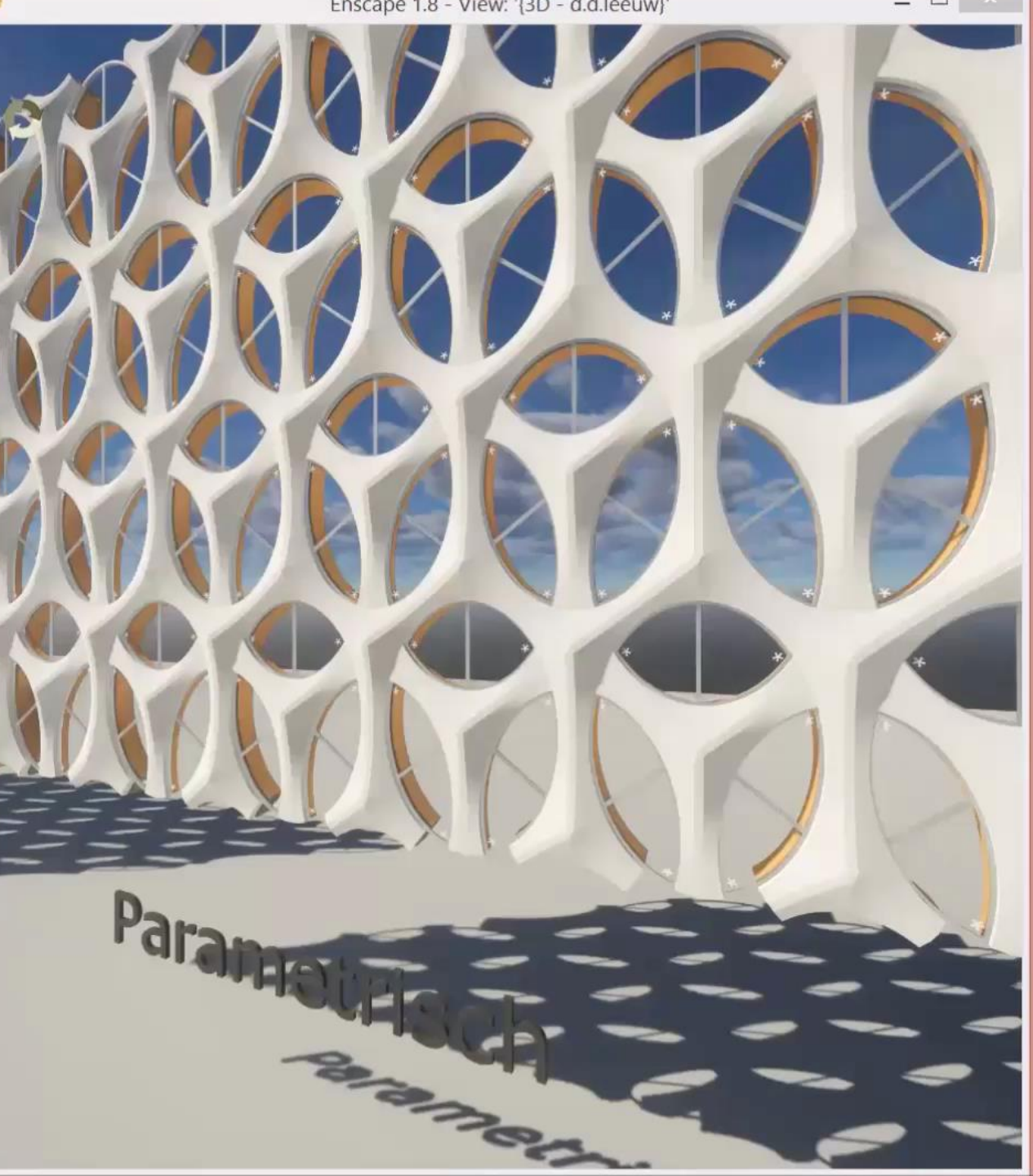
Design variants

Experience your project



Evaluate alternatives in VR


FLUX.IO
Dynamo
Rhinoceros
AUTODESK
REVIT
H
L
B
ENSCAPE



Grasshopper - naturalis_v7*

File Edit View Display Solution Help

naturalis_v7*

Prm Math Set Vec Crv Srf Msh Int Trns Dis GeomGym Wb PanelingTools Kangaroo LunchBox H F S E G F

Geometry Primitive Input Util

125%

a 200

b 300

c 600

d 300

e 200

T-shape panel

k 200

l 200

m 600

n 200

Hoofd geometrie

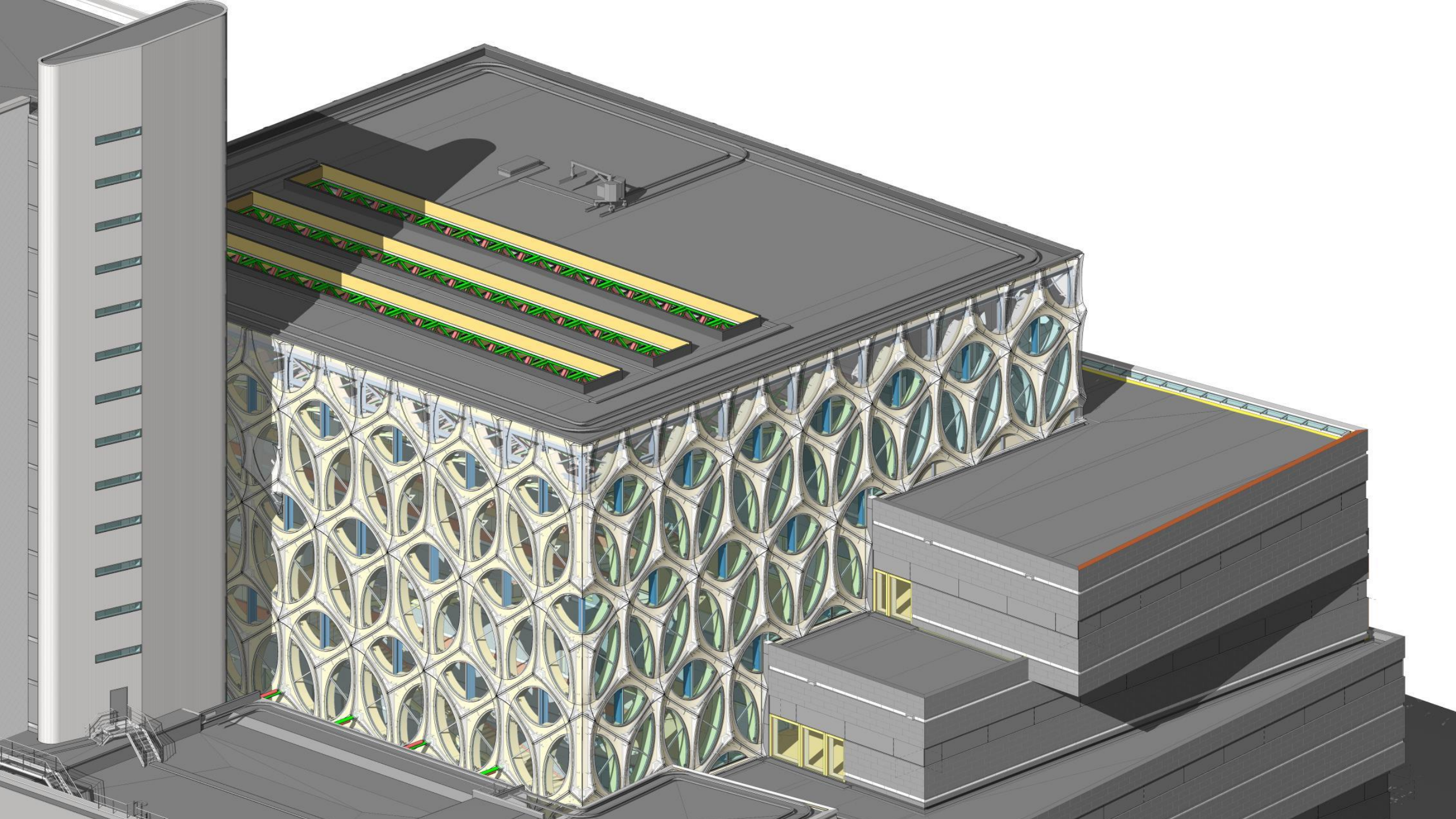
A 3000

B 2250

C 2200

D 3500

0.9.0076



Production

HIBEX, Groningen

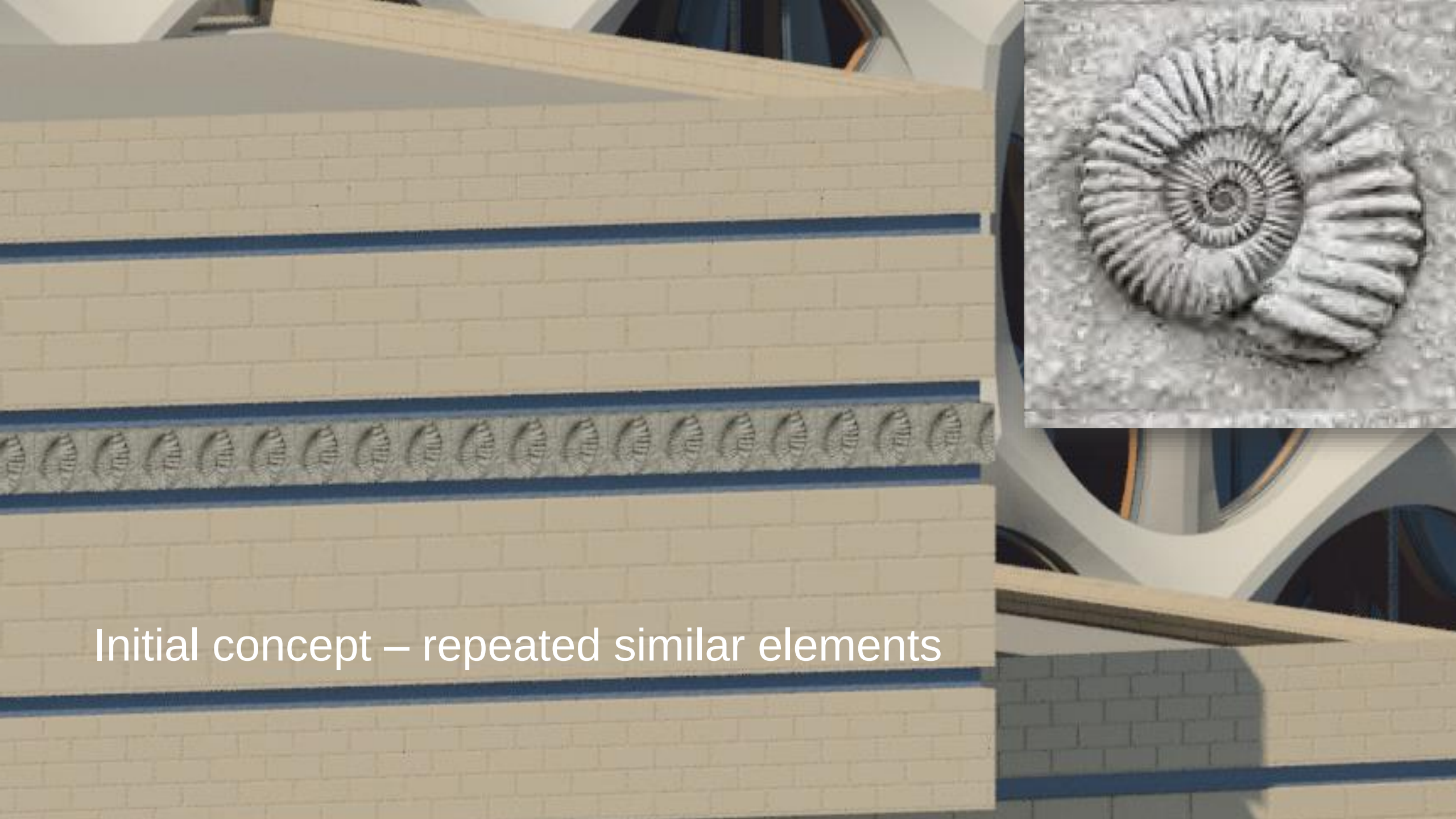
HIBEX, Groningen

Test fit of prefab elements

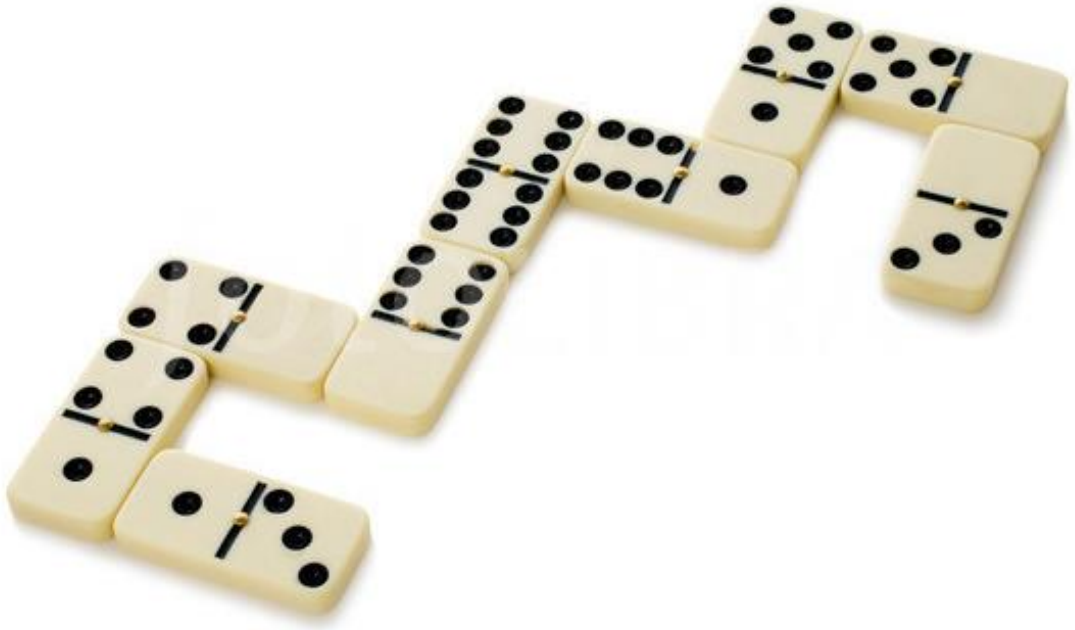
HIBEX, Groningen


Currently under construction


Concrete panels with relief



Initial concept – repeated similar elements



Artist’s design of ornaments

Domino pattern

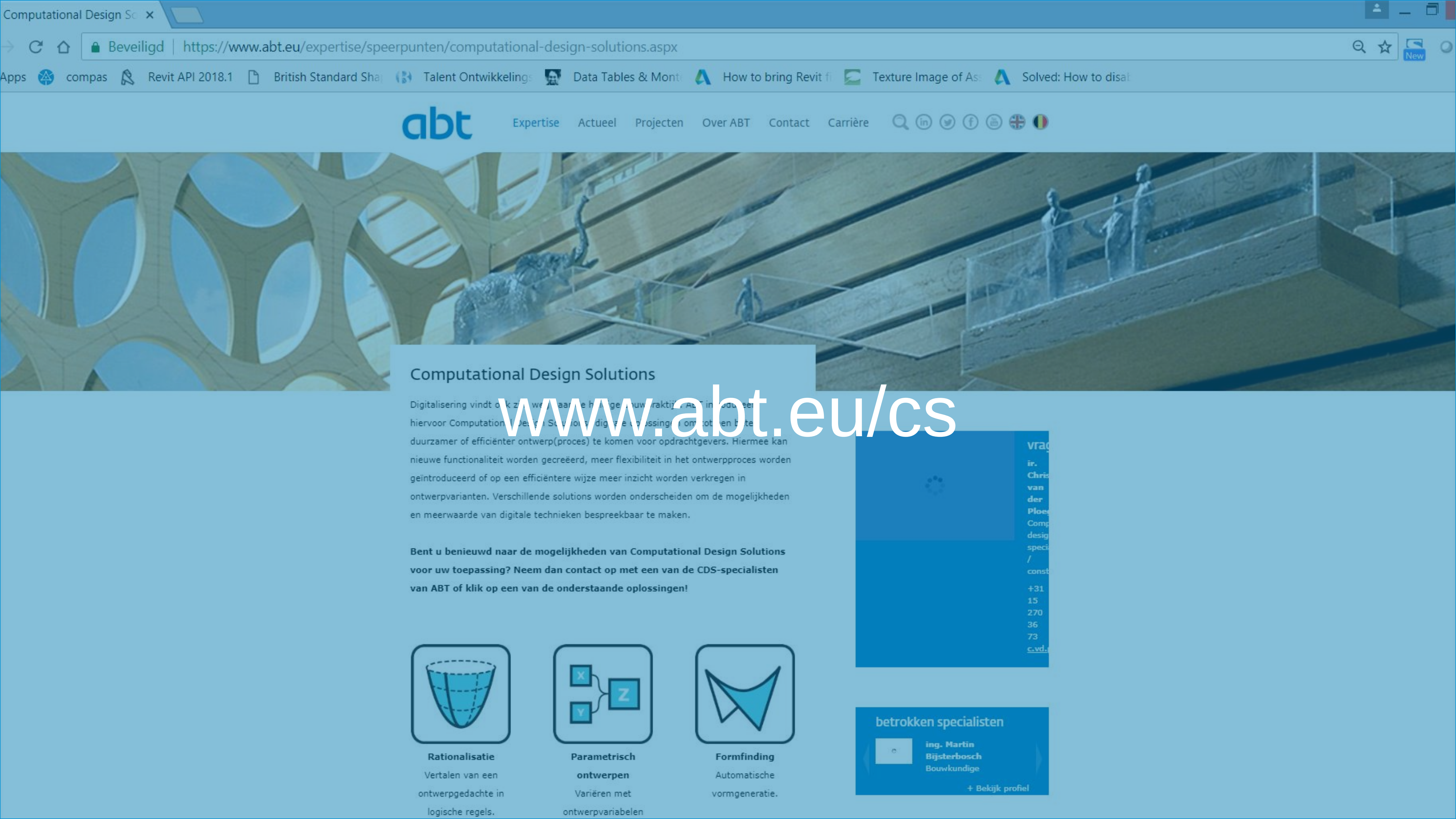
13 unique panels

each 4,0 m x 1,0 m

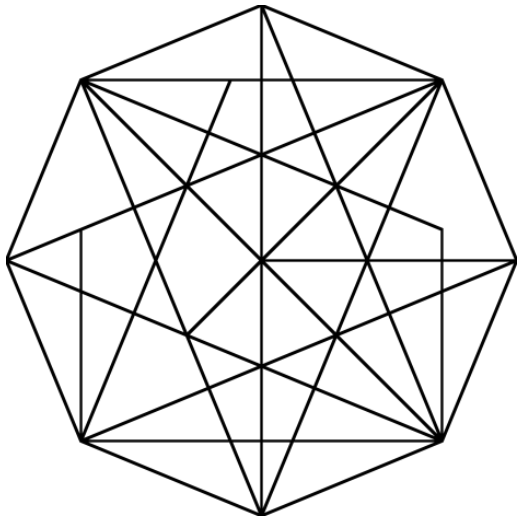
52 m2 unique pattern

Designed as 2D images

Realisation in 3D concrete


Computational Design Sc
Beveiligd
https://www.abt.eu/expertise/speerpunten/computational-design-solutions.aspx
Apps
compas
Revit API 2018.1
British Standard Sha
Talent Ontwikkelings
Data Tables & Mont
How to bring Revit f
Texture Image of As
Solved: How to disa
abt
Expertise
Actueel
Projecten
Over ABT
Contact
Carrière
Computational Design Solutions
www.abt.eu/cs
duurzamer of efficiënter ontwerp(proces) te komen voor opdrachtgevers. Hiermee kan
nieuwe functionaliteit worden gecreëerd, meer flexibiliteit in het ontwerpproces worden
geïntroduceerd of op een efficiëntere wijze meer inzicht worden verkregen in
ontwerpvarianten. Verschillende solutions worden onderscheiden om de mogelijkheden
en meerwaarde van digitale technieken bespreekbaar te maken.
Bent u benieuwd naar de mogelijkheden van Computational Design Solutions
voor uw toepassing? Neem dan contact op met een van de CDS-specialisten
van ABT of klik op een van de onderstaande oplossingen!
Rationalisatie
Vertalen van een
ontwerpgedachte in
logische regels.
Parametrisch
ontwerpen
Variëren met
ontwerpvariabelen
Formfinding
Automatische
vormgeneratie.
betrokken specialisten
ing. Martin
Bijsterbosch
Bouwkundige
+ Bekijk profiel

abt



Logo’s

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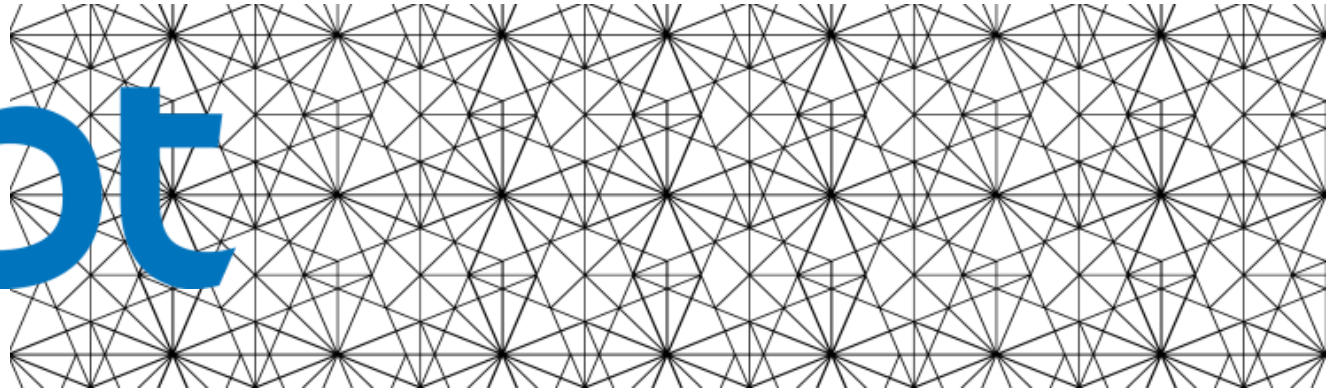
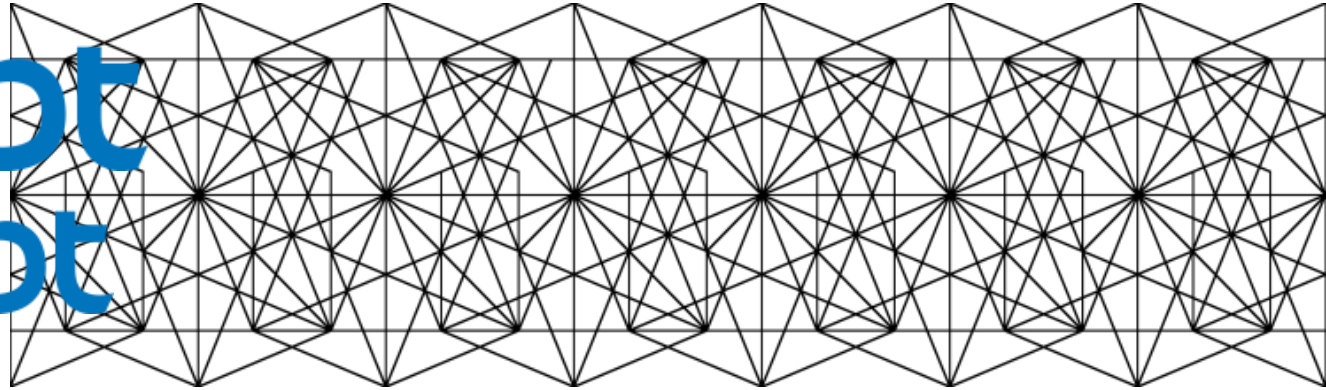


abt

abt



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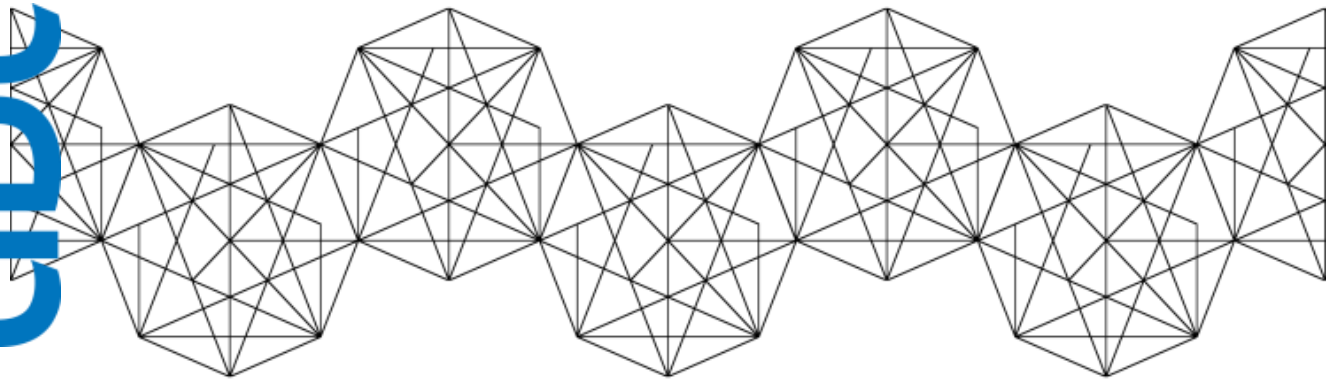
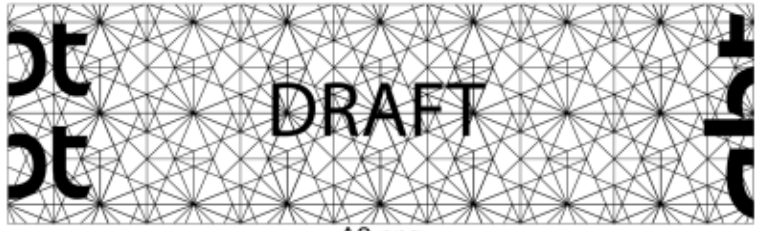
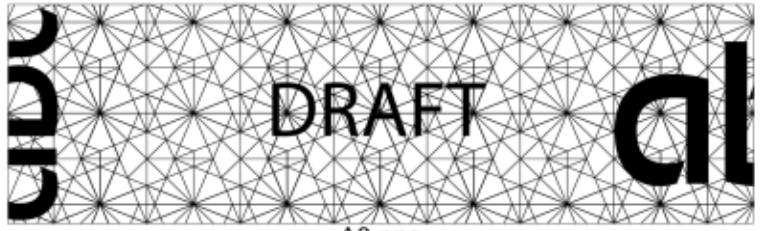


A1.png



A2.png



A3.png

B1.png

B2.png

B3.png

C1.png

C2.png

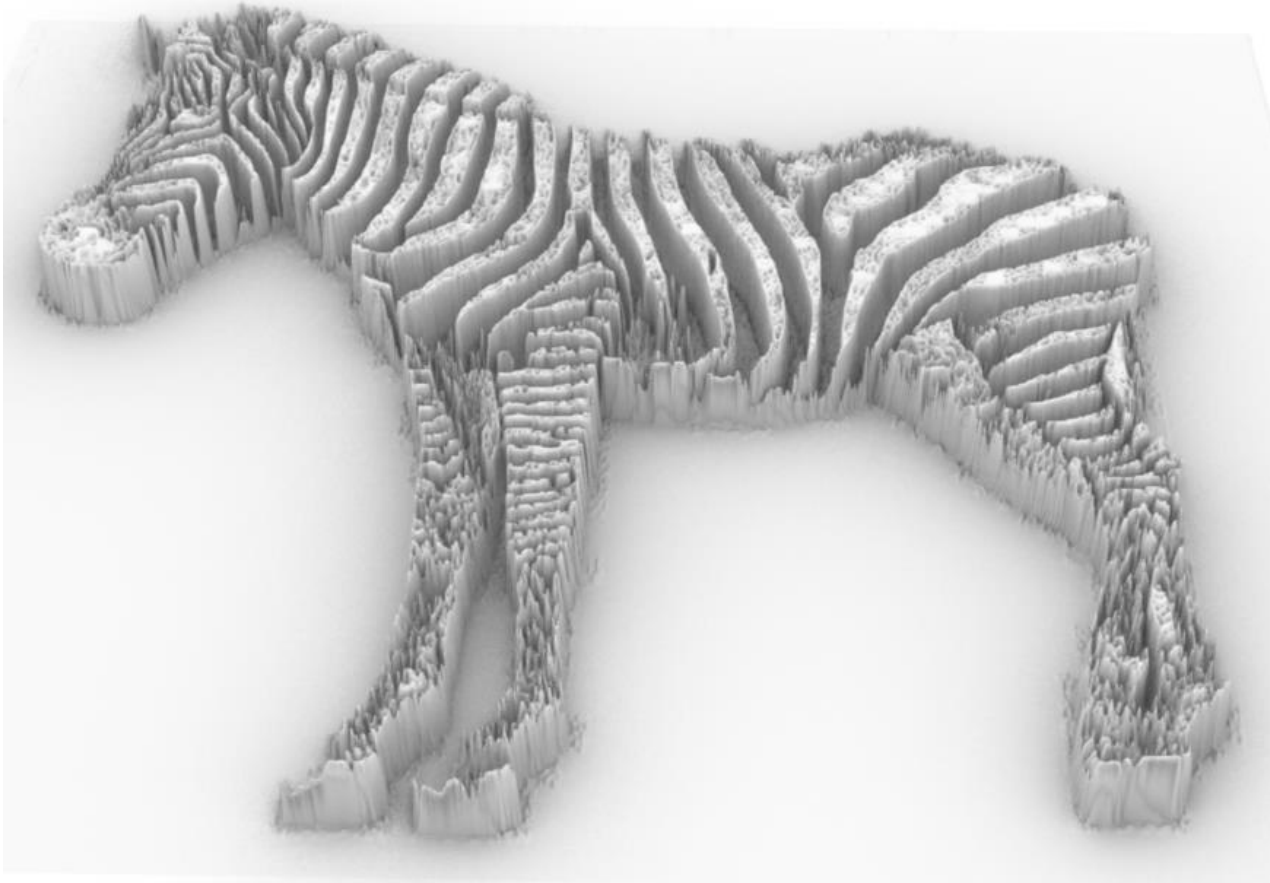
C3.png

x_BC.png

x_CA.png

x_CB.png

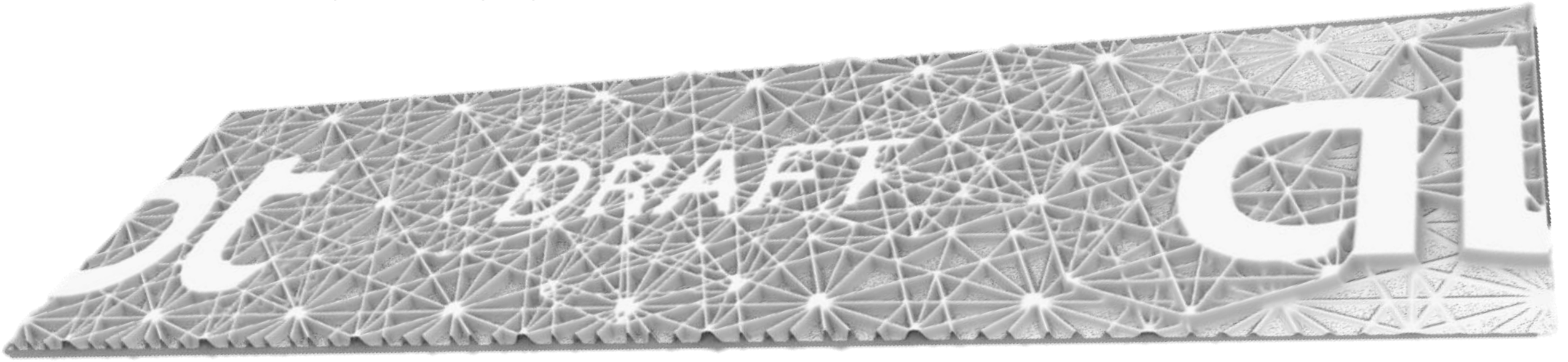
Draft design



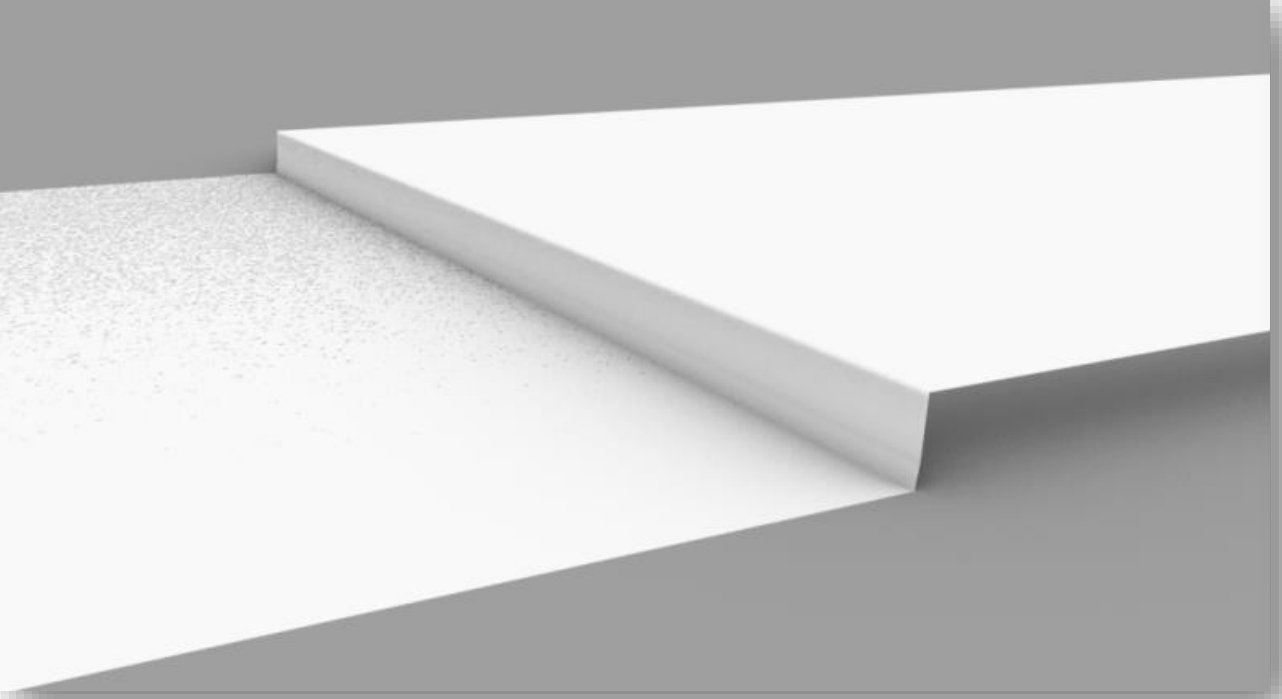
2D design converted to 3D

Automated conversion

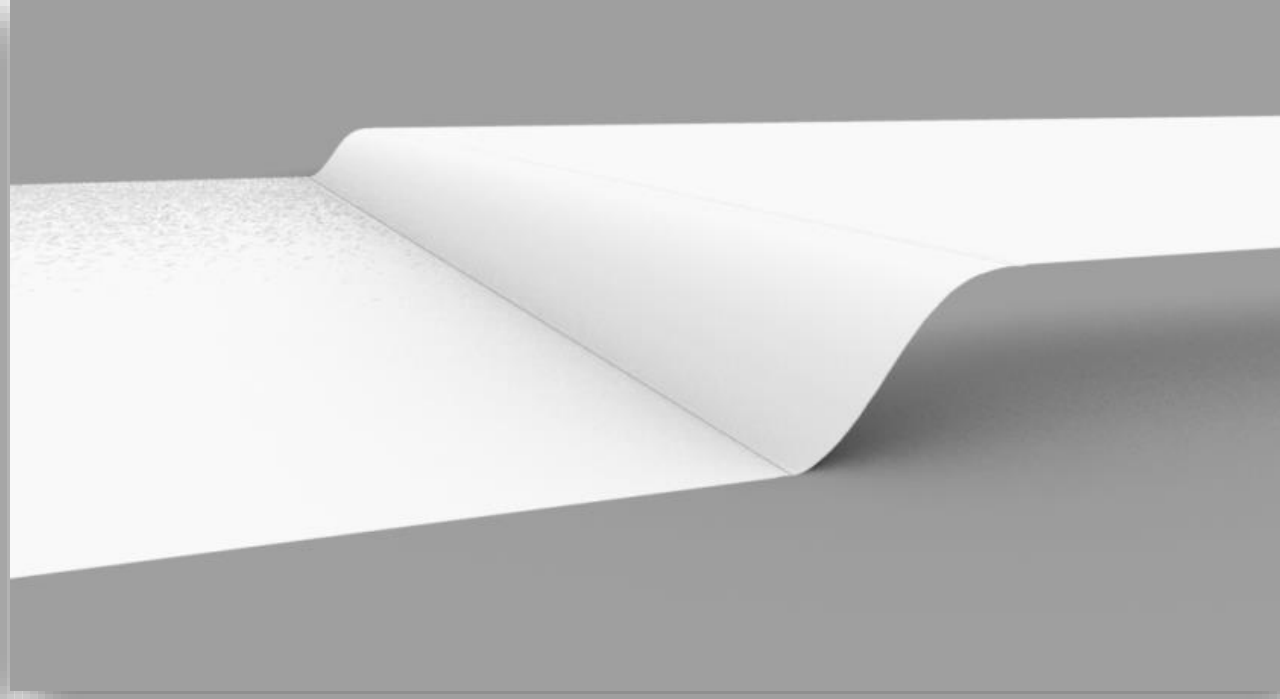
- Convert 2D image to 3D mesh
- Exact dimensions
- Correct for seams between panels
- Generate images of 3D models
- Create mesh of moulds for production (Rhino)
- Create mesh of panel for VR (FBX)



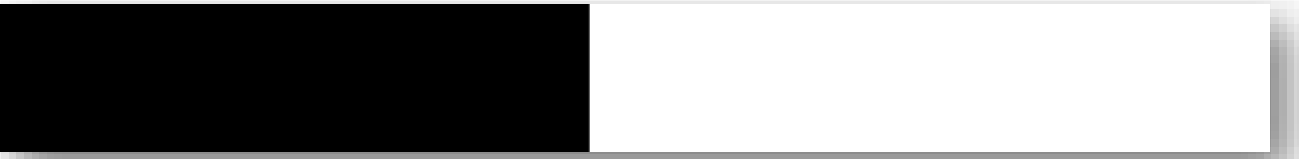
3D conversion

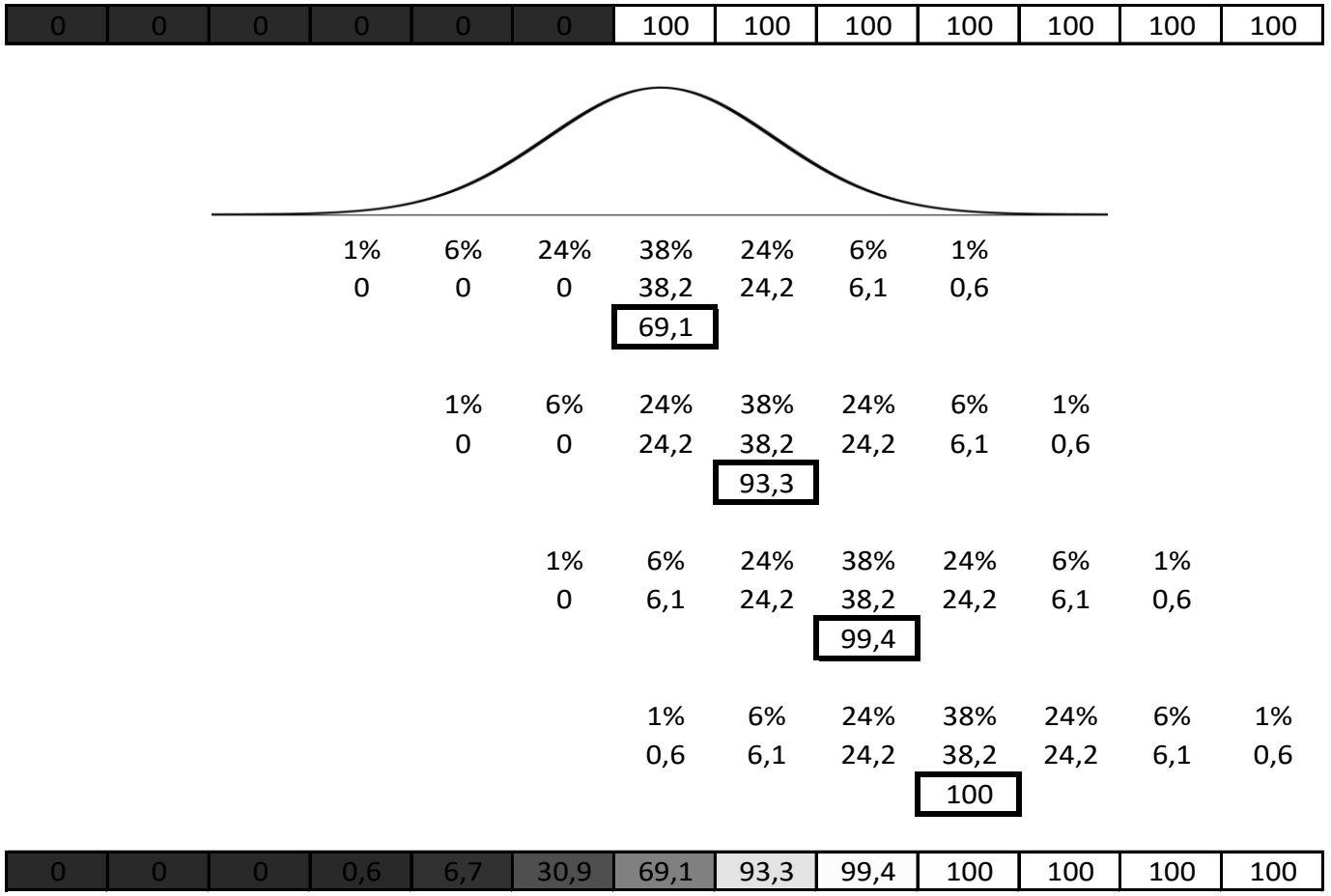


Straight

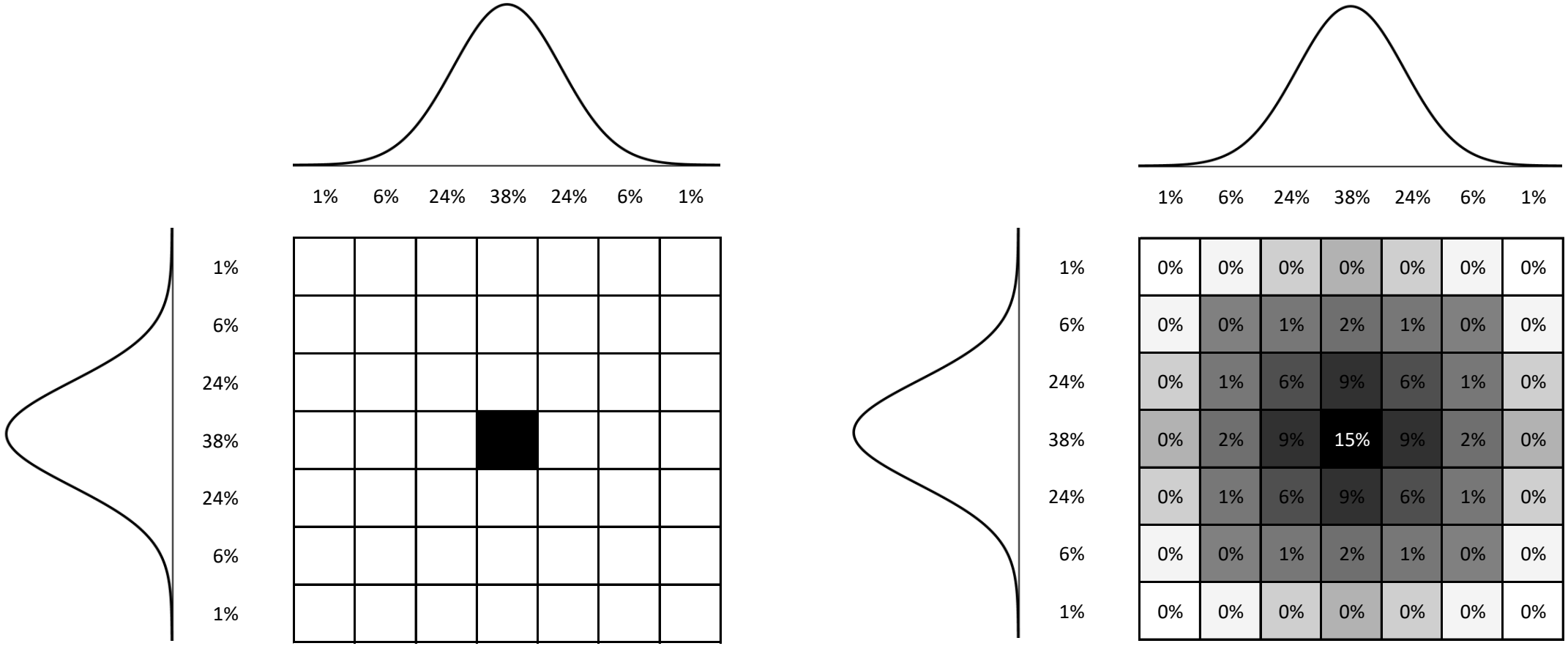


Smooth

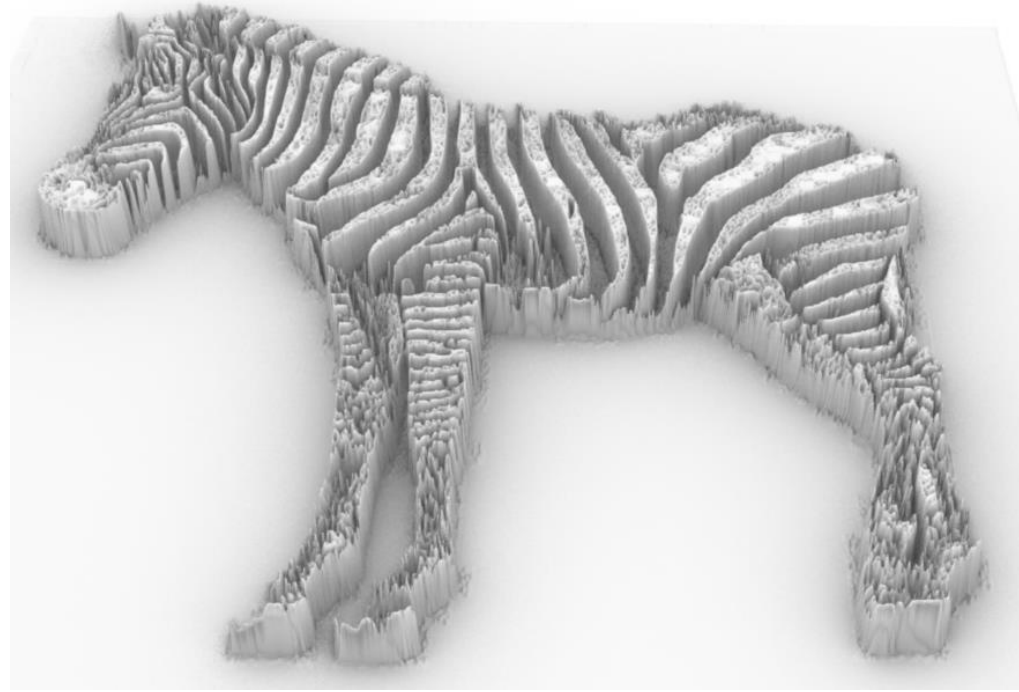


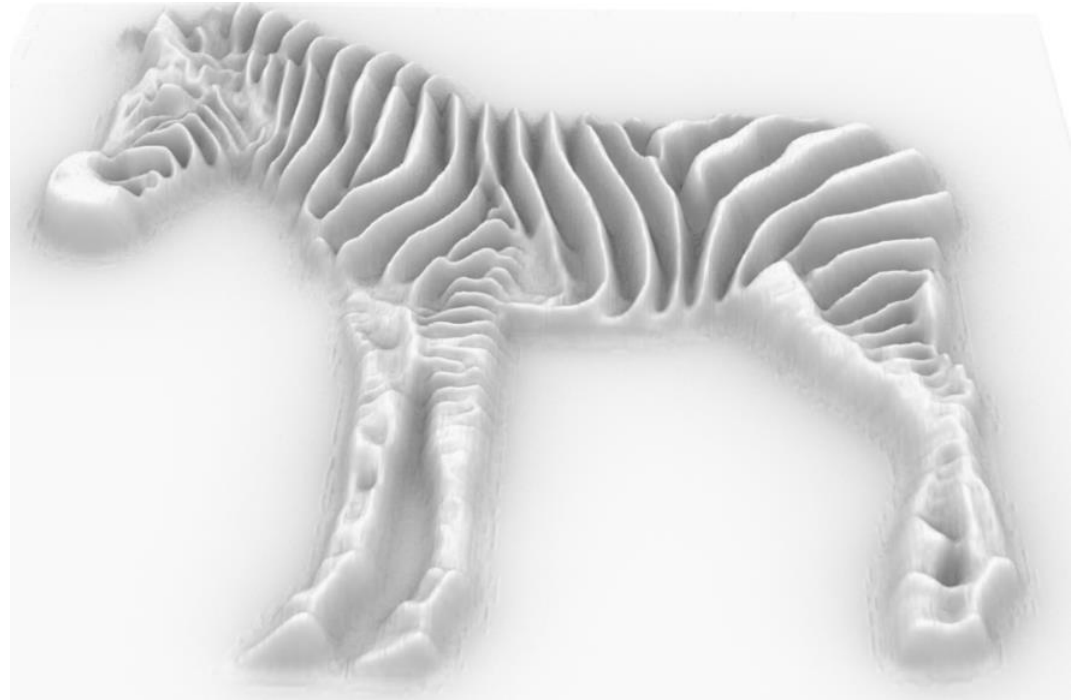


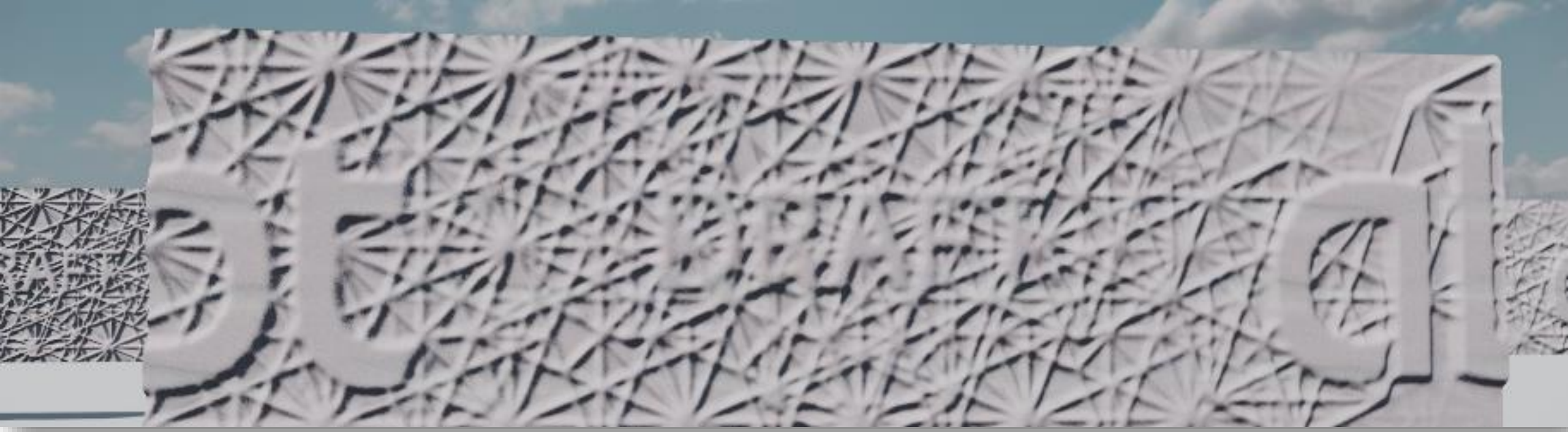
Softening of sharp edges



Softening of sharp edges



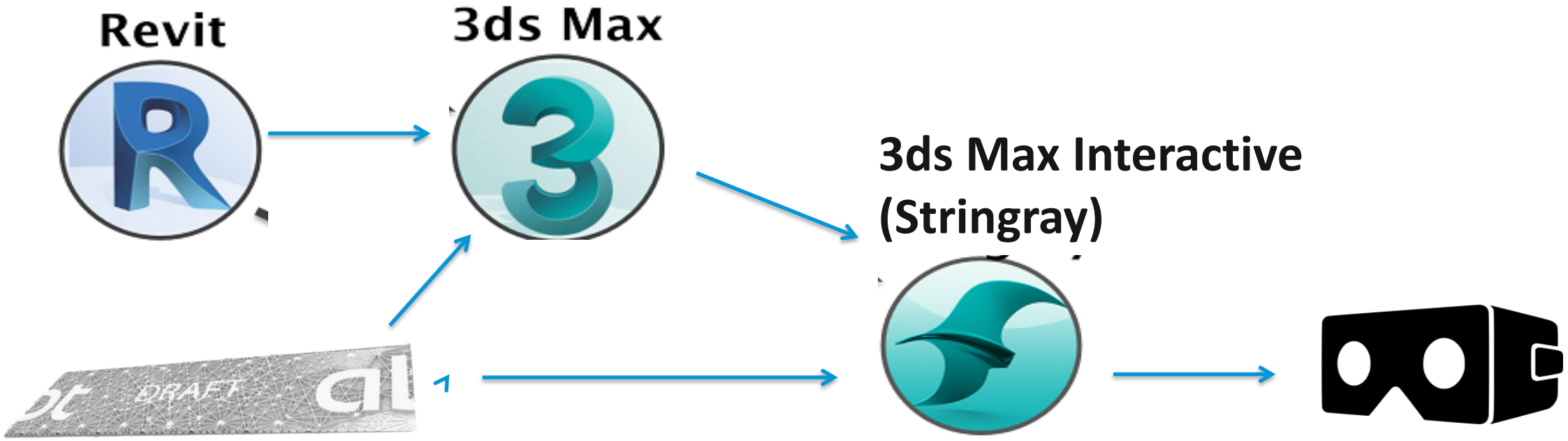




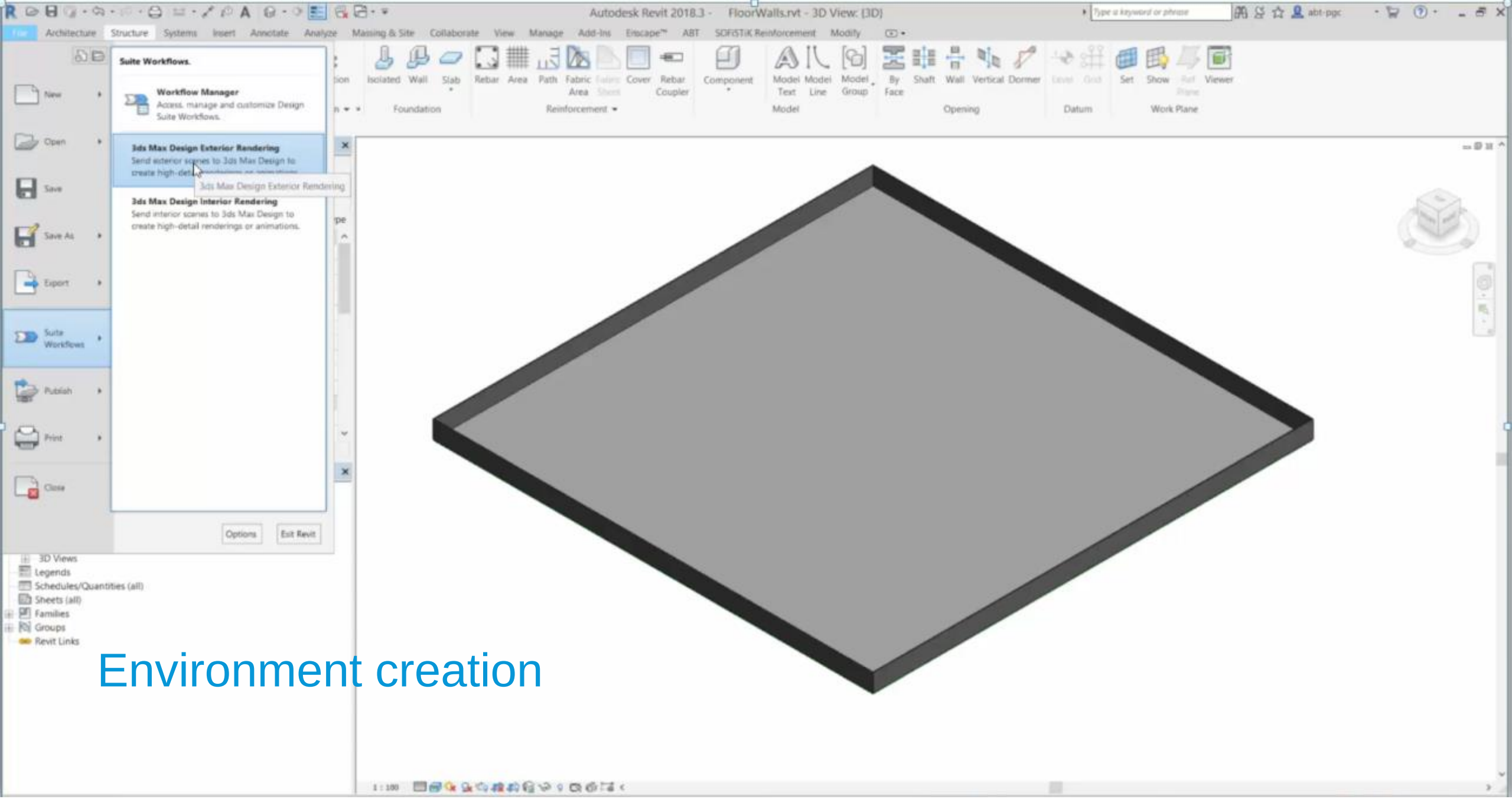
From 2D design to 3D evaluation

Challenges

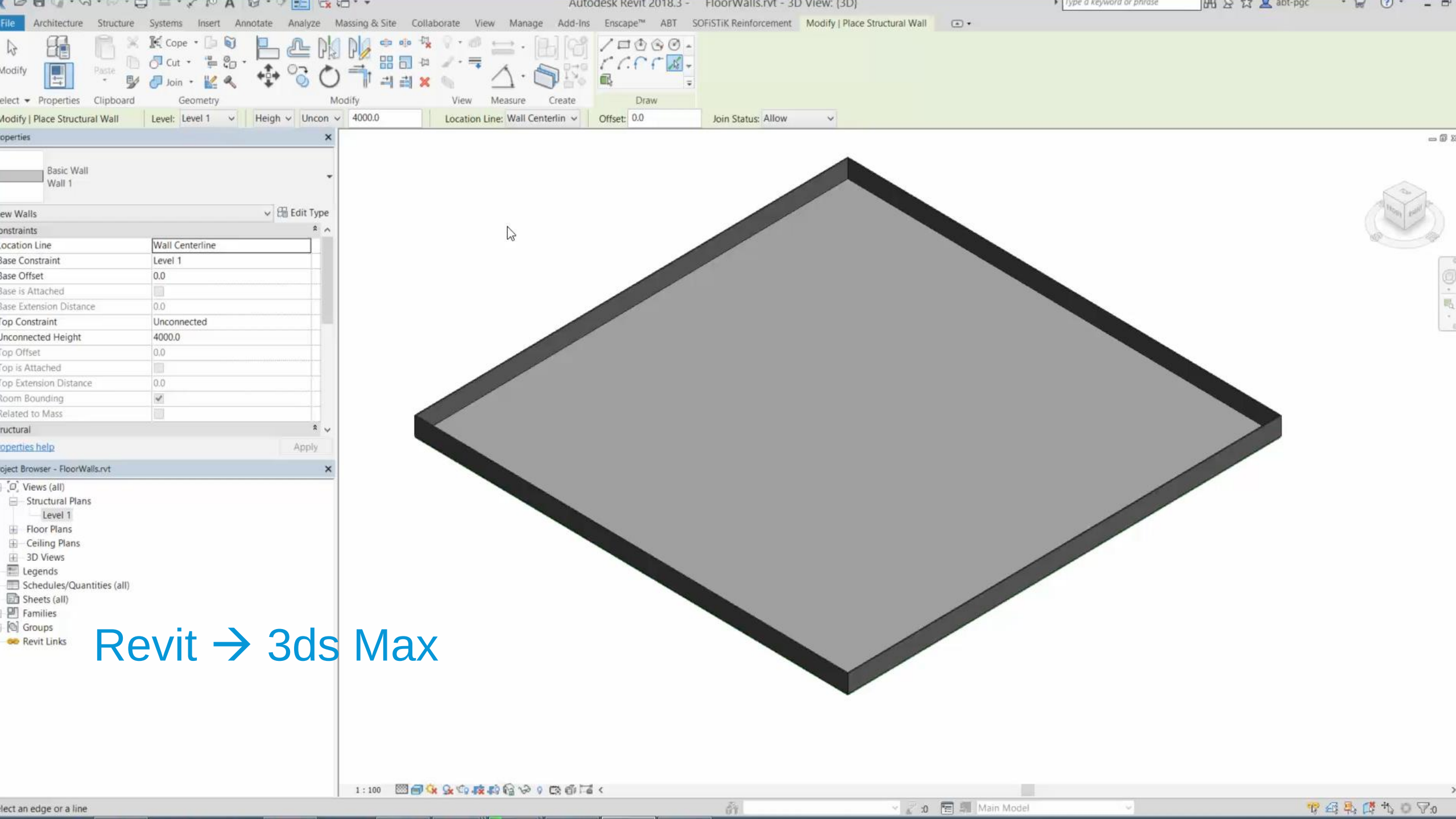
- Depth of pattern
- Required level of smoothening
- Finetuning of design

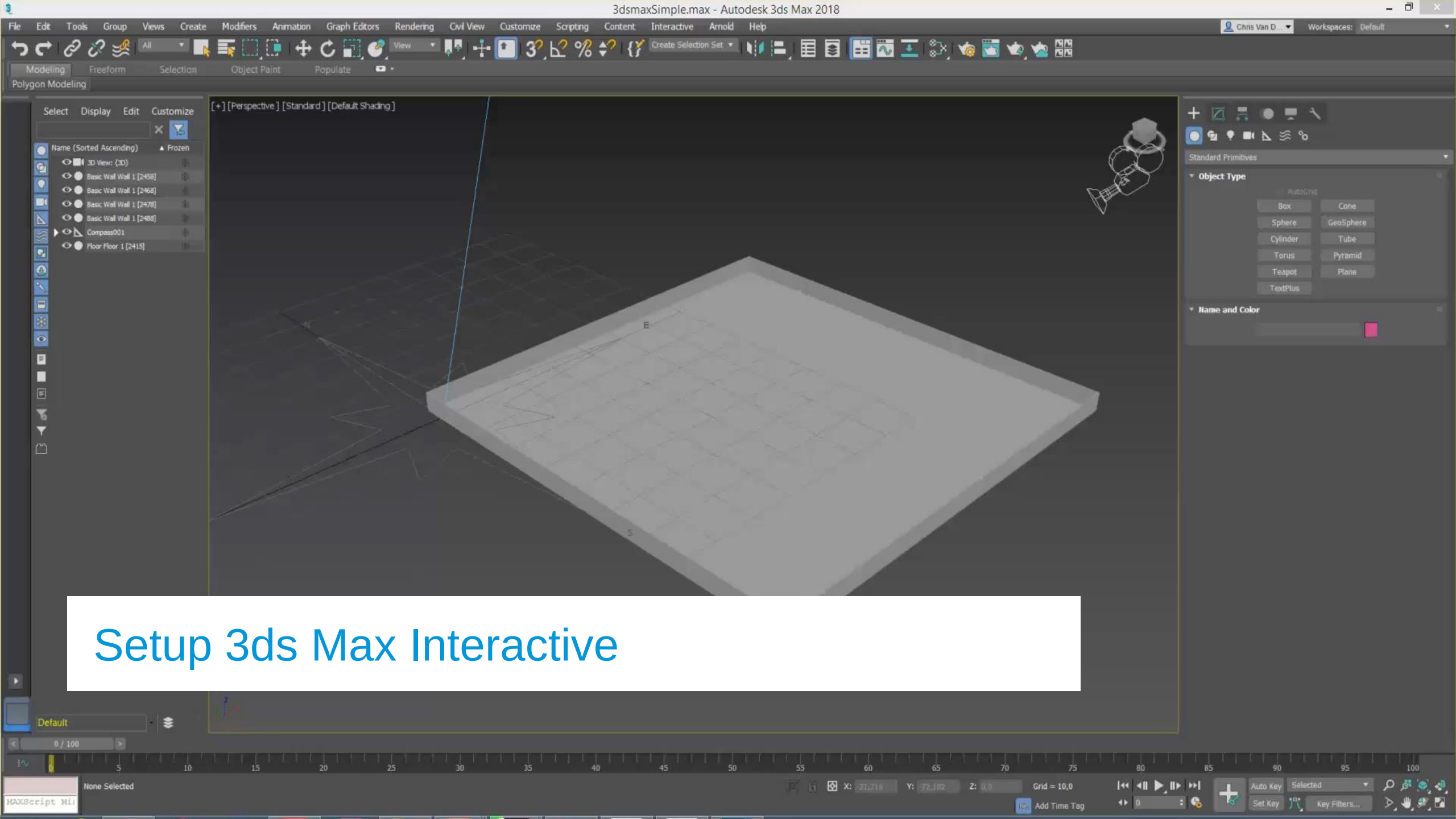


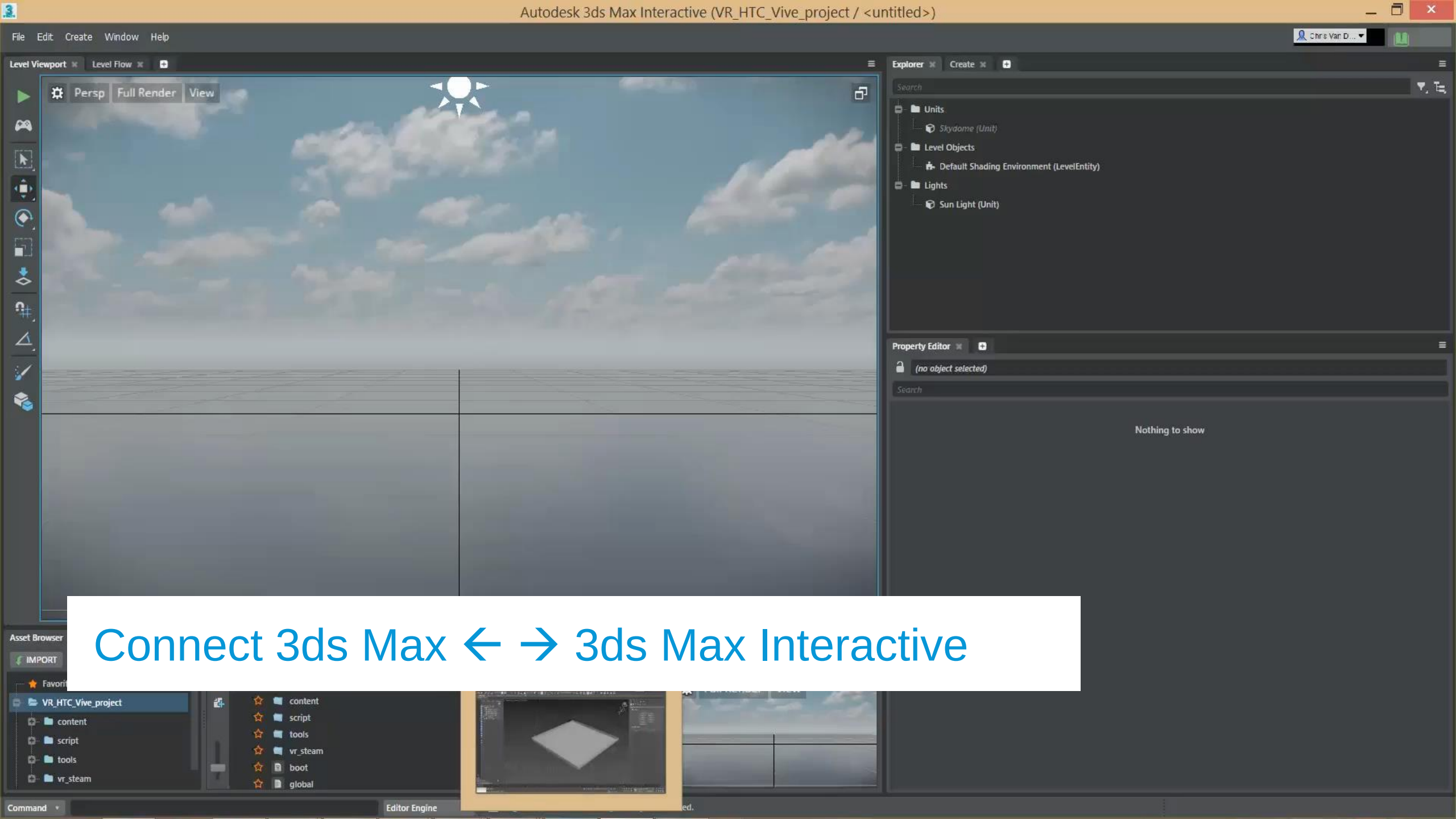
VR Workflow

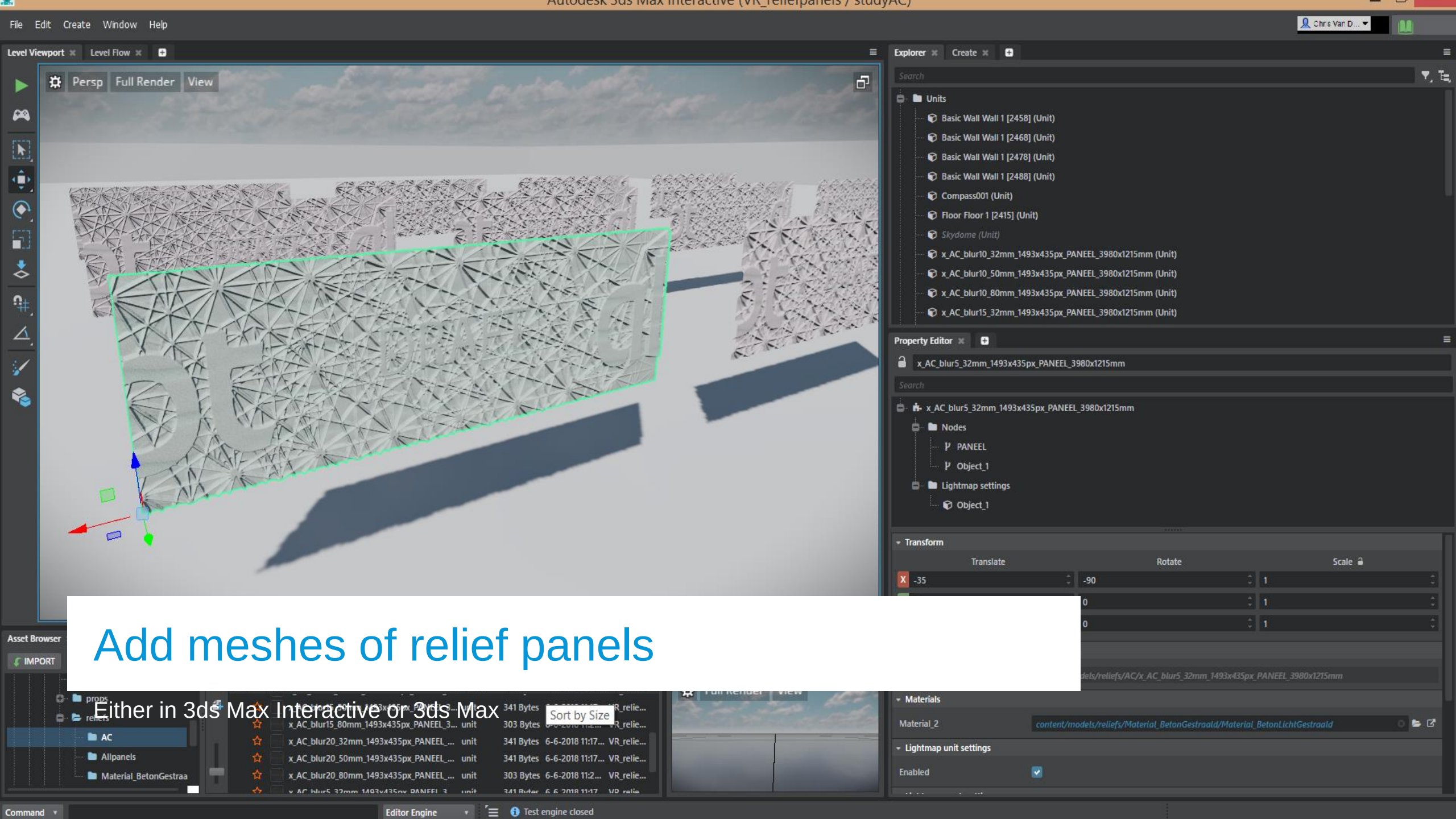


Environment creation


Autodesk Revit 2018.3 - FloorWalls.rvt - 3D View: {3D}
File
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Enscape™
ABT
SOFiSTiK Reinforcement
Modify | Place Structural Wall
Modify
Cope
Cut
Join
Paste
Properties
Clipboard
Geometry
Modify
View
Measure
Create
Draw
Modify | Place Structural Wall
Level: Level 1
Heigh
Uncon
4000.0
Location Line: Wall Centerlin
Offset: 0.0
Join Status: Allow
Basic Wall
Wall 1
Edit Type
Location Line
Wall Centerline
Base Constraint
Level 1
Base Offset
0.0
Top Constraint
Unconnected
Unconnected Height
4000.0
Apply
Project Browser - FloorWalls.rvt
Views (all)
Structural Plans
Level 1
Floor Plans
Ceiling Plans
3D Views
Legends
Schedules/Quantities (all)
Sheets (all)
Families
Groups
Revit Links
Revit → 3ds Max
1 : 100
Main Model


3dsmaxSimple.max - Autodesk 3ds Max 2018
File Edit Tools Group Views Create Modifiers Animation Graph Editors Rendering Civil View Customize Scripting Content Interactive Arnold Help
Modeling Freeform Selection Object Paint Populate
Polygon Modeling
Select Display Edit Customize
[+] [Perspective] [Standard] [Default Shading]
Standard Primitives
Object Type
Box Cone Sphere GeoSphere Cylinder Tube Torus Pyramid Teapot Plane TextPlus
Name and Color
Setup 3ds Max Interactive


Autodesk 3ds Max Interactive (VR_HTC_Vive_project / <untitled>)
File Edit Create Window Help
Level Viewport
Level Flow
Persp
Full Render
View
Explorer
Create
Search
Units
Skydome (Unit)
Level Objects
Default Shading Environment (LevelEntity)
Lights
Sun Light (Unit)
Property Editor
(no object selected)
Search
Nothing to show
Asset Browser
IMPORT
VR_HTC_Vive_project
content
script
tools
vr_steam
content
script
tools
vr_steam
boot
global
Command
Editor Engine
Connect 3ds Max ← → 3ds Max Interactive

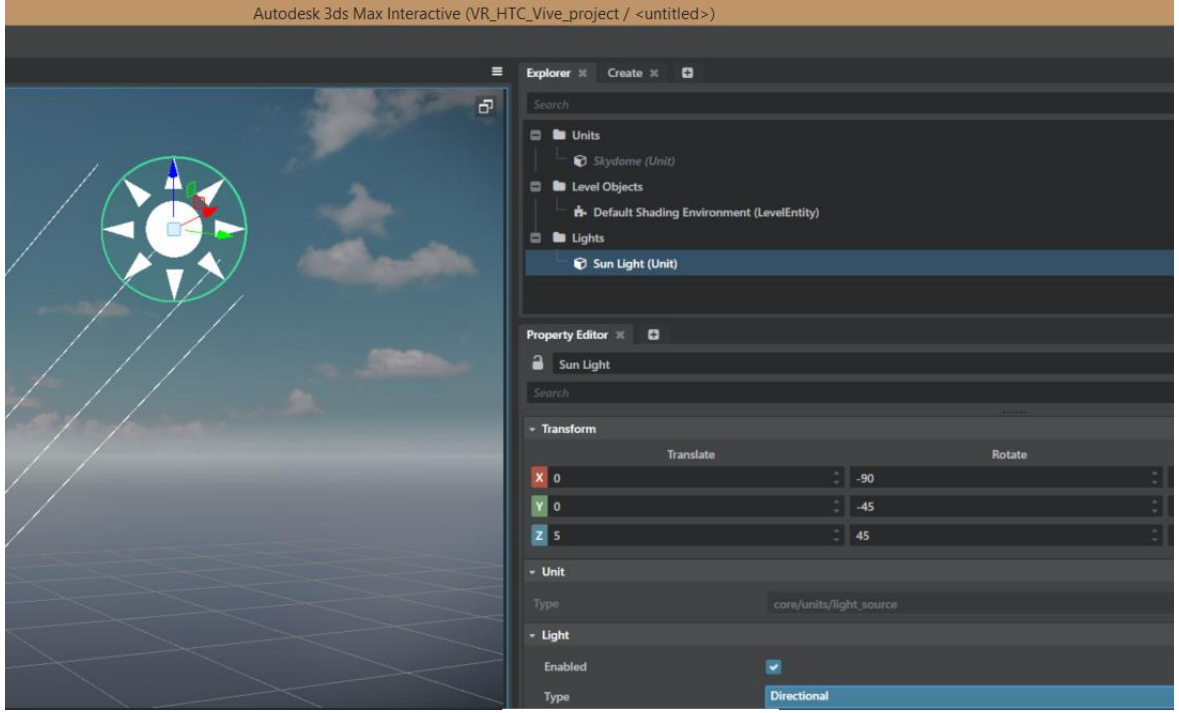


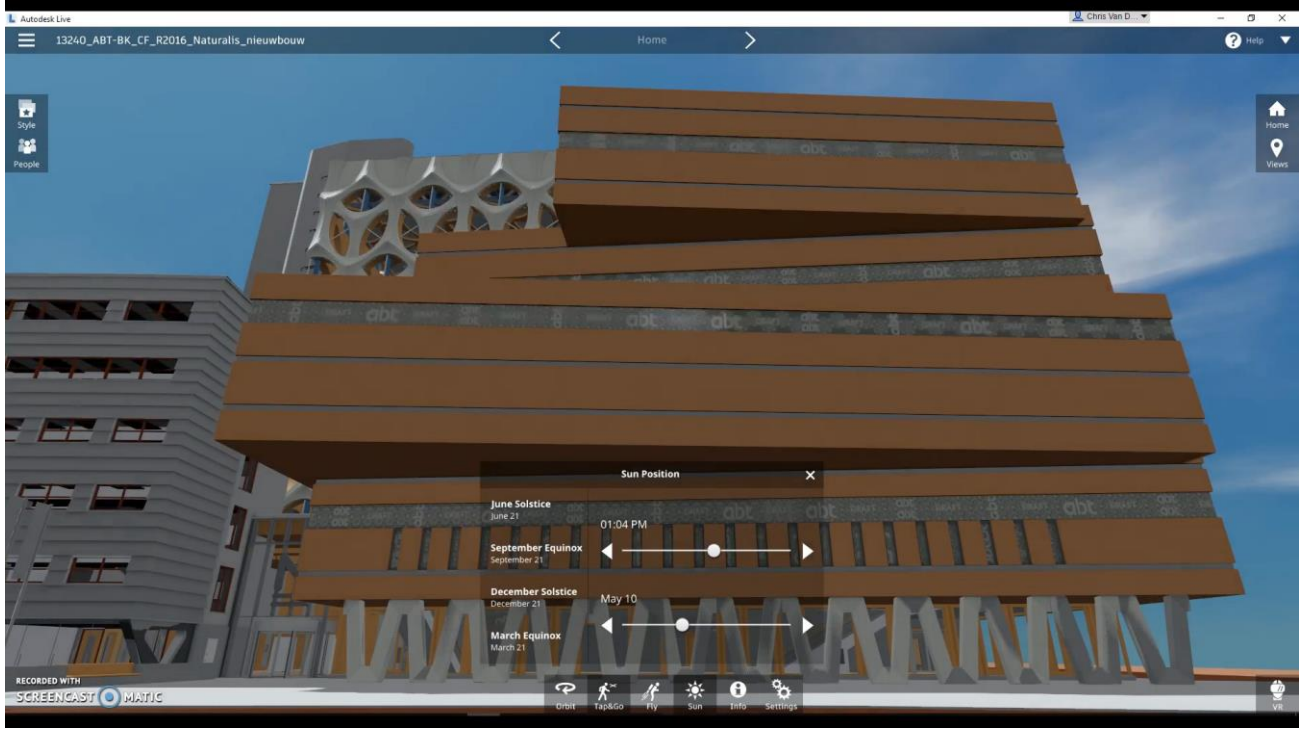
Add meshes of relief panels

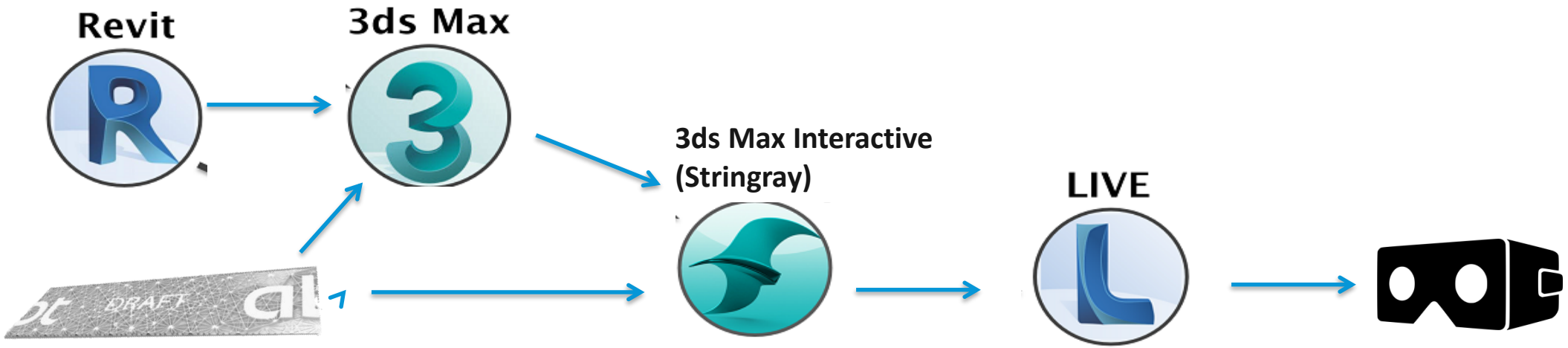
Either in 3ds Max Interactive or 3ds Max

Play!

Play!



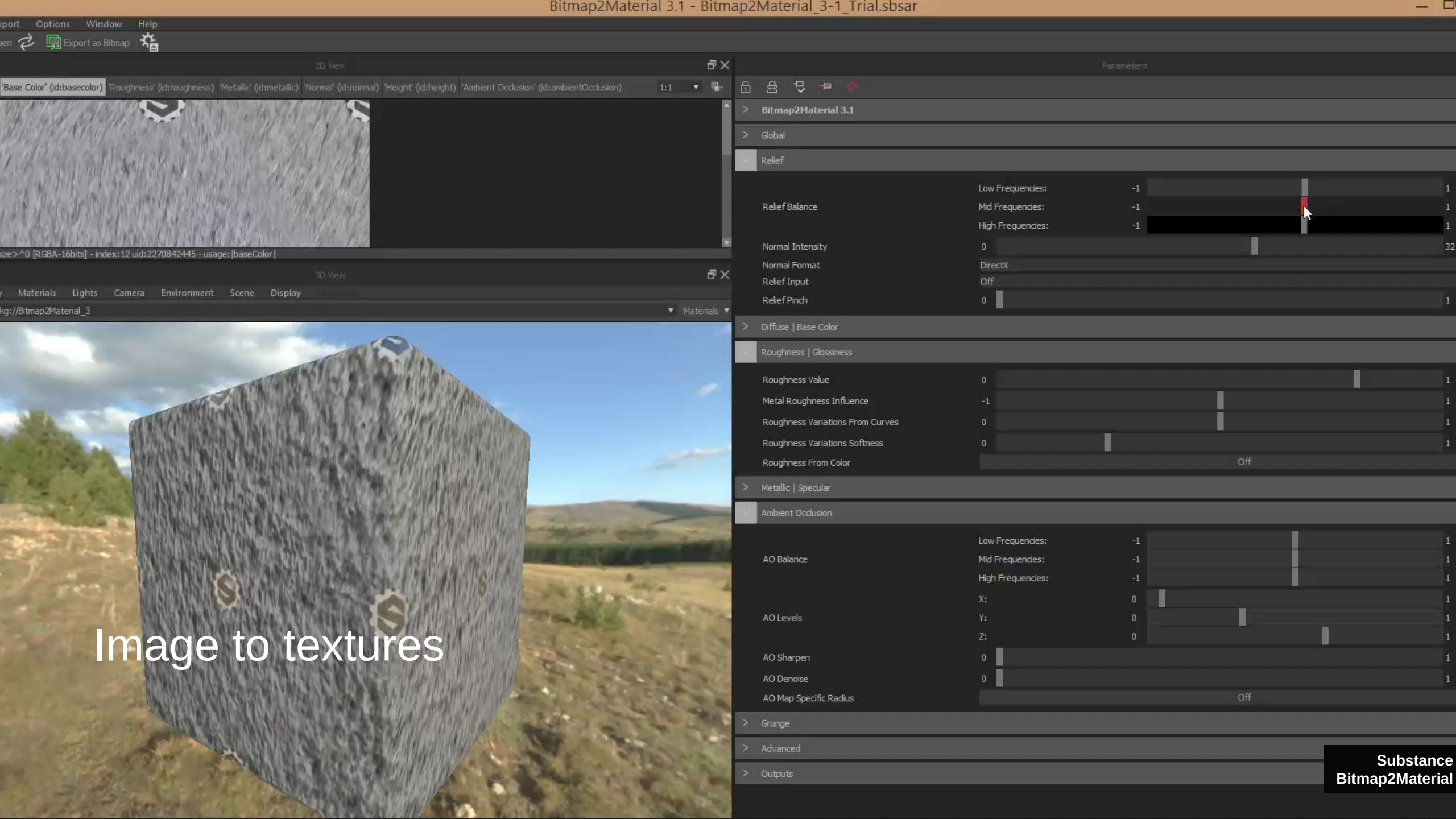


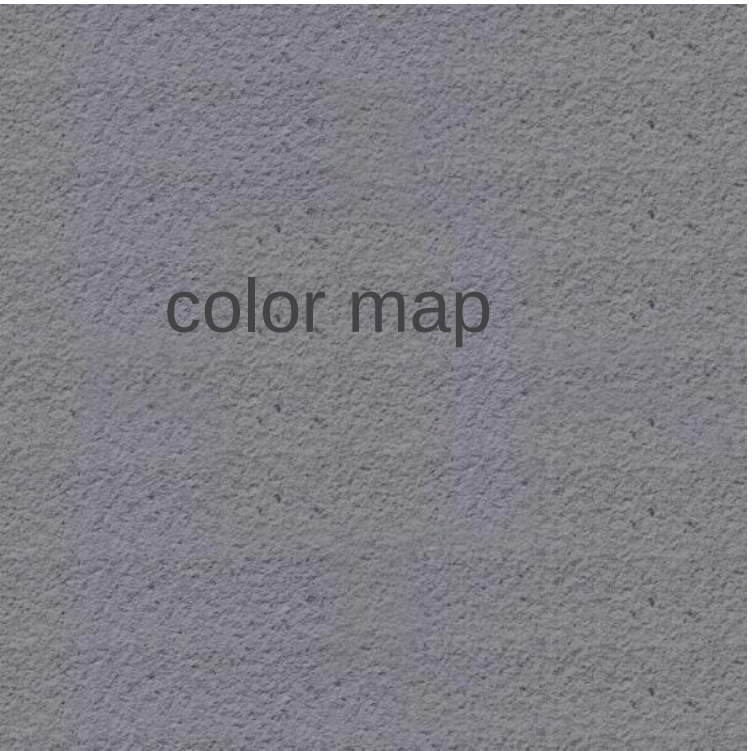


Sun easier to adjust in Live during demos

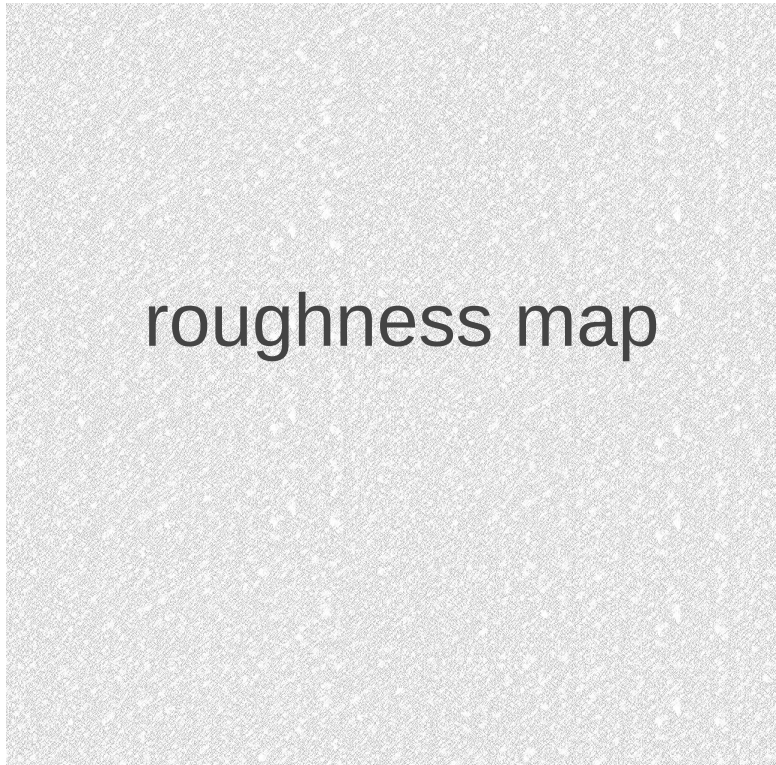
Realistic virtual materials

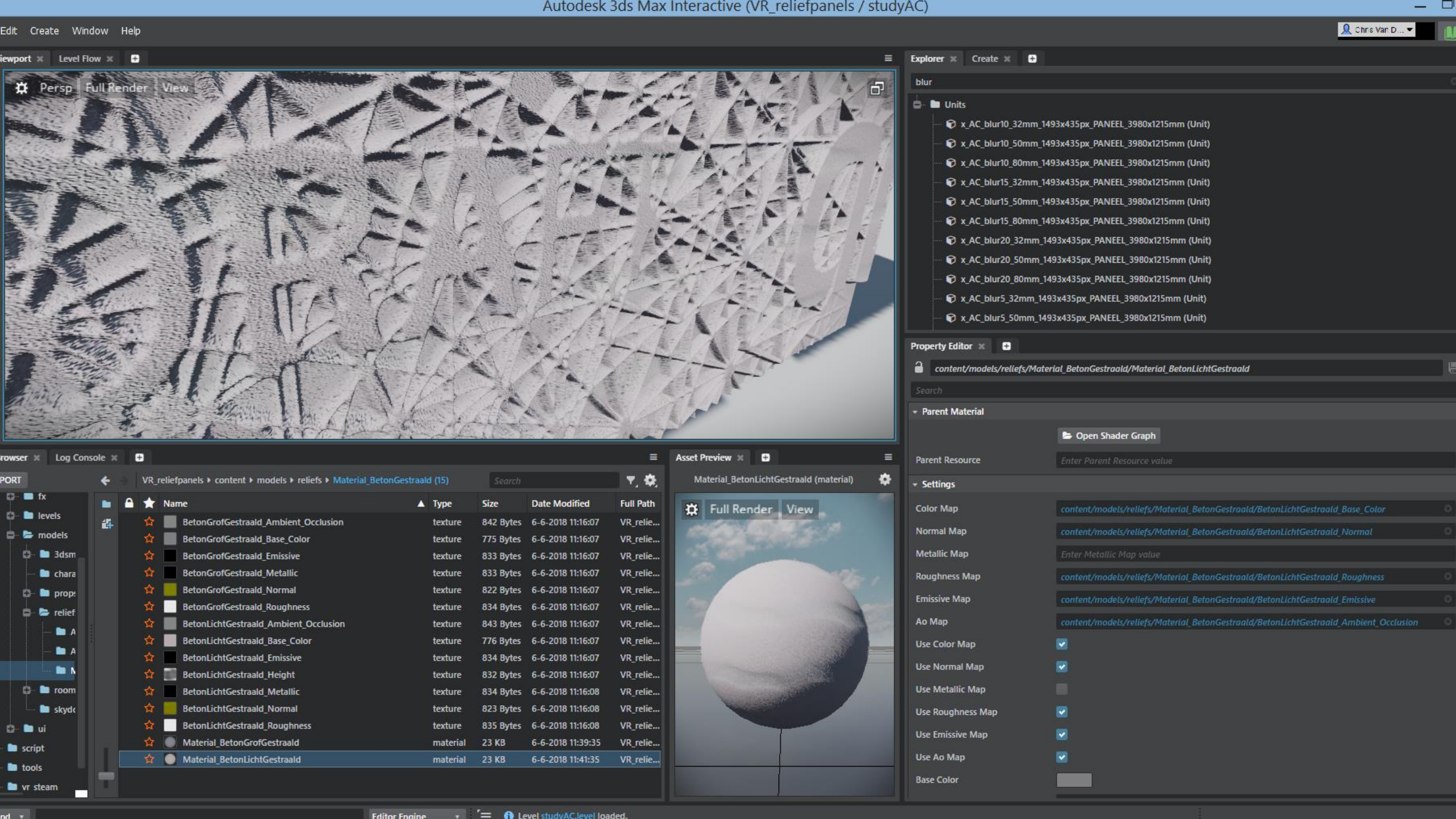
Concrete textures from images of real samples


Bitmap2Material 3.1 - Bitmap2Material_3-1_Trial.sbsar
Options
Window
Help
Export as Bitmap
2D View
'Base Color' (id:basecolor)
'Roughness' (id:roughness)
'Metallic' (id:metallic)
'Normal' (id:normal)
'Height' (id:height)
'Ambient Occlusion' (id:ambientOcclusion)
1:1
size>^0 [RGBA-16bits] - index:12 uid:2270842445 - usage:|baseColor|
3D View
Materials
Lights
Camera
Environment
Scene
Display
kg://Bitmap2Material_3
Materials
Image to textures
Parameters
Bitmap2Material 3.1
Global
Relief
Relief Balance
Low Frequencies:
Mid Frequencies:
High Frequencies:
Normal Intensity
Normal Format
DirectX
Relief Input
Off
Relief Pinch
Diffuse | Base Color
Roughness | Glossiness
Roughness Value
Metal Roughness Influence
Roughness Variations From Curves
Roughness Variations Softness
Roughness From Color
Off
Metallic | Specular
Ambient Occlusion
AO Balance
AO Levels
X:
Y:
Z:
AO Sharpen
AO Denoise
AO Map Specific Radius
Off
Grunge
Advanced
Outputs
Substance
Bitmap2Material


color map


normal map


roughness map


Autodesk 3ds Max Interactive (VR_reliefpanels / studyAC)
Edit
Create
Window
Help
Chris Van D...
Viewport
Level Flow
Persp
Full Render
View
Explorer
Create
blur
Units
x_AC_blur10_32mm_1493x435px_PANEEL_3980x1215mm (Unit)
x_AC_blur10_50mm_1493x435px_PANEEL_3980x1215mm (Unit)
x_AC_blur10_80mm_1493x435px_PANEEL_3980x1215mm (Unit)
x_AC_blur15_32mm_1493x435px_PANEEL_3980x1215mm (Unit)
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x_AC_blur5_50mm_1493x435px_PANEEL_3980x1215mm (Unit)
Property Editor
content/models/reliefs/Material_BetonGestraald/Material_BetonLichtGestraald
Search
Parent Material
Open Shader Graph
Parent Resource
Enter Parent Resource value
Settings
Color Map
content/models/reliefs/Material_BetonGestraald/BetonLichtGestraald_Base_Color
Normal Map
content/models/reliefs/Material_BetonGestraald/BetonLichtGestraald_Normal
Metallic Map
Enter Metallic Map value
Roughness Map
content/models/reliefs/Material_BetonGestraald/BetonLichtGestraald_Roughness
Emissive Map
content/models/reliefs/Material_BetonGestraald/BetonLichtGestraald_Emissive
Ao Map
content/models/reliefs/Material_BetonGestraald/BetonLichtGestraald_Ambient_Occlusion
Use Color Map
Use Normal Map
Use Metallic Map
Use Roughness Map
Use Emissive Map
Use Ao Map
Base Color
Browser
Log Console
VR_reliefpanels ▸ content ▸ models ▸ reliefs ▸ Material_BetonGestraald (15)
Search
fx
levels
models
3dsm
chara
props
relief
room
skydo
ui
script
tools
vr steam
Name
Type
Size
Date Modified
Full Path
BetonGrofGestraald_Ambient_Occlusion texture 842 Bytes 6-6-2018 11:16:07 VR_relie...
BetonGrofGestraald_Base_Color texture 775 Bytes 6-6-2018 11:16:07 VR_relie...
BetonGrofGestraald_Emissive texture 833 Bytes 6-6-2018 11:16:07 VR_relie...
BetonGrofGestraald_Metallic texture 833 Bytes 6-6-2018 11:16:07 VR_relie...
BetonGrofGestraald_Normal texture 822 Bytes 6-6-2018 11:16:07 VR_relie...
BetonGrofGestraald_Roughness texture 834 Bytes 6-6-2018 11:16:07 VR_relie...
BetonLichtGestraald_Ambient_Occlusion texture 843 Bytes 6-6-2018 11:16:07 VR_relie...
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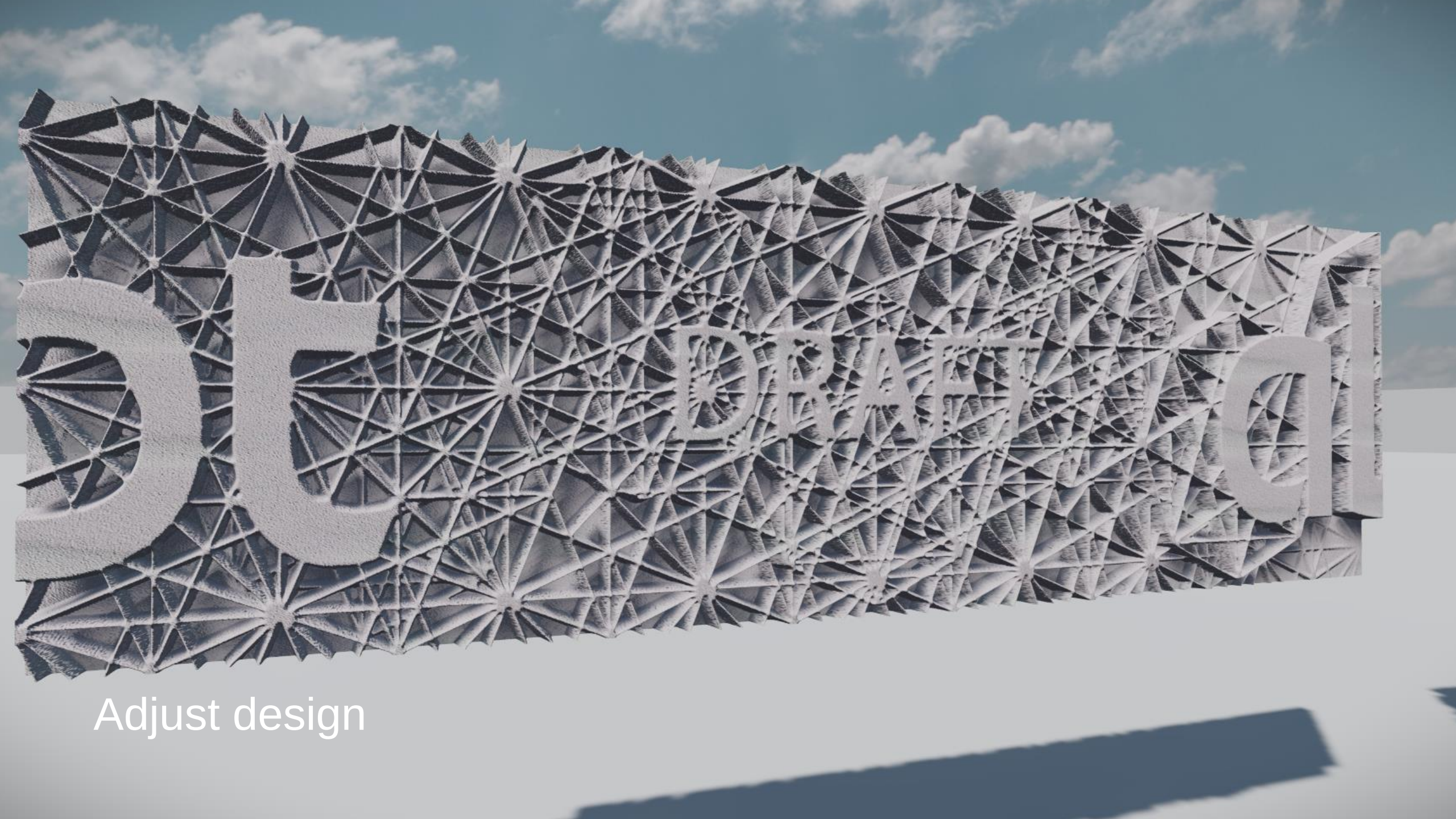
BetonLichtGestraald_Emissive texture 834 Bytes 6-6-2018 11:16:07 VR_relie...
BetonLichtGestraald_Height texture 832 Bytes 6-6-2018 11:16:07 VR_relie...
BetonLichtGestraald_Metallic texture 834 Bytes 6-6-2018 11:16:08 VR_relie...
BetonLichtGestraald_Normal texture 823 Bytes 6-6-2018 11:16:08 VR_relie...
BetonLichtGestraald_Roughness texture 835 Bytes 6-6-2018 11:16:08 VR_relie...
Material_BetonGrofGestraald material 23 KB 6-6-2018 11:39:35 VR_relie...
Material_BetonLichtGestraald material 23 KB 6-6-2018 11:41:35 VR_relie...
Asset Preview
Material_BetonLichtGestraald (material)
Full Render
View
Editor Engine
Level studyAC.level loaded.

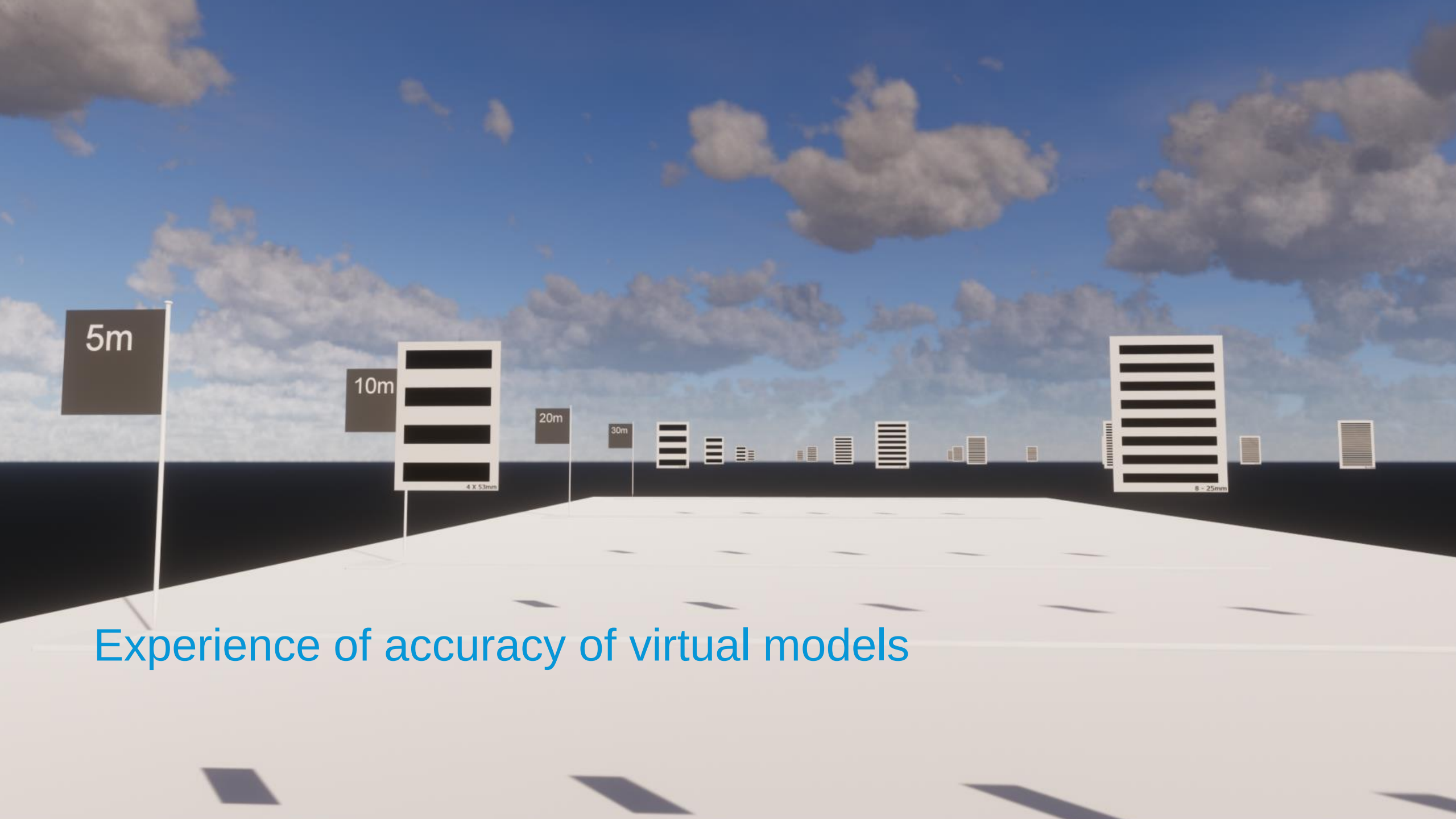
Realistic material experience



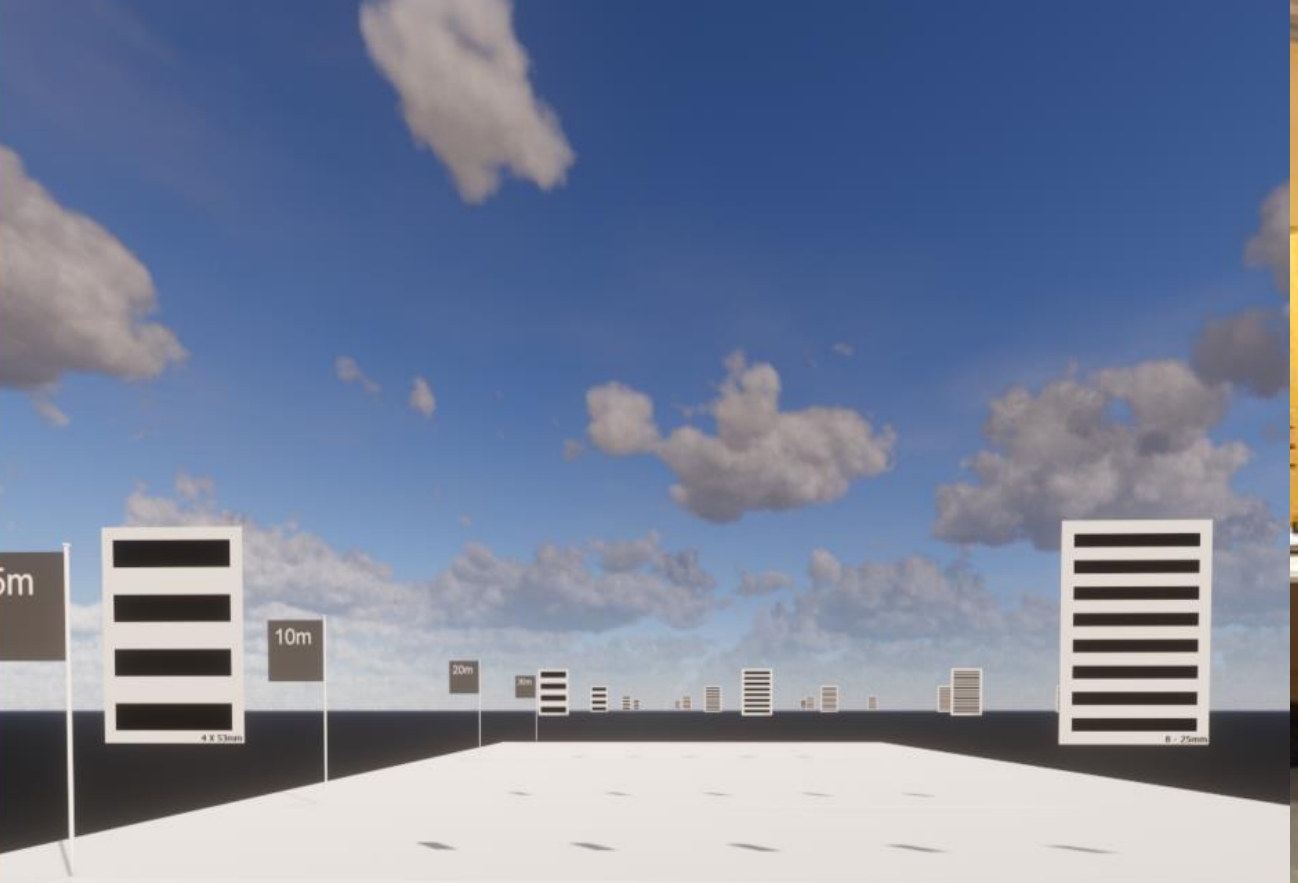
Adjust design

Evaluate design alternatives

Variation in pattern depth & gaussian blur

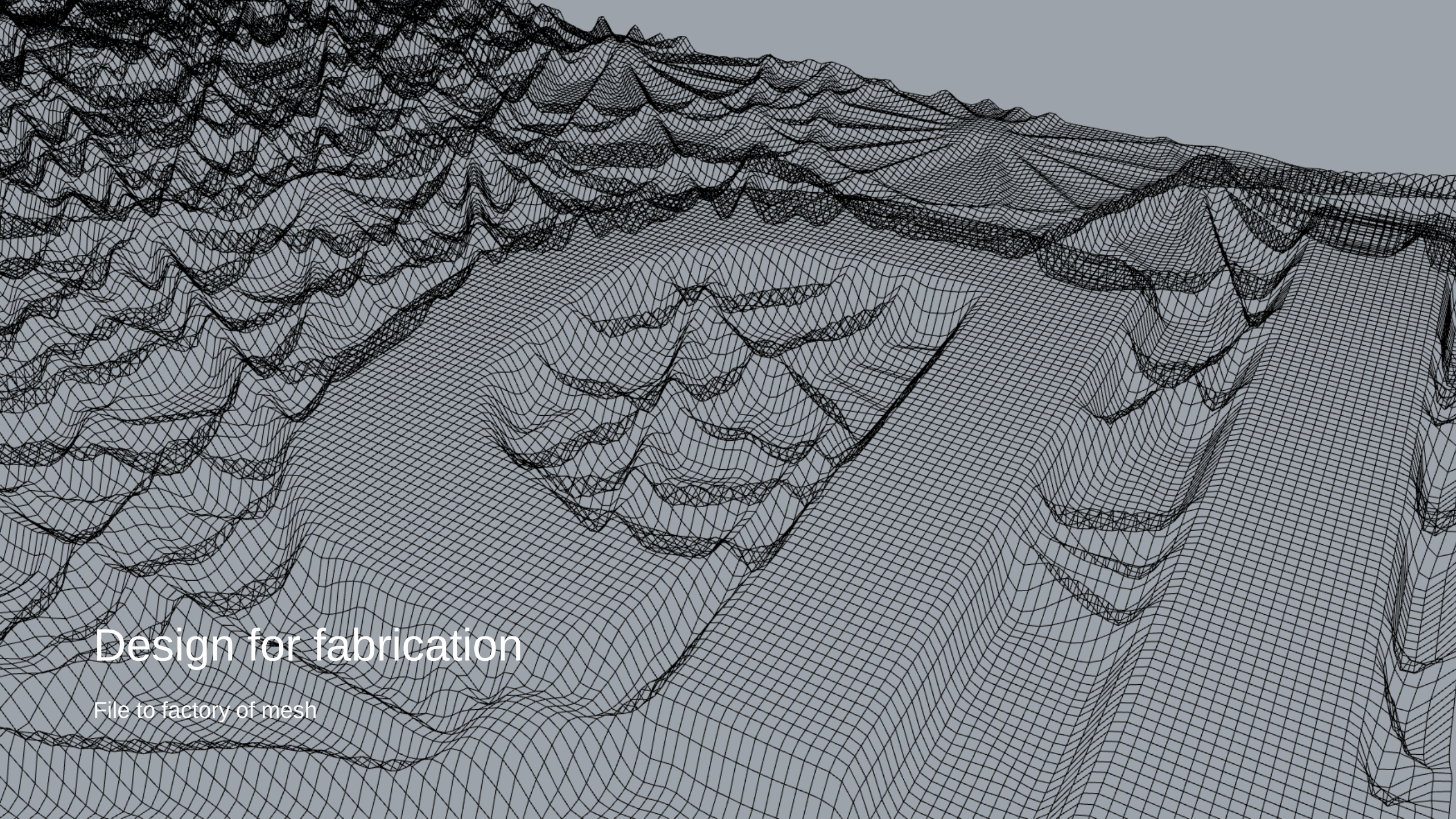


Experience of accuracy of virtual models



Accuracy of detail experience

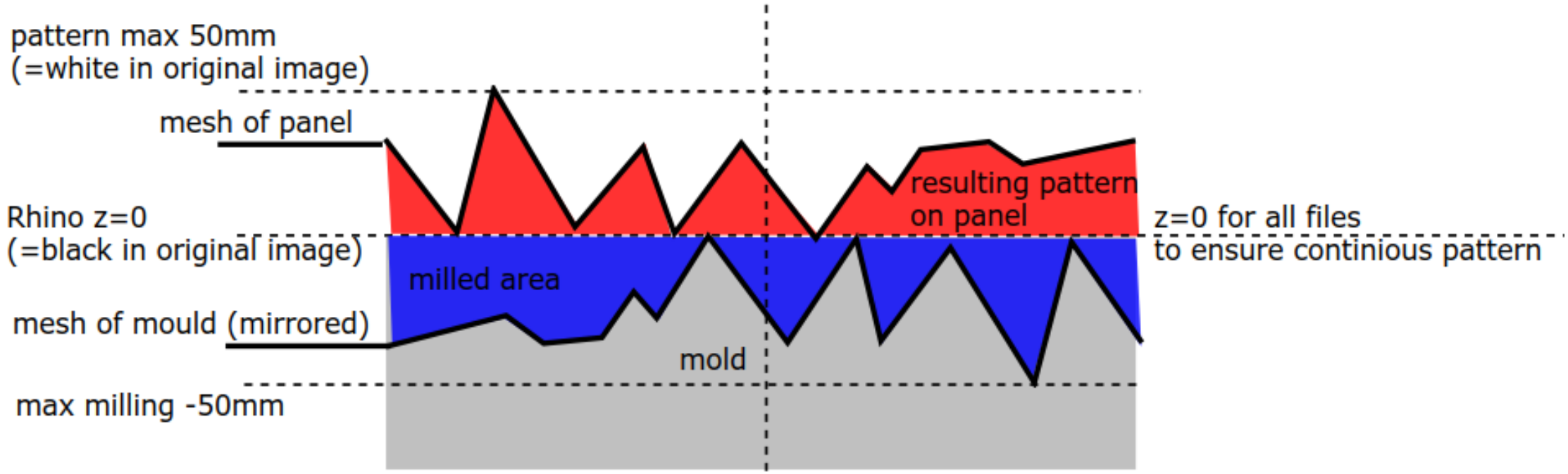
Virtual reality versus reality



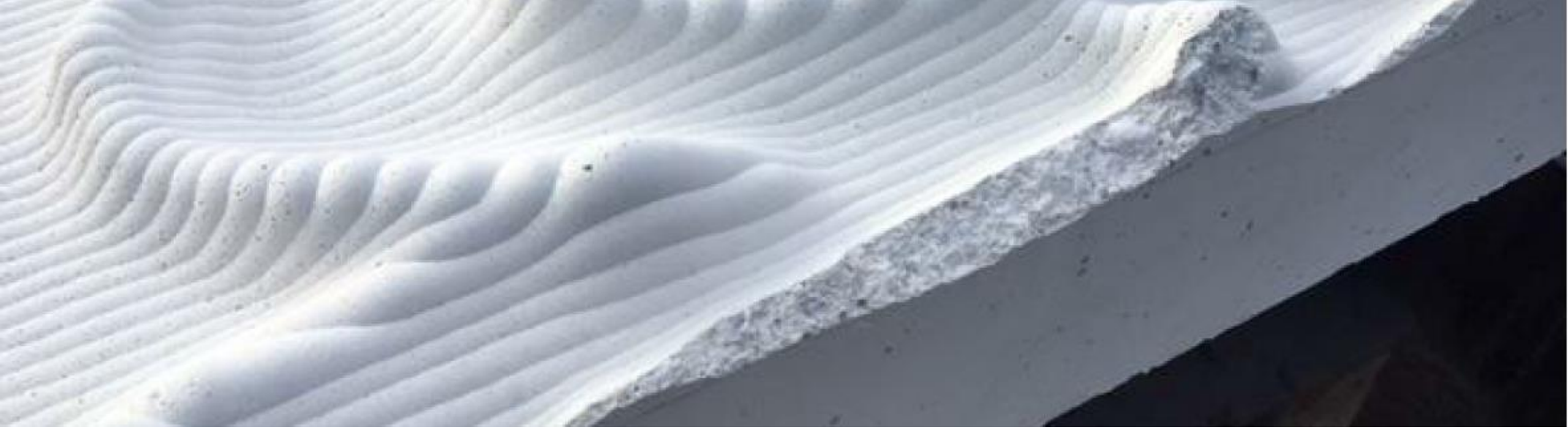
Design for fabrication

File to factory of mesh

File to factory export of mesh

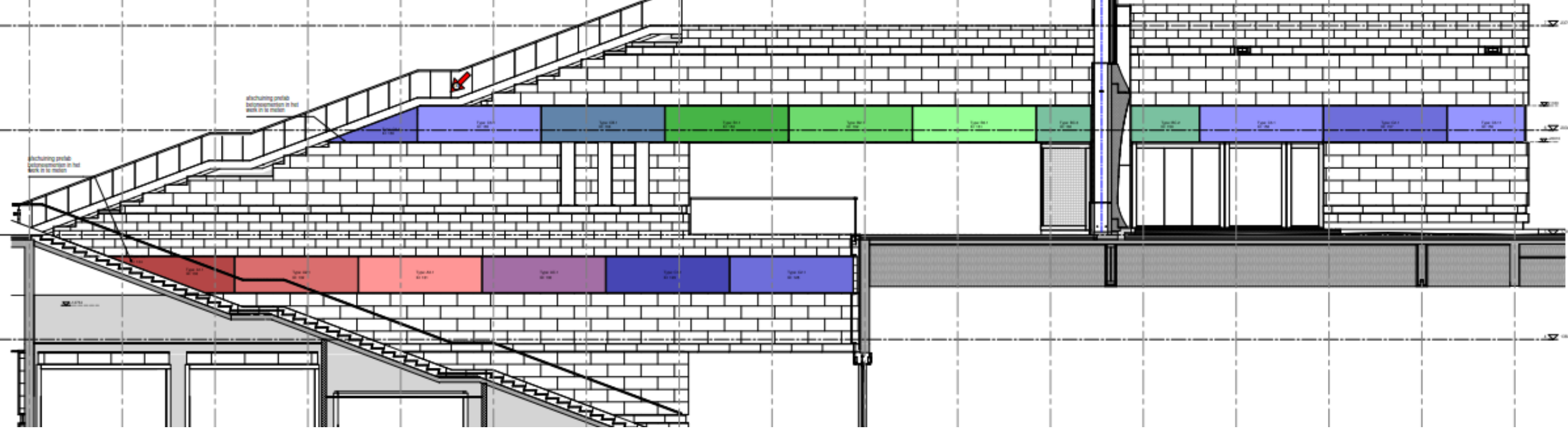


Mould as mirrored version of the panel



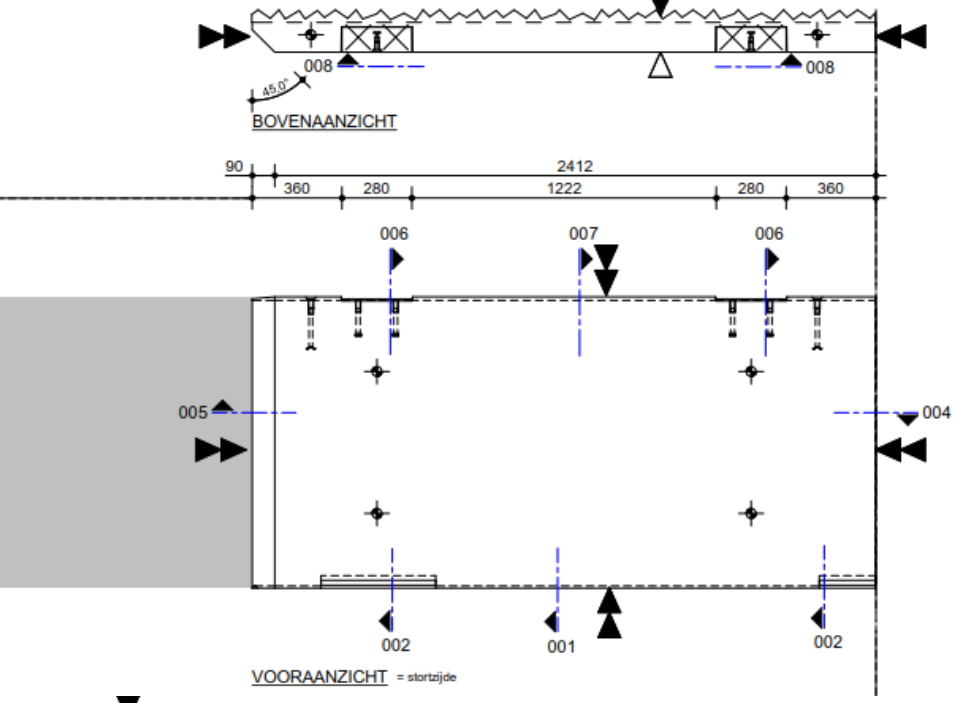
Real mockups required to verify fabricatability

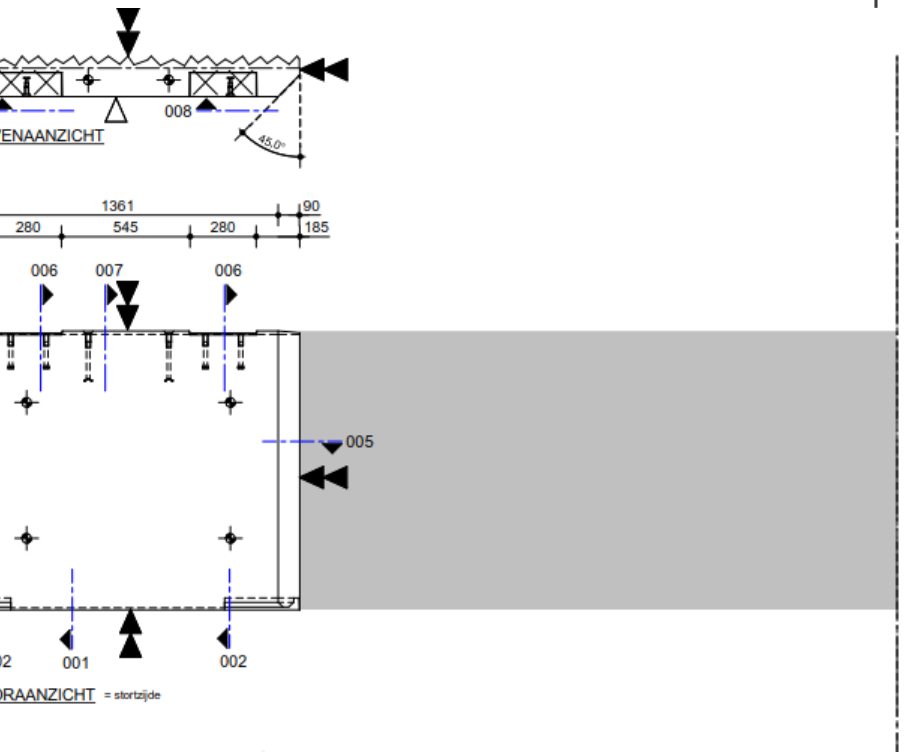
Relief panel distribution



Challenges

- Distributed panels as one continuous ribbon
- Minimum dimensions of panels, no left over pieces
- Continuous pattern along panels
- Sufficient variation of pattern per side

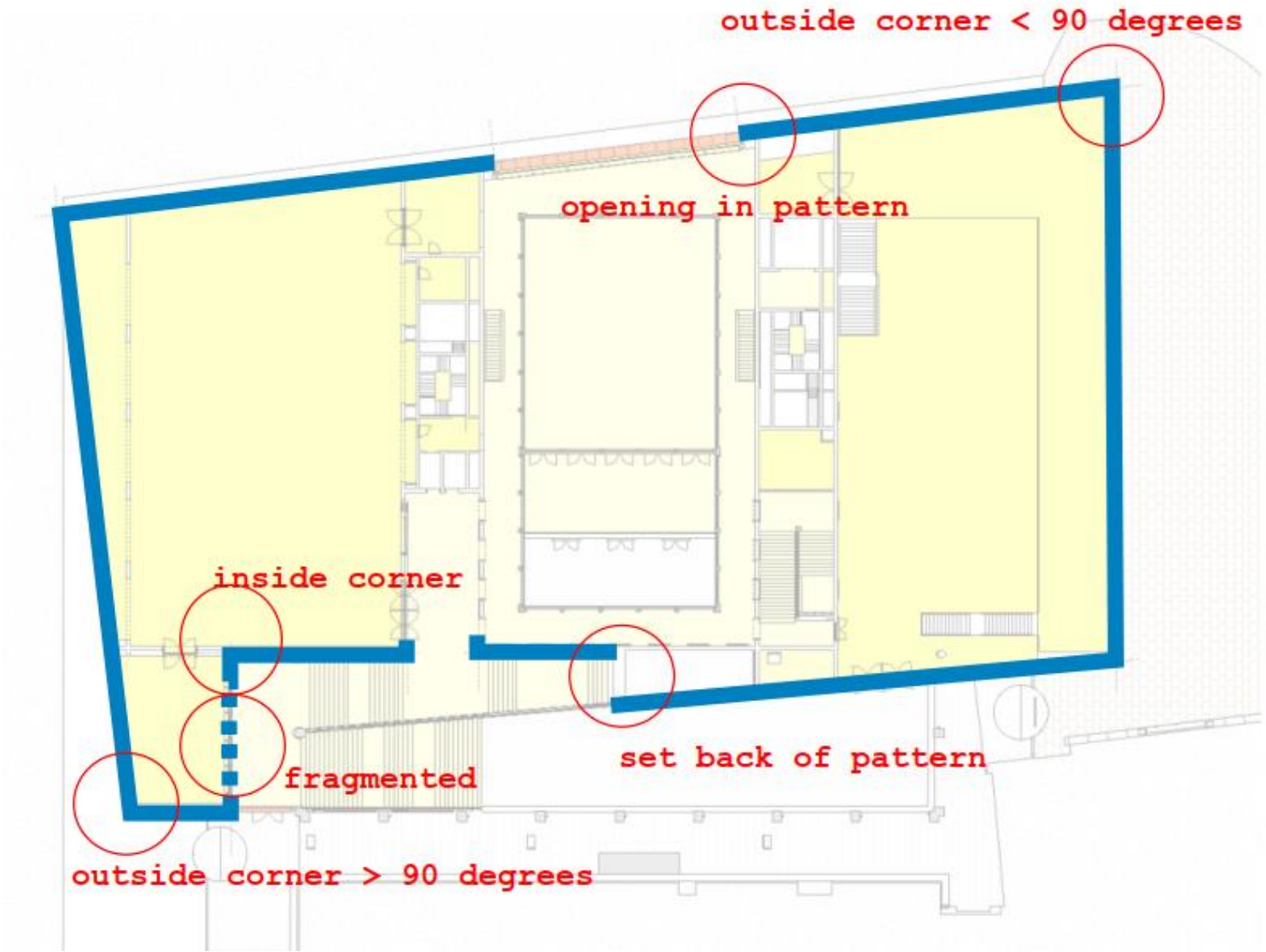




Panels continious around corners

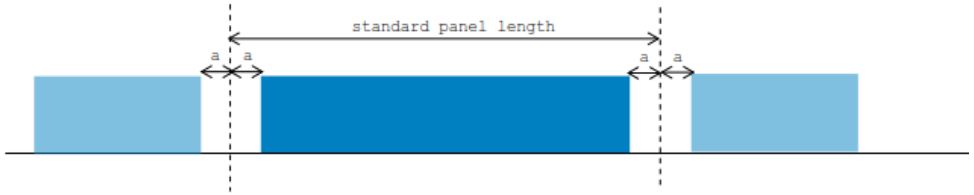
Minimum width criterium

Inventarisation of “exceptions”

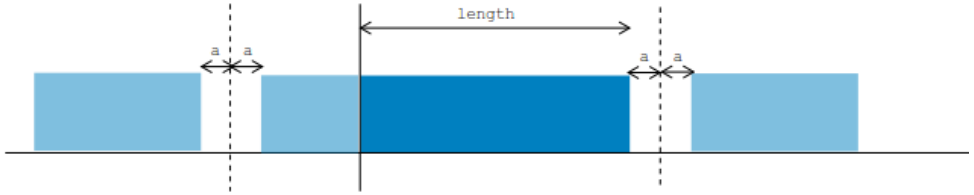


Design rules

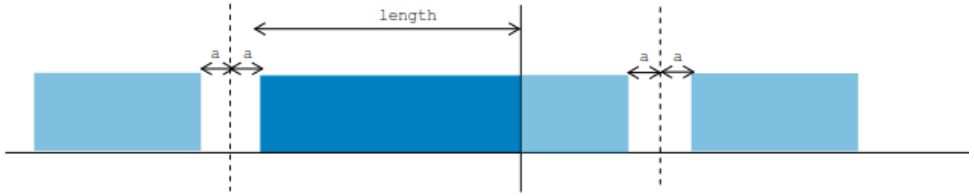
Standard panel



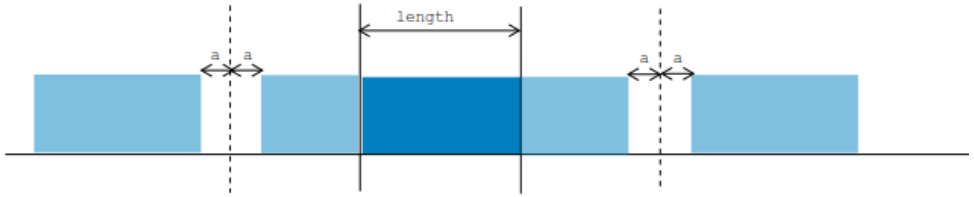
End left



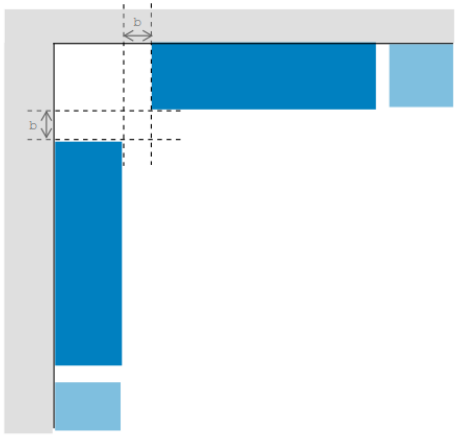
End right



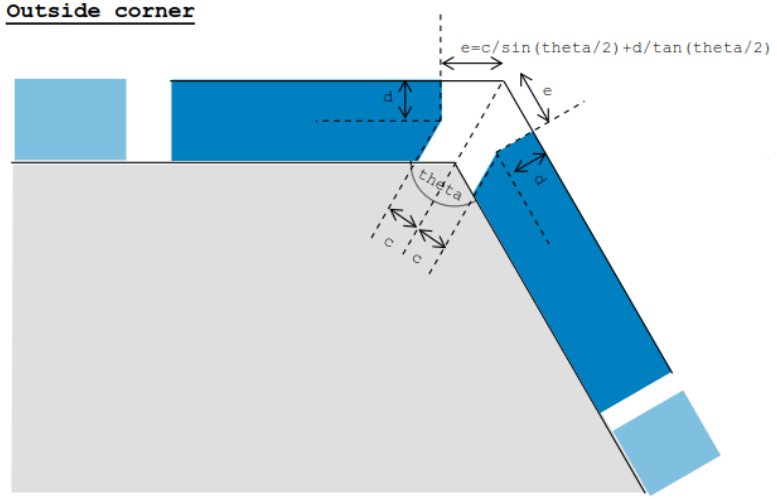
End both

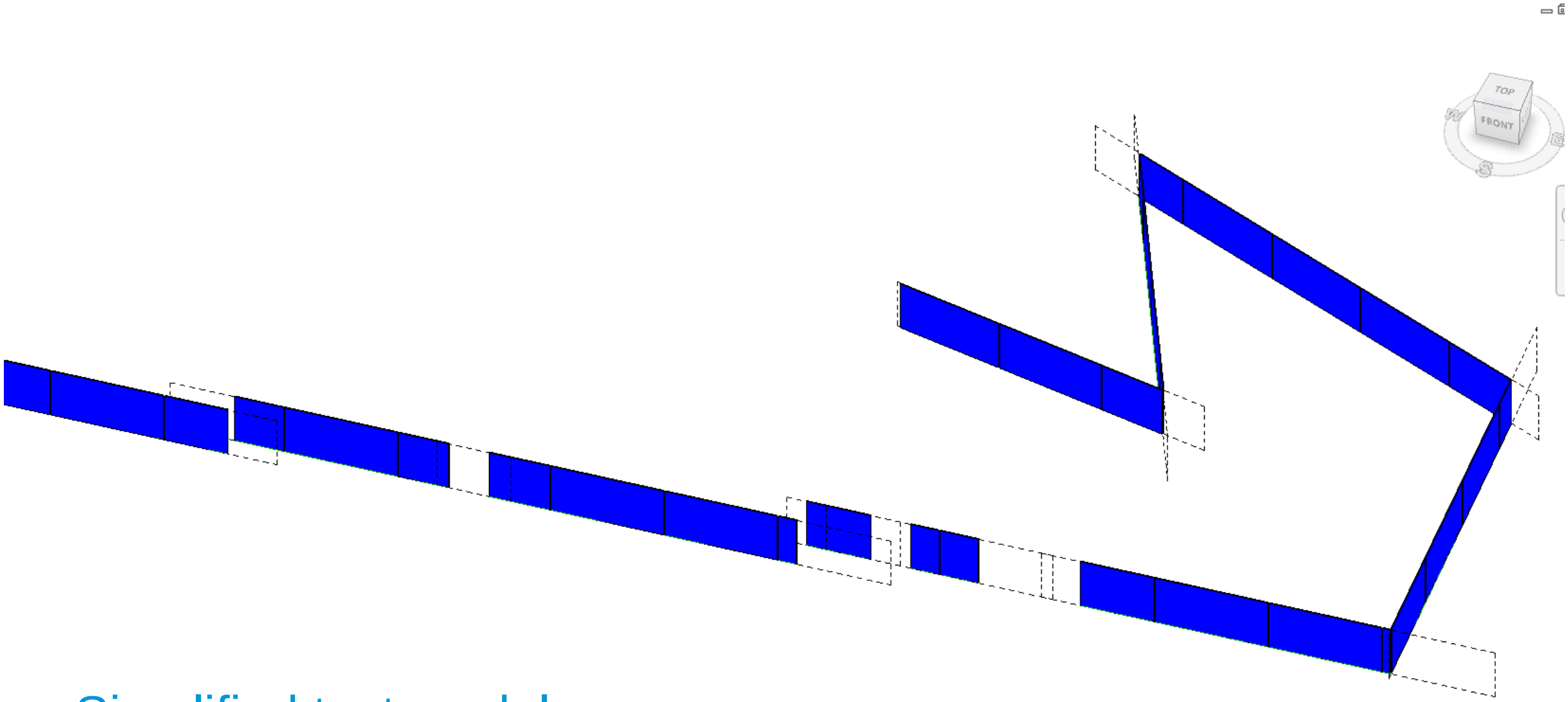


Inside corner

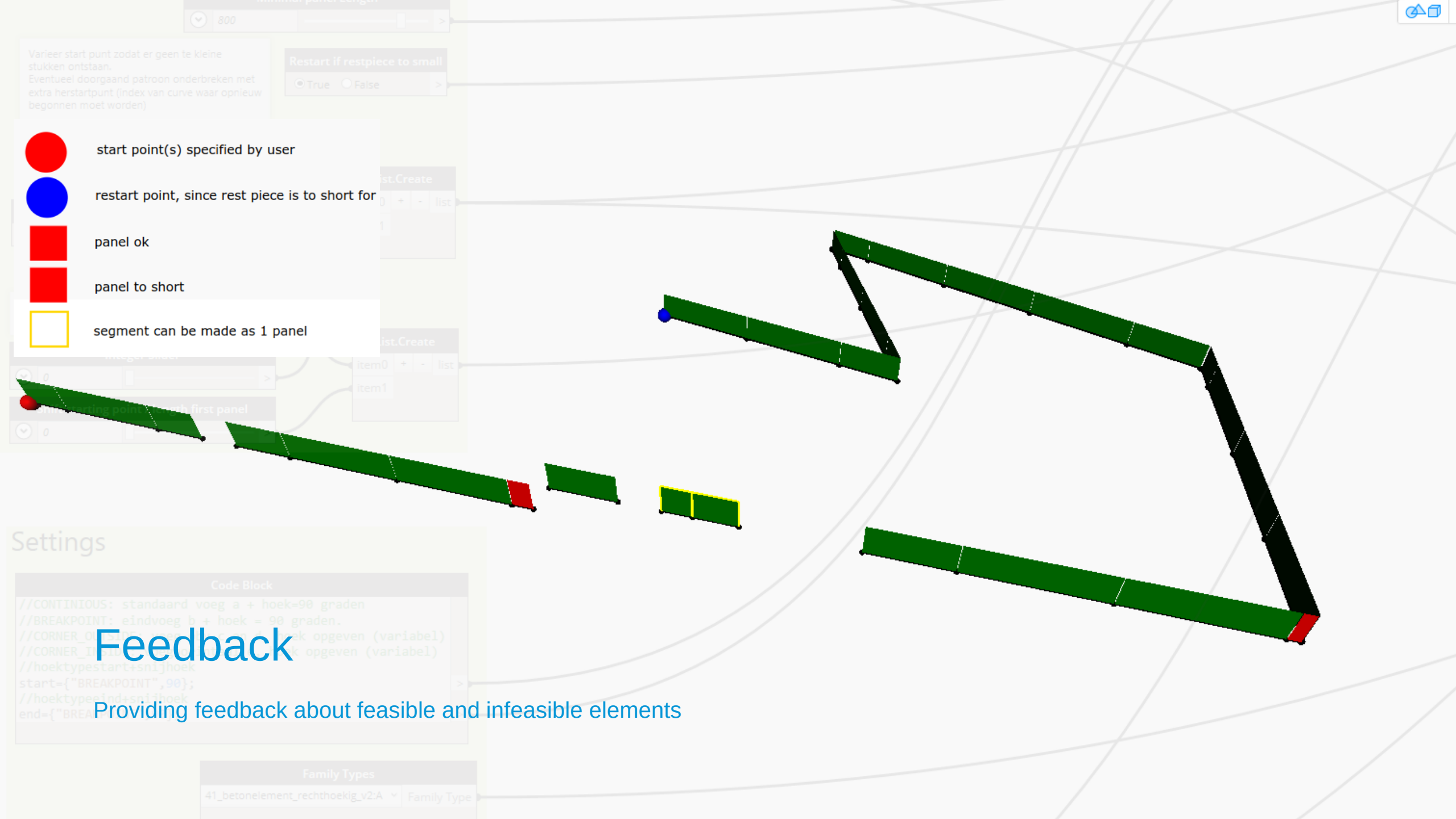


Outside corner





Simplified test model



Feedback

Providing feedback about feasible and infeasible elements

Variables

Panel Height
2000

Panel Length
4000

Minimal panel Length
700

Varieer start punt zodat er geen te kleine stukken ontstaan.
Eventueel doorgaand patroon onderbreken met extra herstartpunt (index van curve waar opnieuw begonnen moet worden)

Restart if restpiece to small
True / False

Code Block
0;

Shift starting point / length first panel
1300

List.Create
item0 + - list
item1
item2

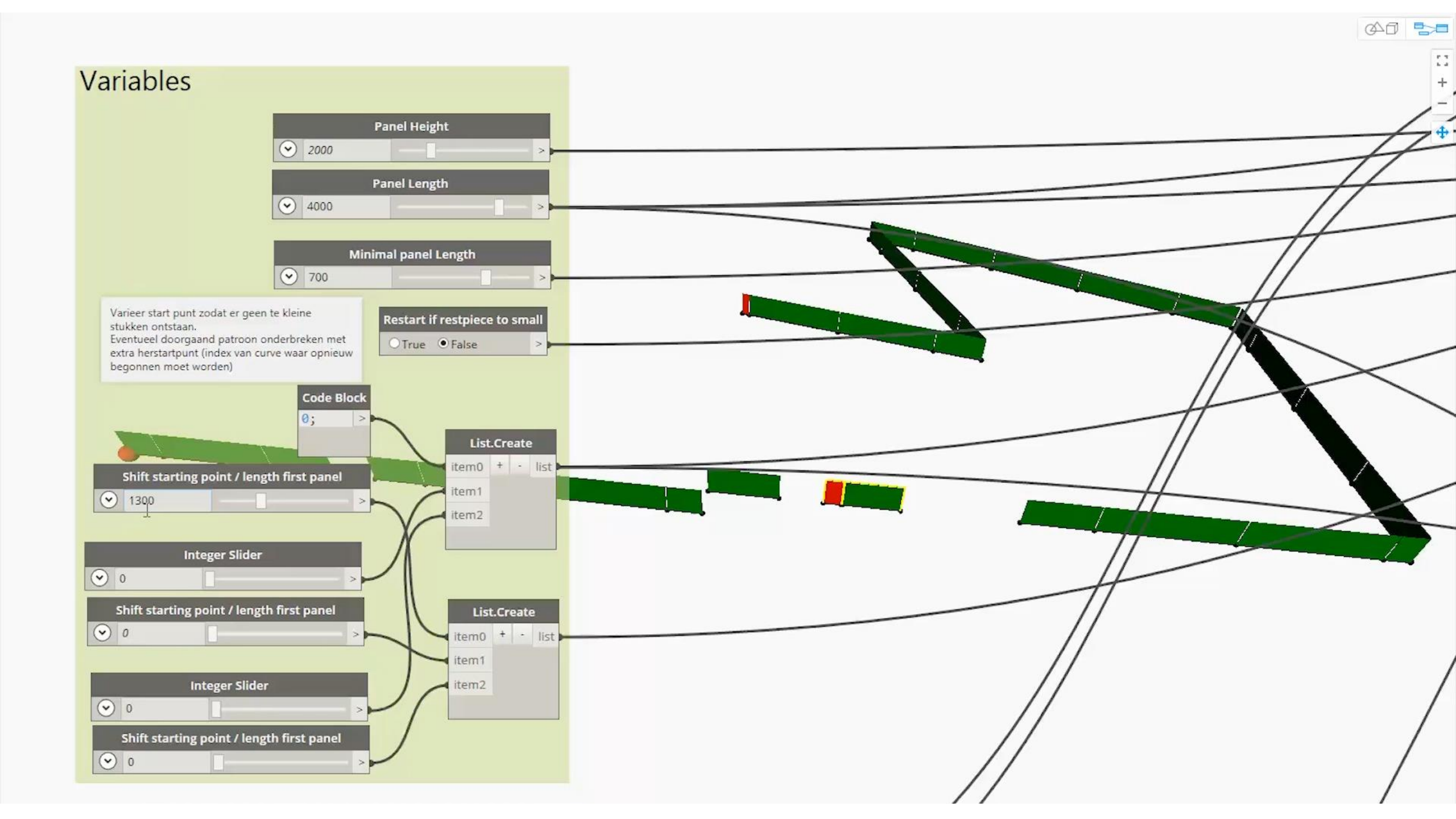
Integer Slider
0

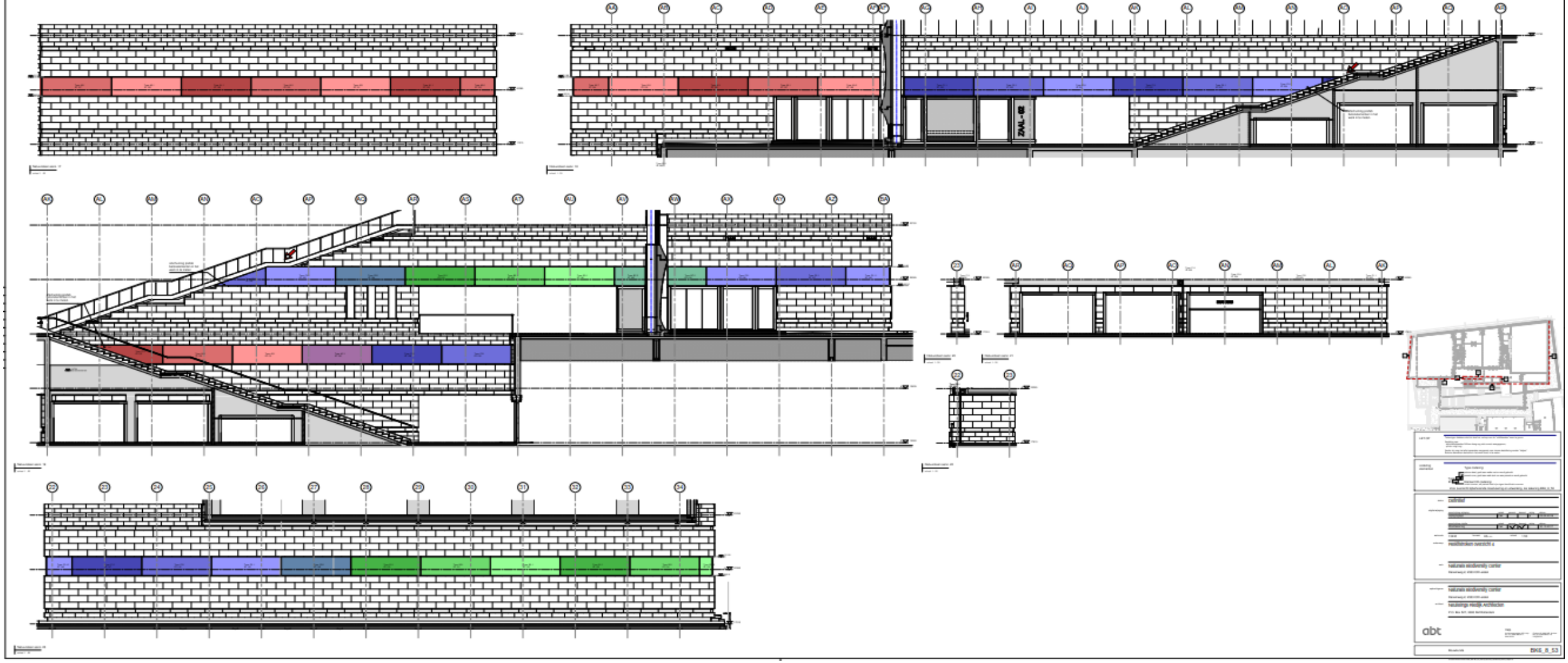
Shift starting point / length first panel
0

List.Create
item0 + - list
item1
item2

Integer Slider
0

Shift starting point / length first panel
0

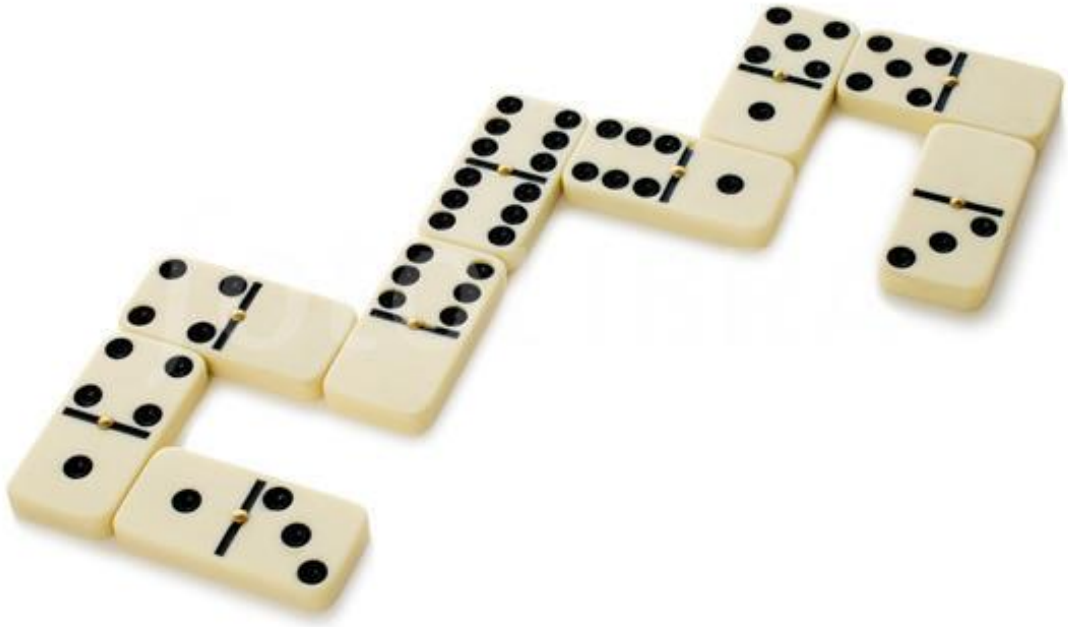




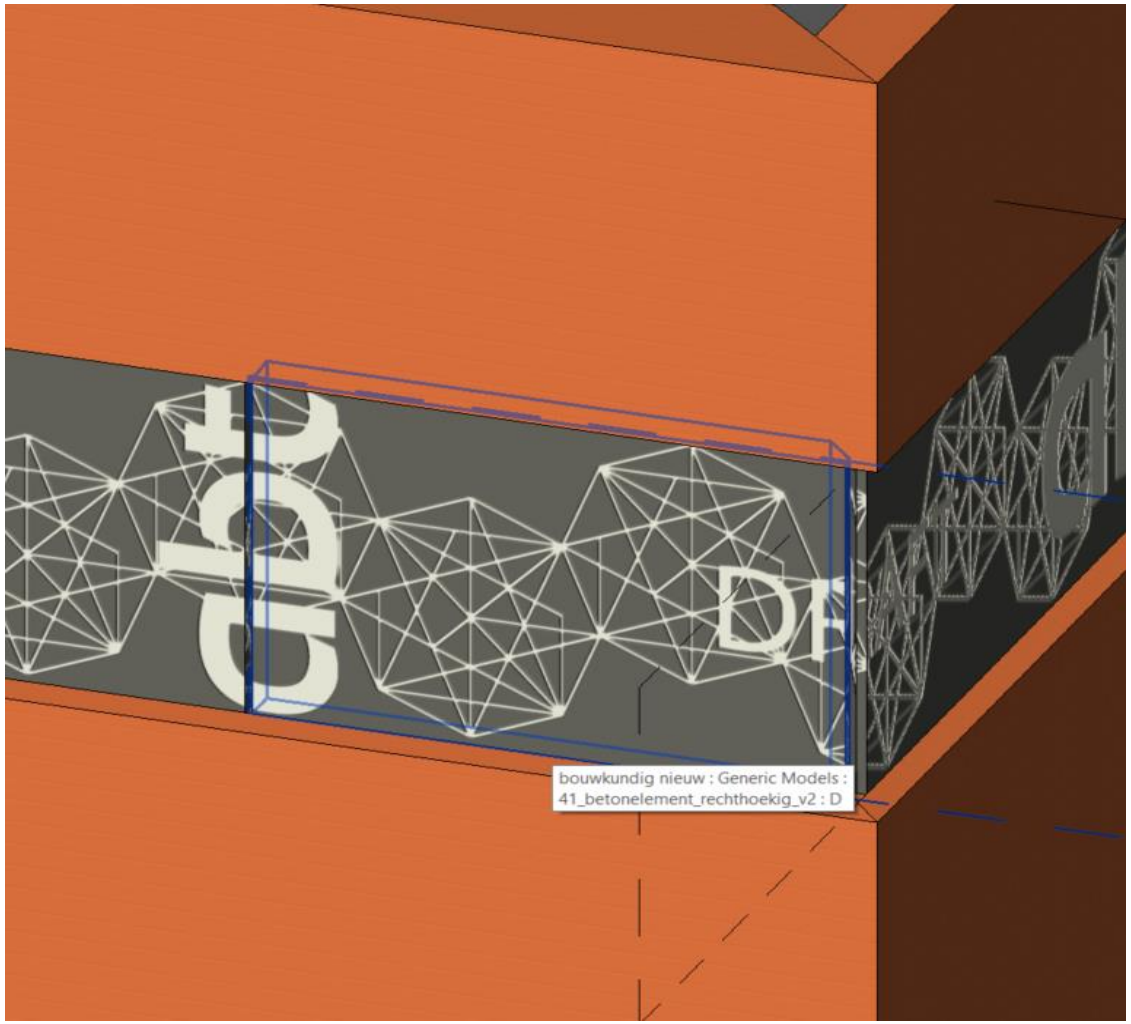
Final panel layout

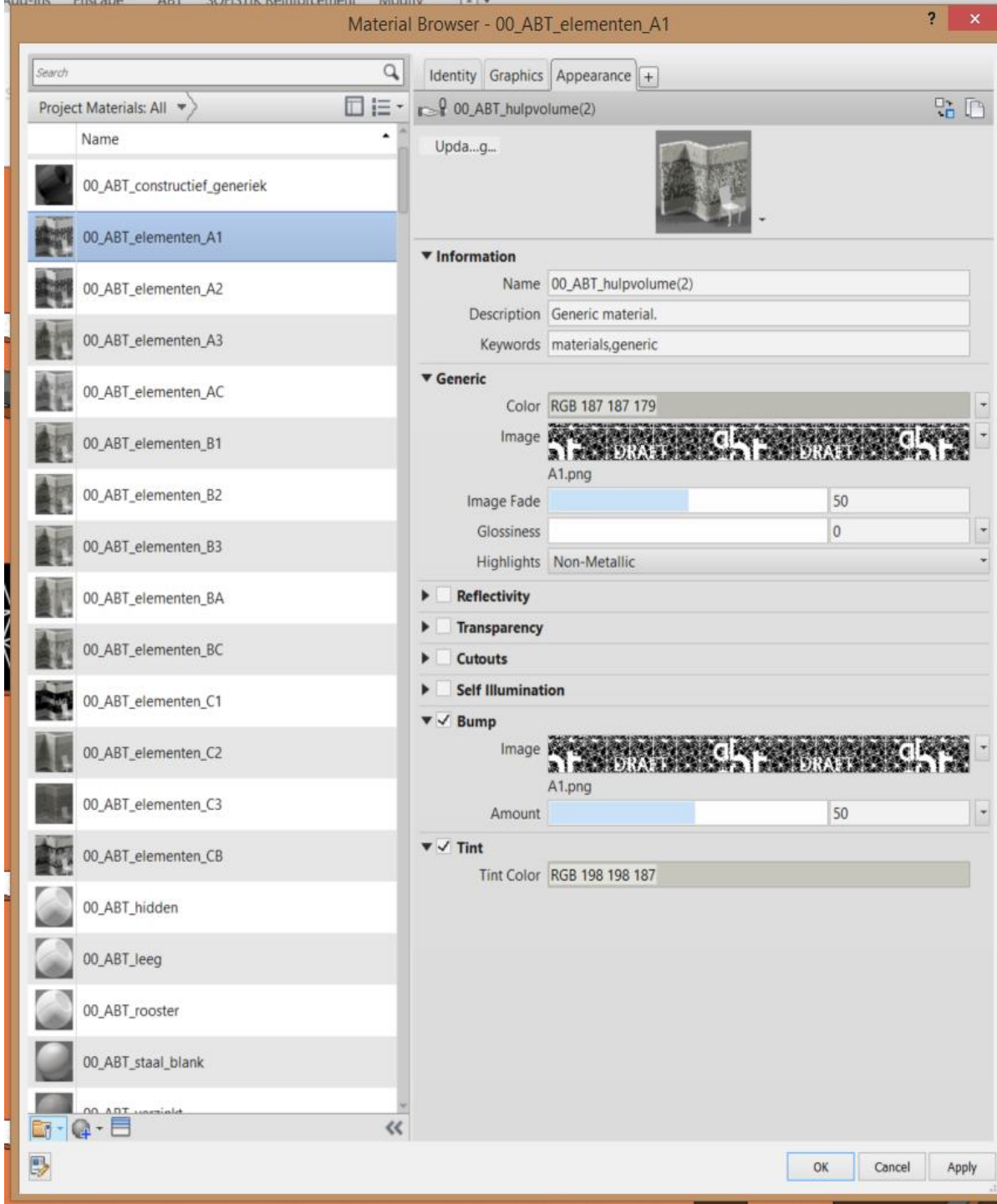
Domino pattern

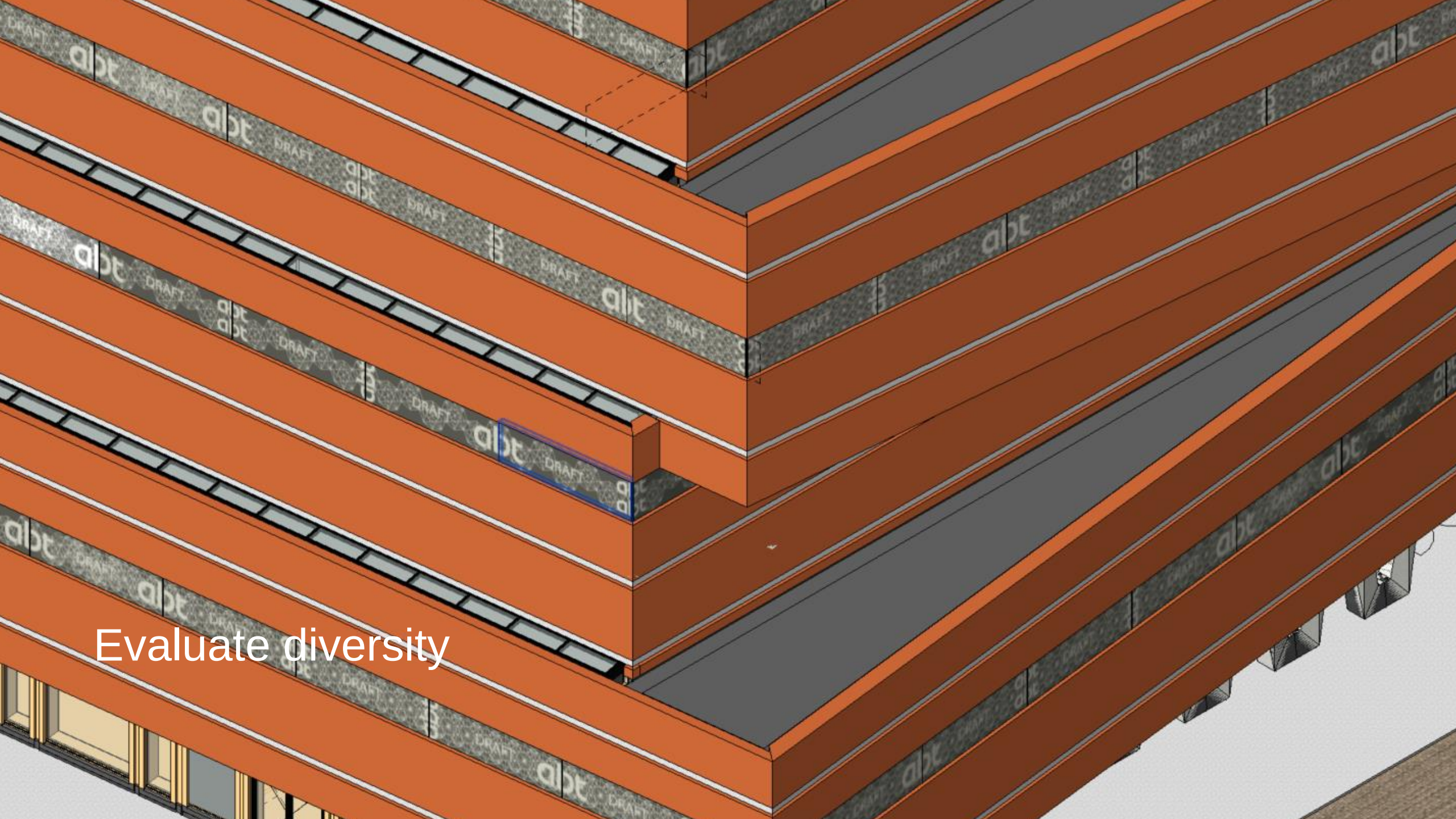
- Continuous
- Diversity

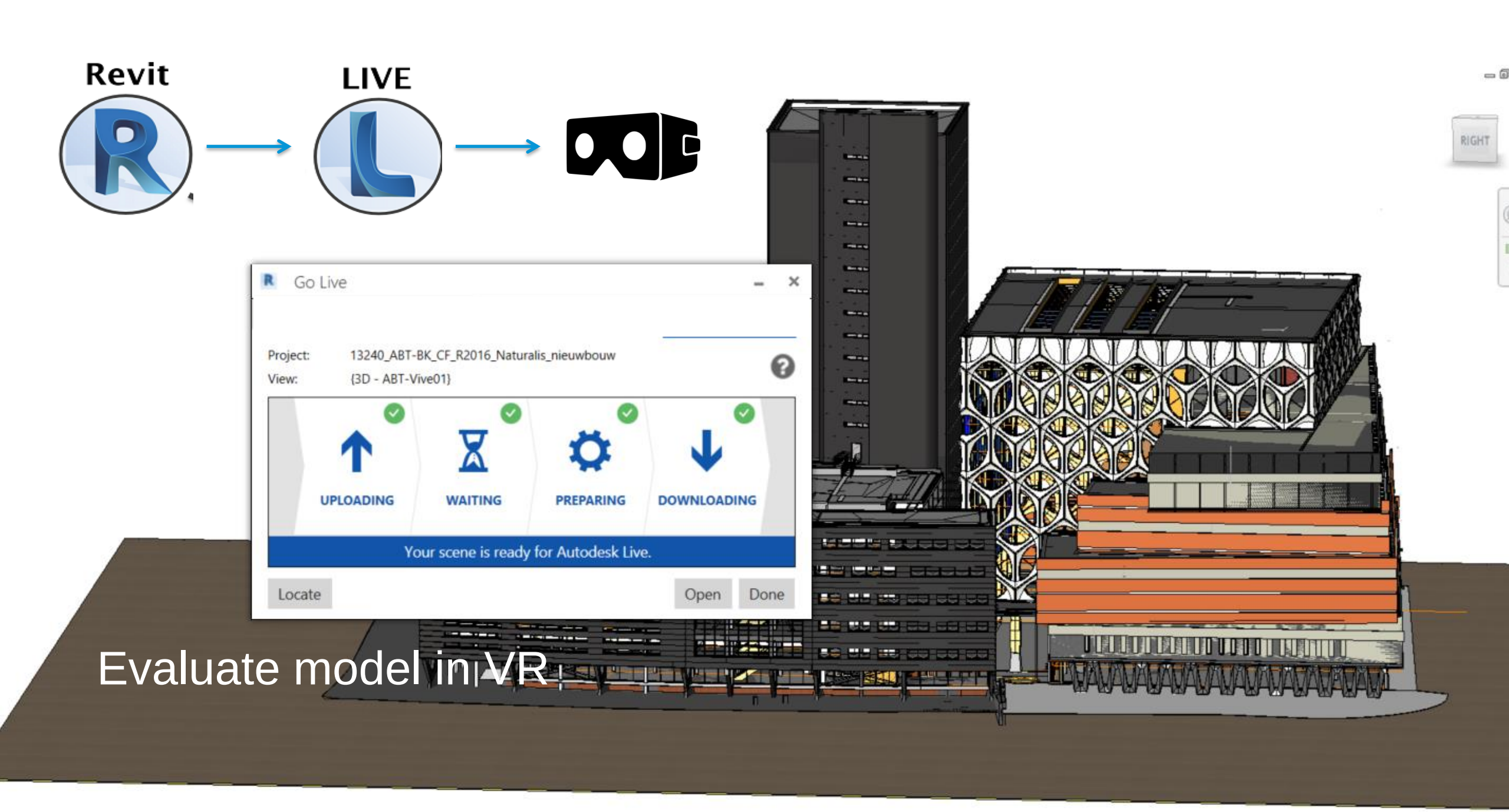


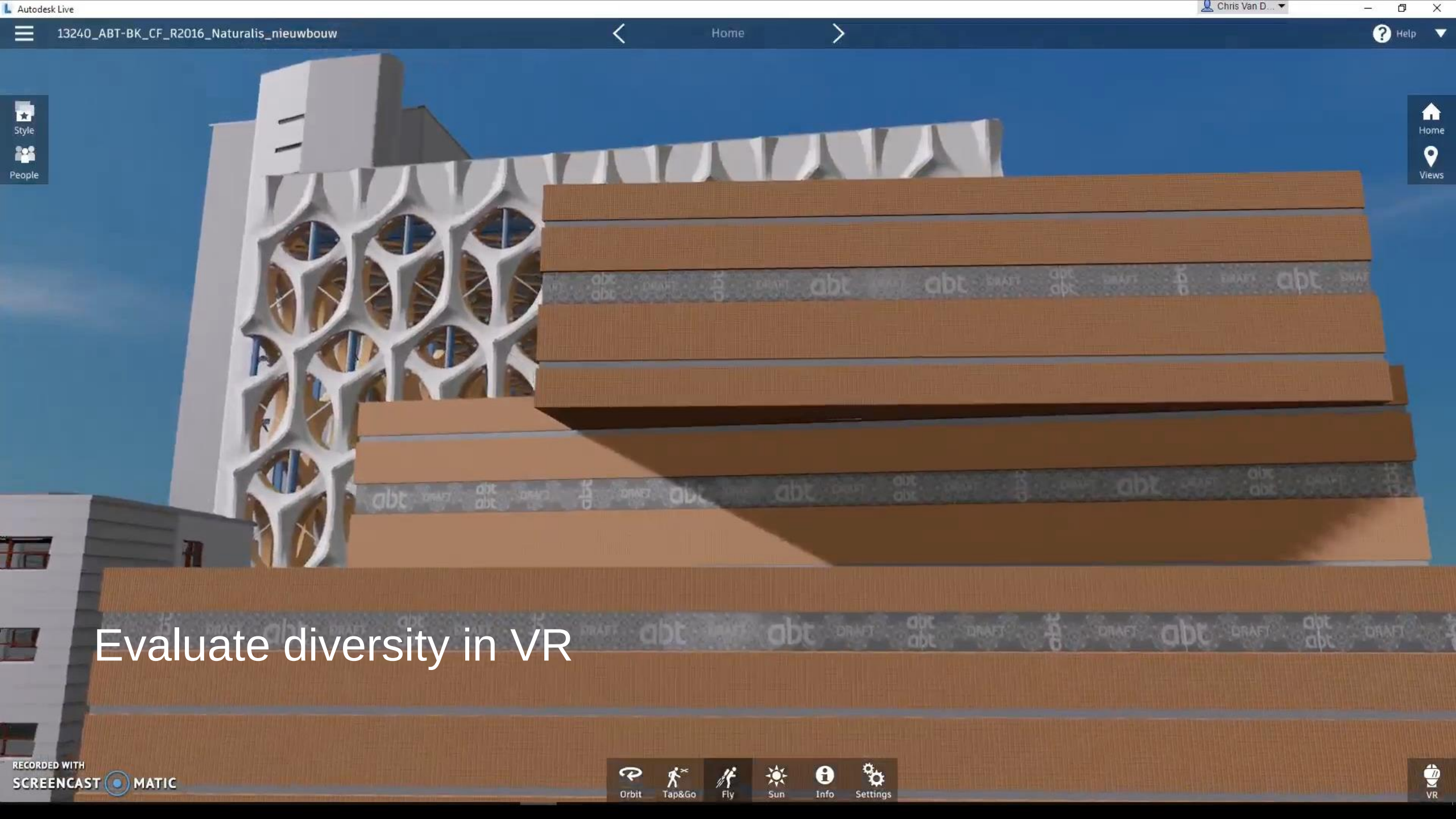
Revit material textures

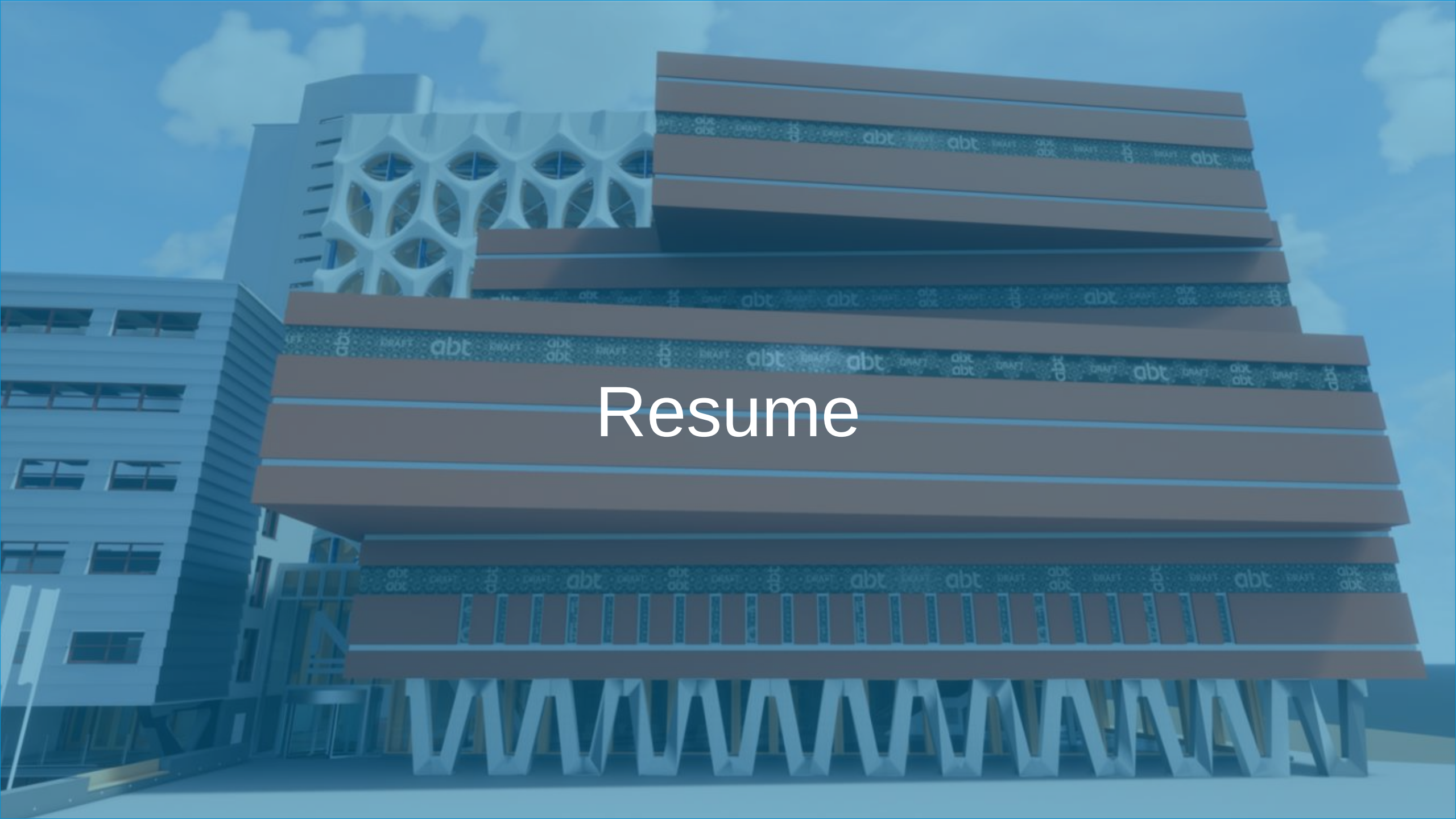


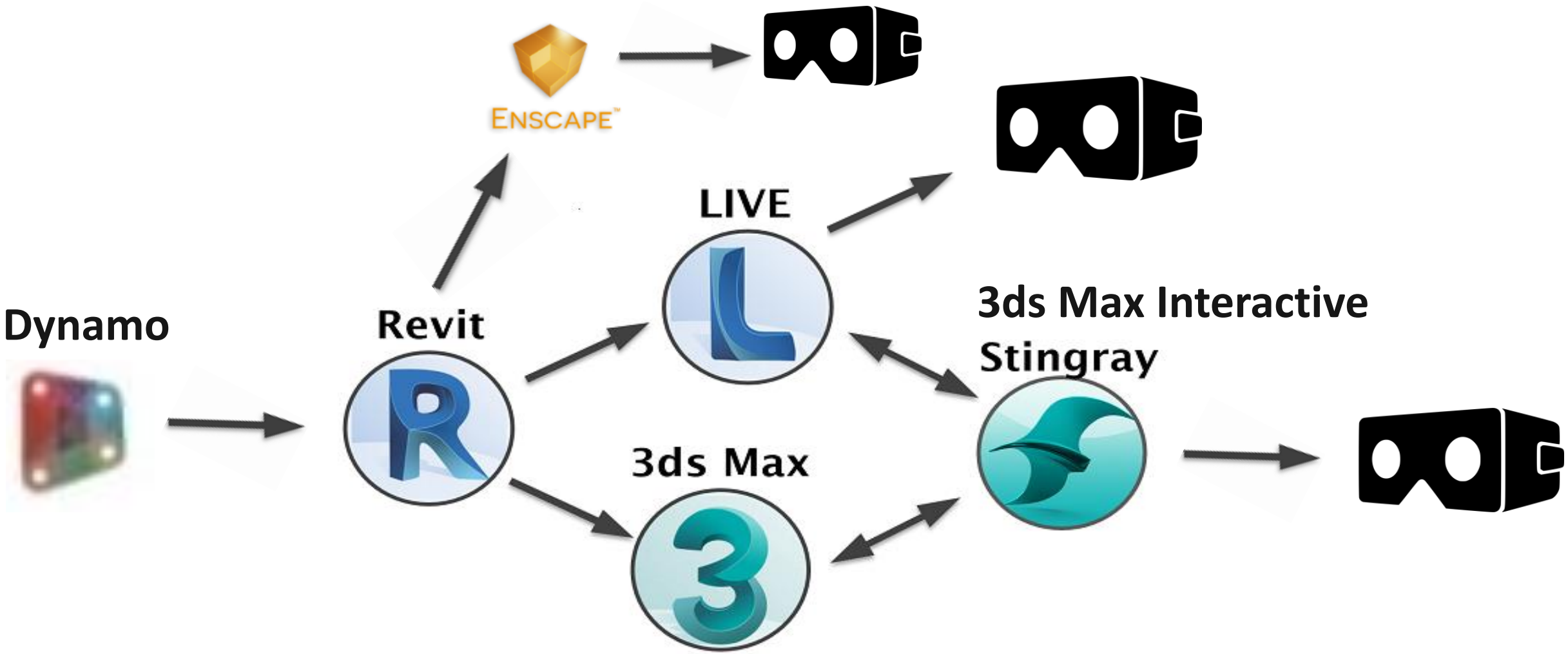



Evaluate diversity


Revit
LIVE
Go Live
Project: 13240_ABT-BK_CF_R2016_Naturalis_nieuwbouw
View: {3D - ABT-Vive01}
UPLOADING
WAITING
PREPARING
DOWNLOADING
Your scene is ready for Autodesk Live.
Locate
Open
Done
RIGHT
Evaluate model in VR


Autodesk Live
Chris Van D...
13240_ABT-BK_CF_R2016_Naturalis_nieuwbouw
Home
Help
Style
People
Home
Views
Evaluate diversity in VR
RECORDED WITH
SCREENCAST MATIC
Orbit
Tap&Go
Fly
Sun
Info
Settings
VR


Resume



Workflows for virtual reality models

Virtual mockups

- Easy to vary, means more variation
- No costs or production time, allows more creativity
- By virtual pre-selection, order the right physical mockup
- Reduce waste, save costs and time
- Location independent

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Real mockups

- The real experience
  - Does the aesthetic appearance live up to expectations
  - Ability to touch the material
  - Experience it in real daylight
- Ensure manufacturability
- Verify attachment to underlying construction
- Test material behaviour in outdoor conditions

New job profile: “The virtual mockup experience creator”?

The virtual mockup

parametric design and optimisation of complex façade panels in virtual reality

Chris van der Ploeg (ABT bv) — Computational design specialist

Sandra Hombergen (ABT bv) — BIM-specialist

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