

# Custom Computational Workflows for BIM Design Implementation

Eckart Schwerdtfeger

BIM Associate | Zaha Hadid Architects



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# Introduction



# Introduction . Speaker



**Eckart Schwerdtfeger** is an architect with 12 years of experience in all project phases and in implementing large-scale, high-profile international projects in Europe, Russia, the Middle East and China.

During his time at Behnisch Architects, Coop Himmelb(l)au and LAVA he parametrically designed, optimised and implemented several remarkable **facades**. His main fields of work were **computational design, BIM management** and **programming**.

Currently, Eckart is BIM Associate at **Zaha Hadid Architects** and responsible for managing the office's BIM team. Besides leading and implementing several large-scale **BIM projects**, he focuses on developing the ZHA global **BIM workflows**.

He develops and writes proprietary software, plugins and scripts to effectively facilitate, optimise and automate BIM and cross-application tasks and to enable the design team to contribute to the BIM models more directly and fluently.

ETFE membrane facade  
Unilever Germany HQ  
Behnisch Architects



# Introduction . Aims

## Effective cross-application workflows from design to BIM

- Be able to use content created in 3rd party software
- Prevent duplicated work

## Parametrise and automate as much as possible

- Enable + accelerate creation of design iterations and implementation of changes
- Save time spent on repetitive tasks

## Custom...

- BIM Elements
- Visual Scripts / Scripts / Macros
- Software / Plugins

# Introduction . Customisation Options



Revit

Family

## Modelling

Parametric geometry + conditions + formulas

Revit family editor

Macro

## Scripting [e.g. C#, VB.Net, Python, Ruby]

Access to Revit programming interface

Integrated editor, SharpDevelop

Plugin

## Programming [e.g. C#, VB.Net]

Standalone library with advanced capabilities

External editor, e.g. Visual Studio



Dynamo

Visual Script

## Visual Scripting

Graphical access to the programming interface

Dynamo

Script

## Scripting [e.g. DesignScript, Python]

Access to Dynamo + Revit programming interface

Integrated script nodes

Zero Touch Node

## Programming [e.g. C#, VB.Net]

Standalone library with advanced capabilities

Custom Node

Simple user-defined functions

Extension

Custom user interface possible

Global access and extension of Dynamo possible

External editor, e.g. Visual Studio

# Project 1

Project BIM Team  
Eckart Schwerdtfeger



# Project 1



- Master plan with extent of about 800 x 300 m
- Around 40 buildings with varying size and typology

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# Project 1



## Aims

- . Parameterisation and automation of the design process
- . Effective use of freeform geometry in BIM

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# Native Elements

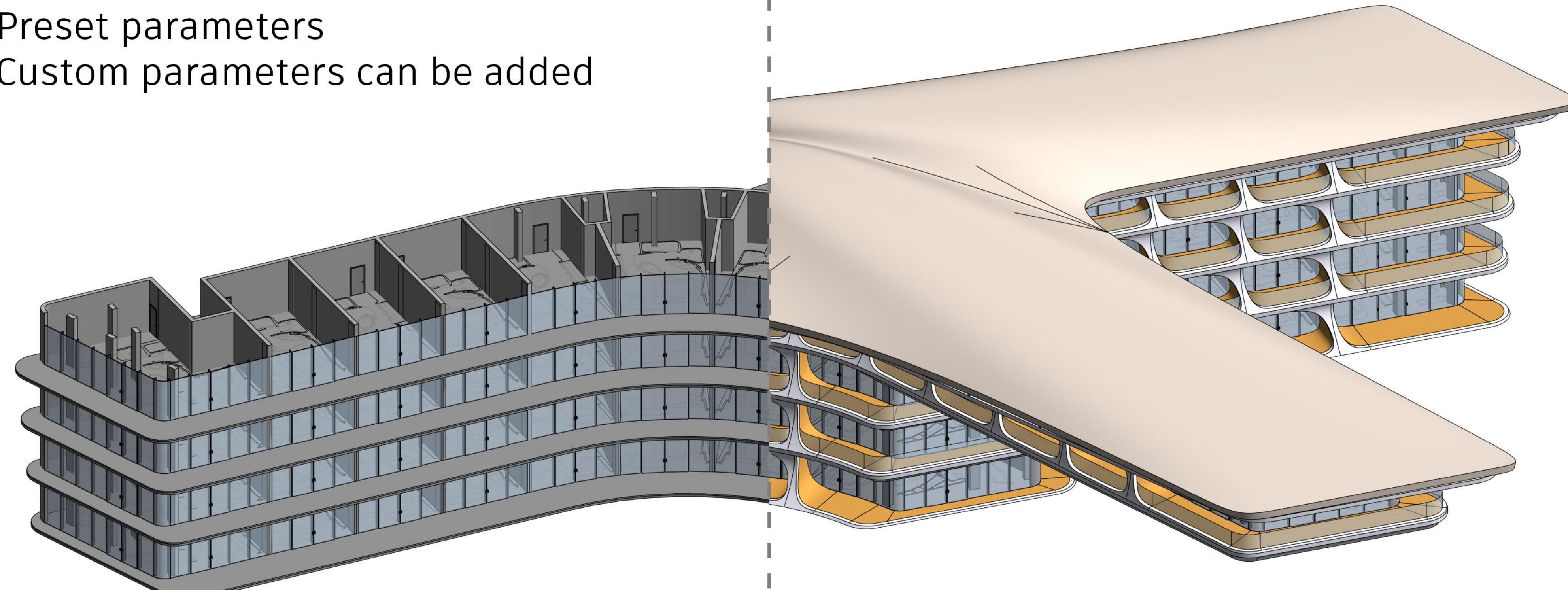


# Native Elements

- E.g. floors, walls, columns, beams, curtain walls, doors, furniture, etc.
- Preset constraints and restrictions for every category
- Preset parameters
- Custom parameters can be added

## Creation

- Manual drawing
- Manual conversion of pre-existing CAD lines
- Automated custom workflow



# Native Elements

190 Floors  
5760 Walls  
4000 Doors  
1725 Furniture groups  
940 Apartments  
2925 Text tags  
Etc.



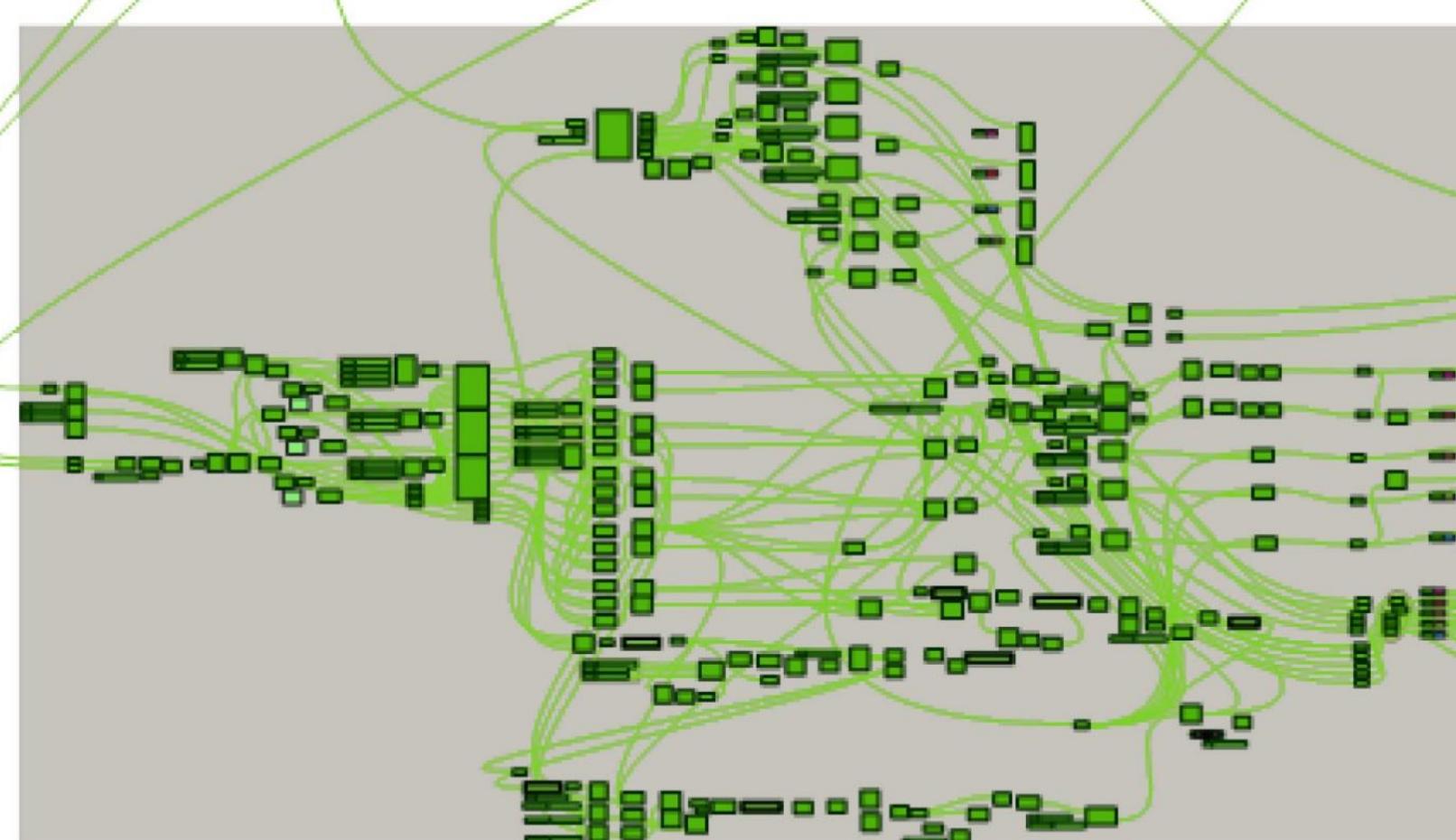
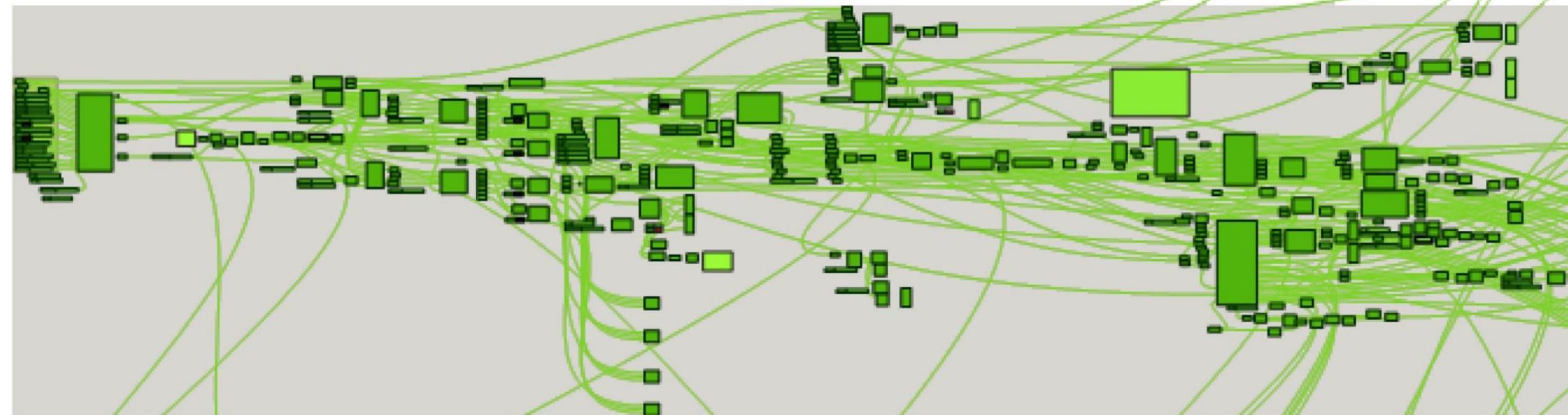
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# Native Elements . Source

## Grasshopper Script

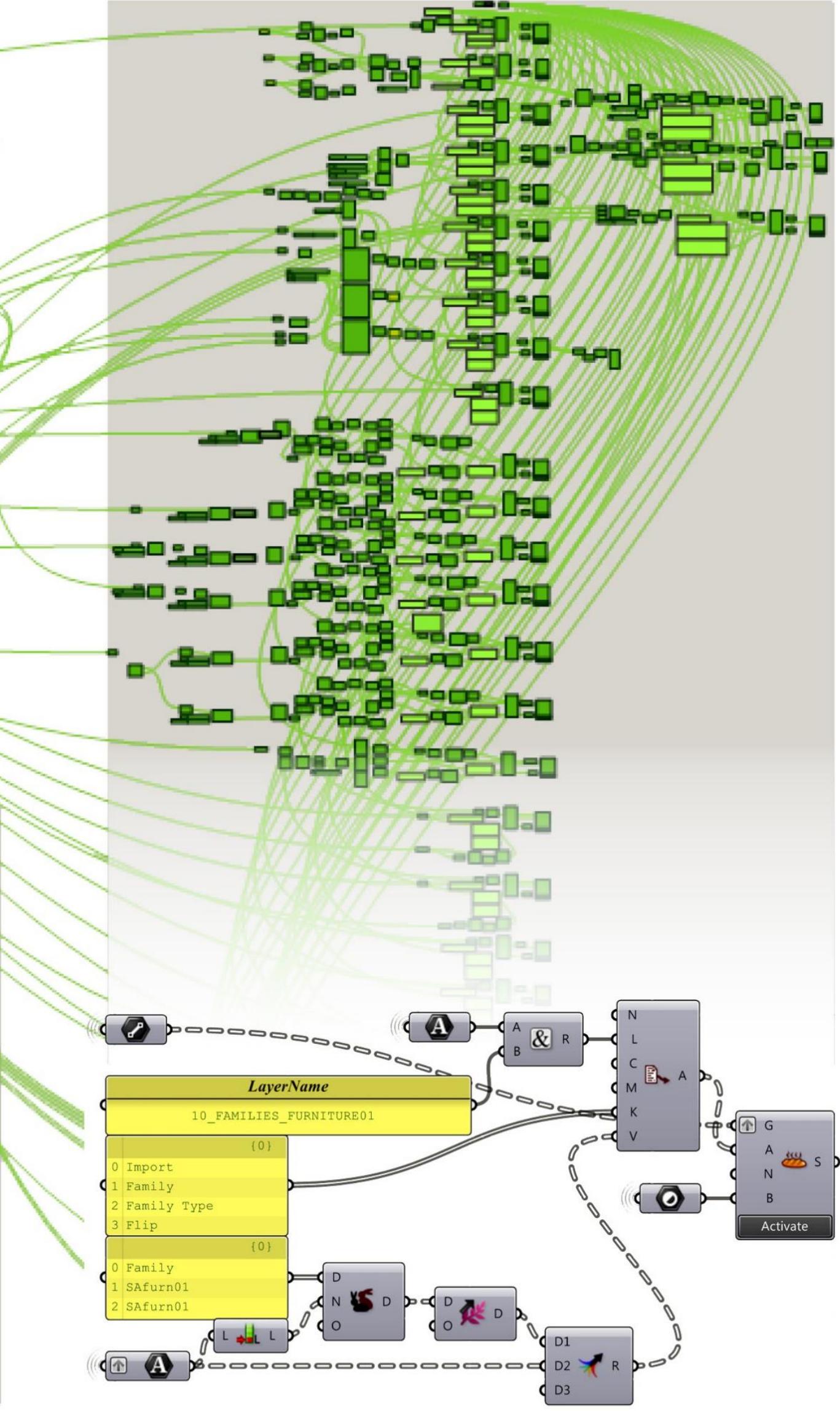
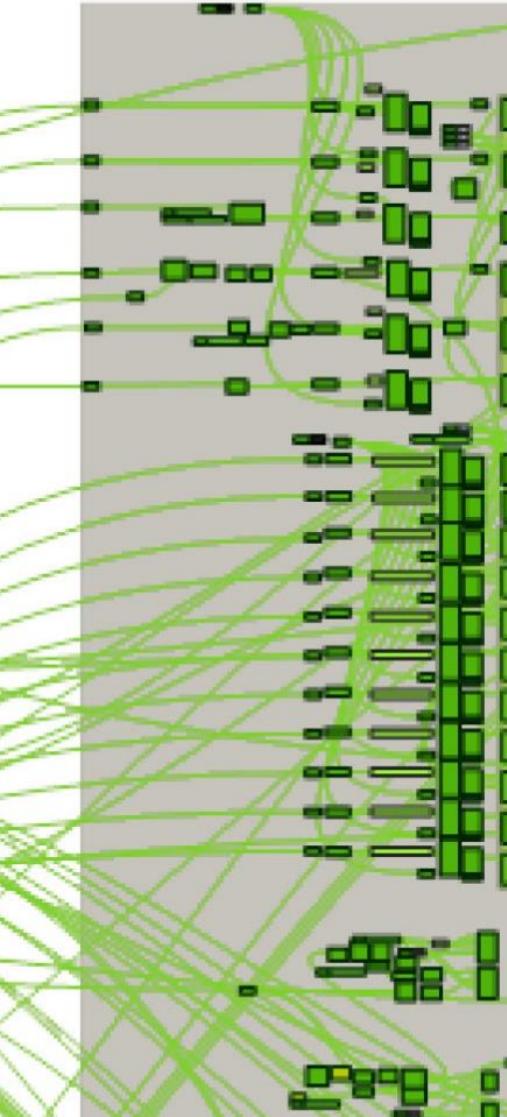
Architecture



Structure

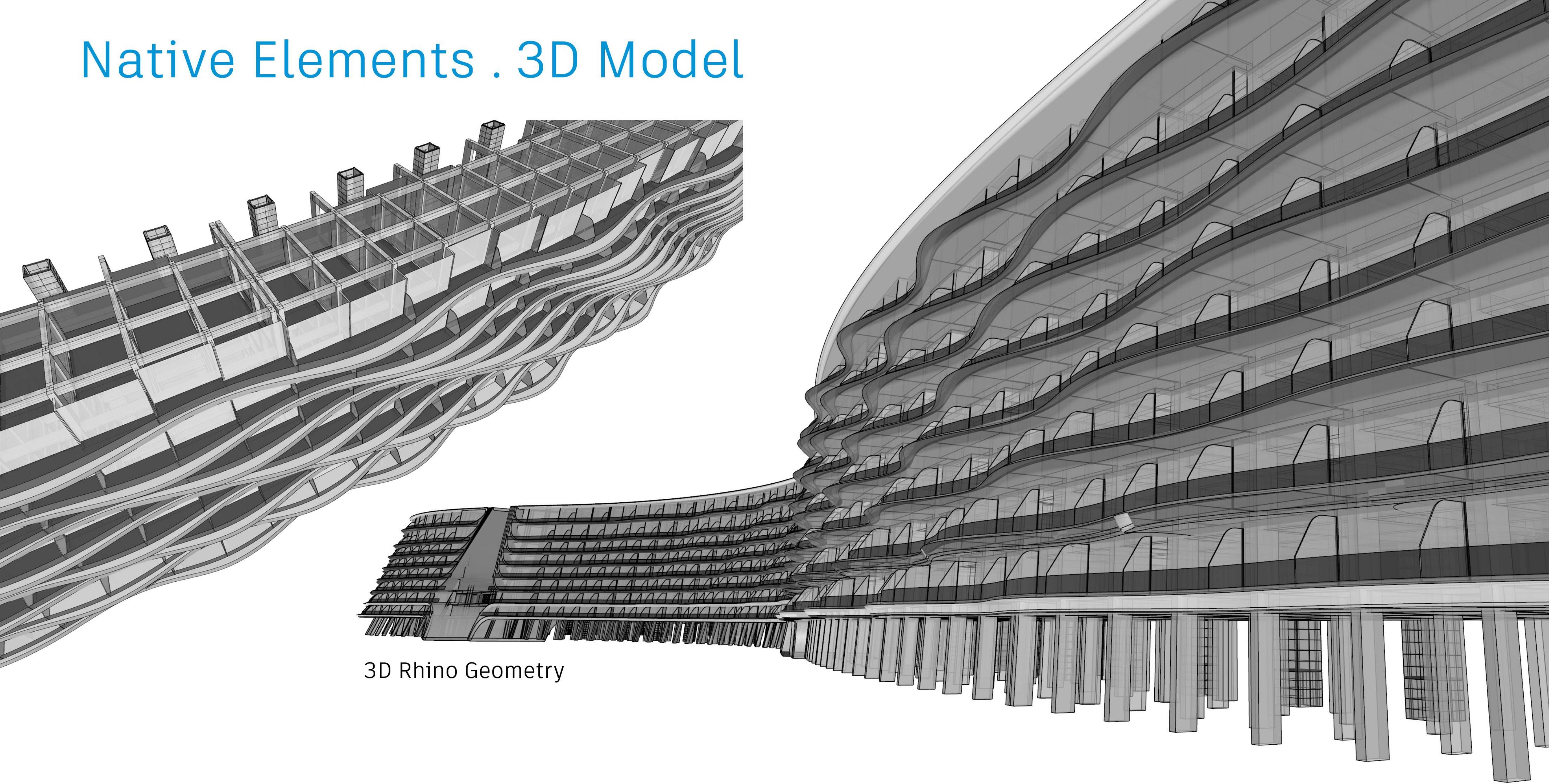
Area calculation

3D Display



Geometry baking

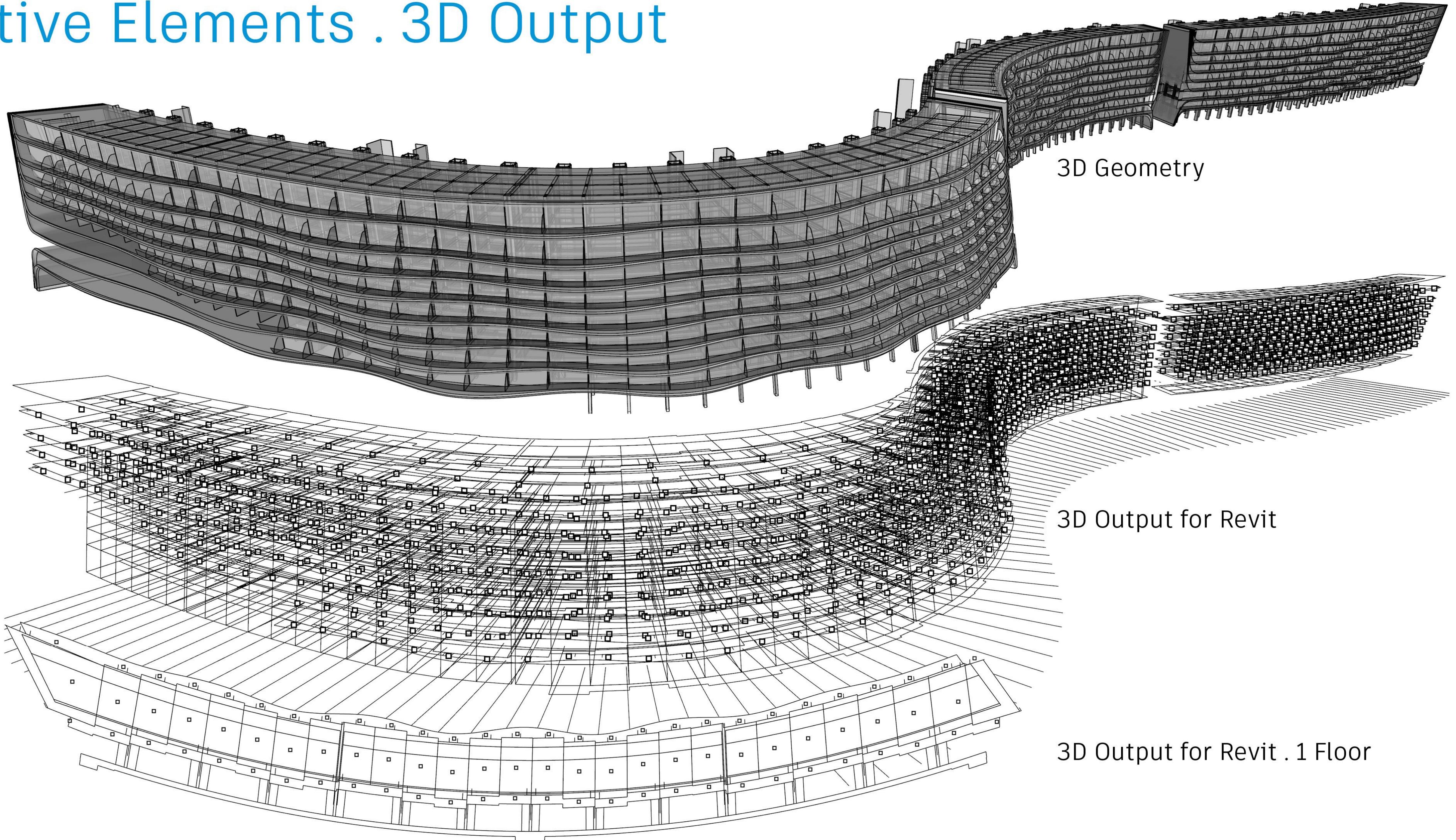
# Native Elements . 3D Model



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# Native Elements . 3D Output



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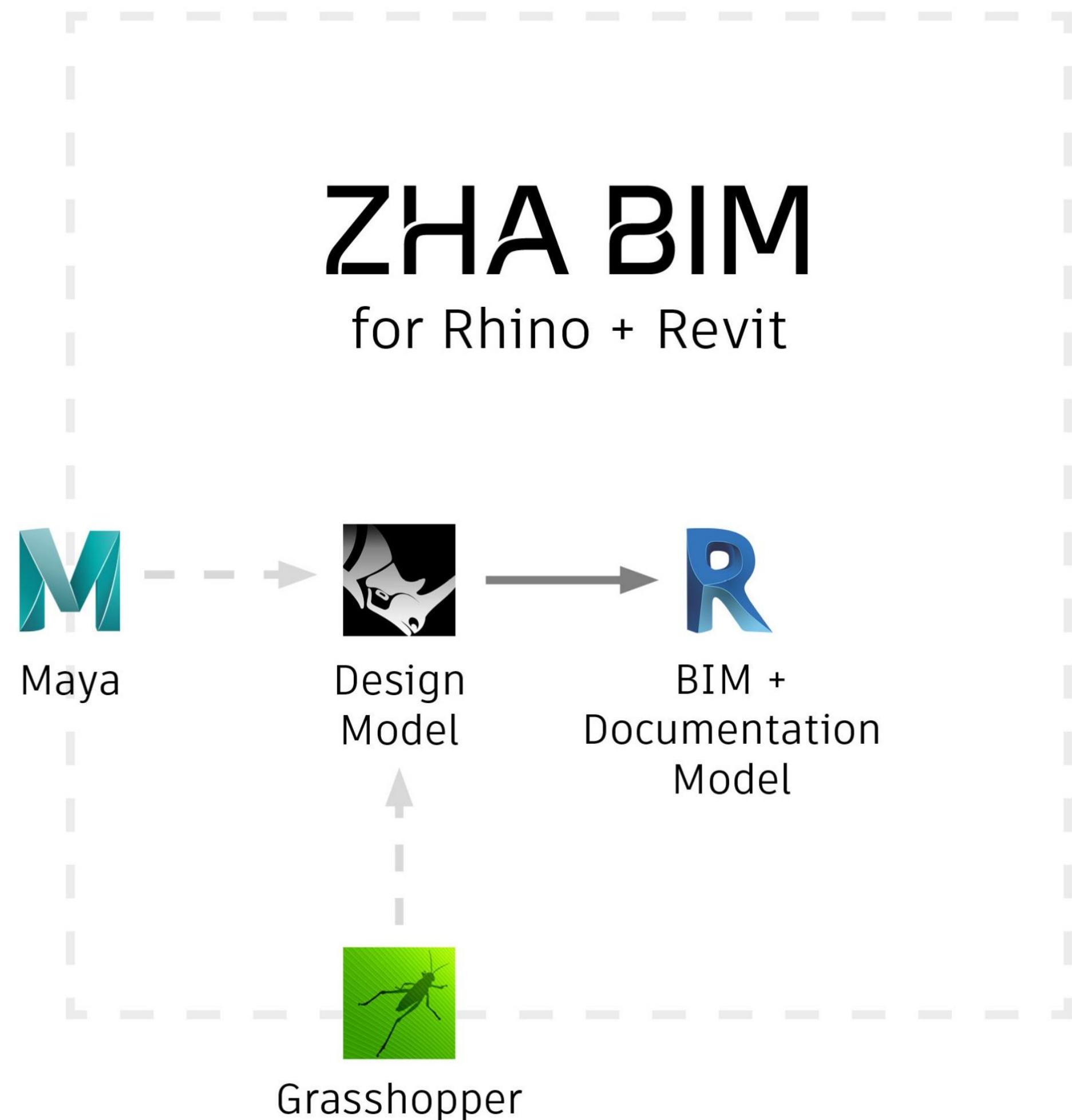
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# ZHA BIM

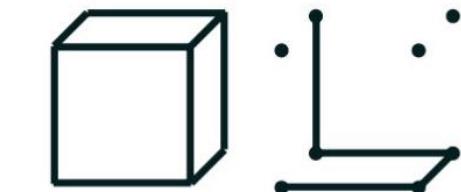
Development +  
Programming  
Eckart Schwerdtfeger



# ZHA BIM . Introduction



To Transfer an element cross-application we need



## Geometry

of element or it's underlying geometry



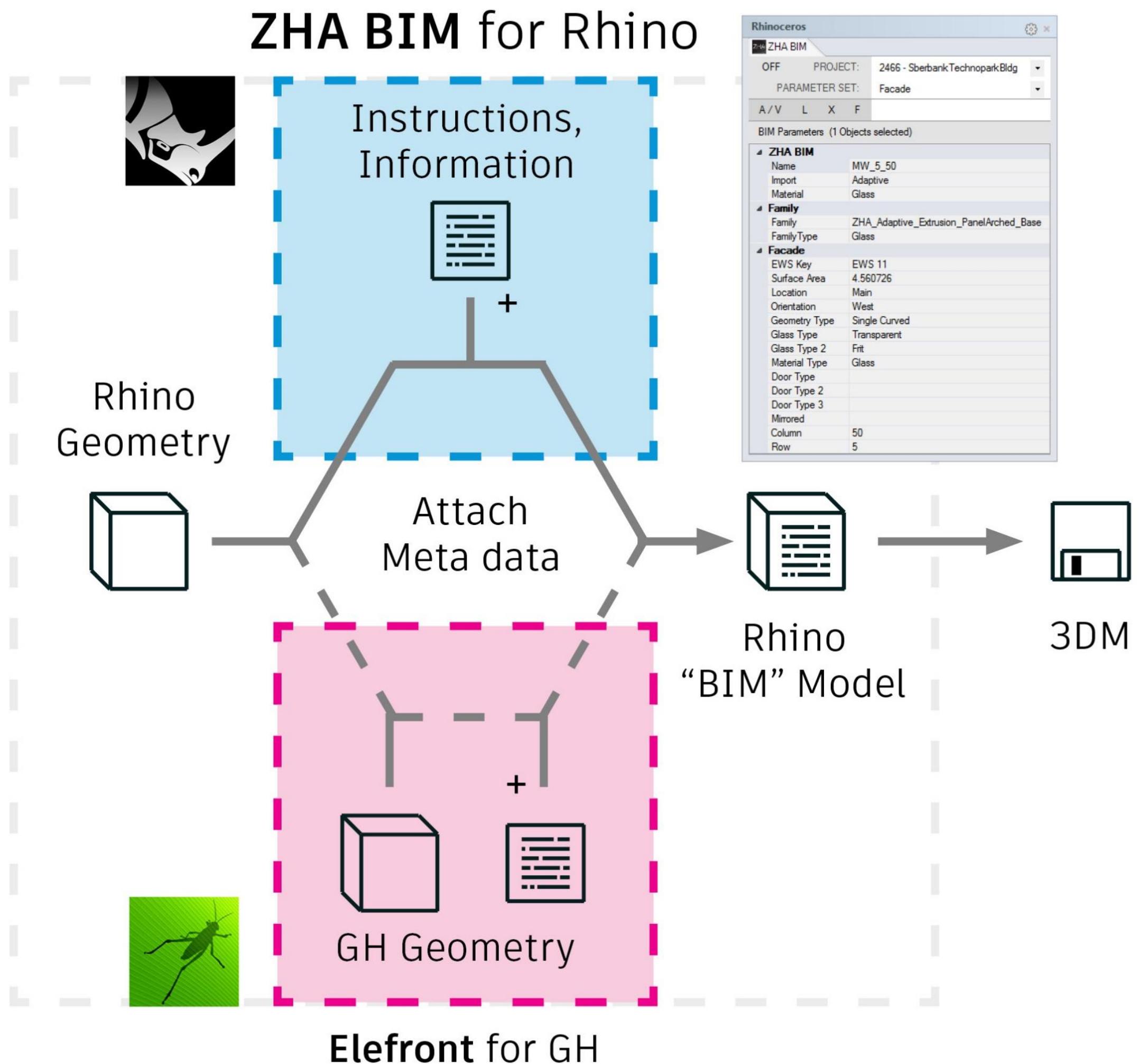
## Instructions

for transfer process and targeted software

## Building element information

Parameters, meta data [optional]

# ZHA BIM . Process



To Transfer an element cross-application we need



**Geometry**

of element or it's underlying geometry



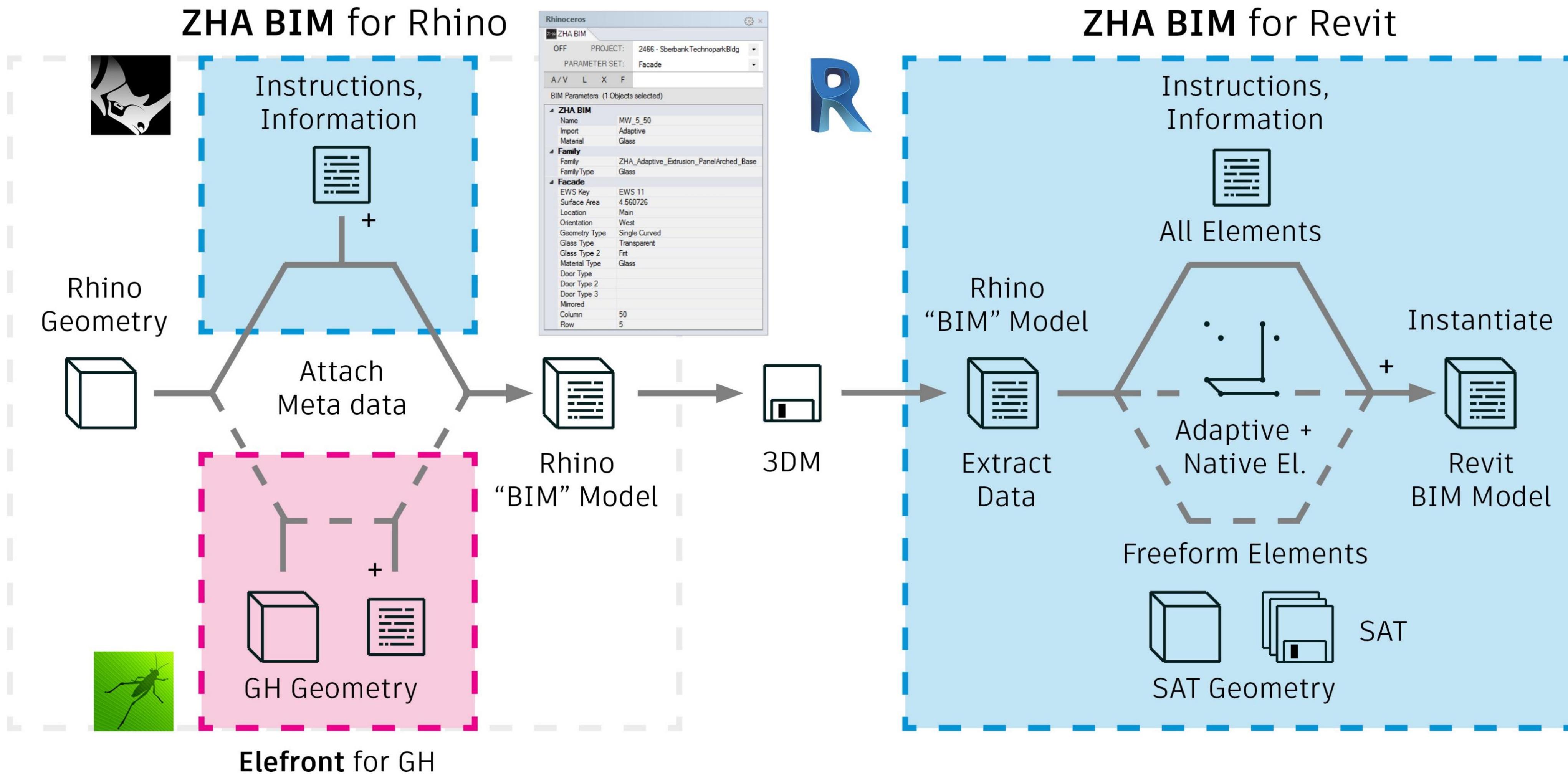
**Instructions**

for transfer process and targeted software

**Building element information**

Parameters, meta data [optional]

# ZHA BIM . Process



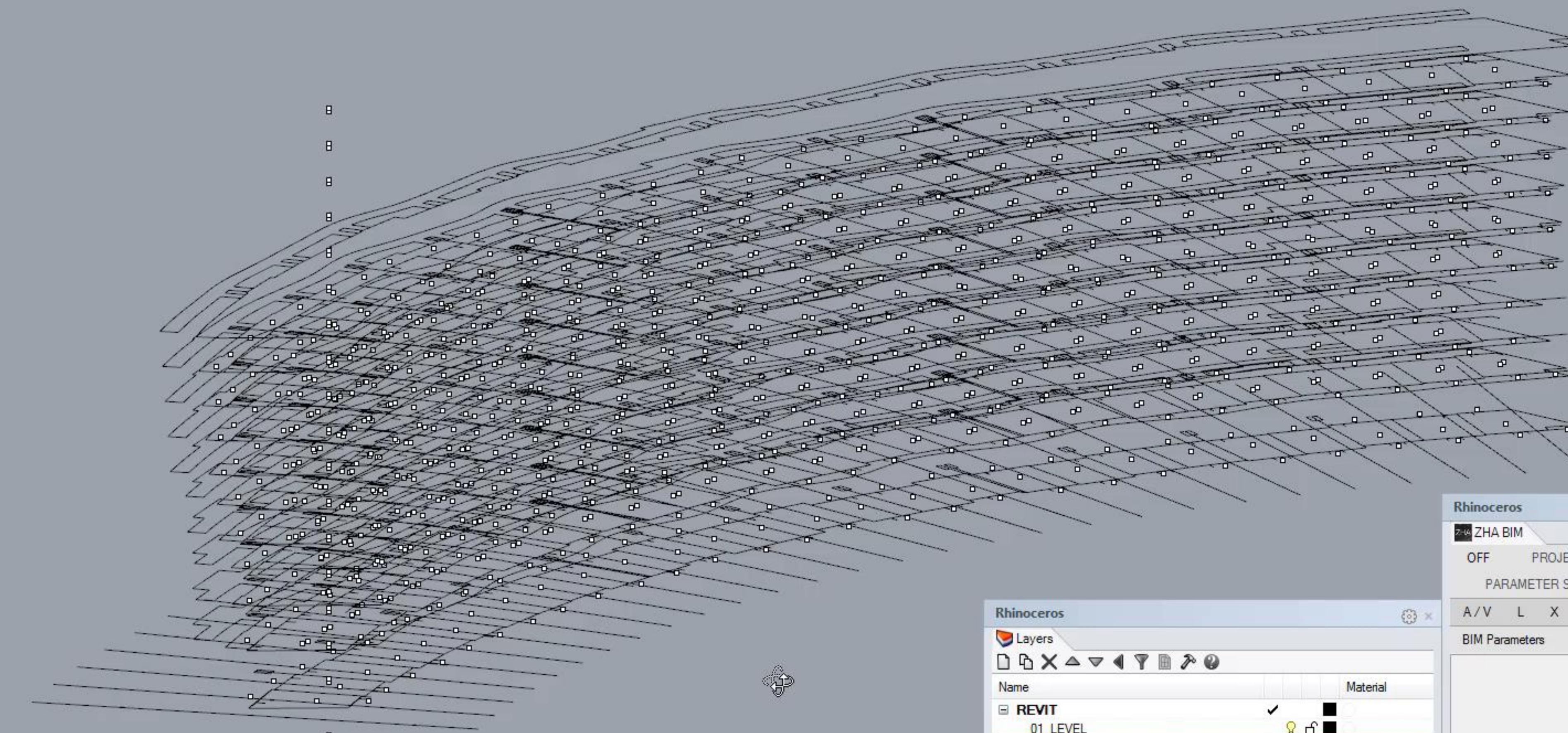
Command: \_SaveAs  
File successfully written as

Command:

Standard Display Set View Select Viewport Layout Visibility Transform Curve Tools Surface Tools Solid Tools Mesh Tools Render Tools Drafting New in V5 VisualARQ Tools



Front ▾



| Rhinoceros       |          |
|------------------|----------|
| Layers           |          |
| Name             | Material |
| REVIT            |          |
| 01_LEVEL         |          |
| 02_GRID          |          |
| 03_FLOOR         |          |
| 06_WALLS         |          |
| 06_WALLS_CURTAIN |          |
| 08_DOORS_CURTAIN |          |
| 10_FURNITURE     |          |
| 13_TEXTNOTES     |          |
| 12_ROOMS         |          |

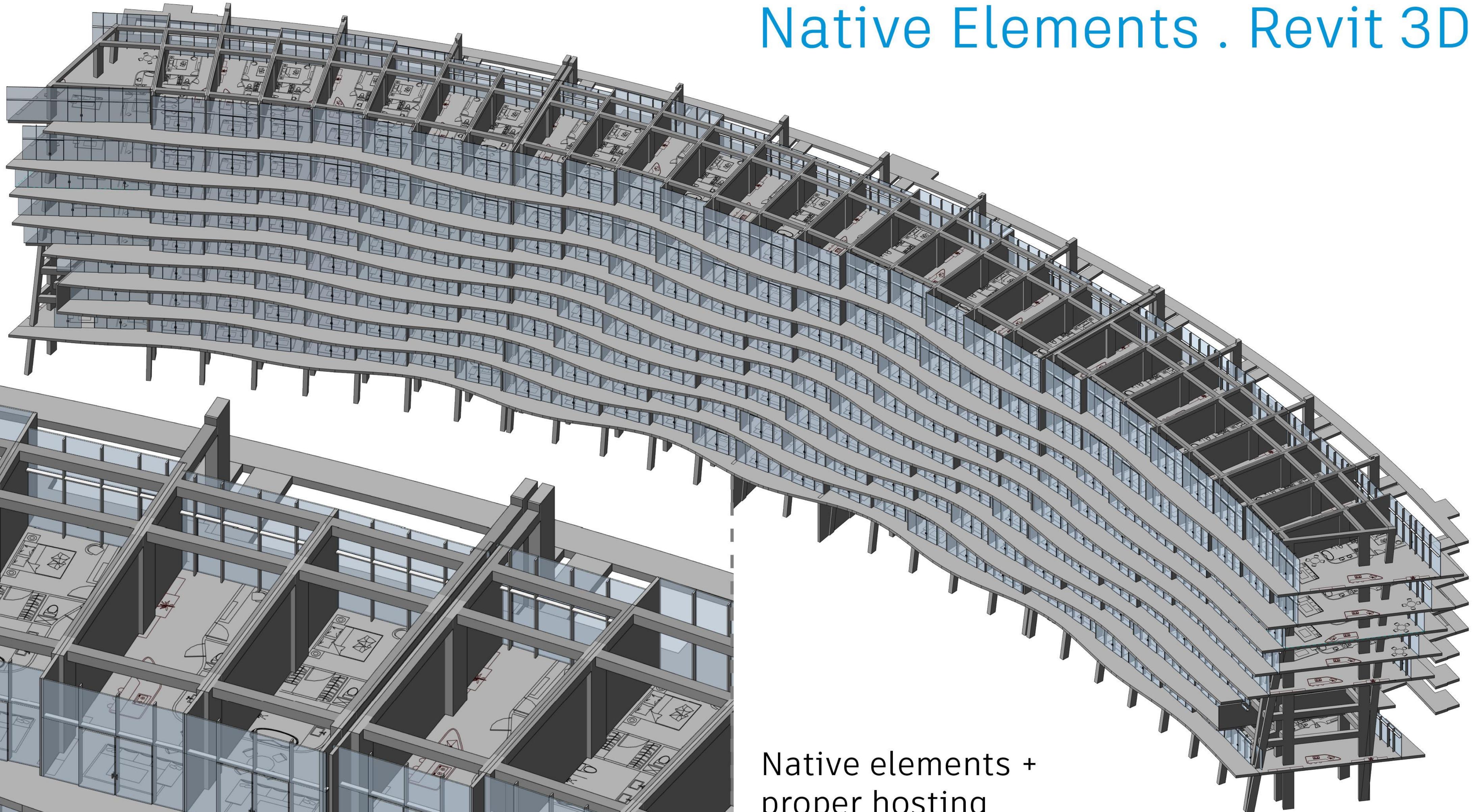
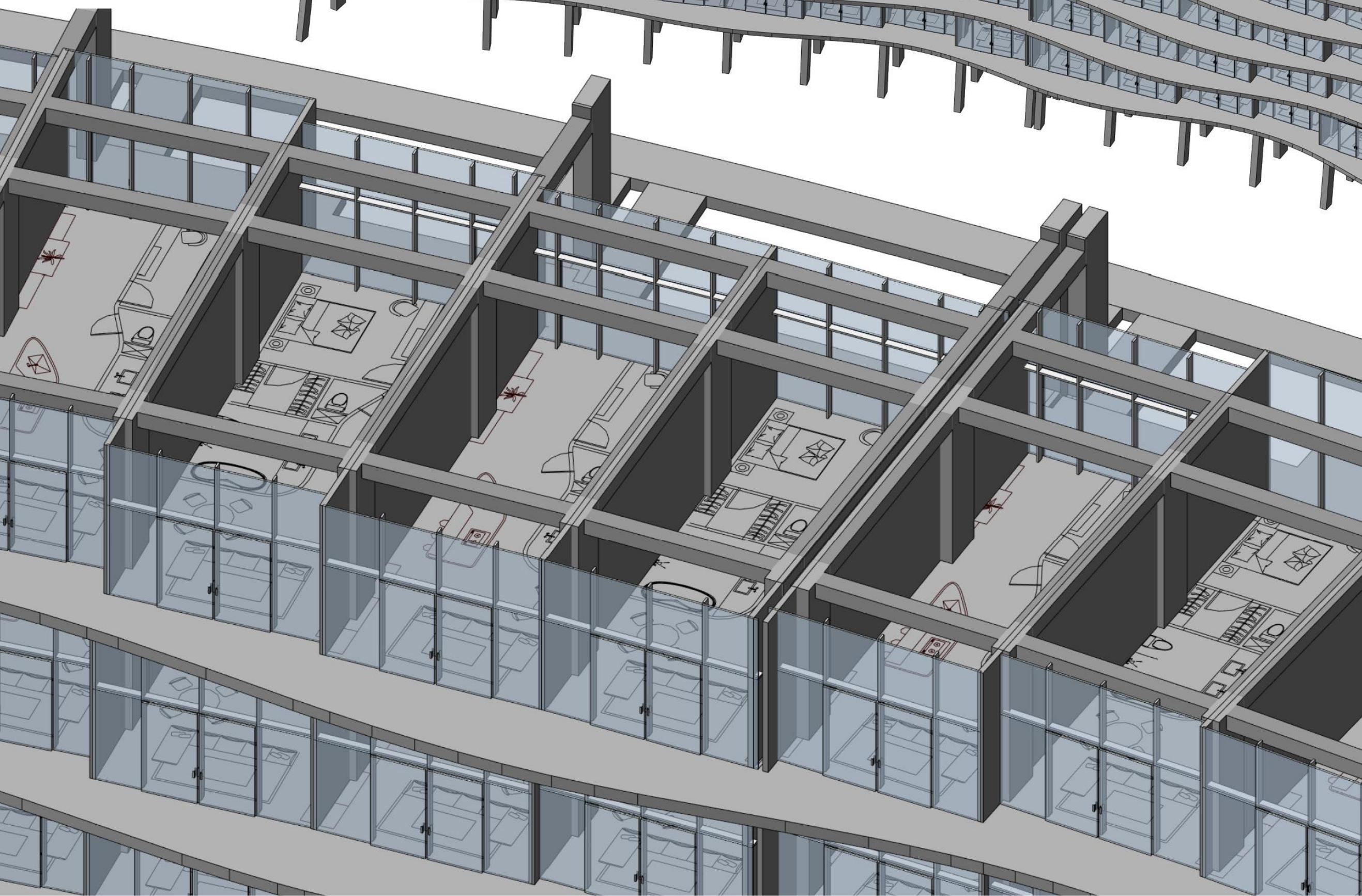
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| Z-HA                    | ZHA BIM | OFF | PROJECT: |
|-------------------------|---------|-----|----------|
| PARAMETER SET: Extended |         |     |          |
| A/V                     | L       | X   | F        |

BIM Parameters

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# Native Elements . Revit 3D

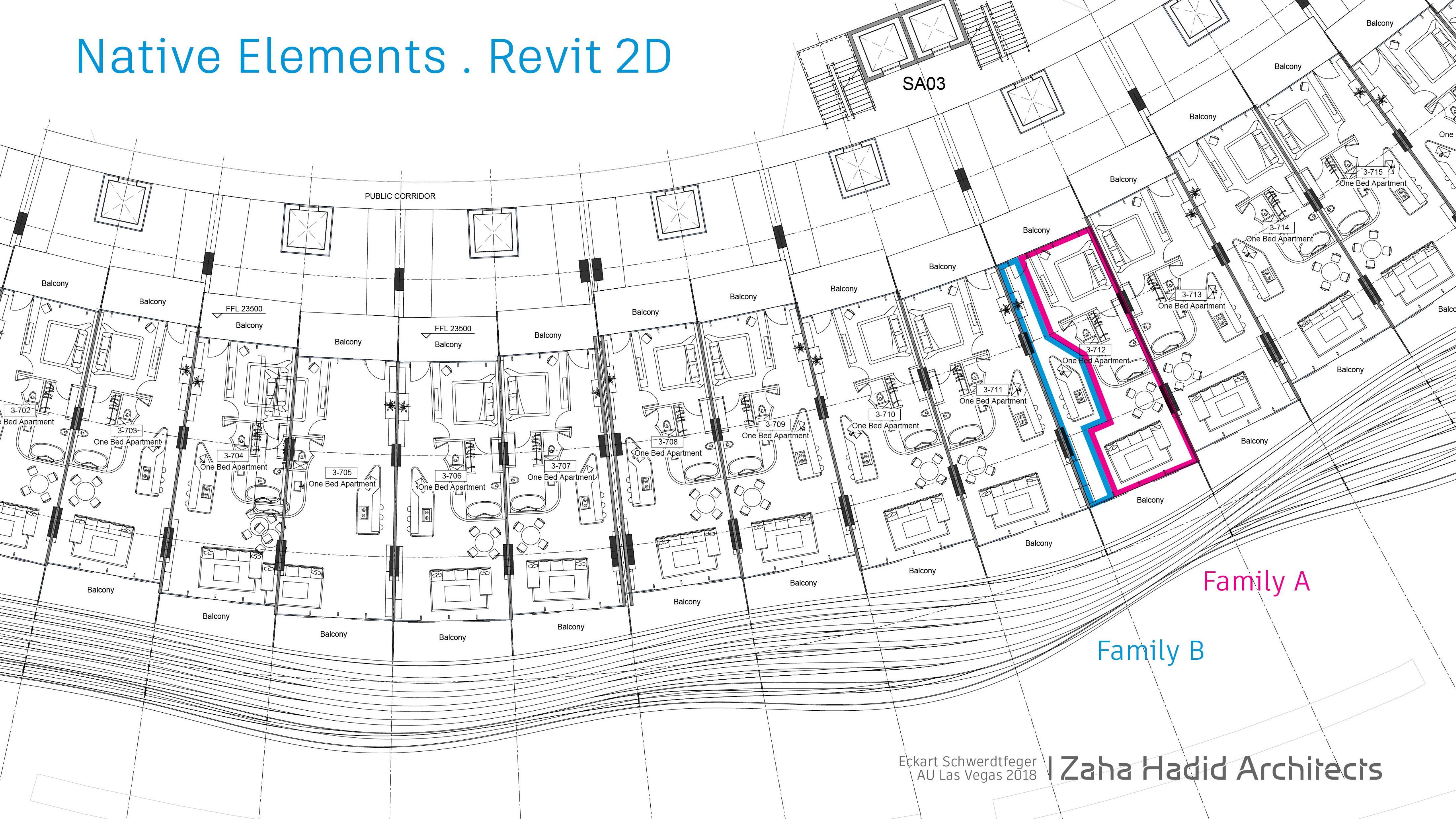


Native elements +  
proper hosting

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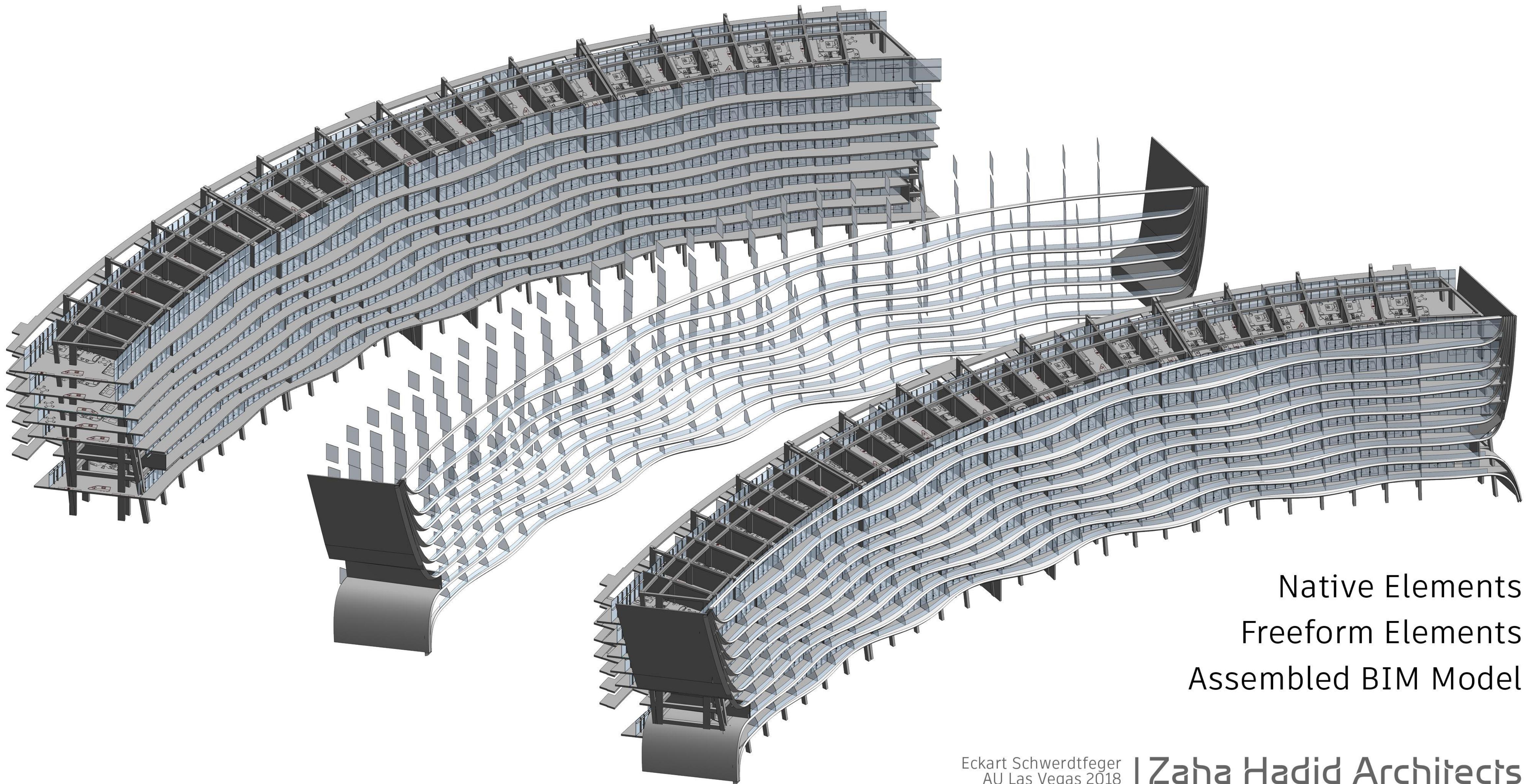
# Native Elements . Revit 2D



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# Native Elements . Revit



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# Freeform Elements

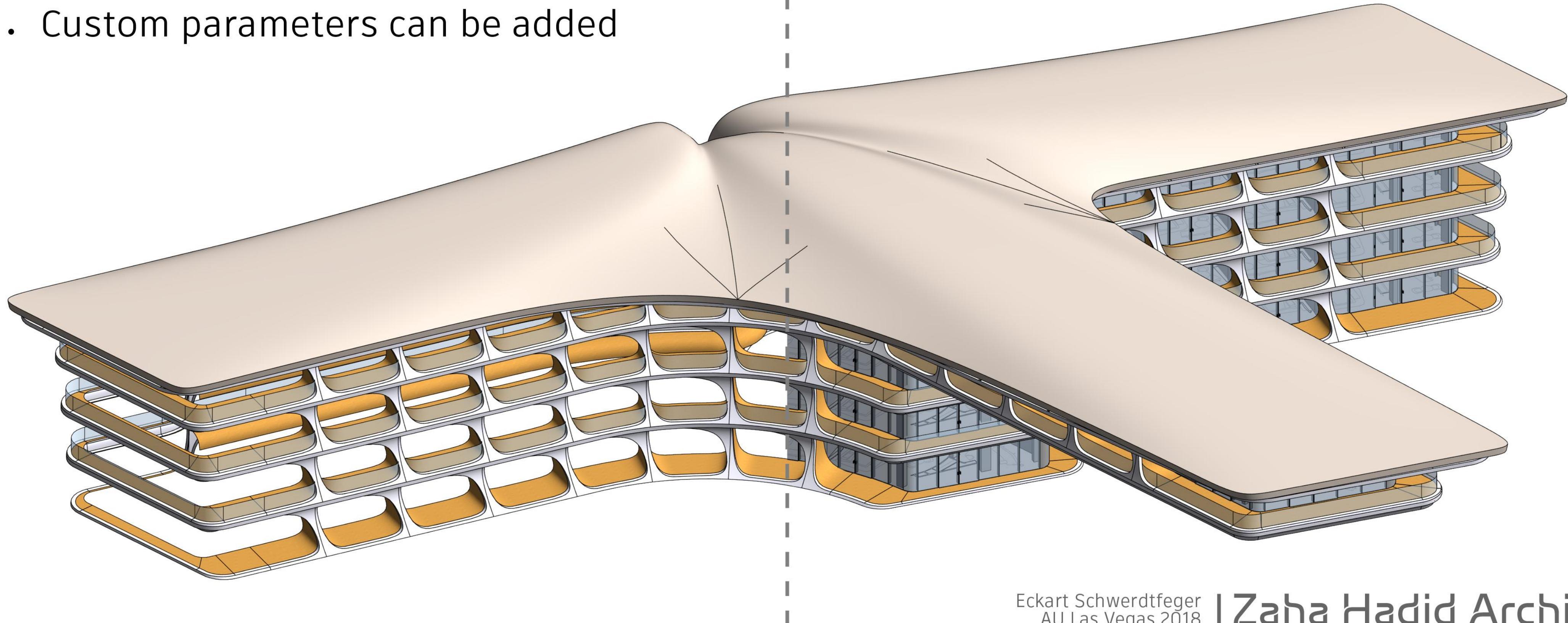


# Freeform Elements

- E.g. sculpted roof, facade and balcony cladding, balustrades, etc.
- Freeform geometry not supported by preset building elements
- Custom parameters can be added

## Creation

- Manual import [tedious process, slow, limitations]
- Automated custom workflow



# Freeform Elements



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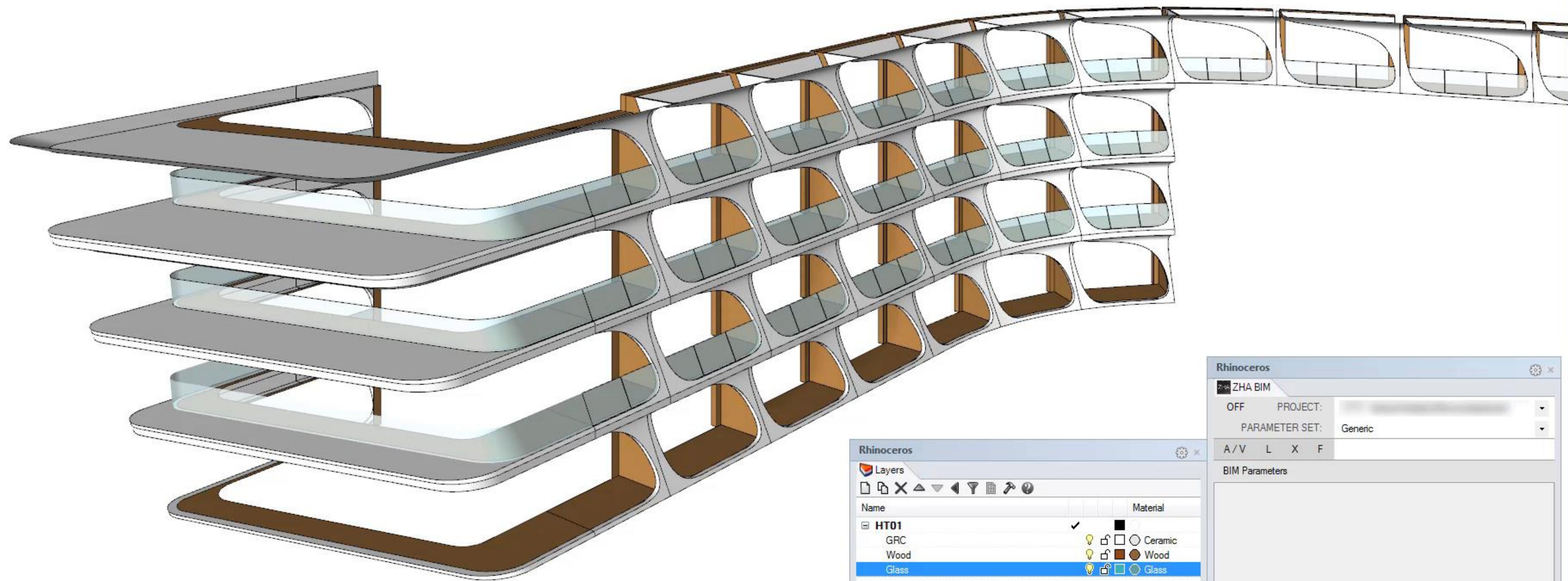
Command: SelAll  
742 surfaces added to selection.

Command:

Standard Display Set View Select Viewport Layout Visibility Transform Curve Tools Surface Tools Solid Tools Mesh Tools Render Tools Drafting New in V5 VisualARQ Tools



Top ▾



Rhinoceros

Layers

| Name  | Material |
|-------|----------|
| HT01  |          |
| GRC   | Ceramic  |
| Wood  | Wood     |
| Glass | Glass    |

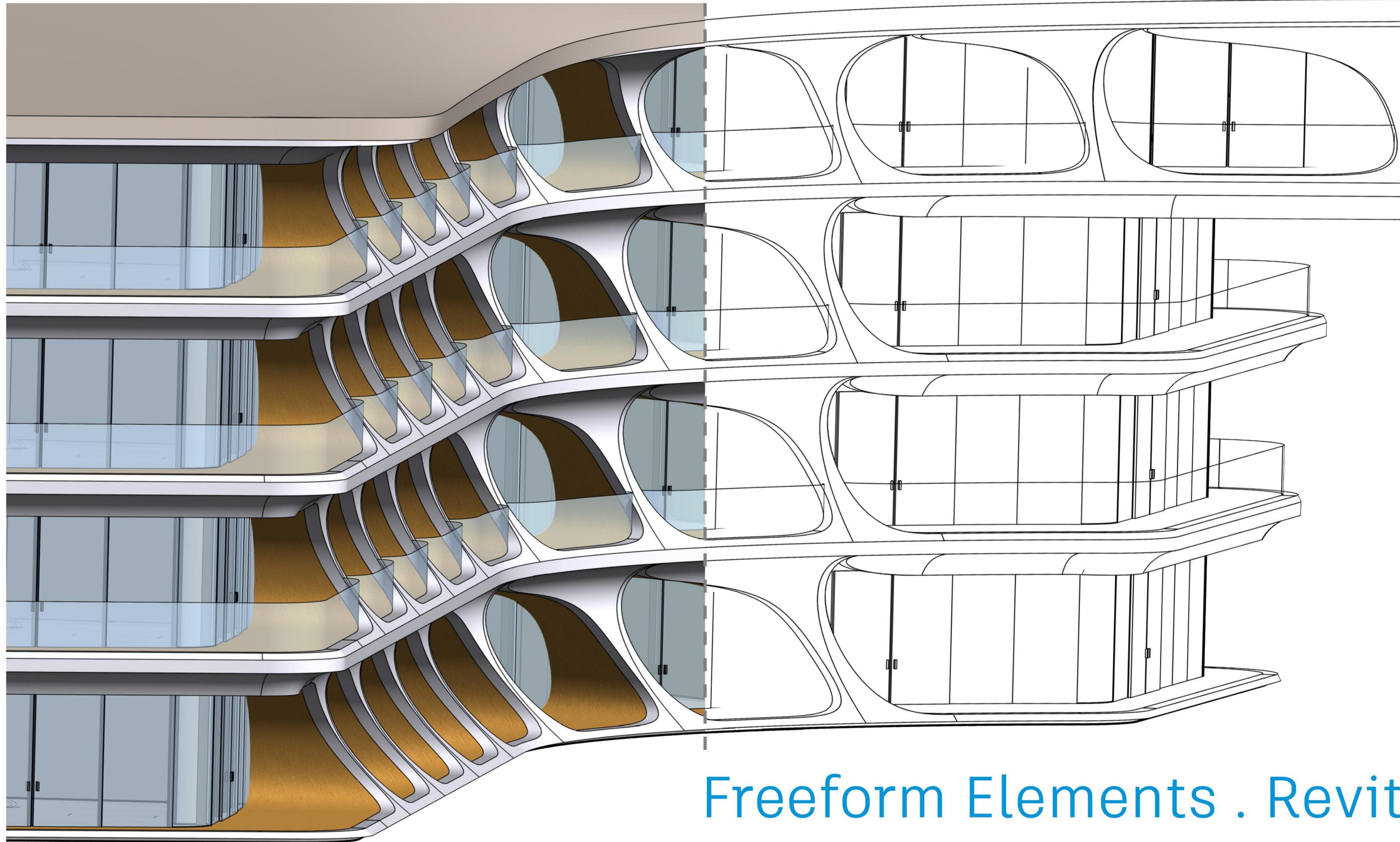
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Rhinoceros

ZHA BIM PROJECT: Generic

A/V L X F

BIM Parameters

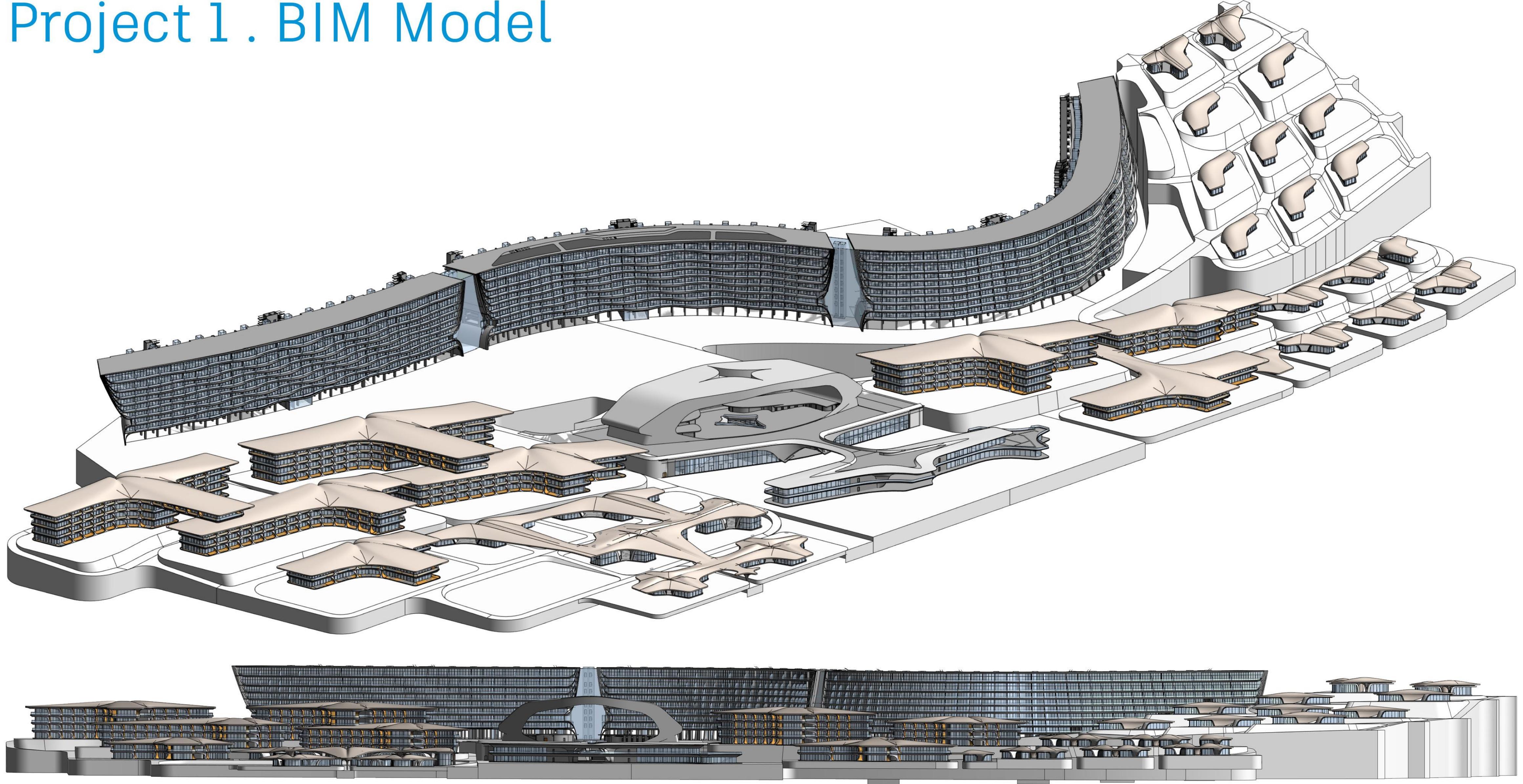


Freeform Elements . Revit 3D

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# Project 1 . BIM Model



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# Project 2

Project BIM Team

Eckart Schwerdtfeger  
Valeria Perco  
Maria Avrami  
Mauro Sabiu





# Project 2

- Building complex of about 262.000 m<sup>2</sup>
- Office building for up to 17.000 employees working in innovation + development

# Project 2

## Aims

- . Parametric Revit elements instead of importing “dead” geometry
- . Intensified use of visual scripting / Dynamo

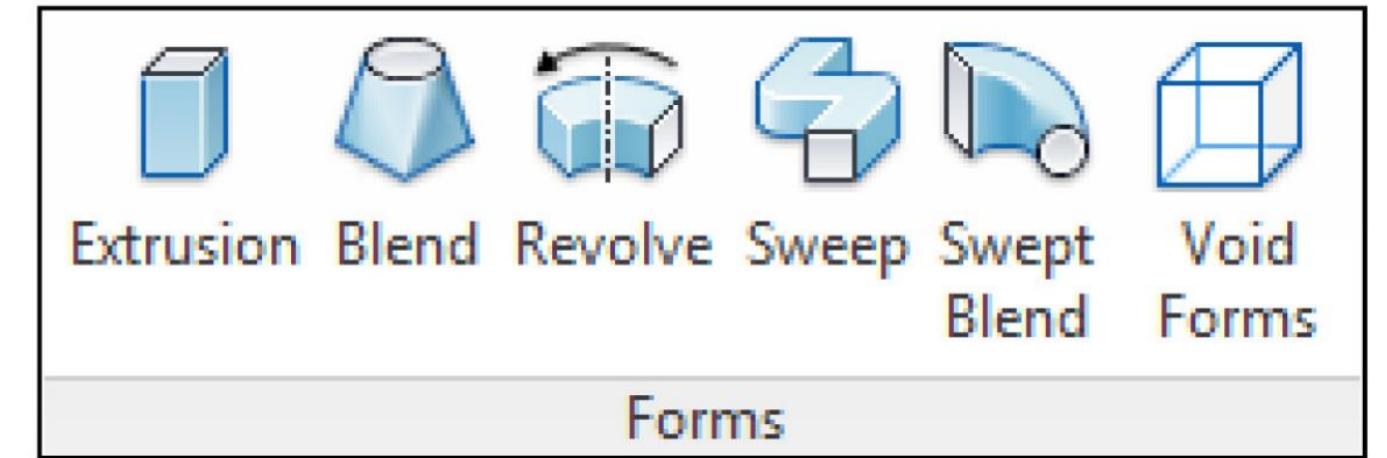
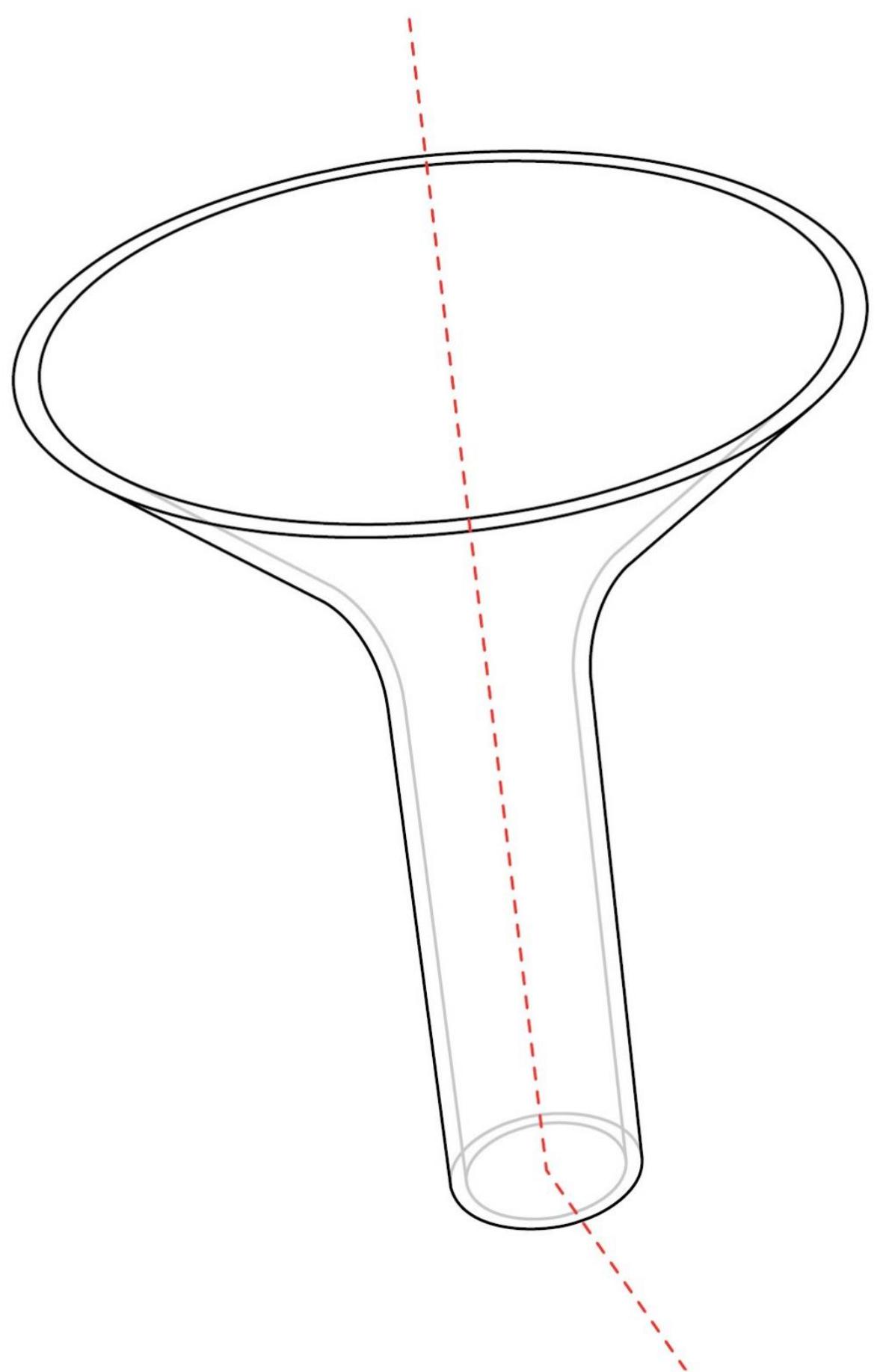
# Freeform Elements In Revit



# Freeform Elements . Forms

Mushroom column 360°

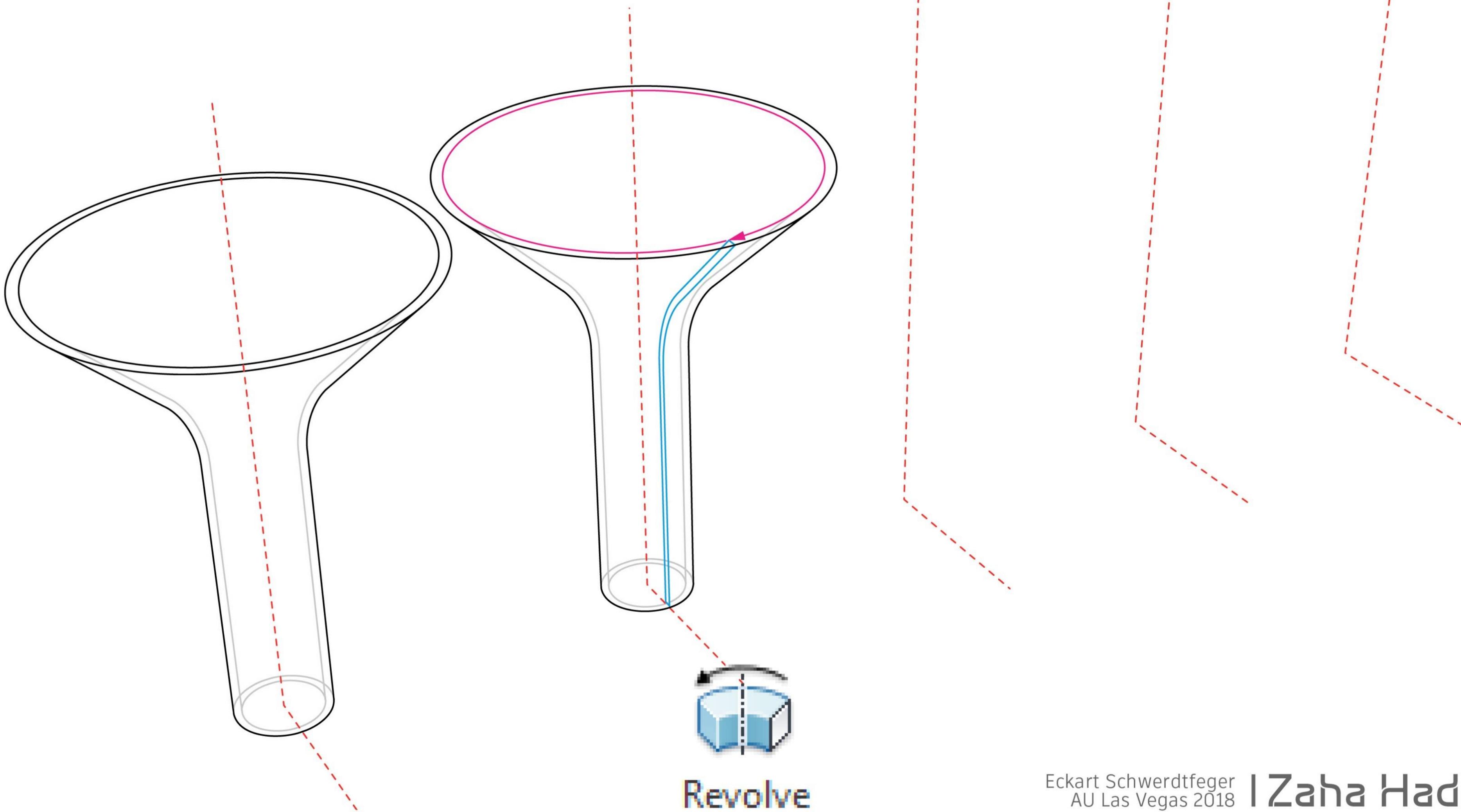
Cladding



# Freeform Elements . Forms

Mushroom column 360°

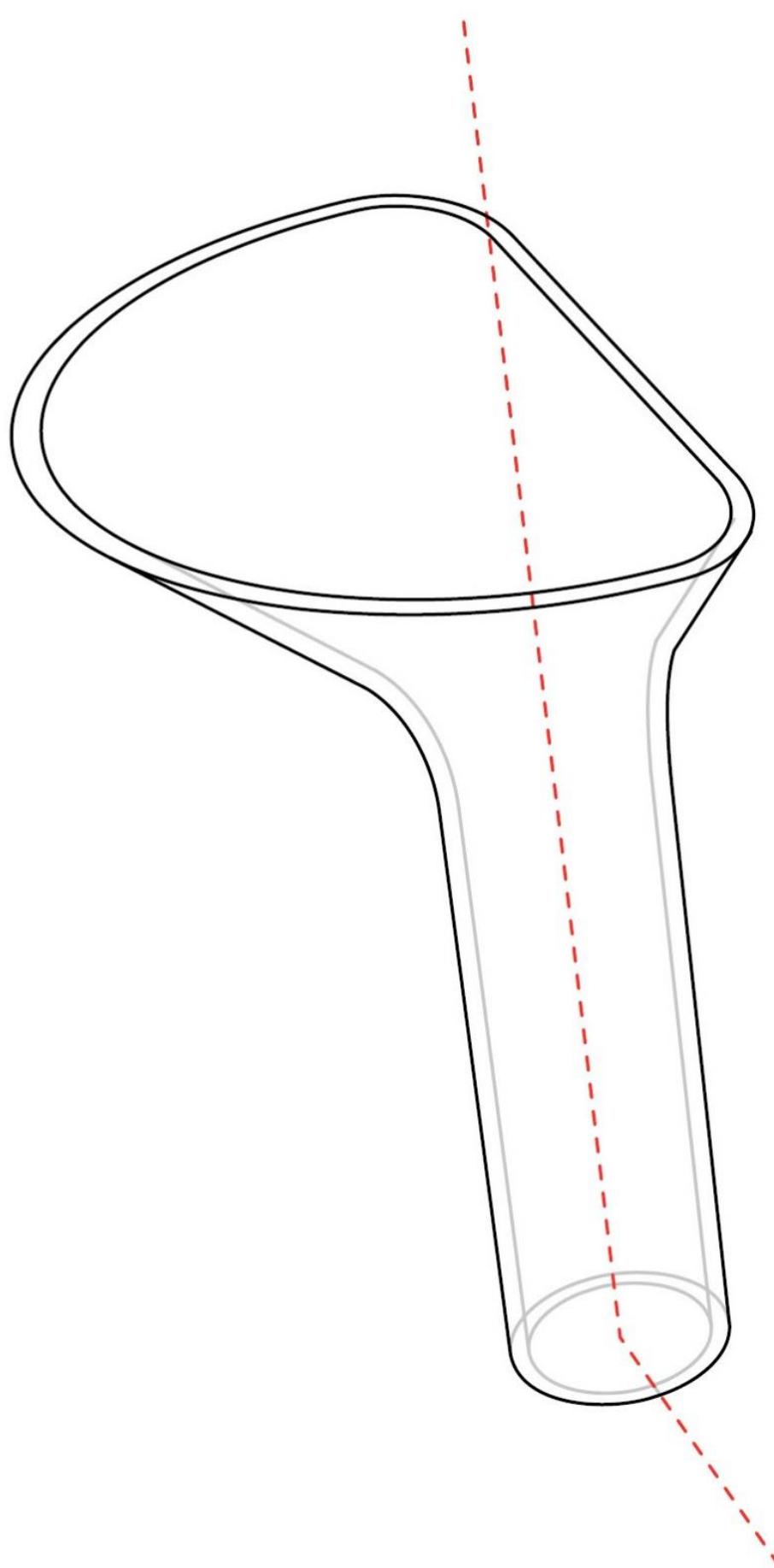
Cladding



# Freeform Elements . Forms

Mushroom column 180°

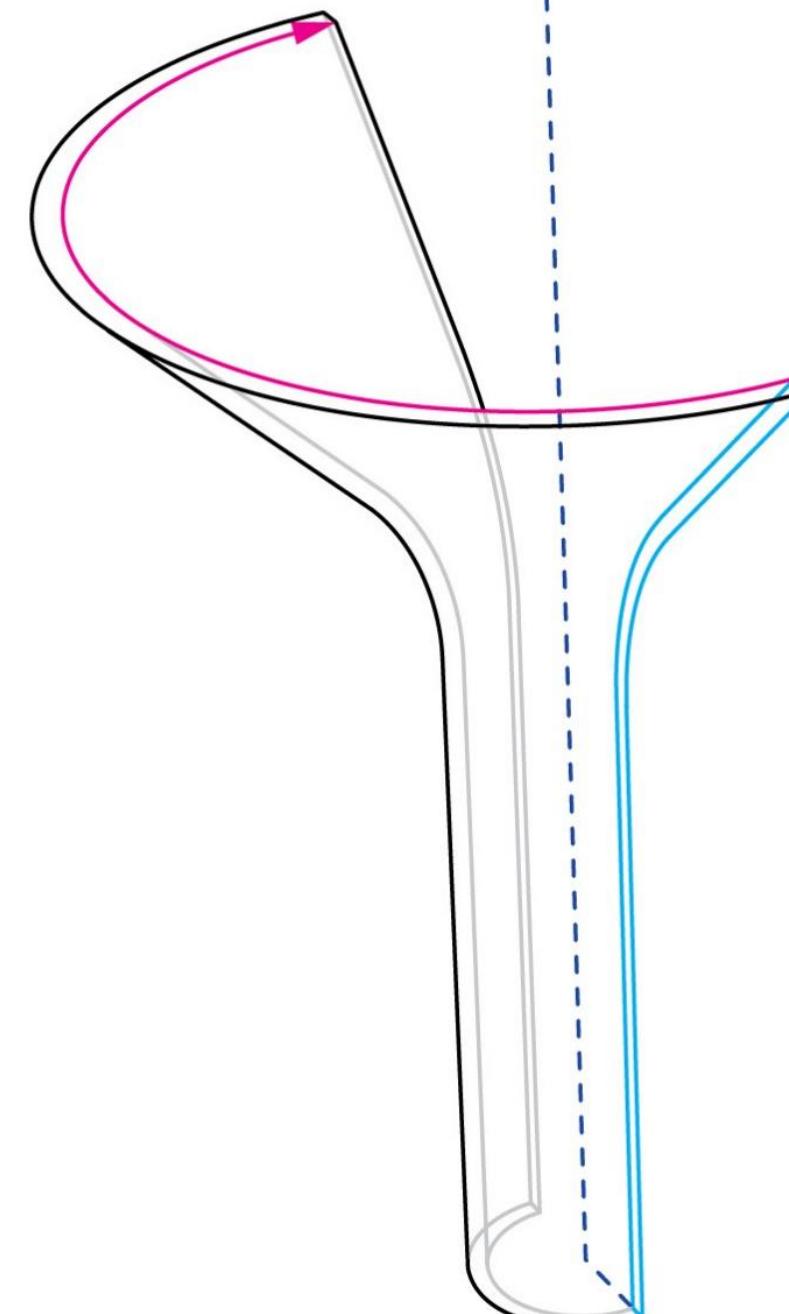
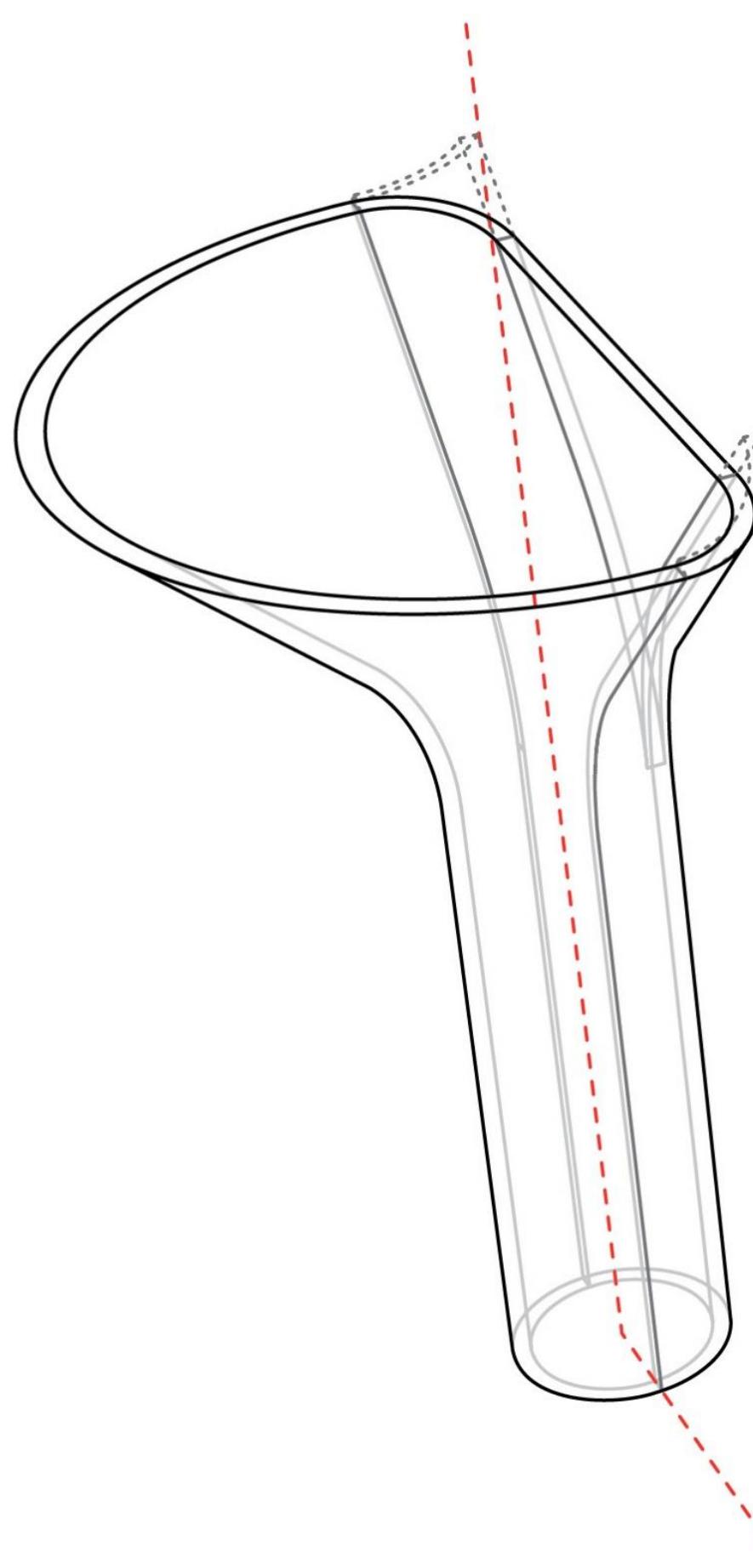
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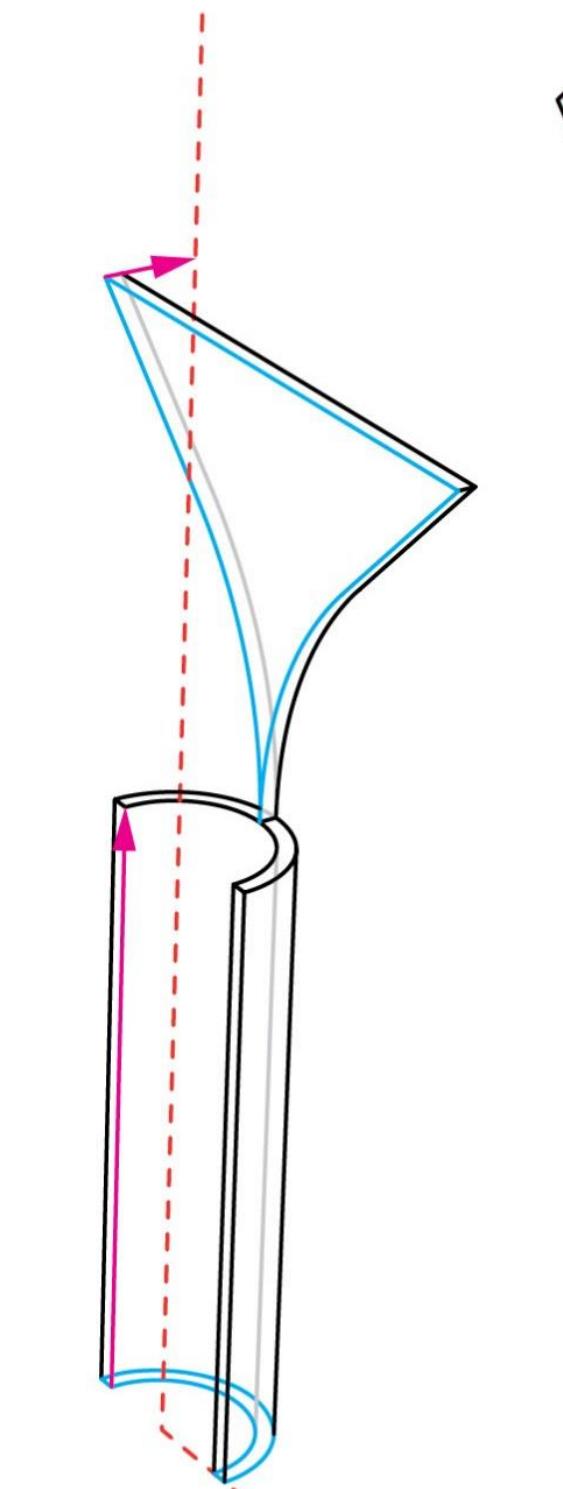
# Freeform Elements . Forms

Mushroom column 180°

Cladding



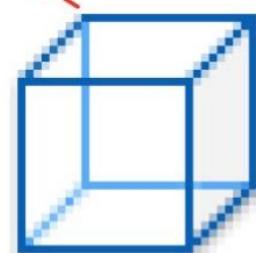
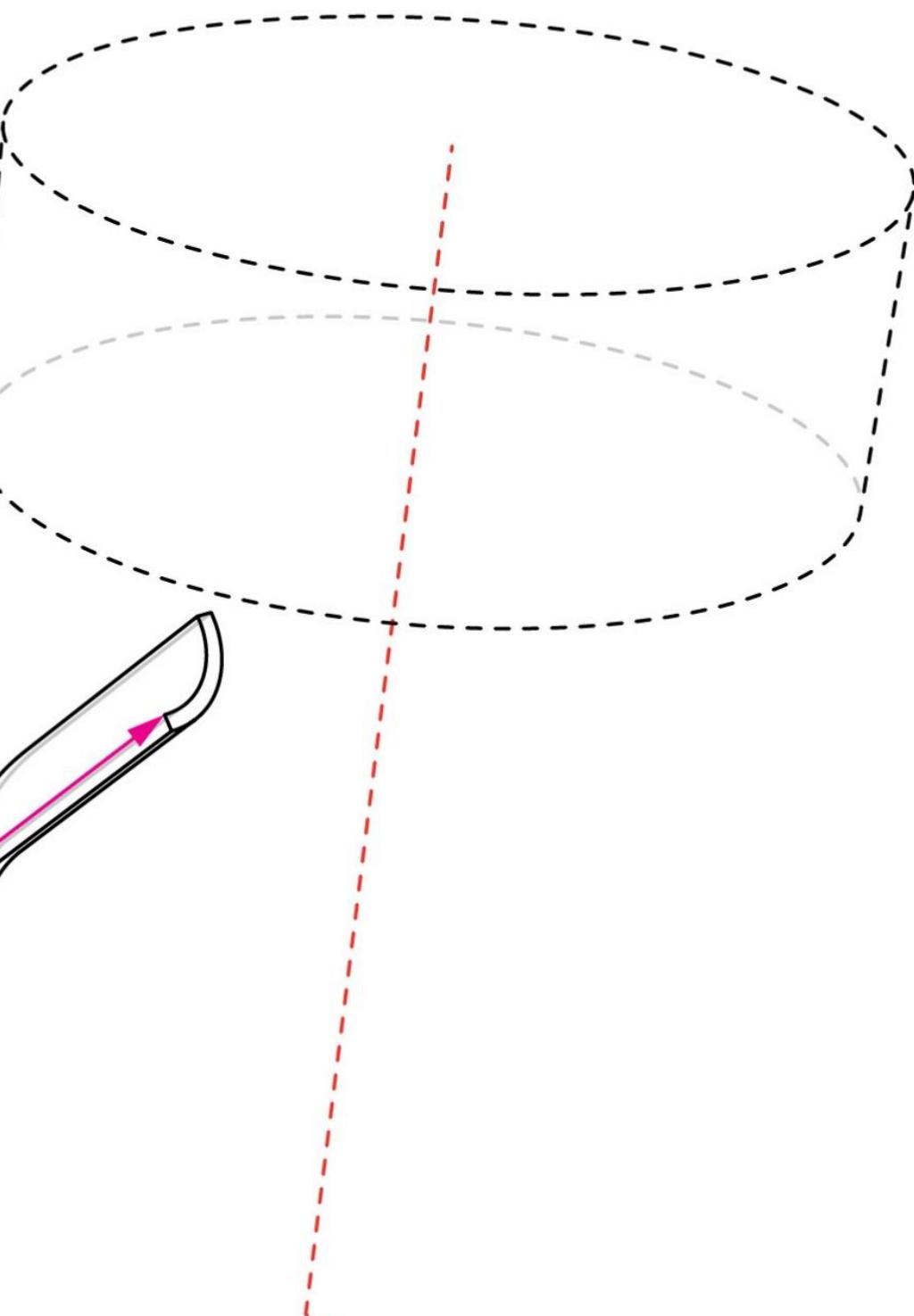
Revolve



Extrusion



Sweep

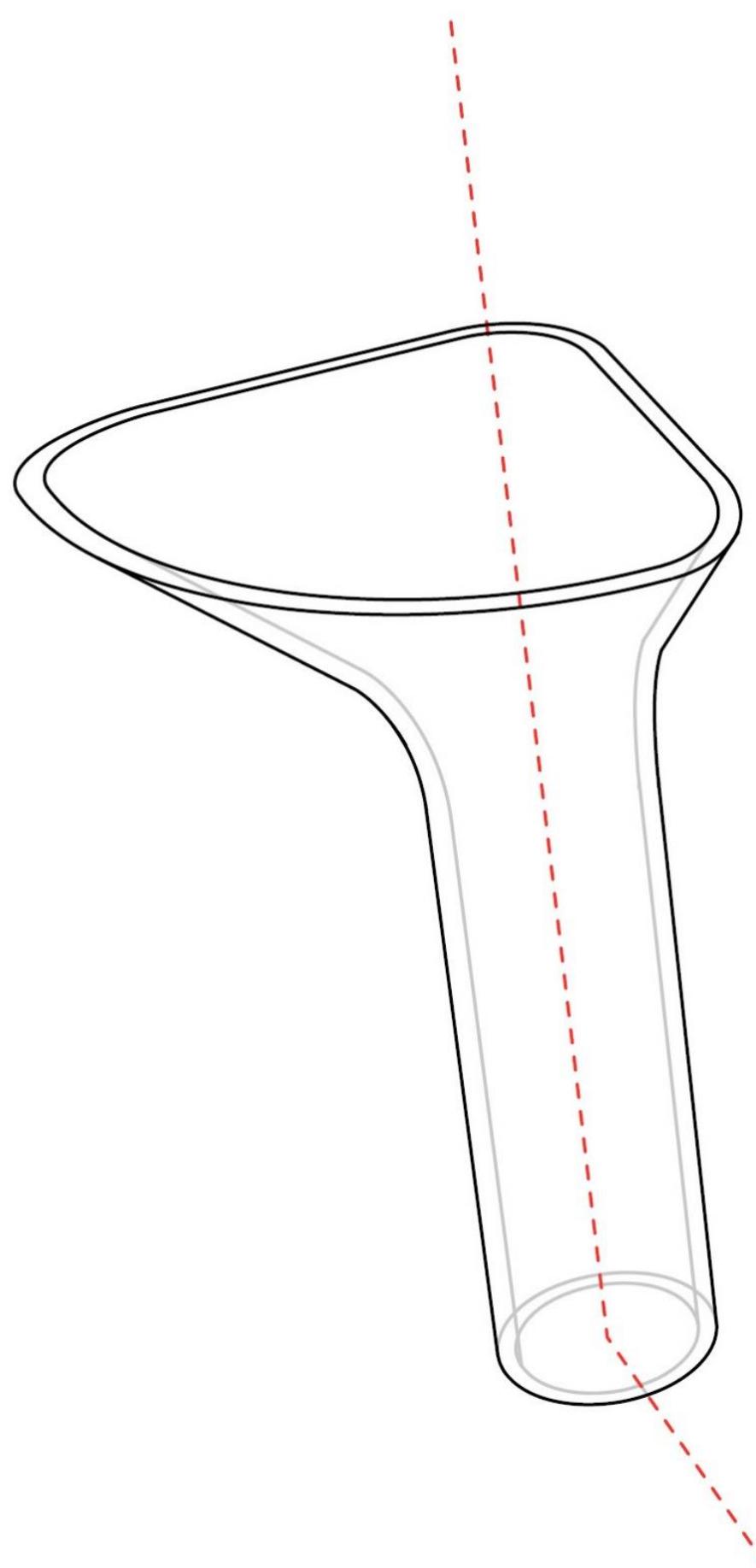


Void  
Forms

# Freeform Elements . Forms

Mushroom column 90°

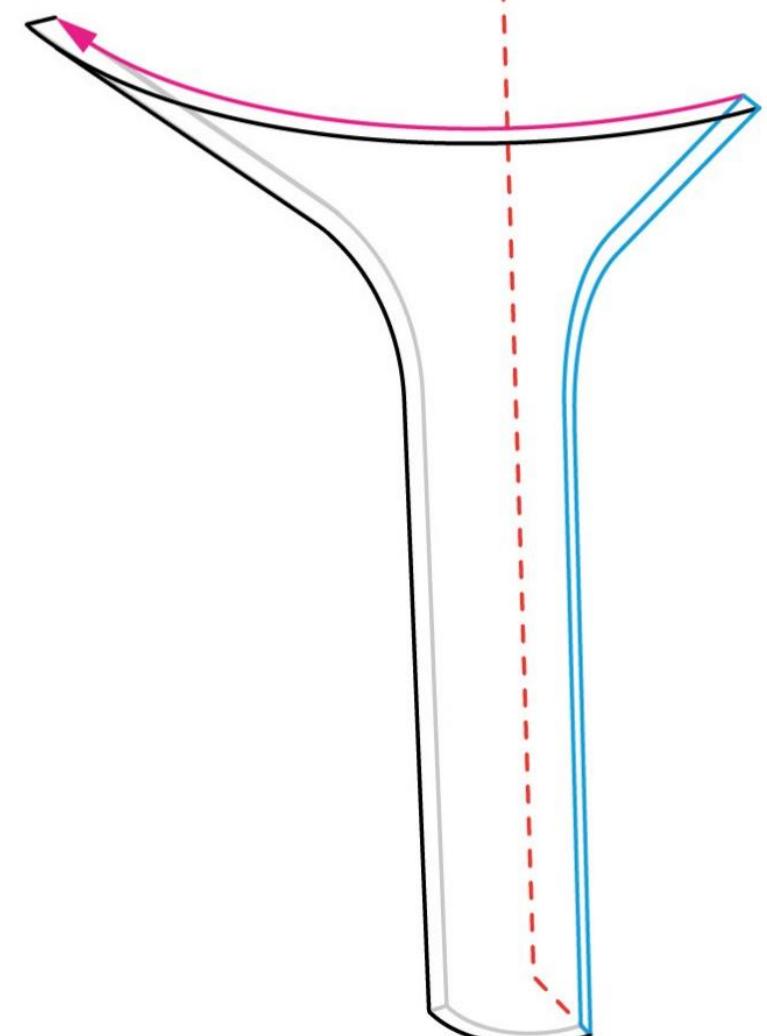
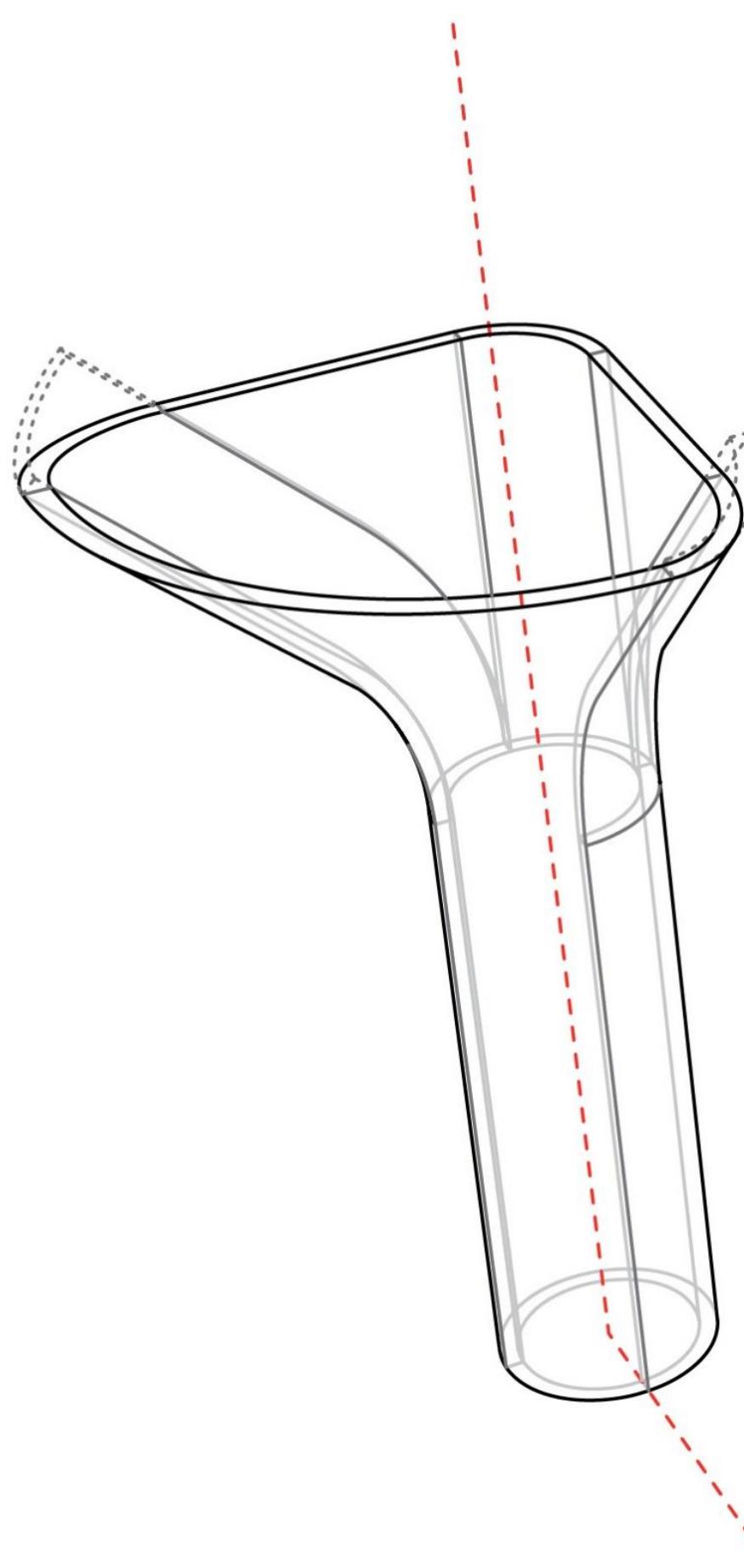
Cladding



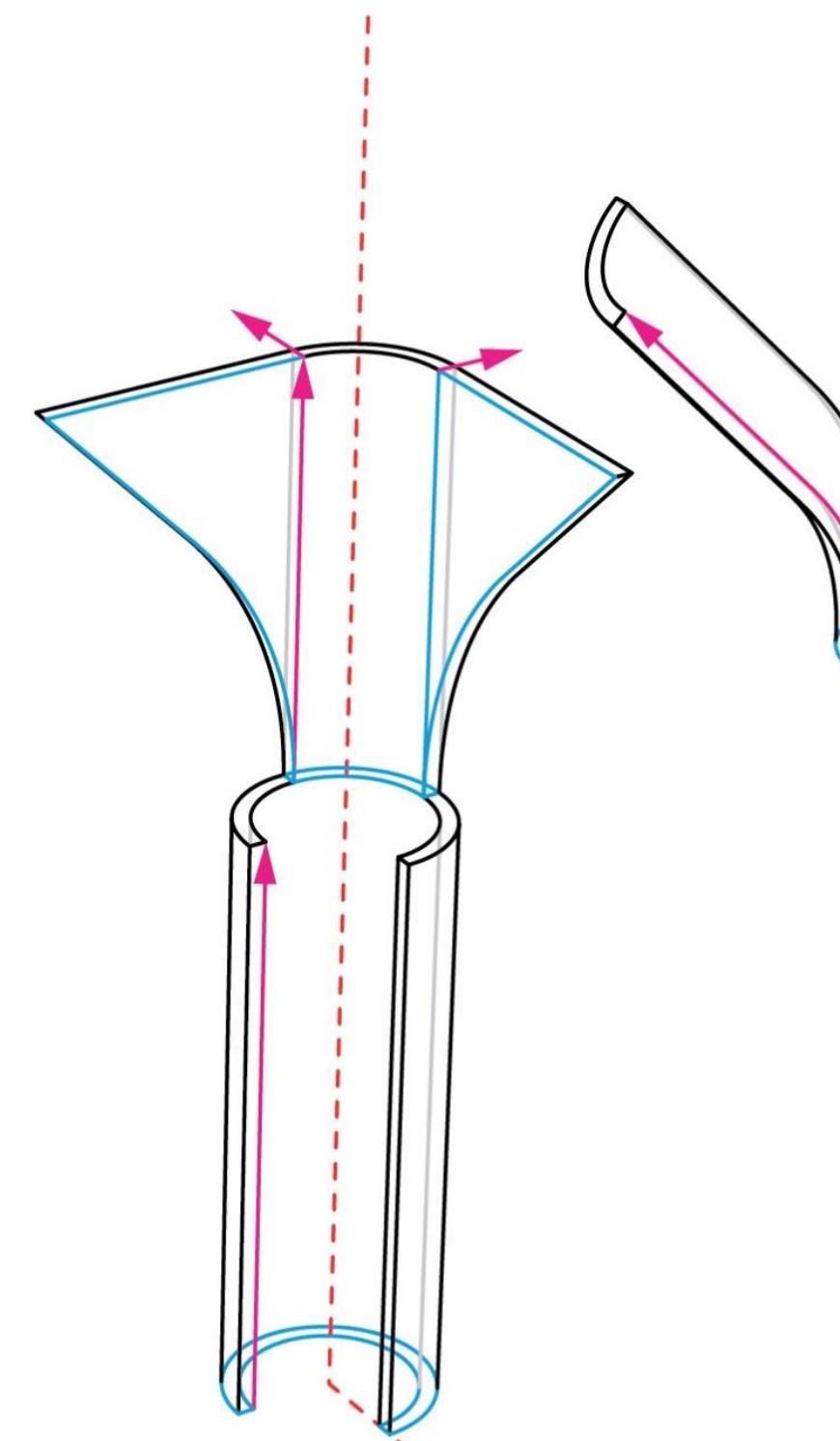
# Freeform Elements . Forms

Mushroom column 90°

Cladding



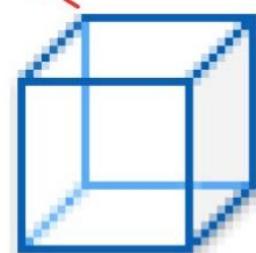
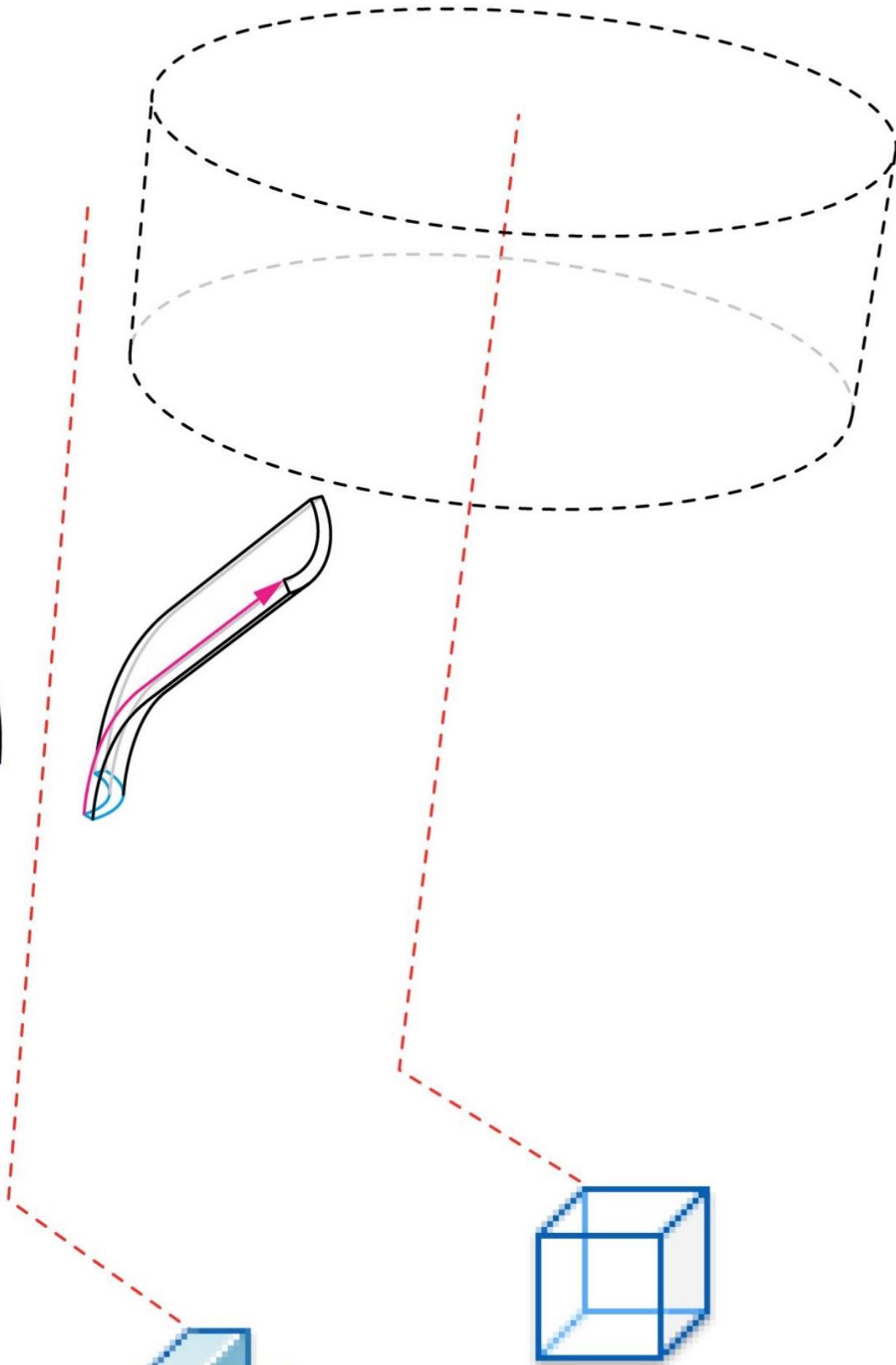
Revolve



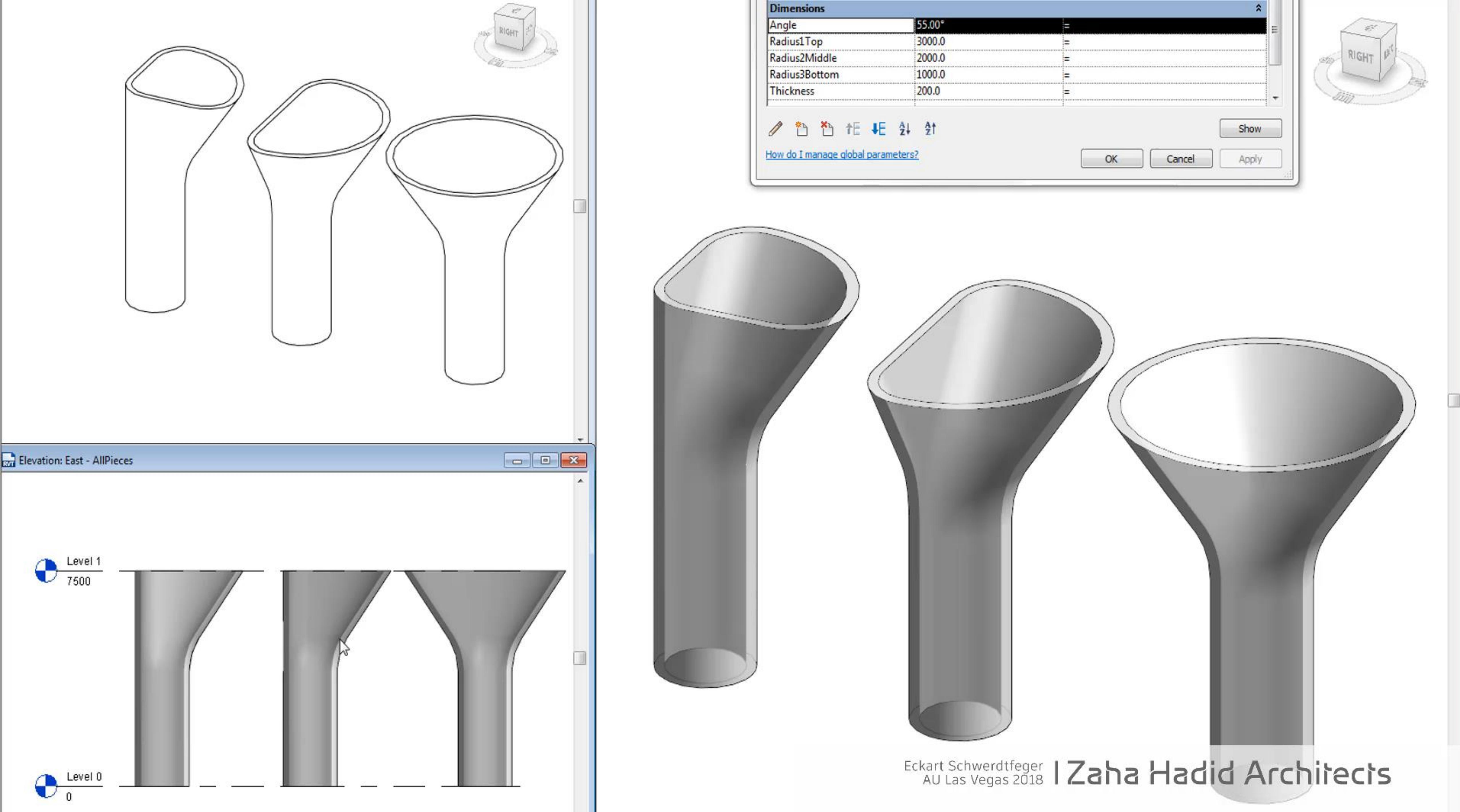
Extrusion



Sweep

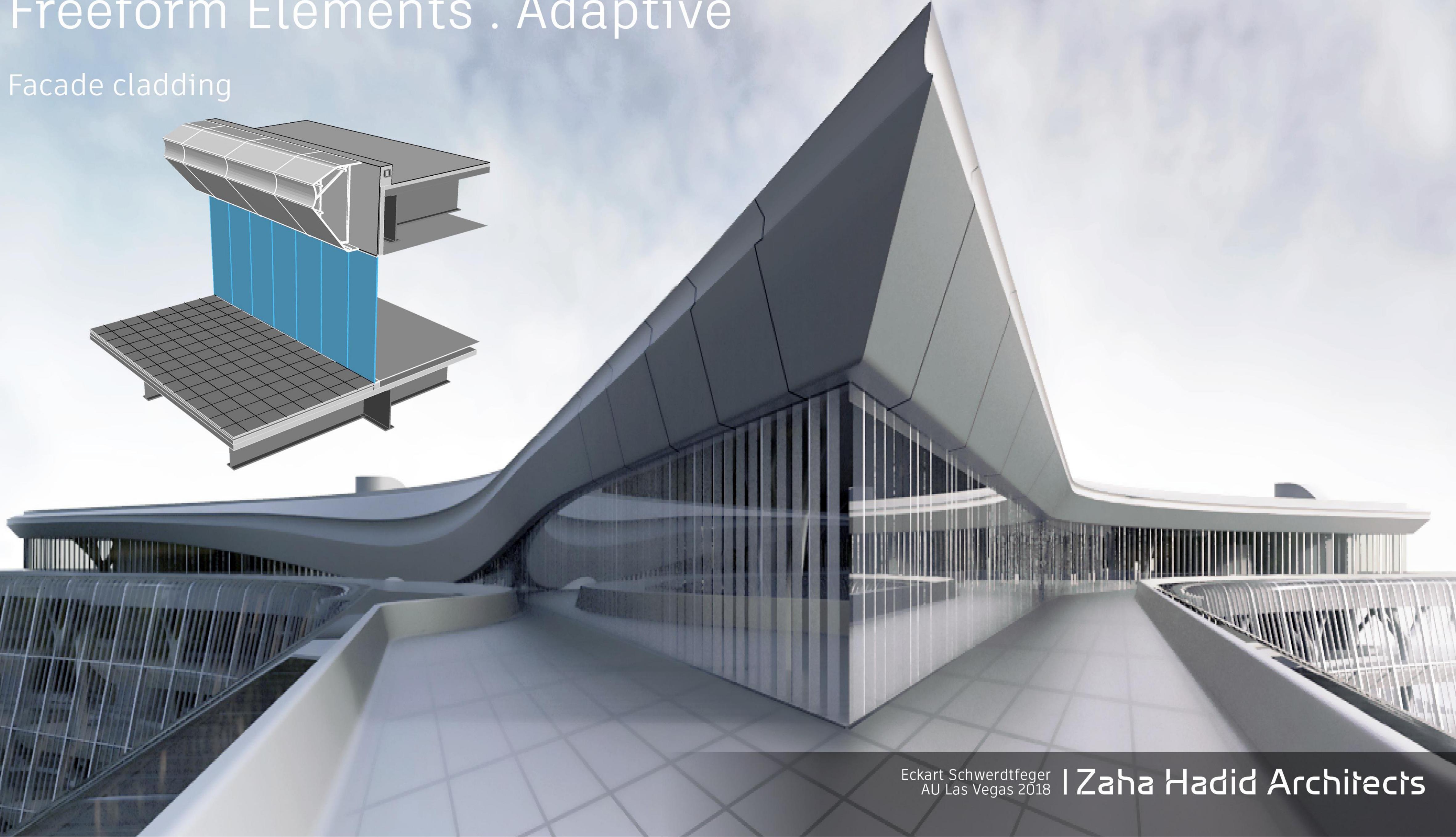


Void  
Forms



# Freeform Elements . Adaptive

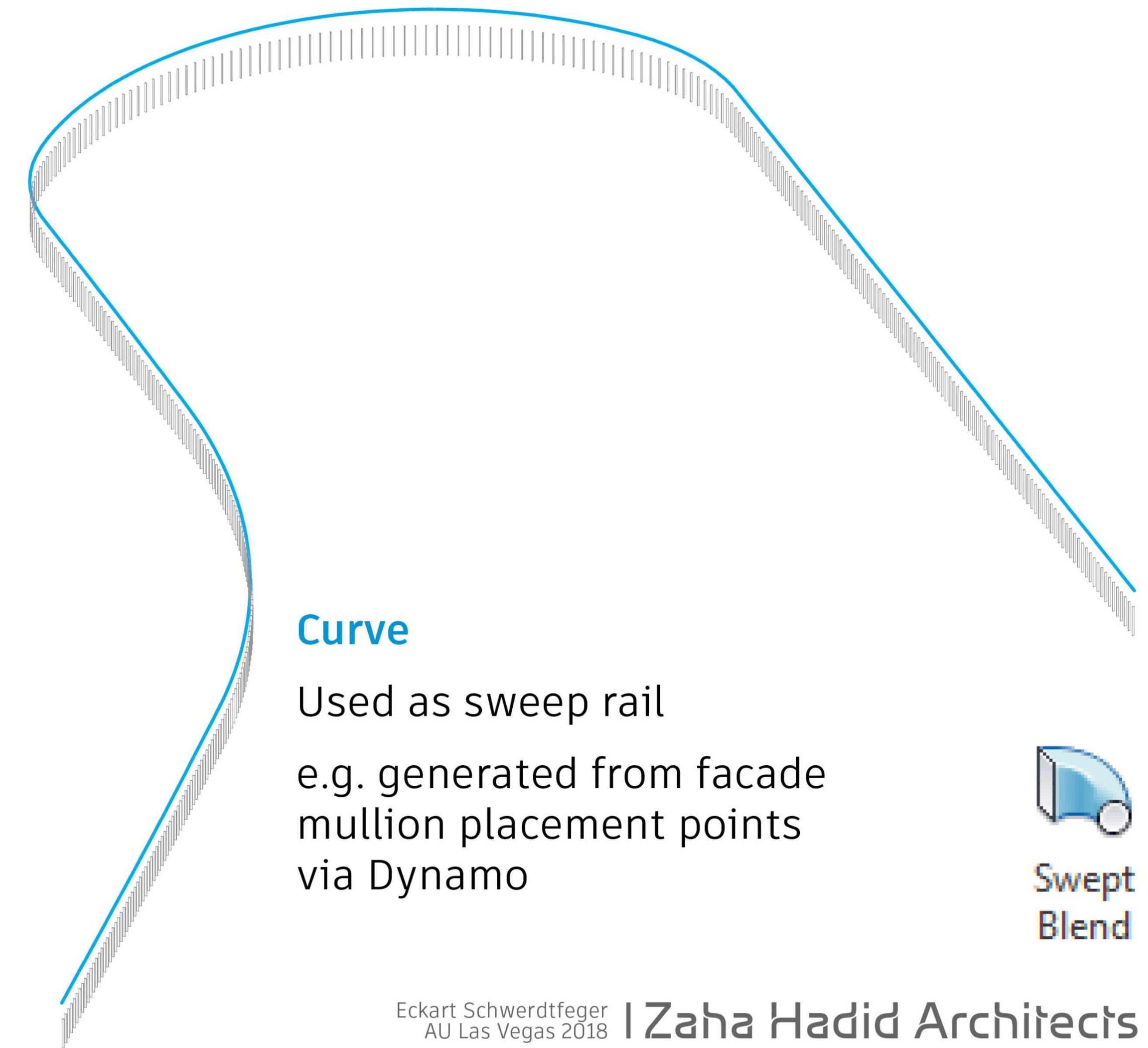
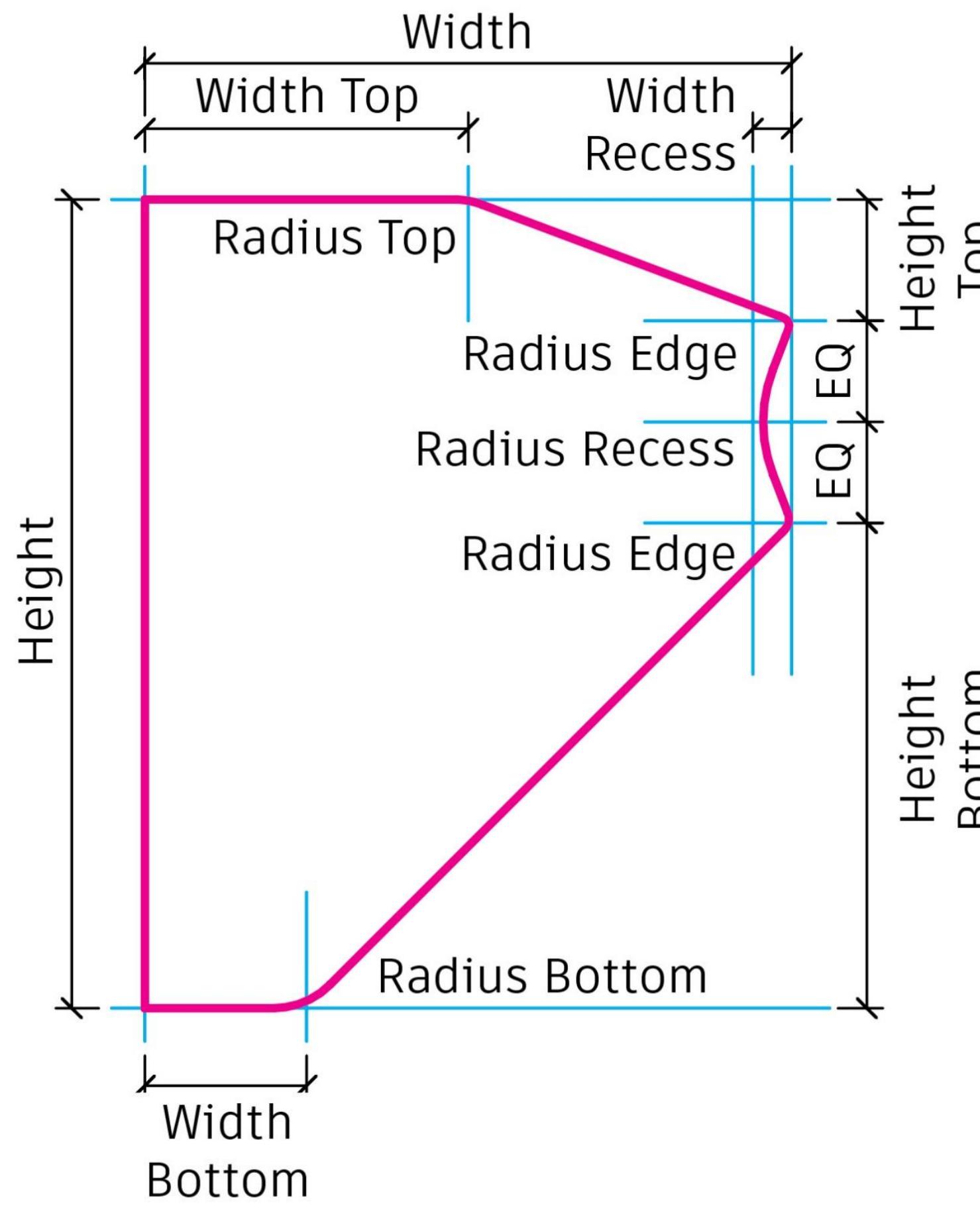
Facade cladding

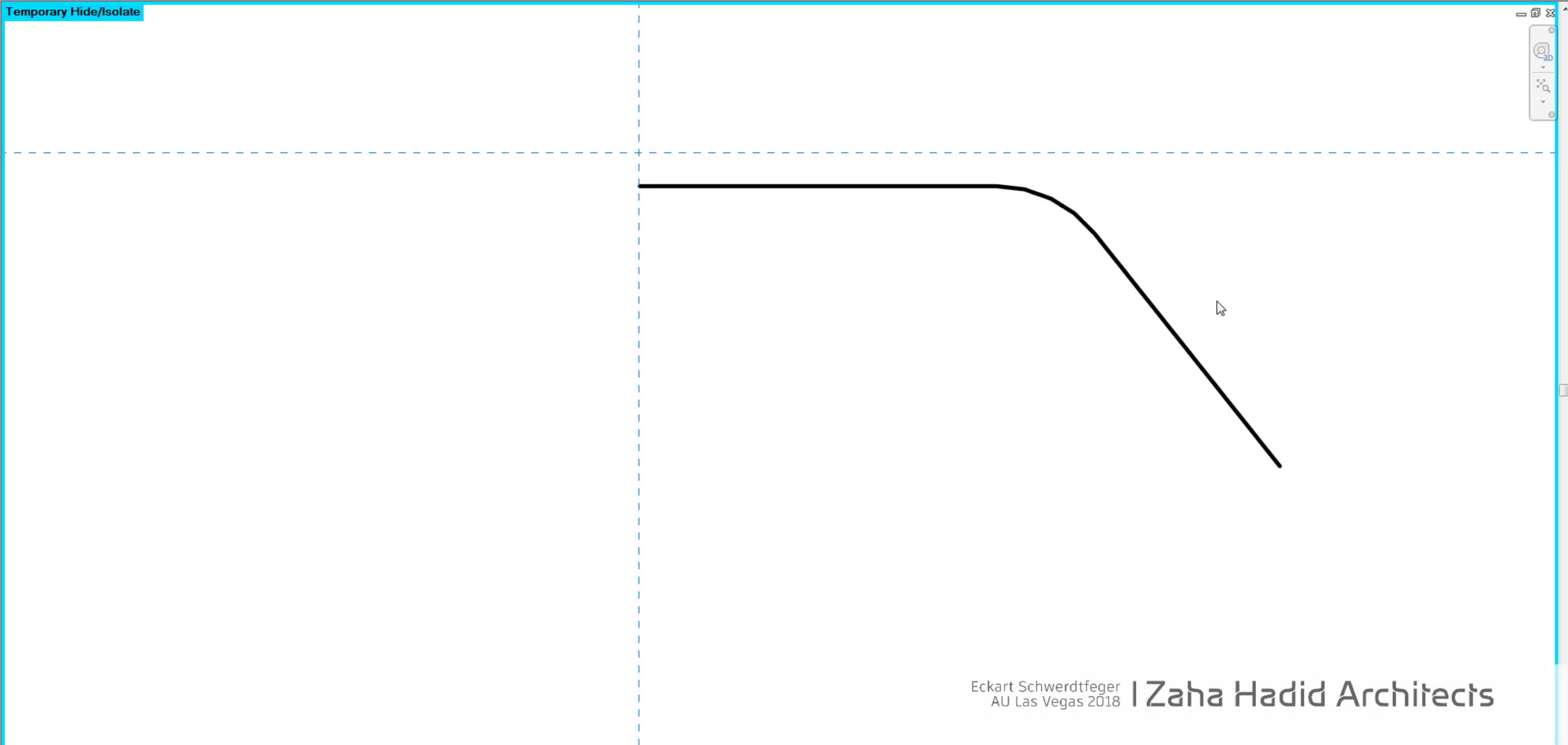
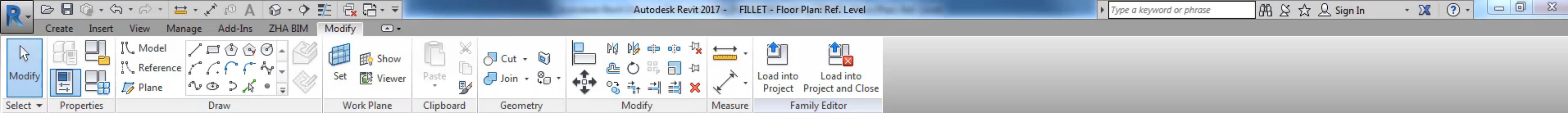


# Freeform Elements . Adaptive

## Facade cladding

Curve  
+ Parameter-based profile





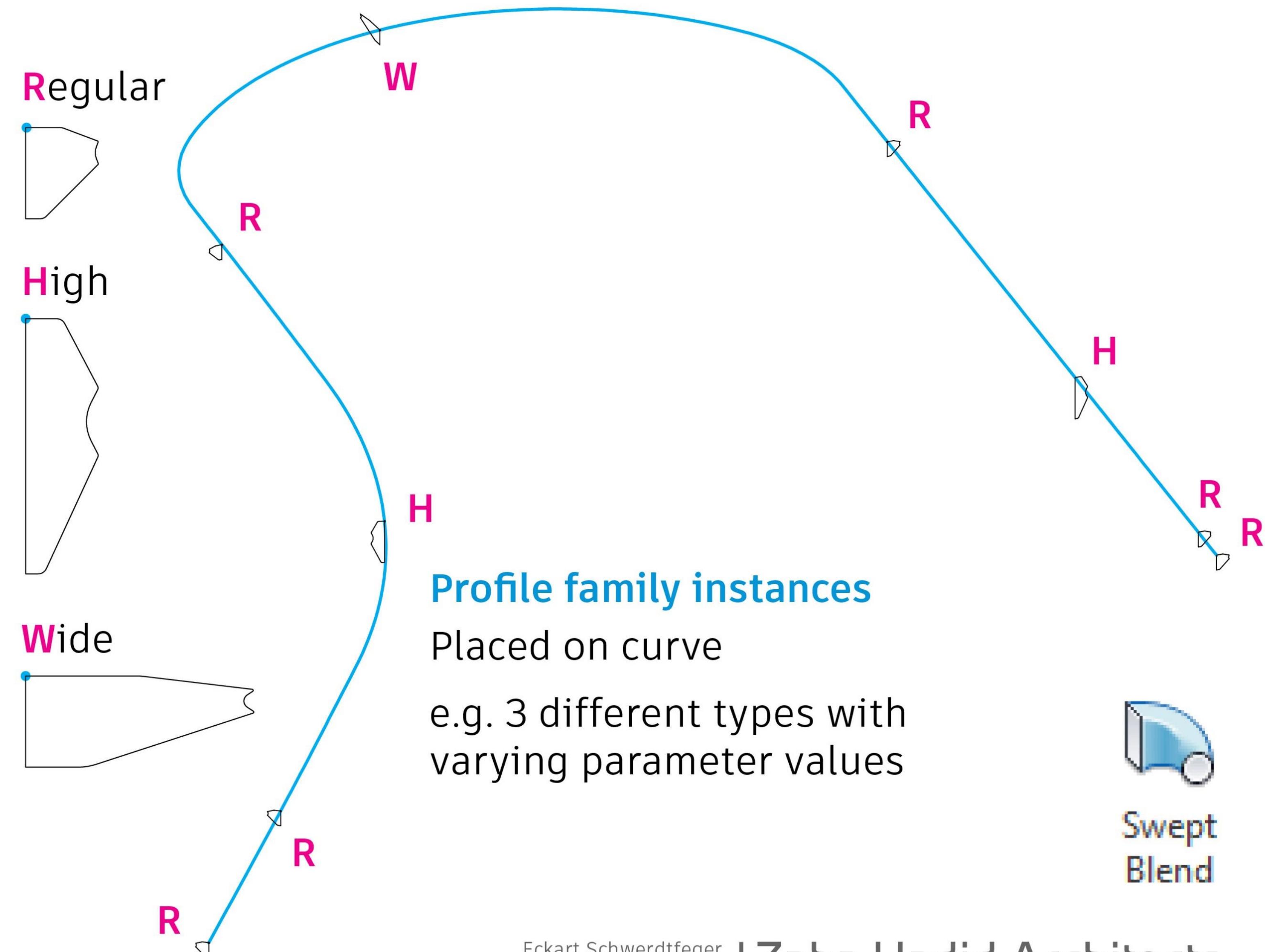
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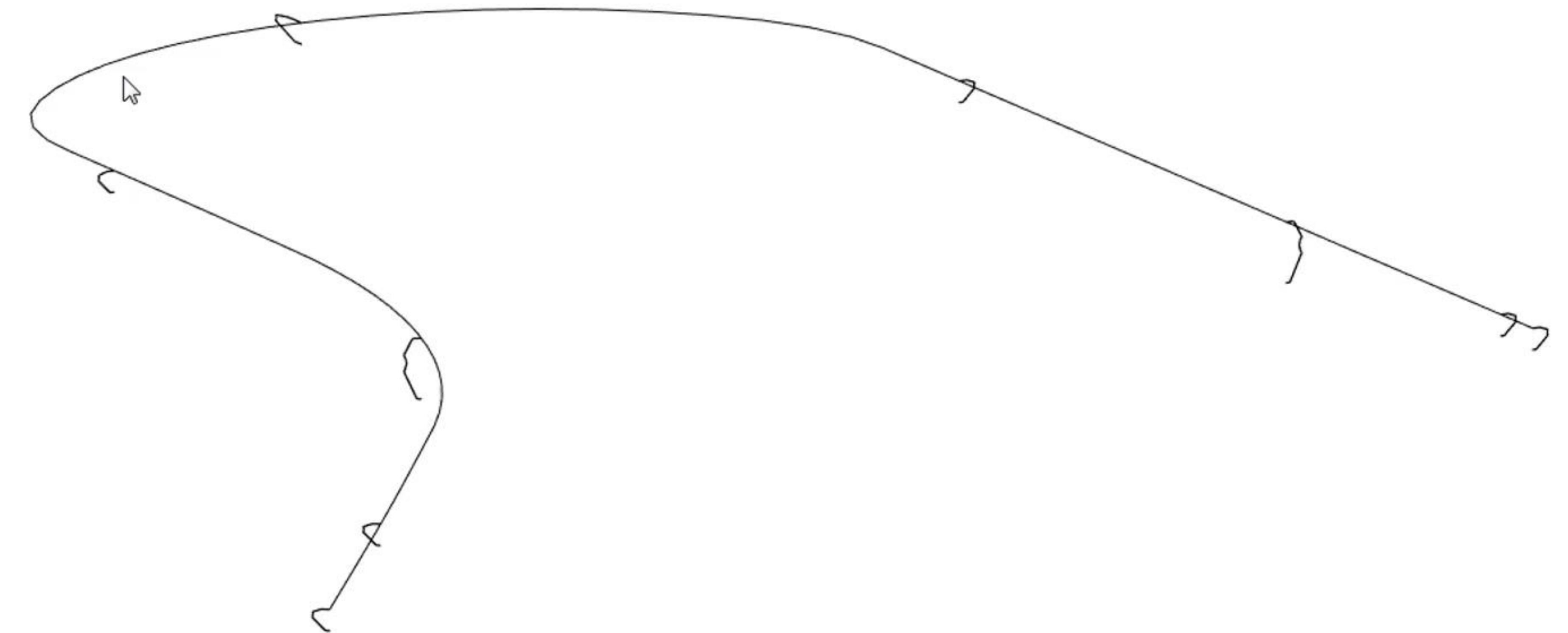
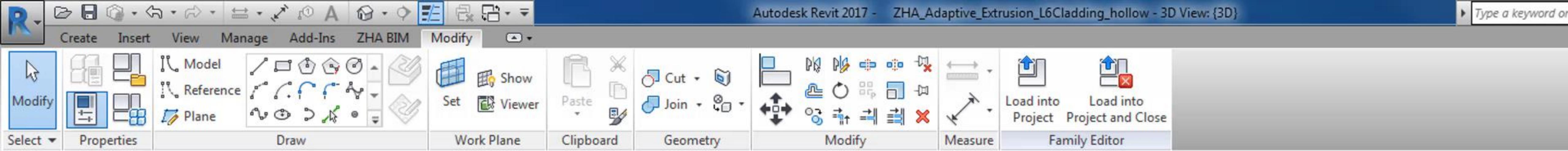
# Freeform Elements . Adaptive

## Facade cladding

- Curve
- + Parameter-based profile
- + Profile family instances

| Type          | R    | H    | W    |
|---------------|------|------|------|
| Width         | 2000 | 2000 | 6300 |
| Width Top     | 1000 | 1000 | 3150 |
| Width Bottom  | 500  | 500  | 1700 |
| Width Recess  | 120  | 475  | 475  |
| Height        | 2500 | 7000 | 2500 |
| Height Top    | 375  | 1900 | 375  |
| Height Bottom | 1500 | 3250 | 1500 |
| Radius Top    | 250  | 250  | 2000 |
| Radius Bottom | 250  | 250  | 1600 |
| Radius Edge   | 30   | 100  | 30   |
| Radius Recess | 450  | 1150 | 200  |





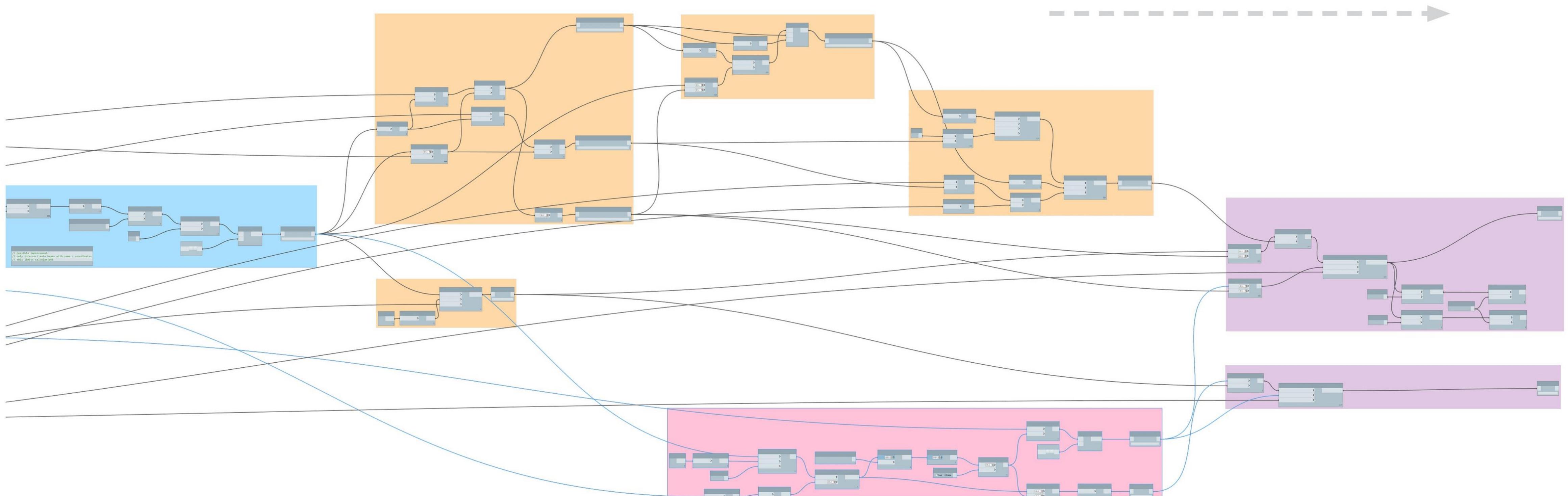
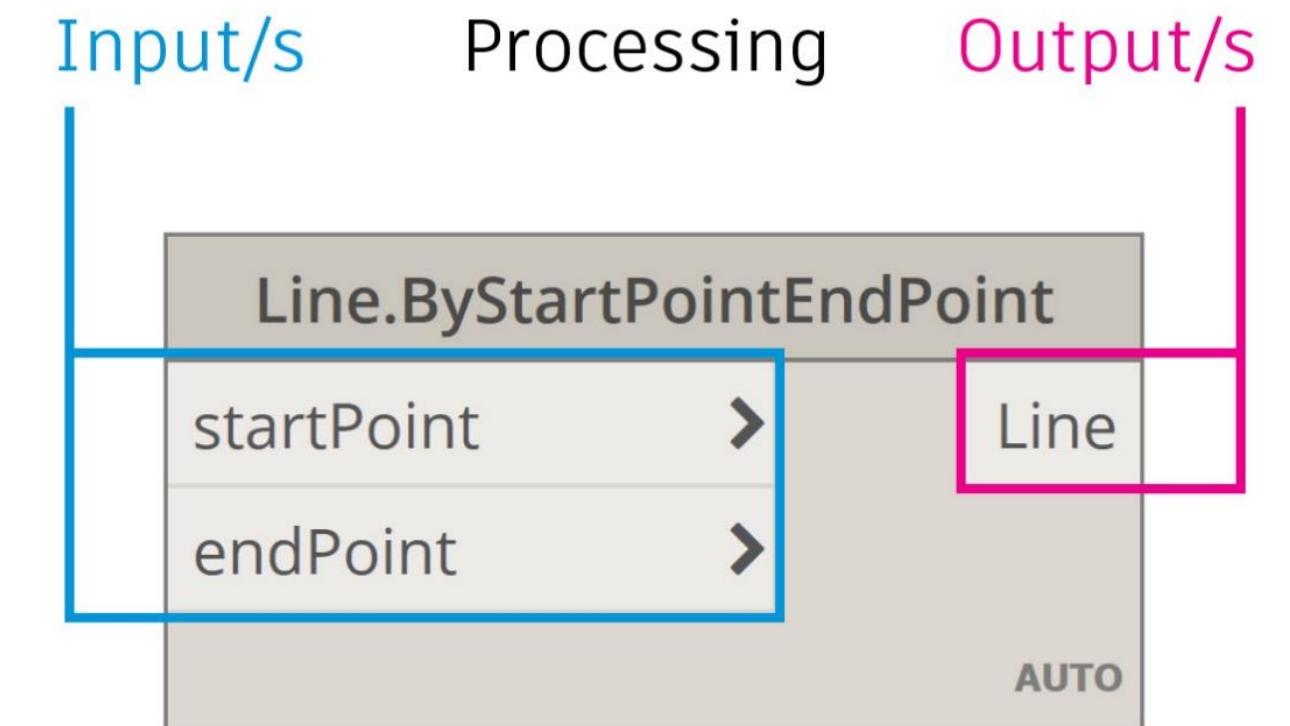
# Dynamo Visual Scripting



# Dynamo . Introduction

# Visual Scripting

- Graphical user interface for Dynamo + Revit application programming interface [API]
  - Linear sequence of instructions [**Nodes**]





Dynamo . Visual Scripting

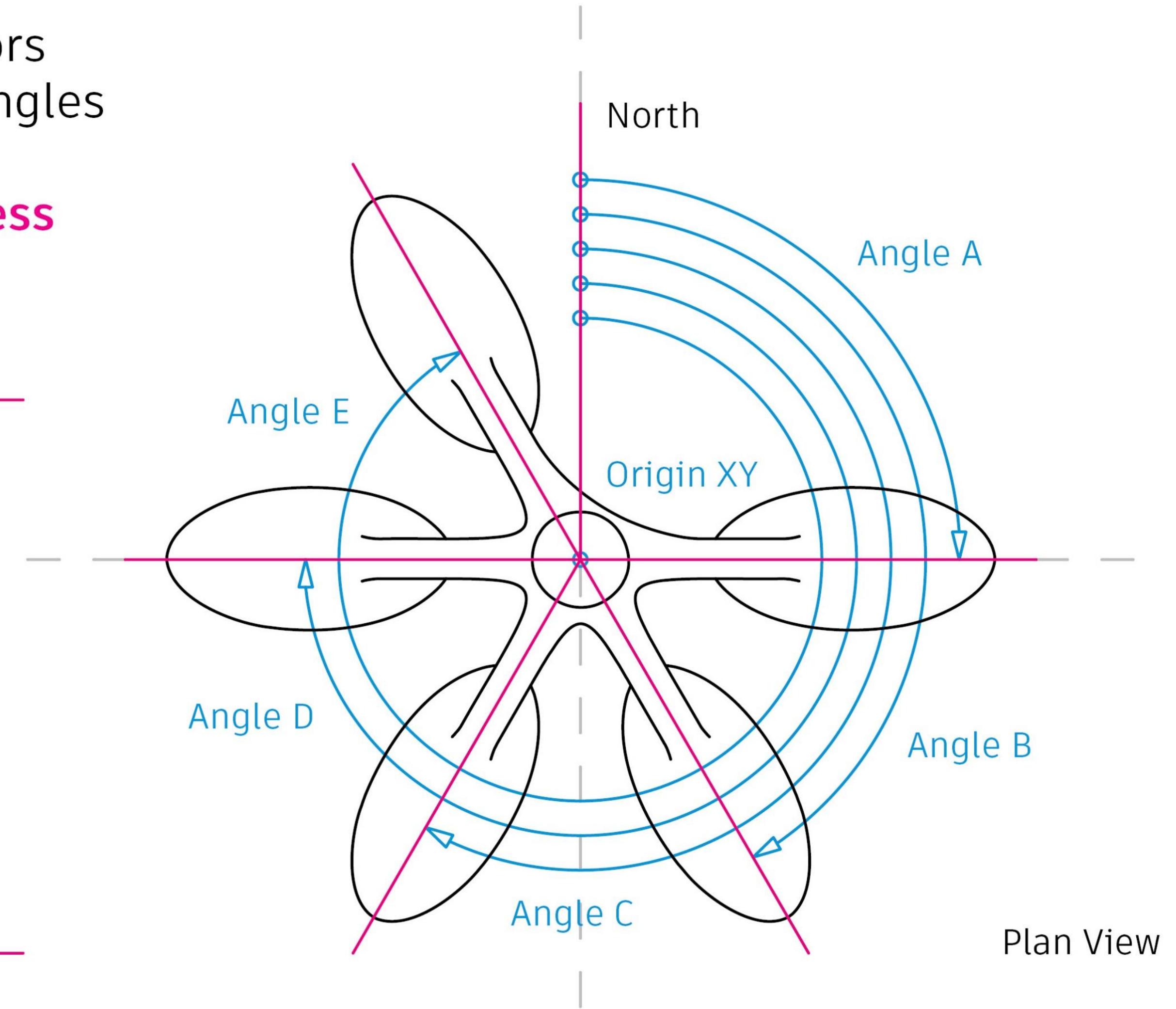
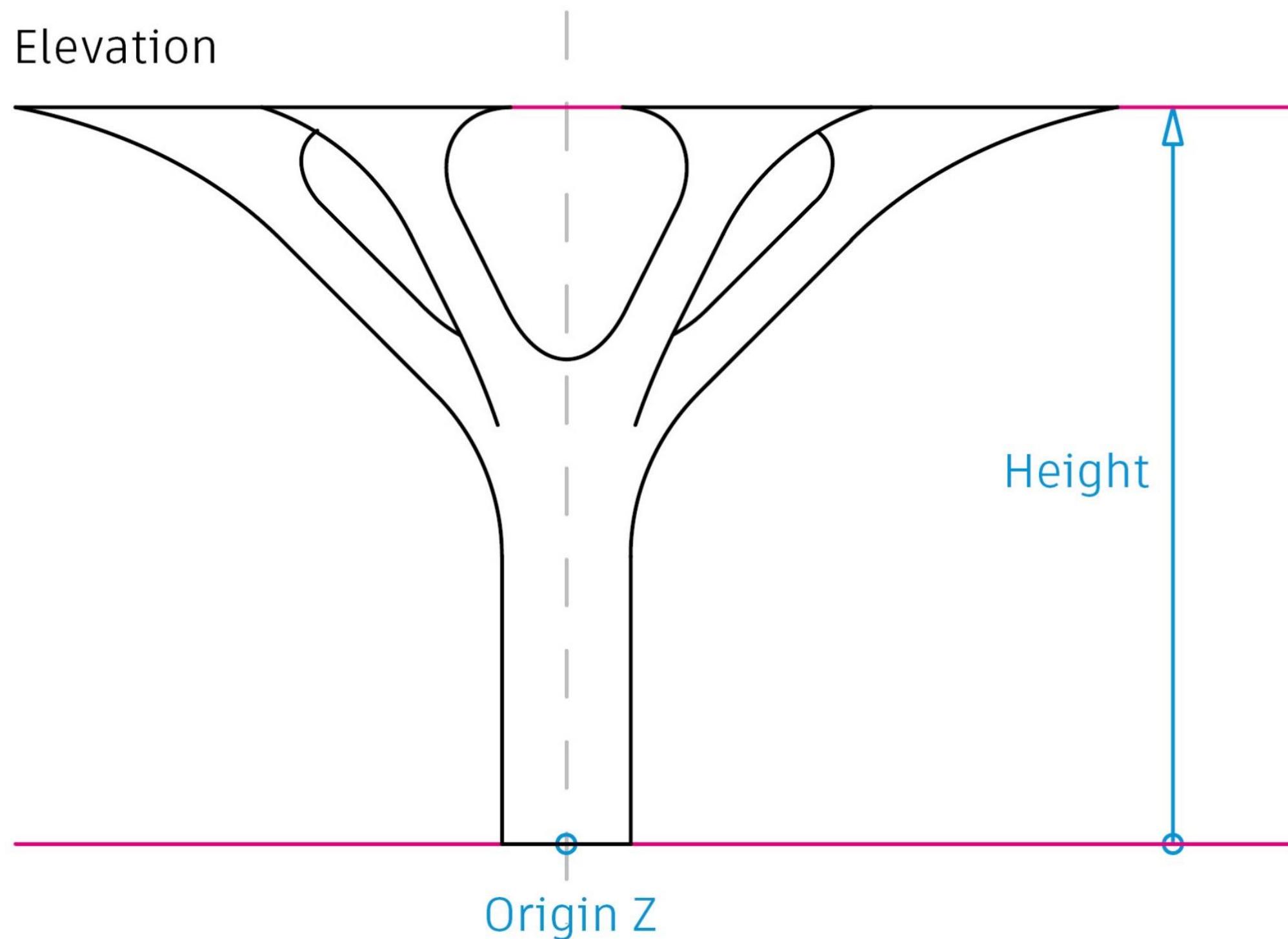
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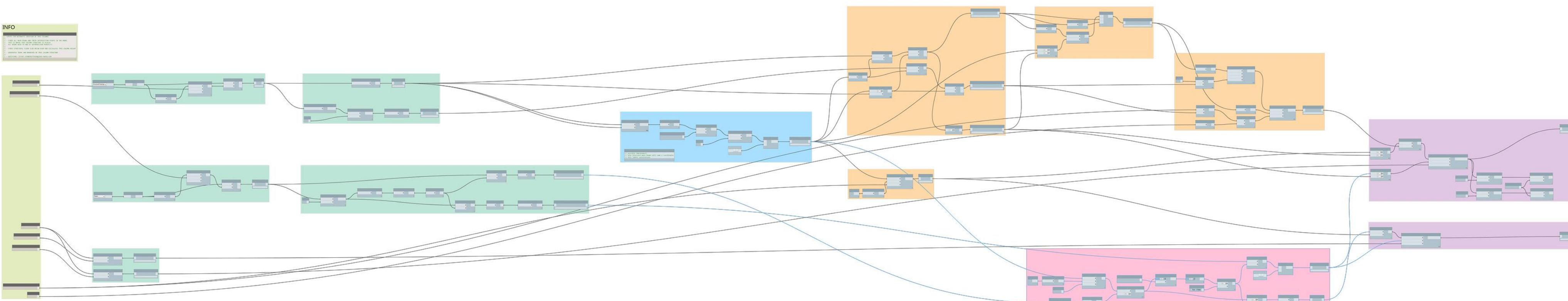
# Dynamo . Tree Columns

## Process

- Analyse **live** building model - main beams, floors
- Collect + sort meta data - origin XYZ, height, angles
- Store meta data - csv spreadsheet file
- **Generate structure - automated Dynamo process**
- ...



# Dynamo . Tree Column Structure



1 Define parameters

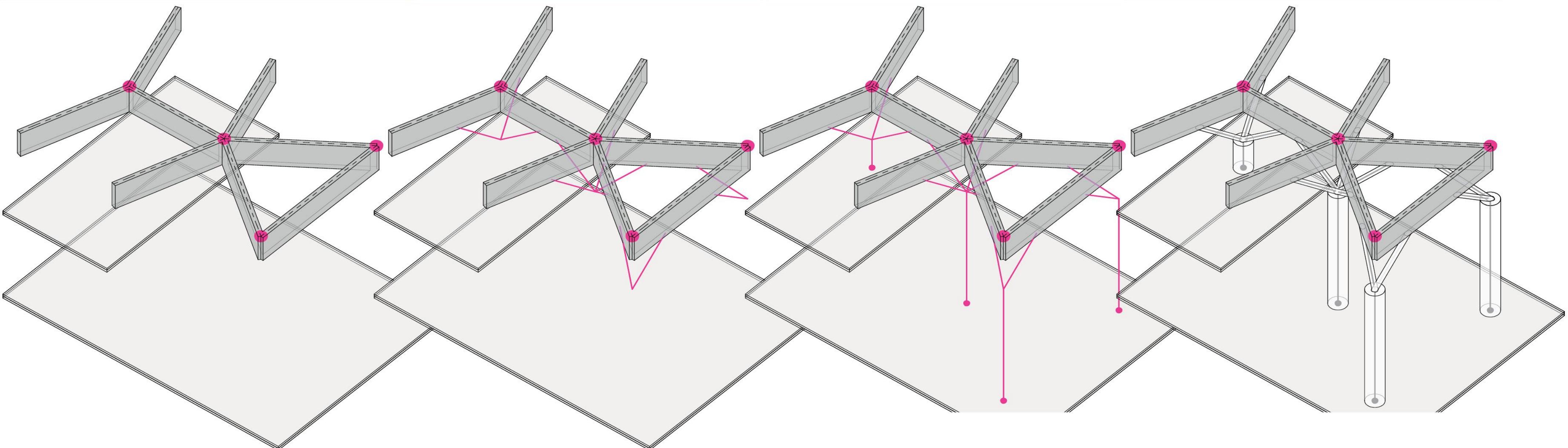
3 Find main beam intersections  
for tree column placement

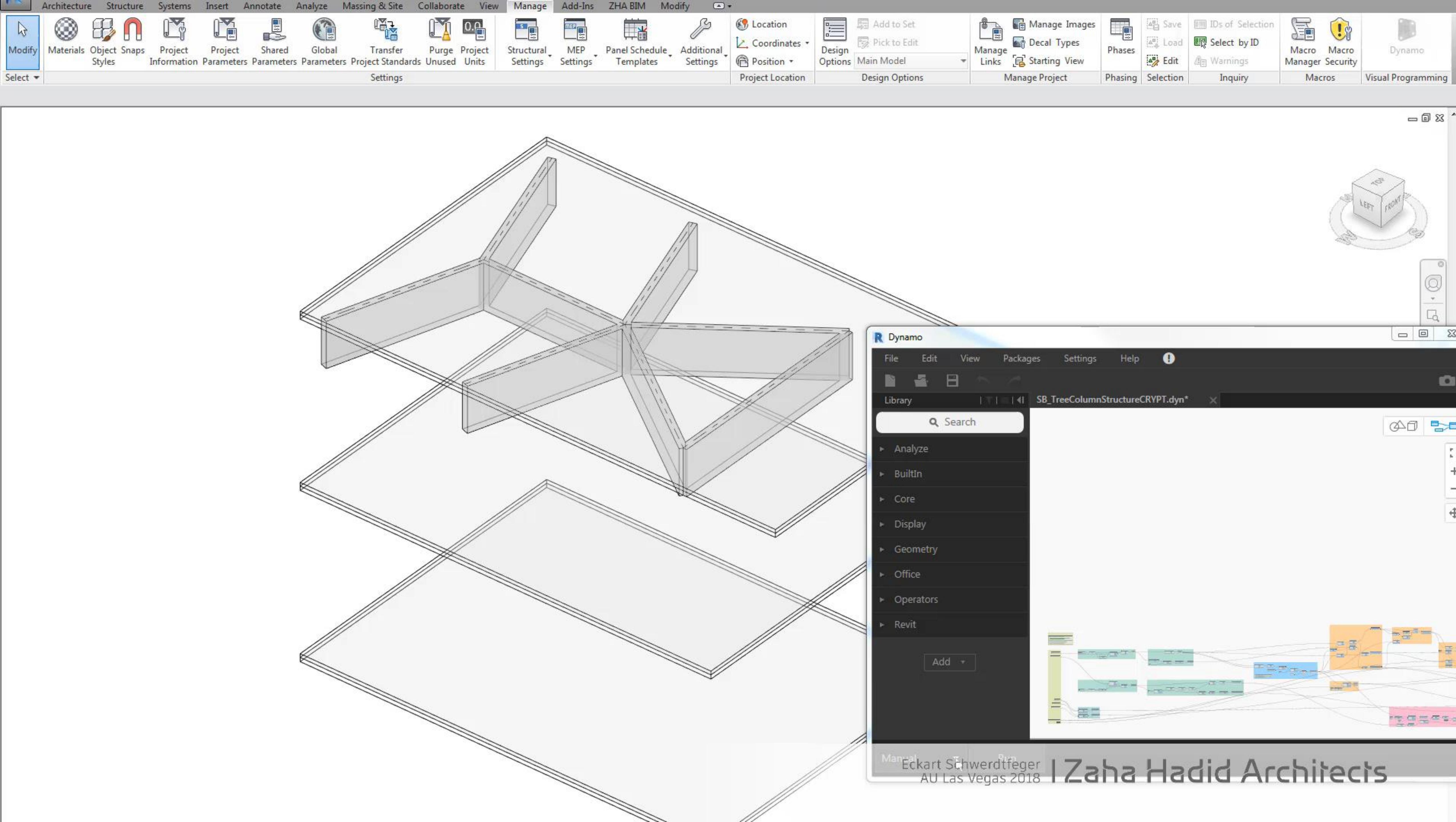
2 Read building elements and their properties from current Revit file, e.g. beams, floors

4 Generate axis lines for  
tree column branches

5 Find floor slab below to  
create tree column trunks

6 Create building elements  
for branches and trunks





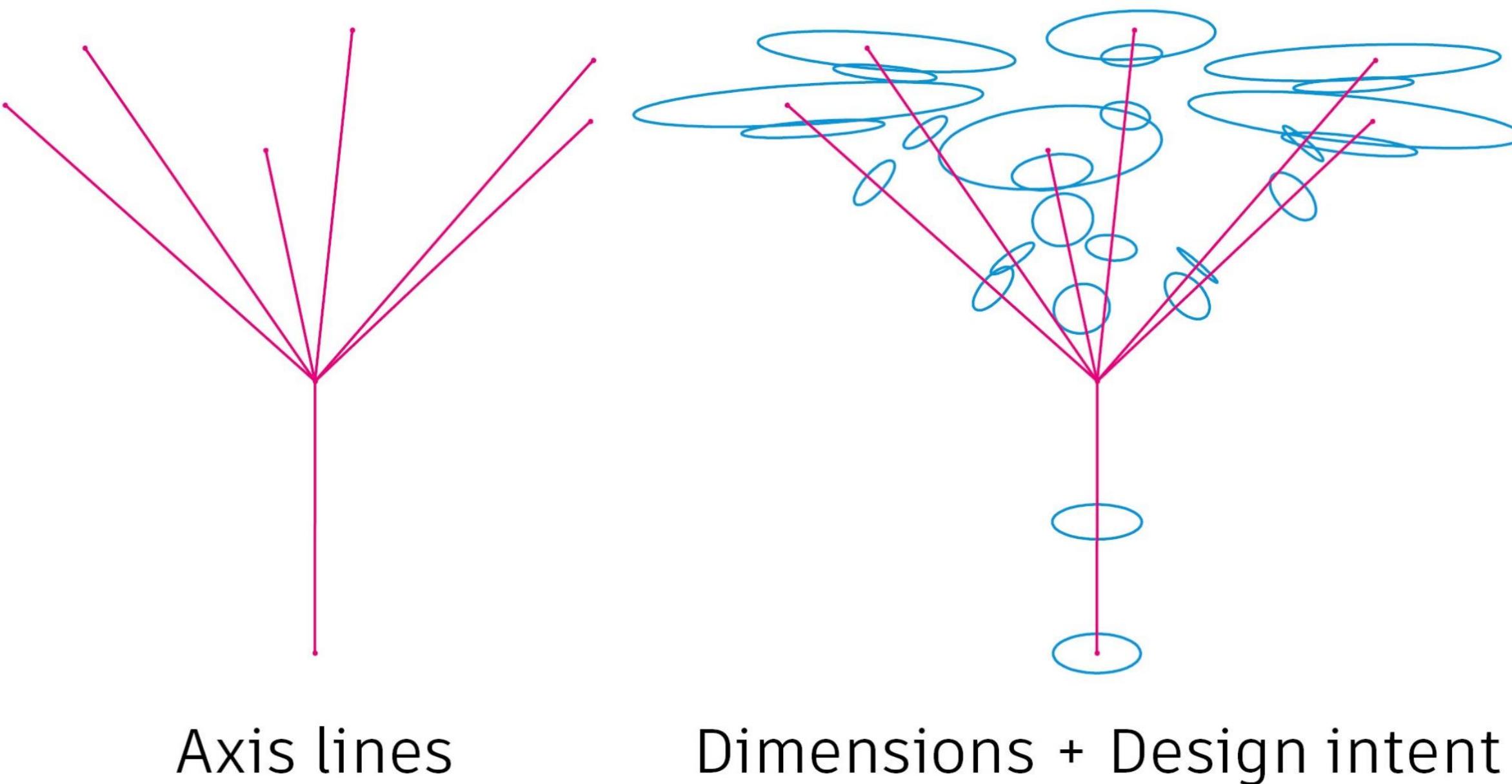
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# Dynamo . Tree Column Cladding

## Process

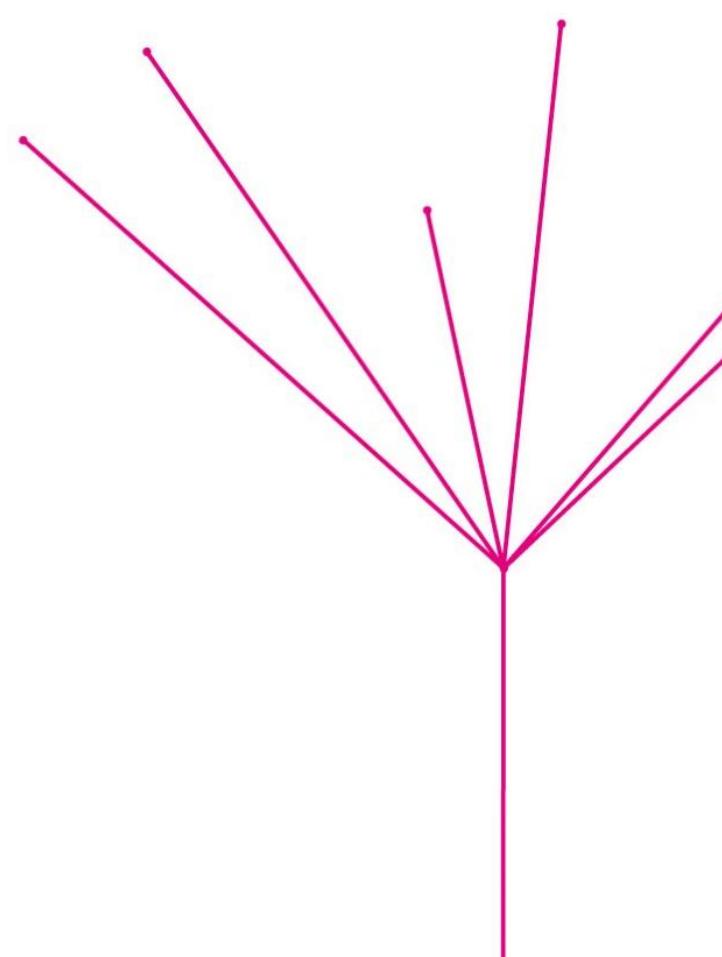
- Analyse live building model - main beams, floors
- Collect + sort meta data - origin XYZ, height, angles
- Store meta data - csv spreadsheet file
- Generate structure - automated Dynamo process
- **Generate freeform cladding**
- **Automated Dynamo + T-Splines process**



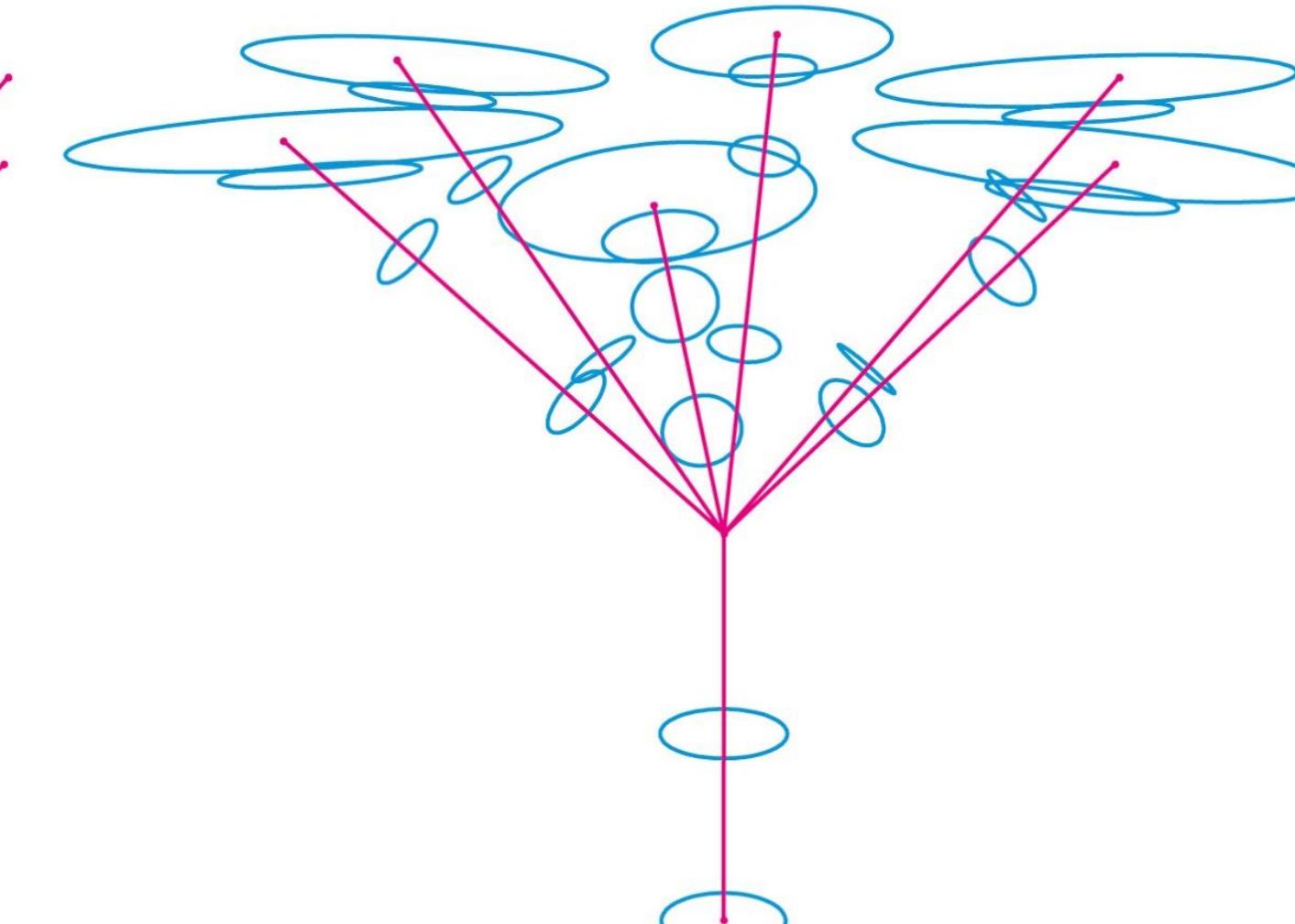
# Dynamo . Tree Column Cladding

## Process

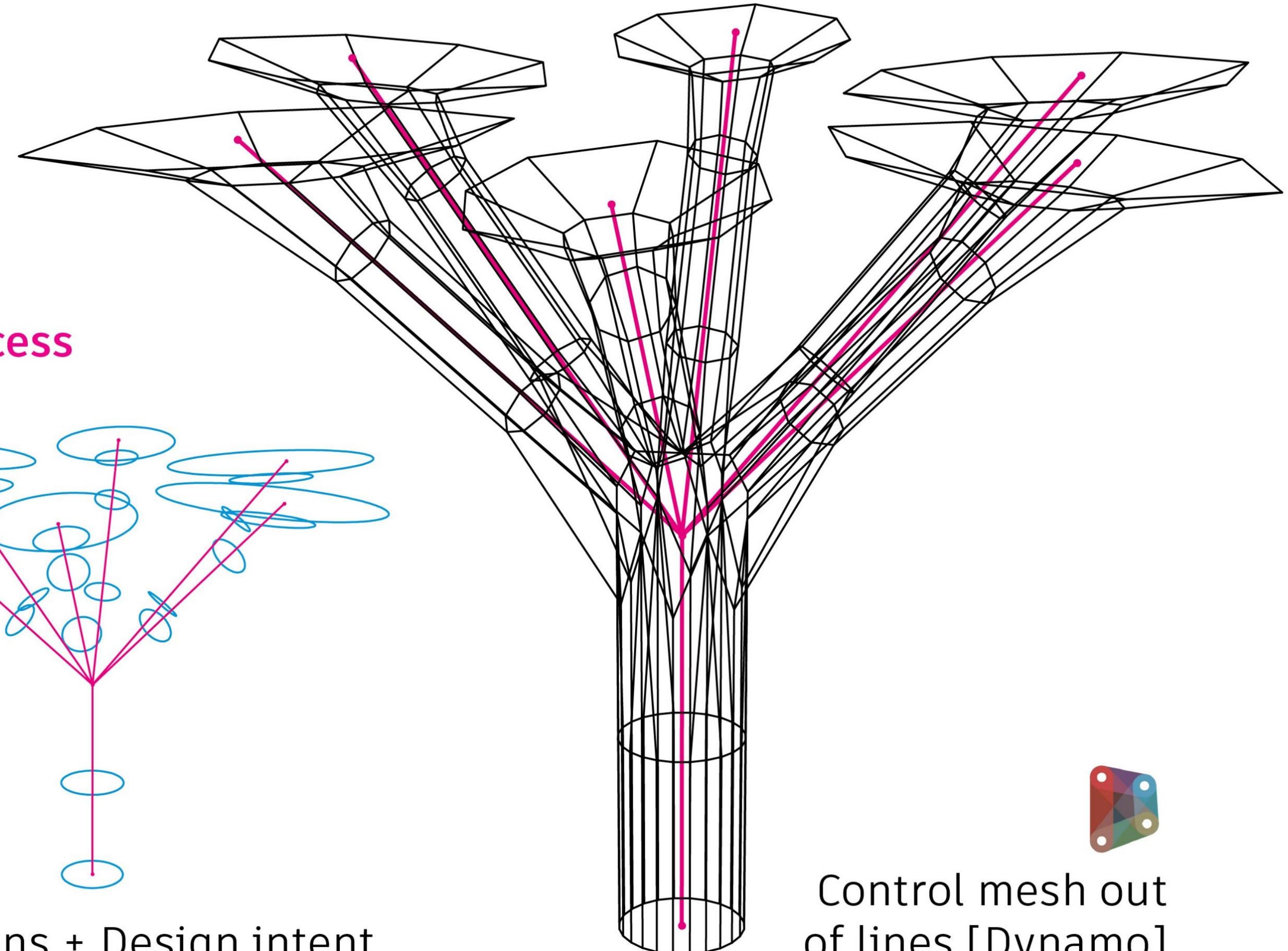
- Analyse live building model
- Collect + sort meta data
- Store meta data
- Generate structure
- **Generate freeform cladding**
- **Automated Dynamo + T-Splines process**



Axis lines



Dimensions + Design intent

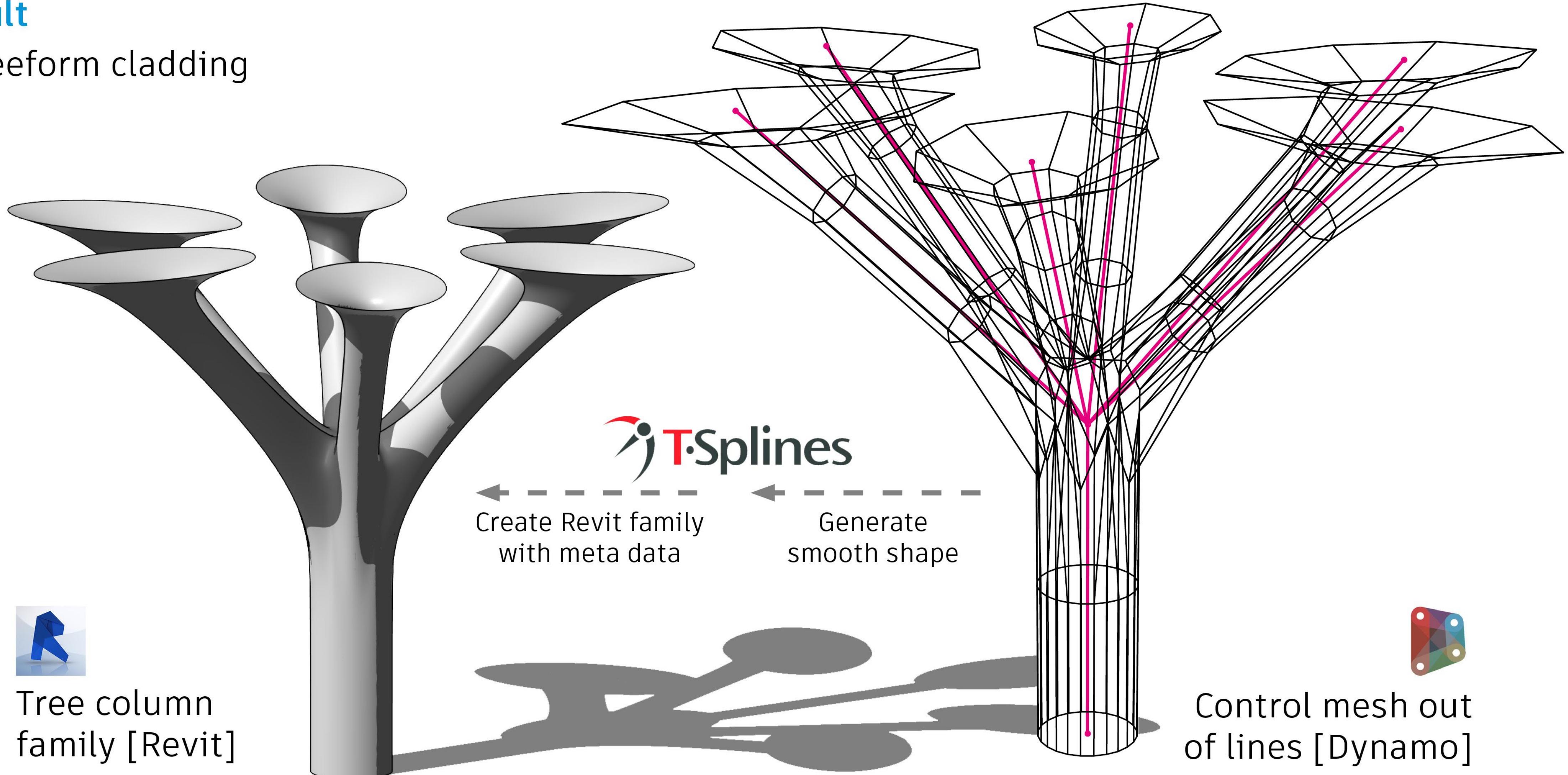


Control mesh out  
of lines [Dynamo]

# Dynamo . Tree Column Cladding

## Result

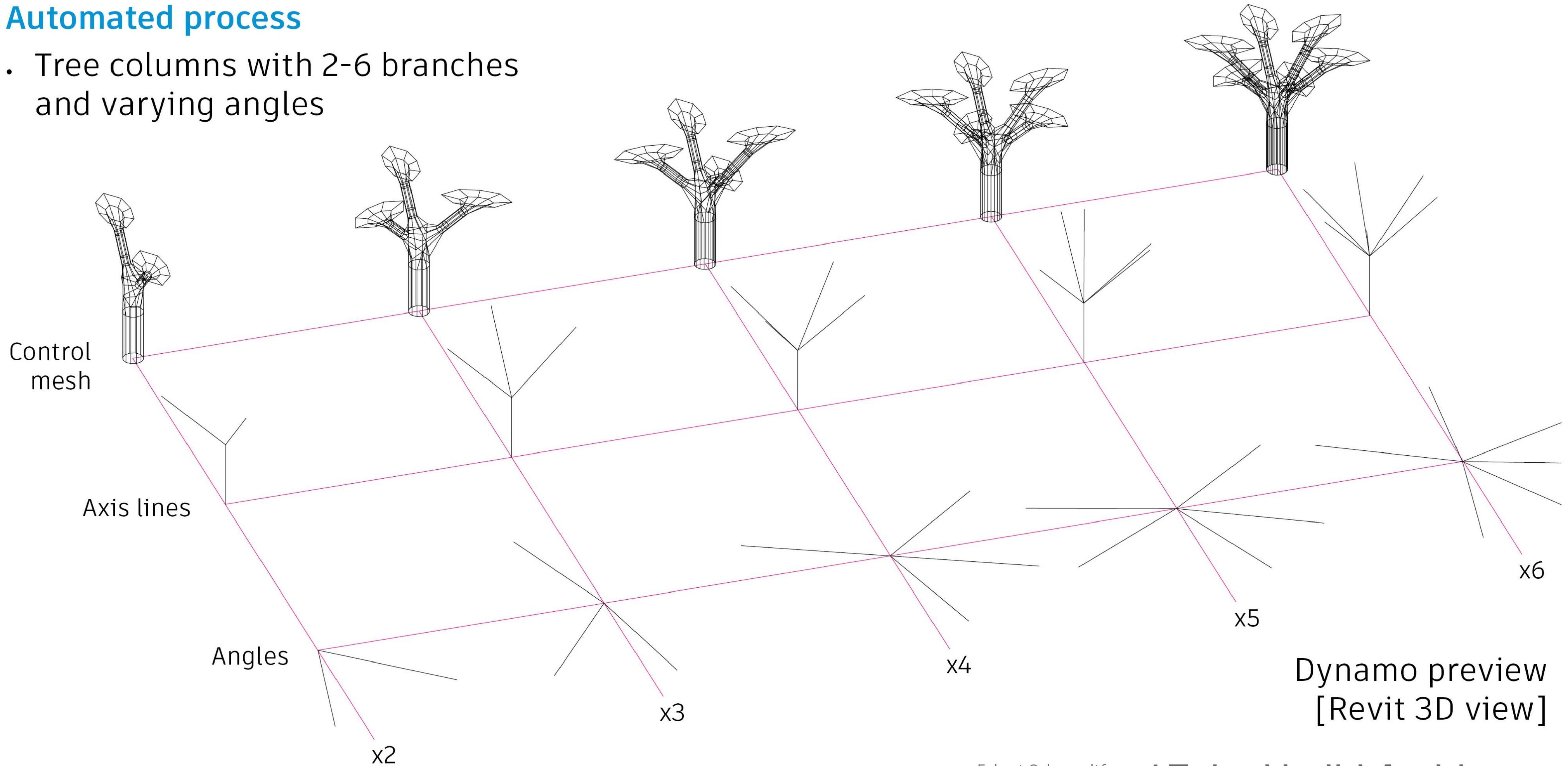
- Freeform cladding



# Dynamo . Tree Column Cladding

## Automated process

- Tree columns with 2-6 branches and varying angles



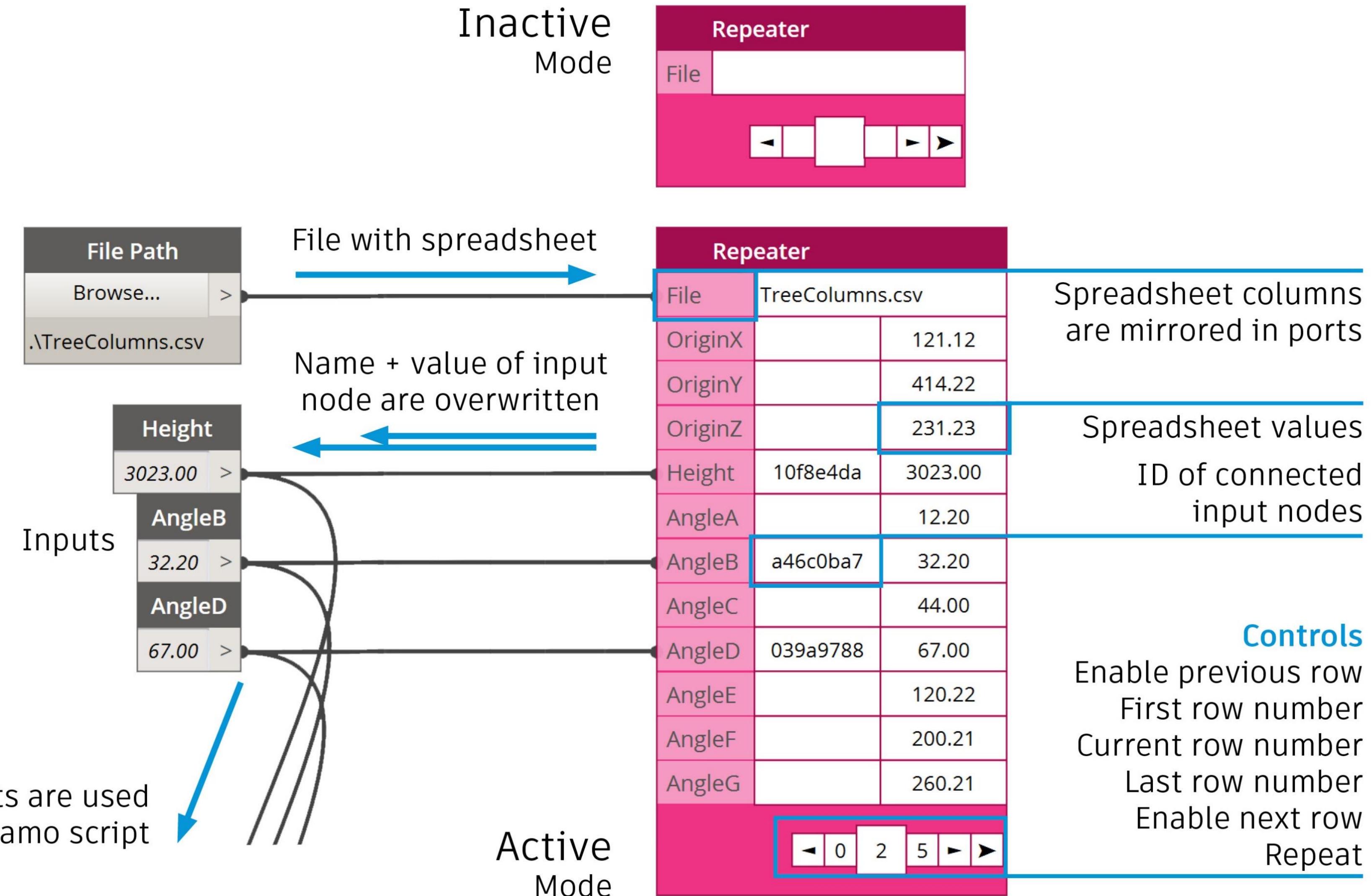
# Dynamo . Custom Nodes

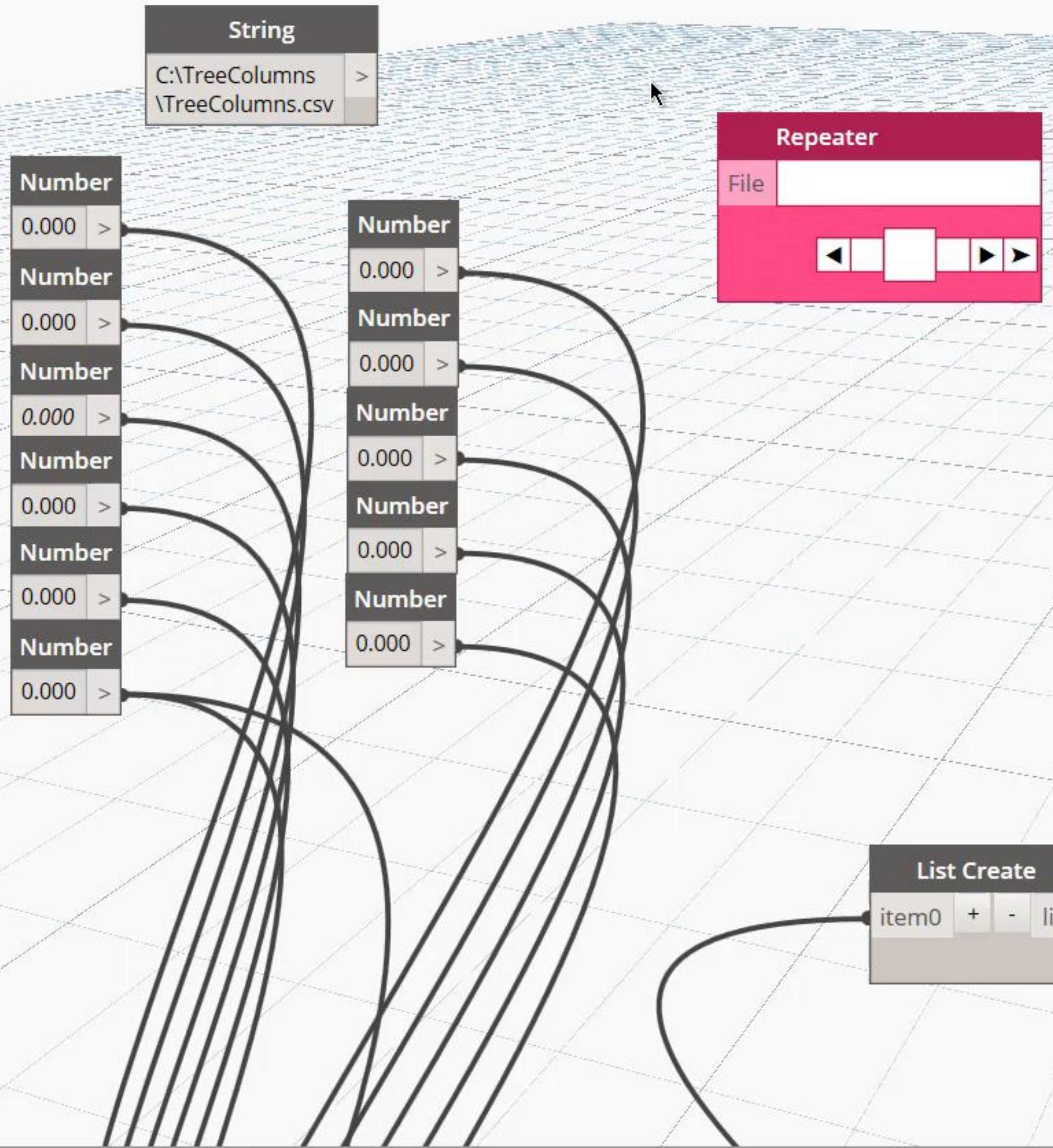
## Automation Plugin

### Repeater Node

Custom user interface node

Run a Dynamo script repeatedly and with varying input values that are loaded from a spreadsheet file

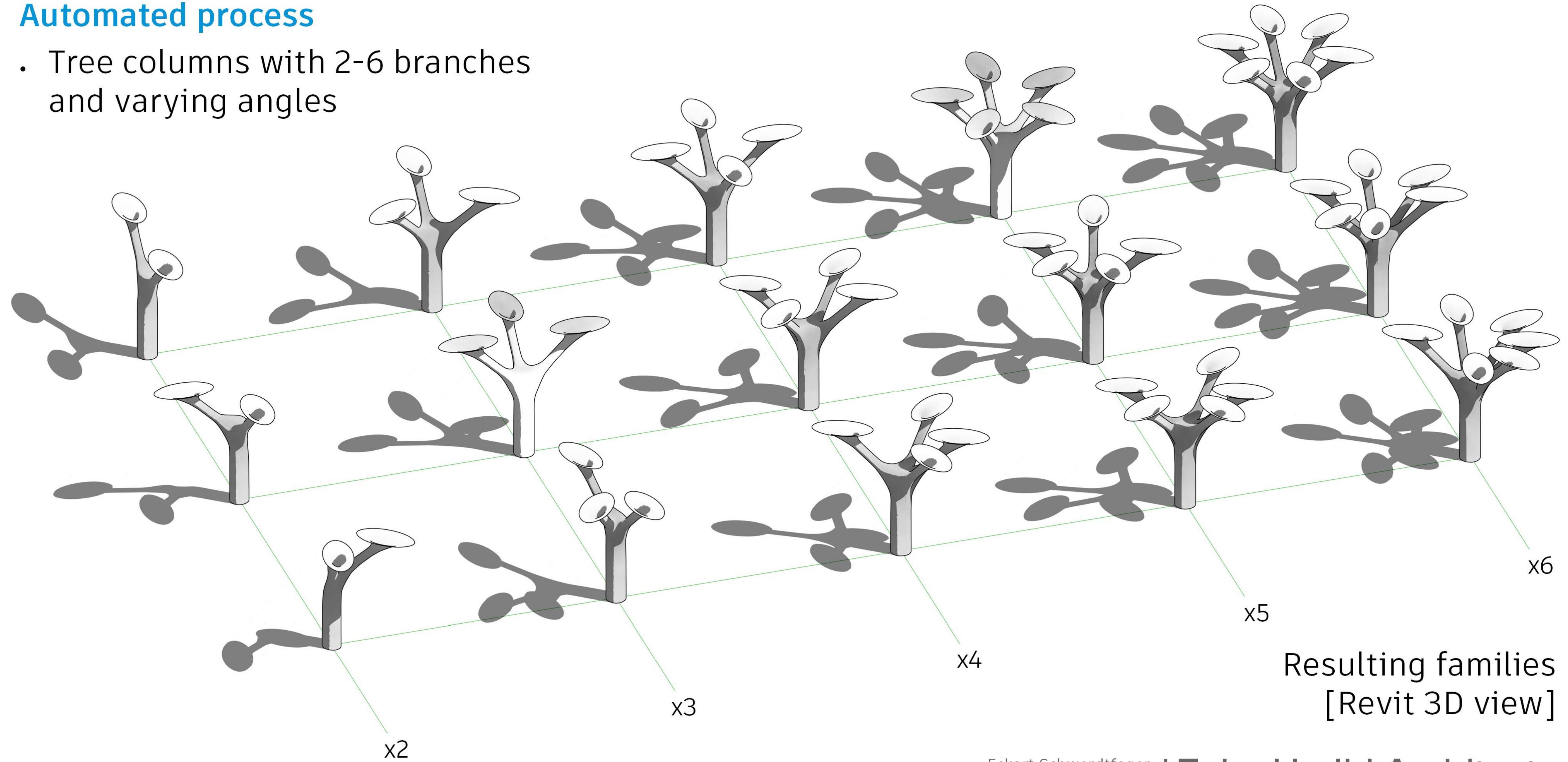




# Dynamo . Tree Column Cladding

## Automated process

- Tree columns with 2-6 branches and varying angles



# Dynamo . Skylight

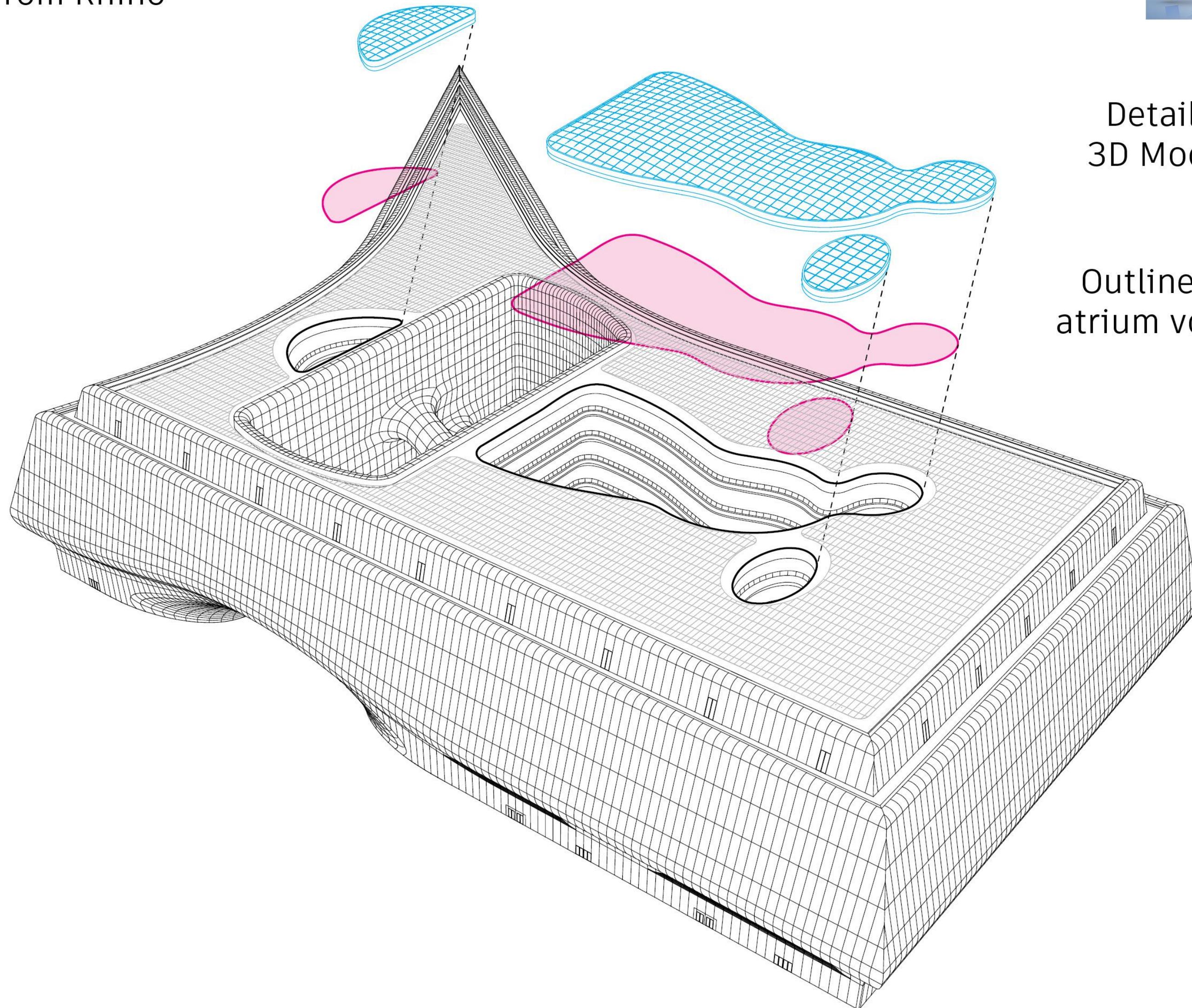


Base geometry  
from Rhino

?



BIM 3D model with  
meta data + schedules



Detailed  
3D Model

Outline of  
atrium void

# Dynamo . Skylight

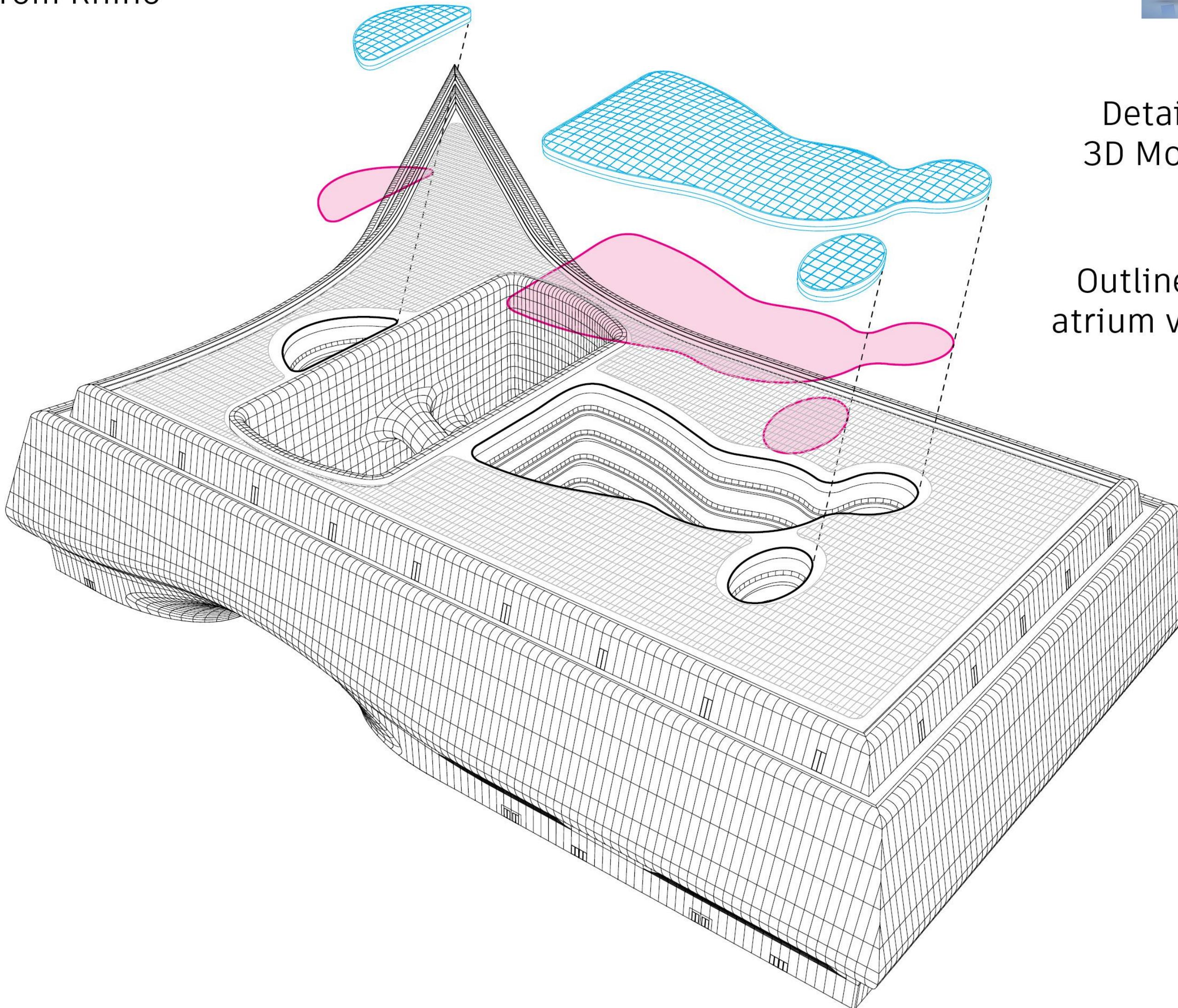


Base geometry  
from Rhino

?



BIM 3D model with  
meta data + schedules



Detailed  
3D Model



Outline of  
atrium void



## Aims

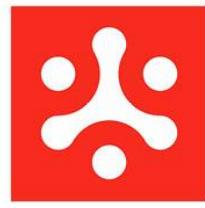
- Exchange geometry via cloud server
- Visual scripting in Revit
- Structurally sound design via physics simulation
- Detailed model generated by Dynamo + Revit

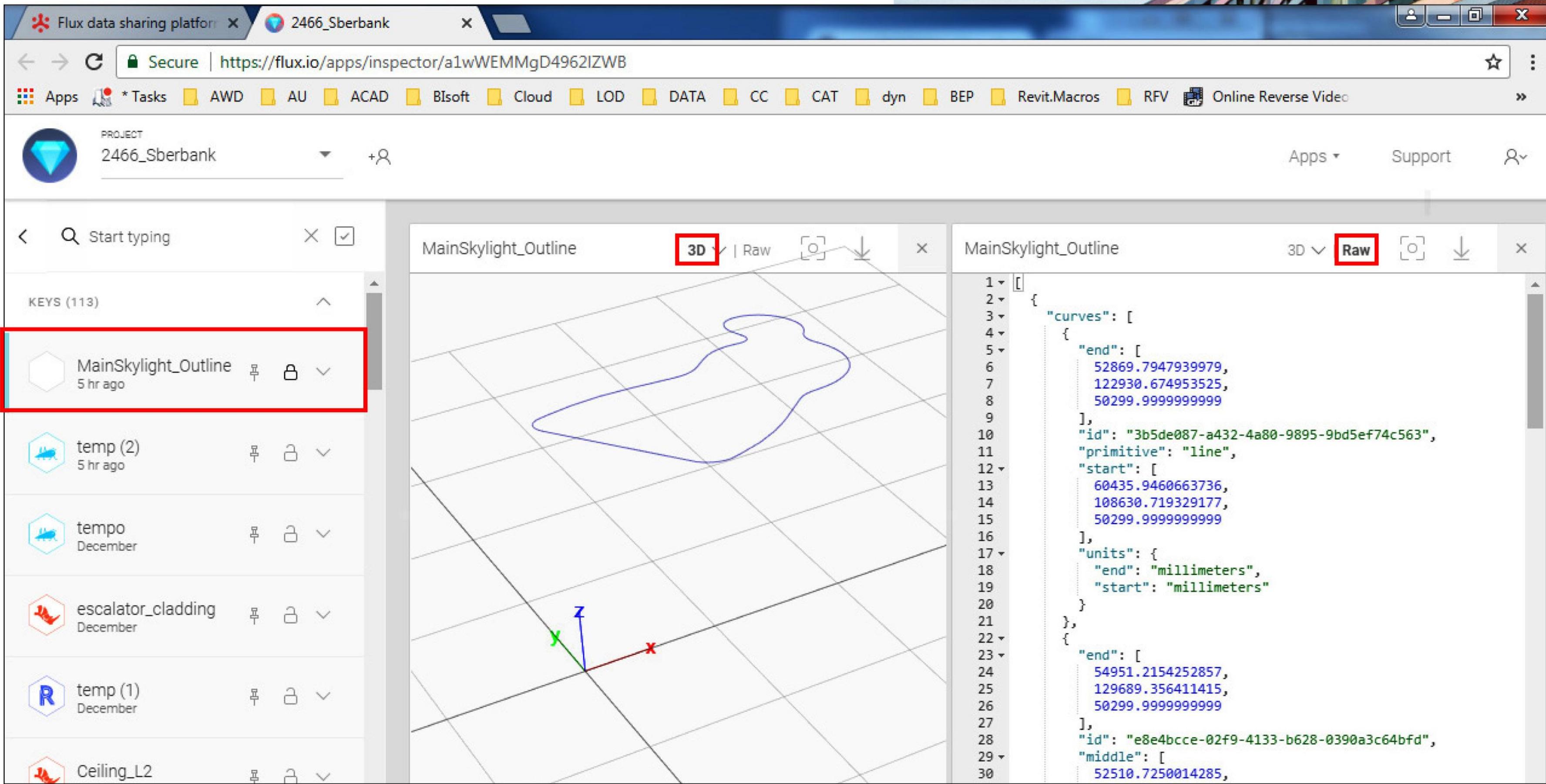
# Dynamo . Skylight



Predictably Great Building™  
Connecting Architects, Engineers, and Contractors  
to the information they need, when they need it.

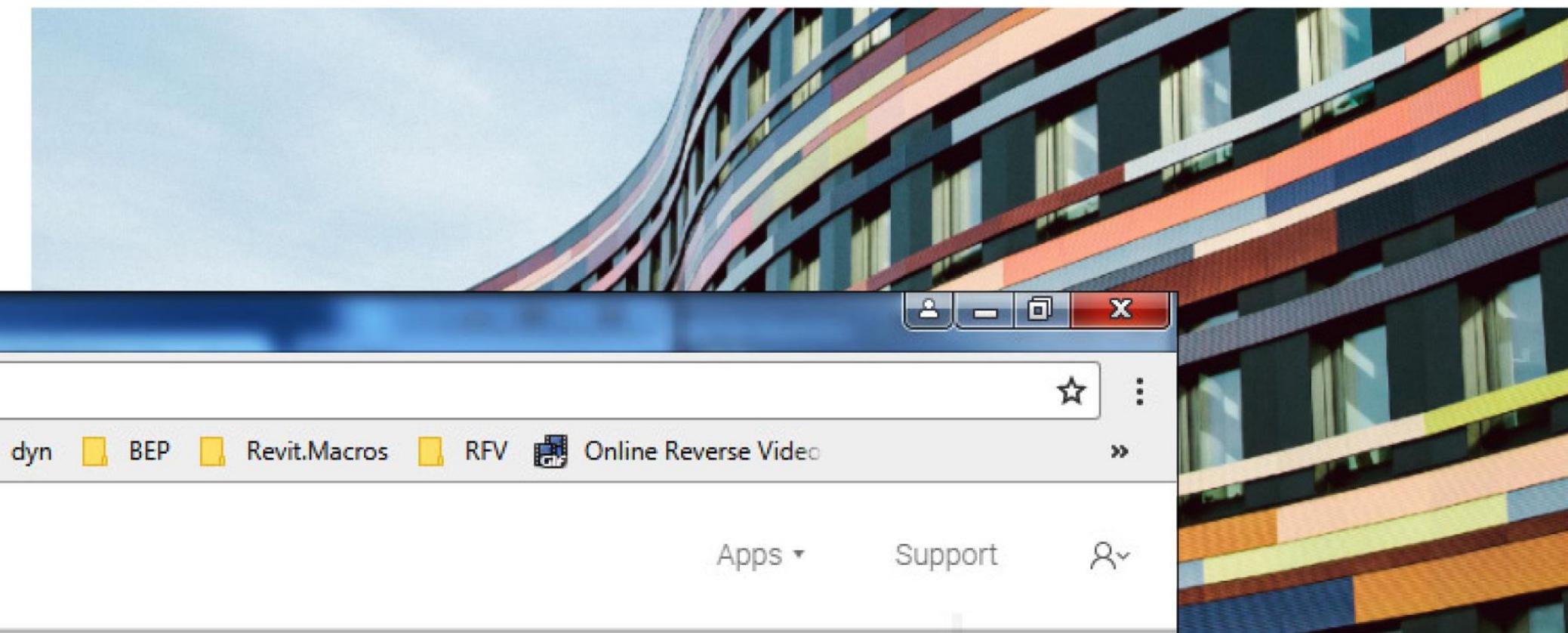
 Base geometry  
from Rhino

 Geometry transfer  
via cloud service



The screenshot shows the Flux data sharing platform interface. On the left, a sidebar lists various keys and their details. One key, "MainSkylight\_Outline", is highlighted with a red box. In the center, there are two 3D viewports. The left one shows a 3D model of a building's facade with a blue outline representing the skylight. The right one shows the raw JSON data for this outline. The JSON code is as follows:

```
1  [
2    {
3      "curves": [
4        {
5          "end": [
6            52869.7947939979,
7            122930.674953525,
8            50299.999999999
9          ],
10        "id": "3b5de087-a432-4a80-9895-9bd5ef74c563",
11        "primitive": "line",
12        "start": [
13           60435.9460663736,
14           108630.719329177,
15           50299.999999999
16        ],
17        "units": {
18           "end": "millimeters",
19           "start": "millimeters"
20        }
21      },
22      {
23        "end": [
24           54951.2154252857,
25           129689.356411415,
26           50299.999999999
27        ],
28        "id": "e8e4bcce-02f9-4133-b628-0390a3c64bfd",
29        "middle": [
30           52510.7250014285,
31           119320.0414141415,
32           50299.999999999
33        ],
34        "primitive": "arc"
35      }
36    ]
37  ]
```



ARUP



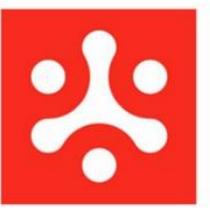
building Data

great building. Our  
models, planning  
or easy collaboration and  
[LEARN MORE](#)  
data between

# Dynamo . Skylight



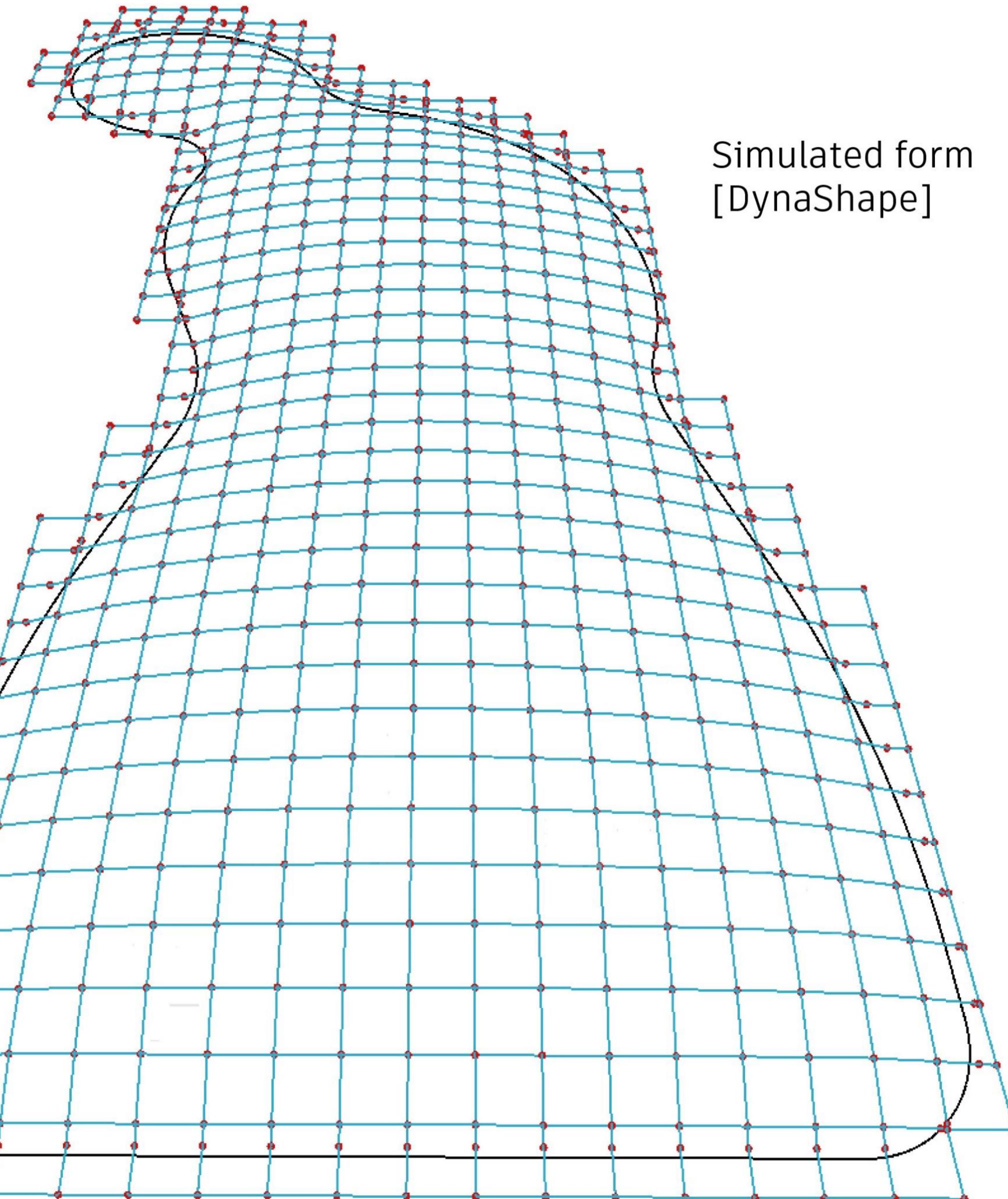
Base geometry  
from Rhino



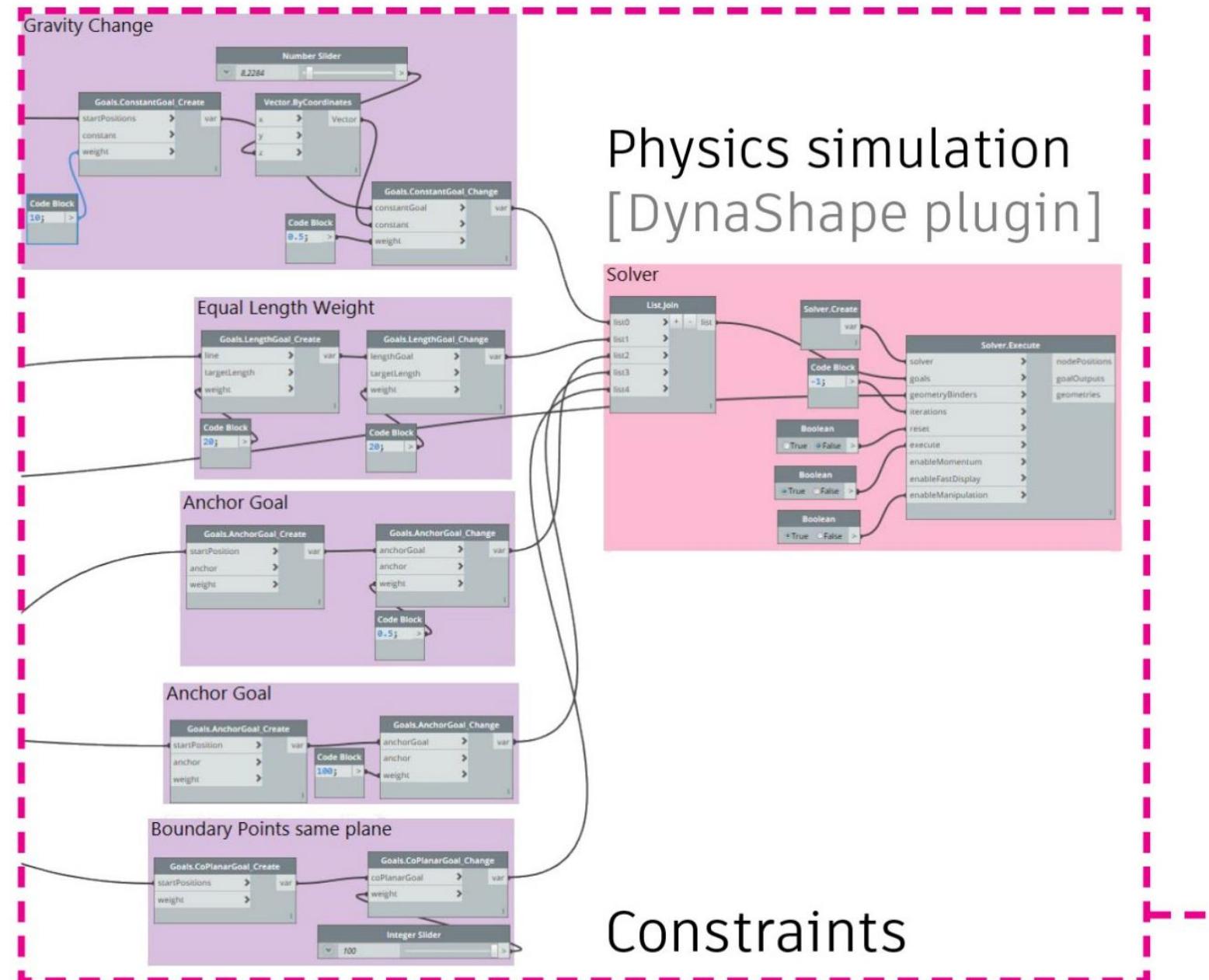
Geometry transfer  
via cloud service



Visual scripting  
Physics simulation

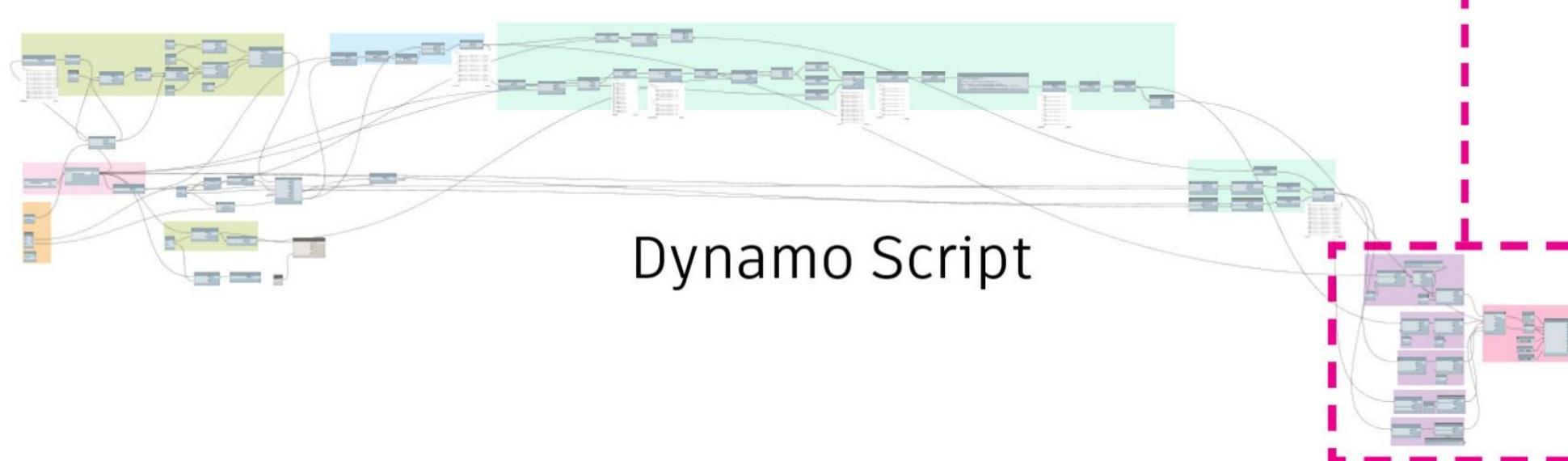


Simulated form  
[DynaShape]



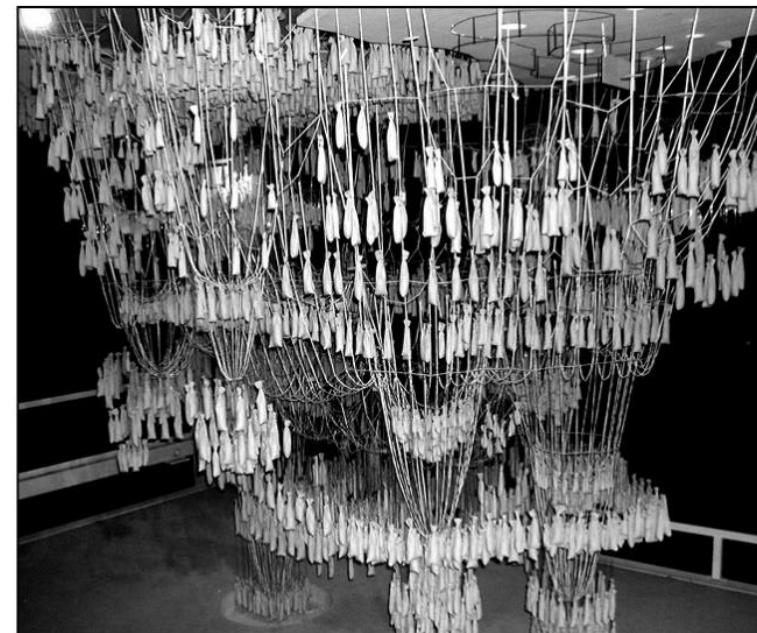
Physics simulation  
[DynaShape plugin]

Constraints



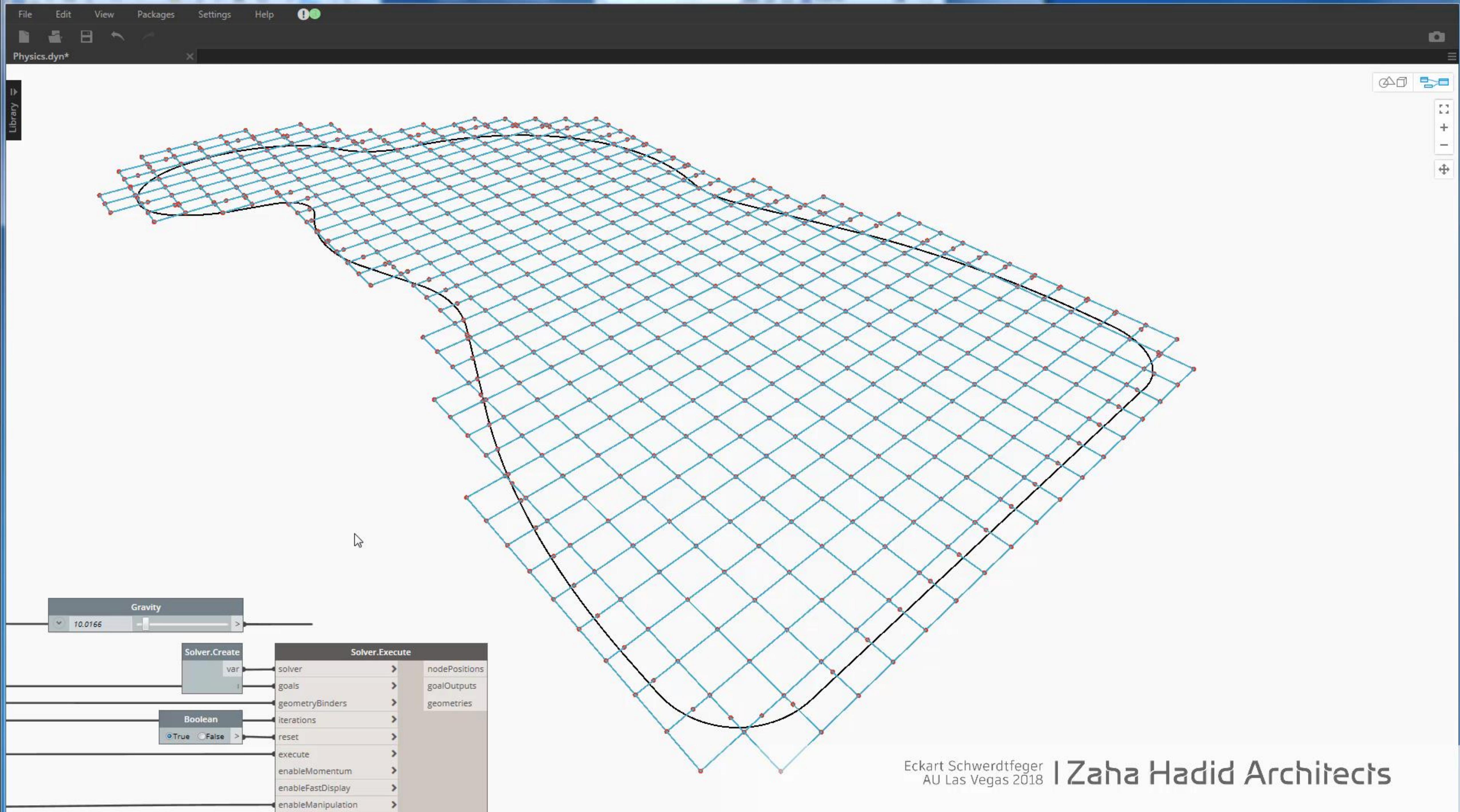
Dynamo Script

Gaudi . Hanging  
chain model



Dynamo script by Mauro Sabiu  
DynaShape plugin by Long Nguyen

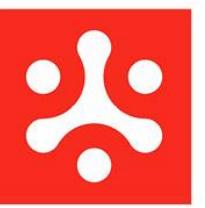
Eckart Schwerdtfeger  
AU Las Vegas 2018 | Zaha Hadid Architects



# Dynamo . Skylight



Base geometry  
from Rhino



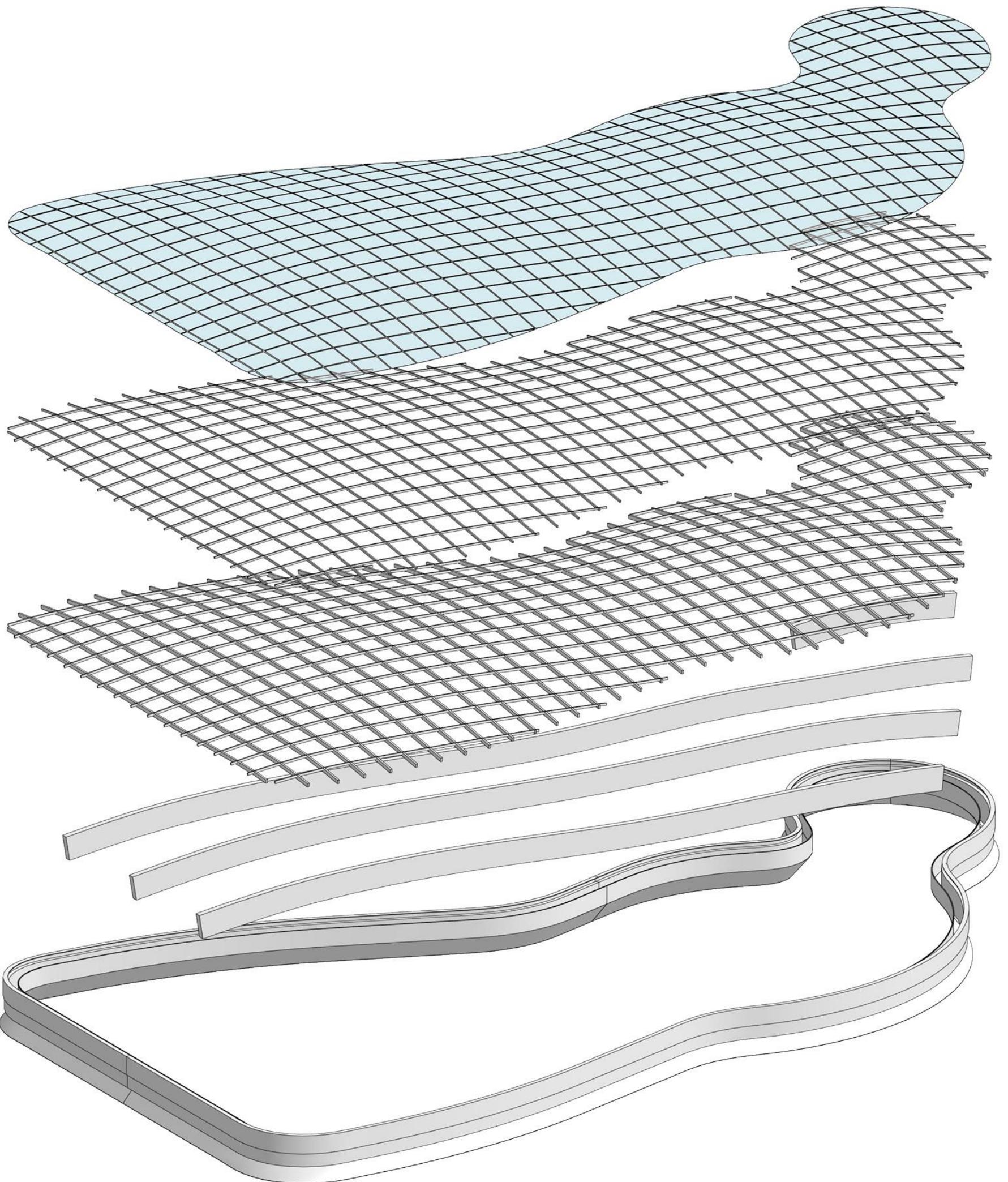
Geometry transfer  
via cloud service



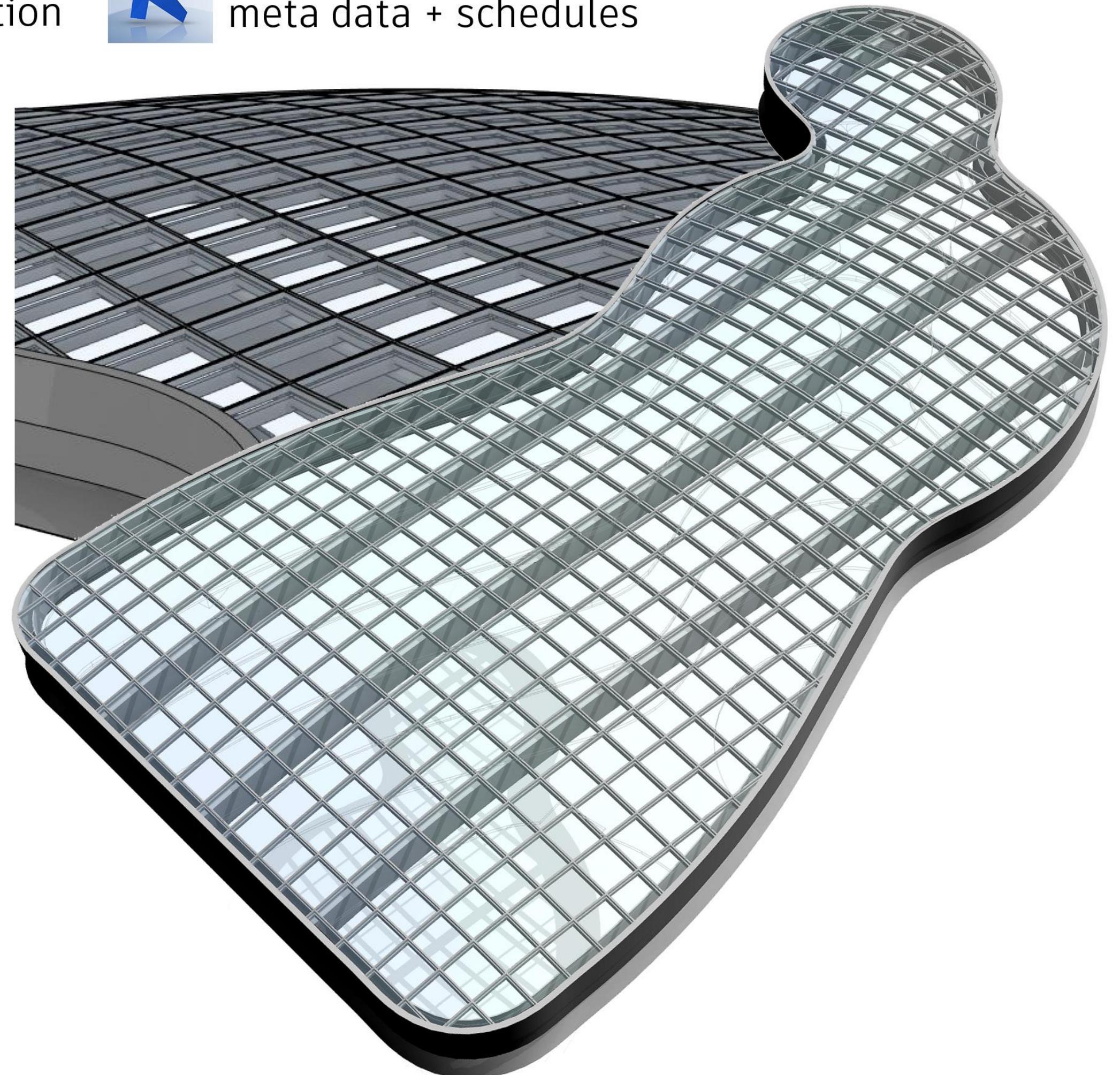
Visual scripting  
Physics simulation



BIM 3D model with  
meta data + schedules



Panels  
Profiles  
Structure  
Beams  
Cladding

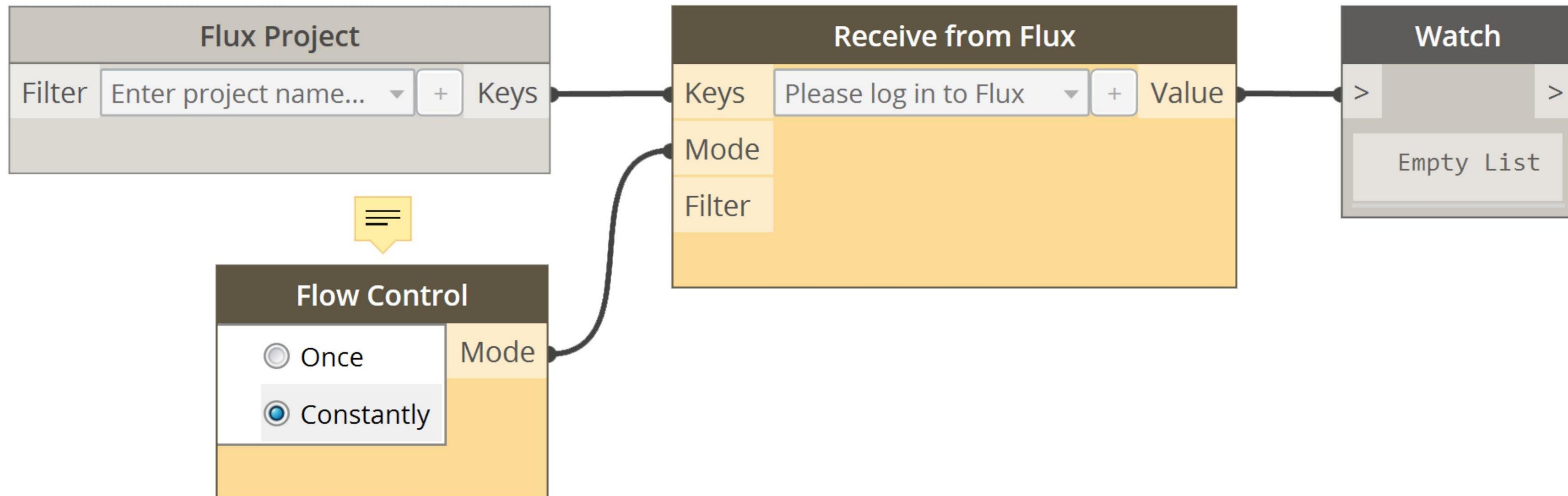
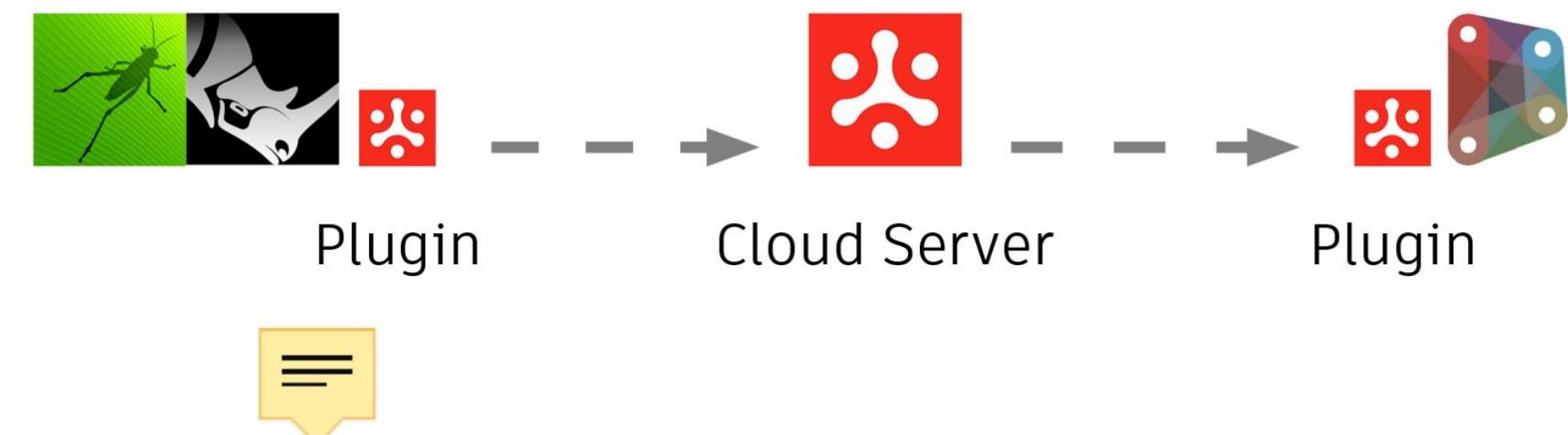


# Dynamo . Custom Nodes

?

## Cloud Plugin

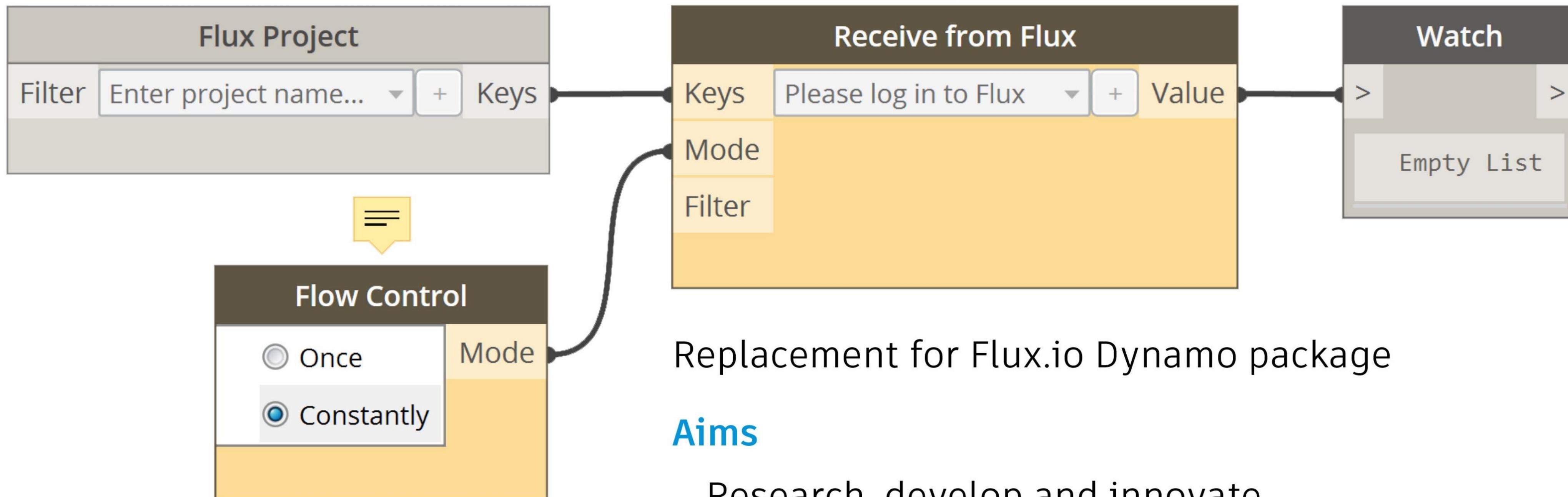
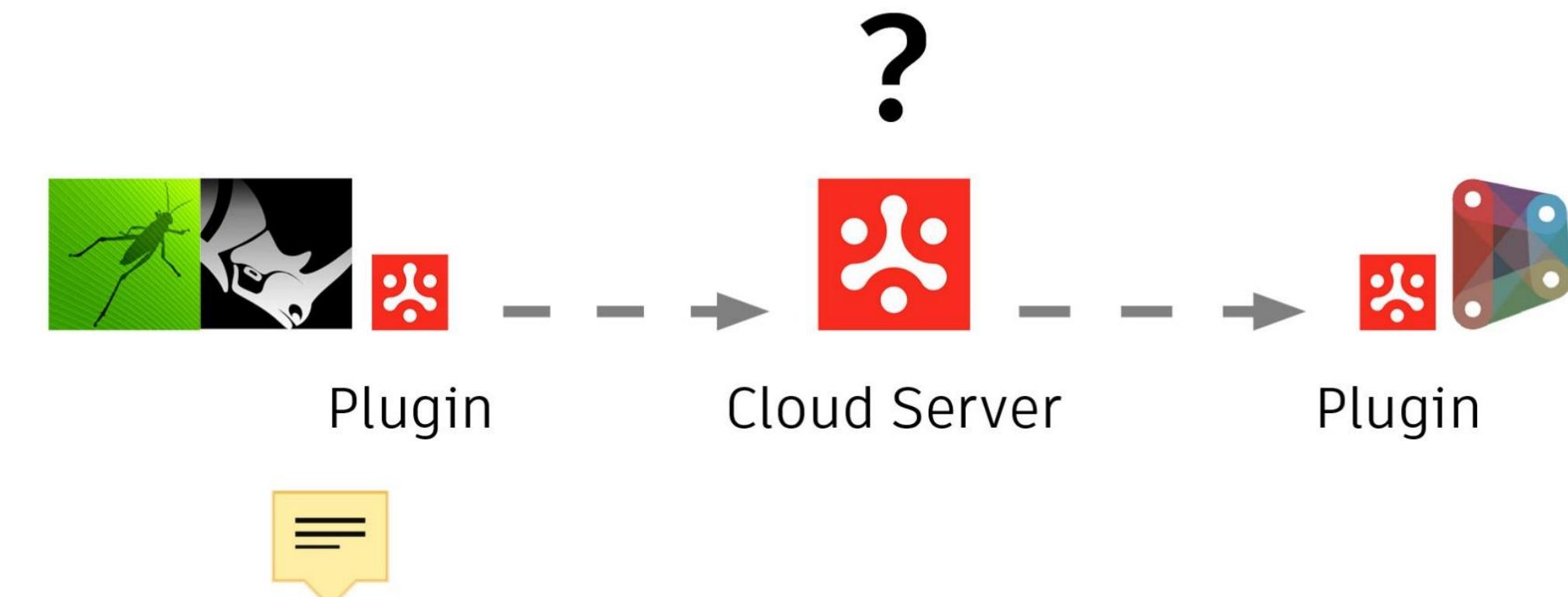
for cross-application transfer  
of base geometry and meta data



# Dynamo . Custom Nodes

## Cloud Plugin

for cross-application transfer  
of base geometry and meta data



Replacement for Flux.io Dynamo package

## Aims

- Research, develop and innovate
- Efficient, intelligent and adaptable nodes
- Better user interaction and user friendliness

# Dynamo . Custom Nodes

## Cloud Plugin

### Account Node

Custom user interface node

Select an existing account or login + register a new account

Account selection

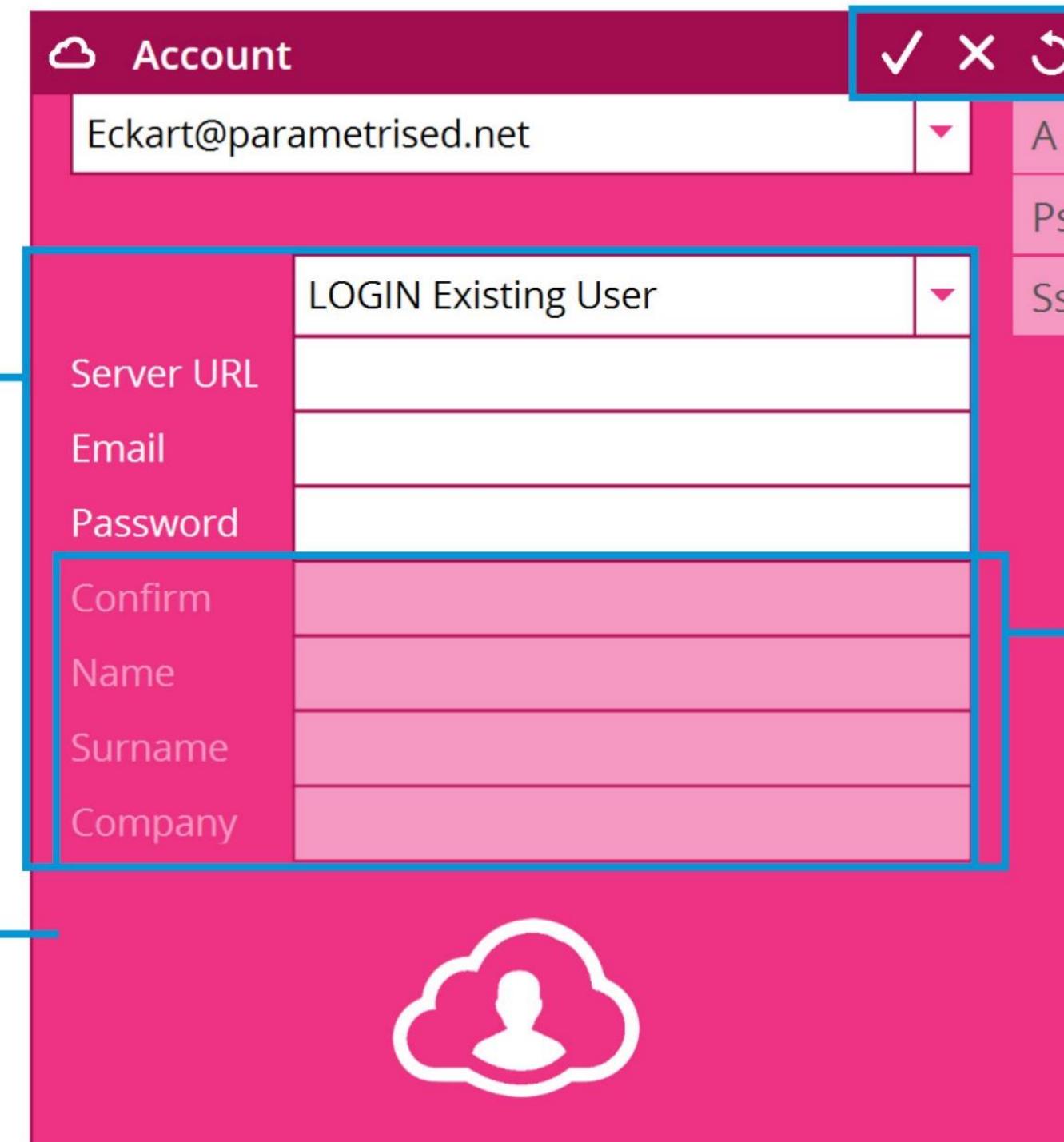
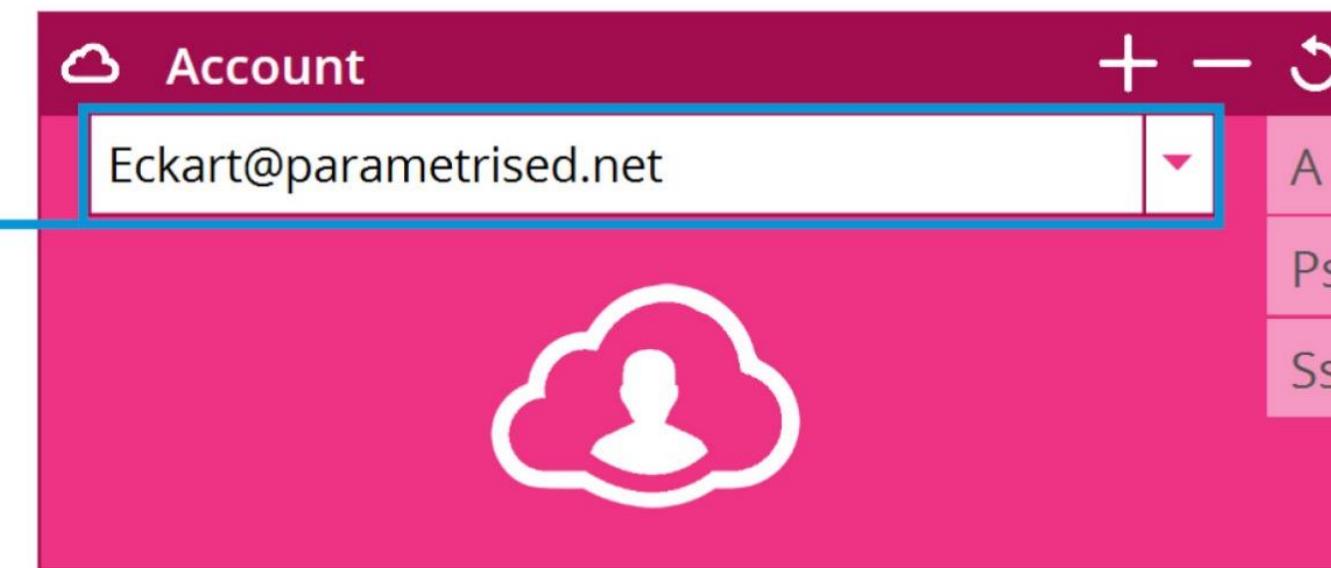
Account Selection Mode

Account Login + Registration Mode

All necessary functionality is embedded inside node

Node layout adapts on the fly

Custom colour scheme

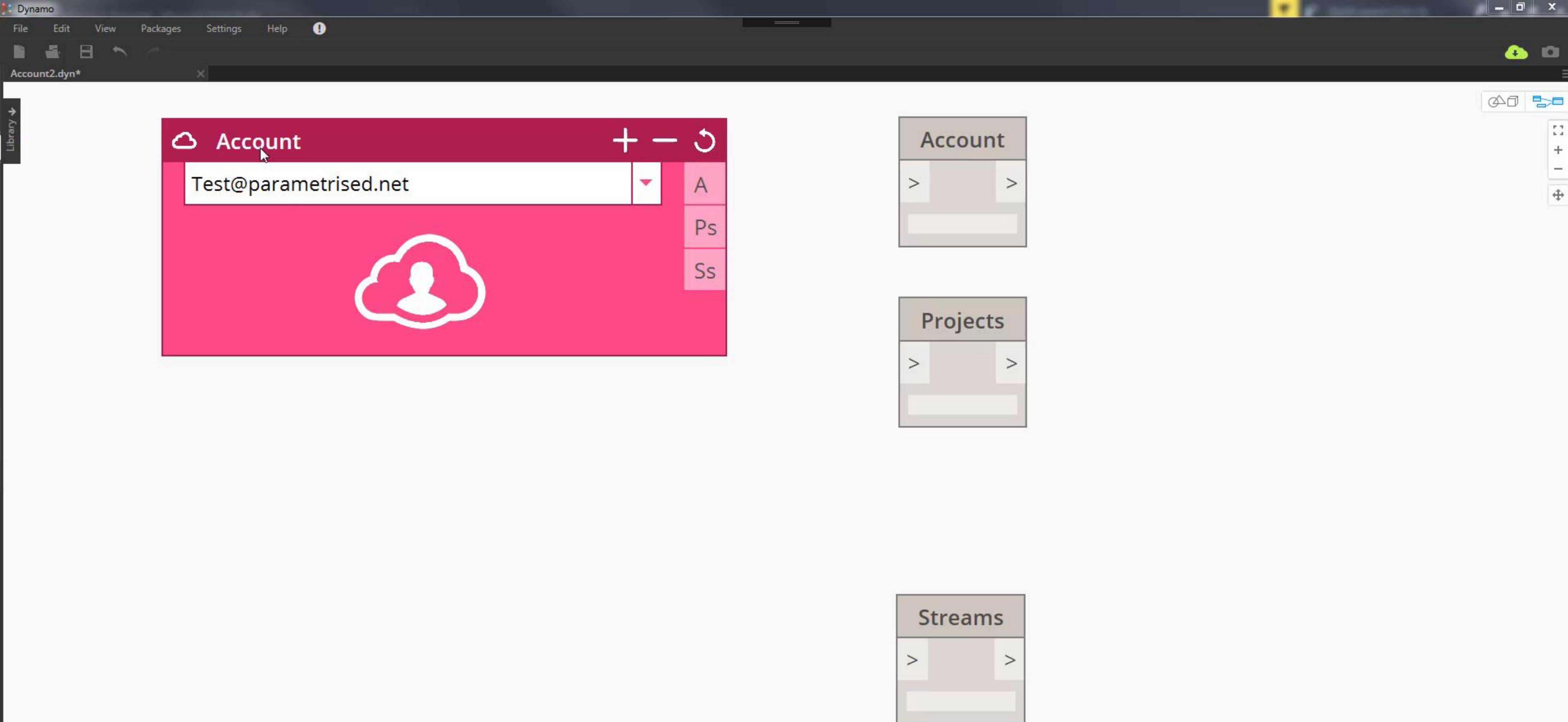


Account  
Projects  
Streams

Adaptive windows-like control buttons for additional functions

e.g.  
Add, delete account, submit, cancel, reload

User interface adapts to user interaction for guidance



# Dynamo . Custom Nodes

## Cloud Plugin

### Stream Node

Custom user interface node

Select a data stream and receive the associated geometry + meta data

Stream selection

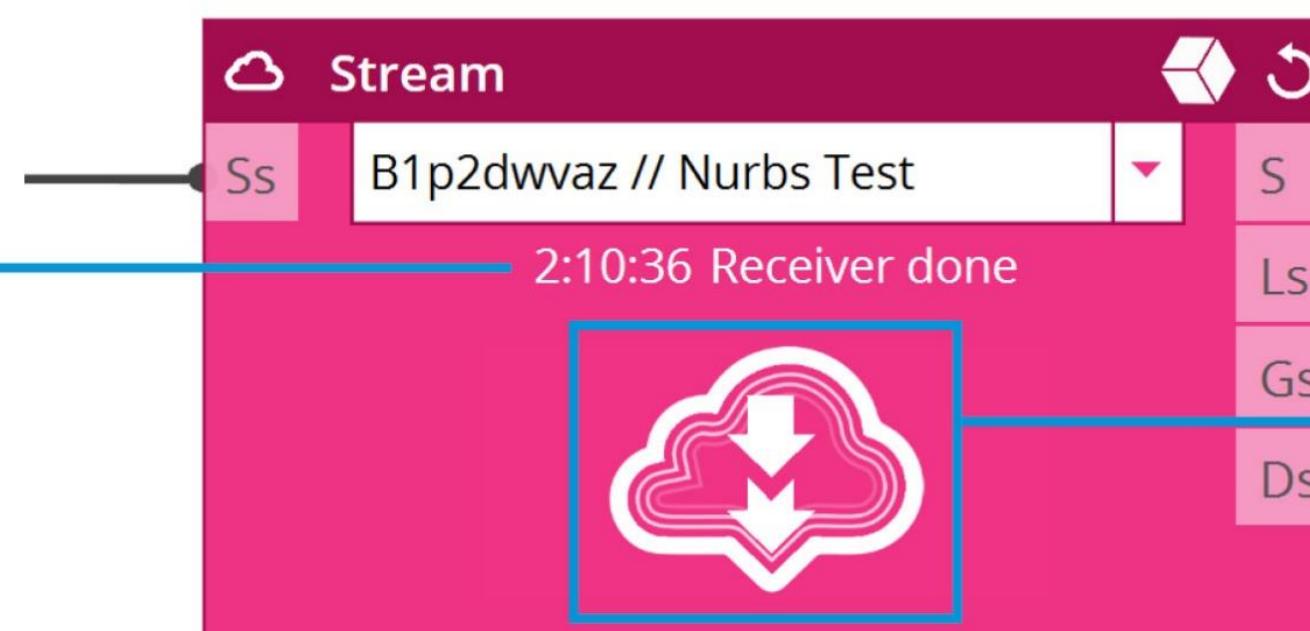
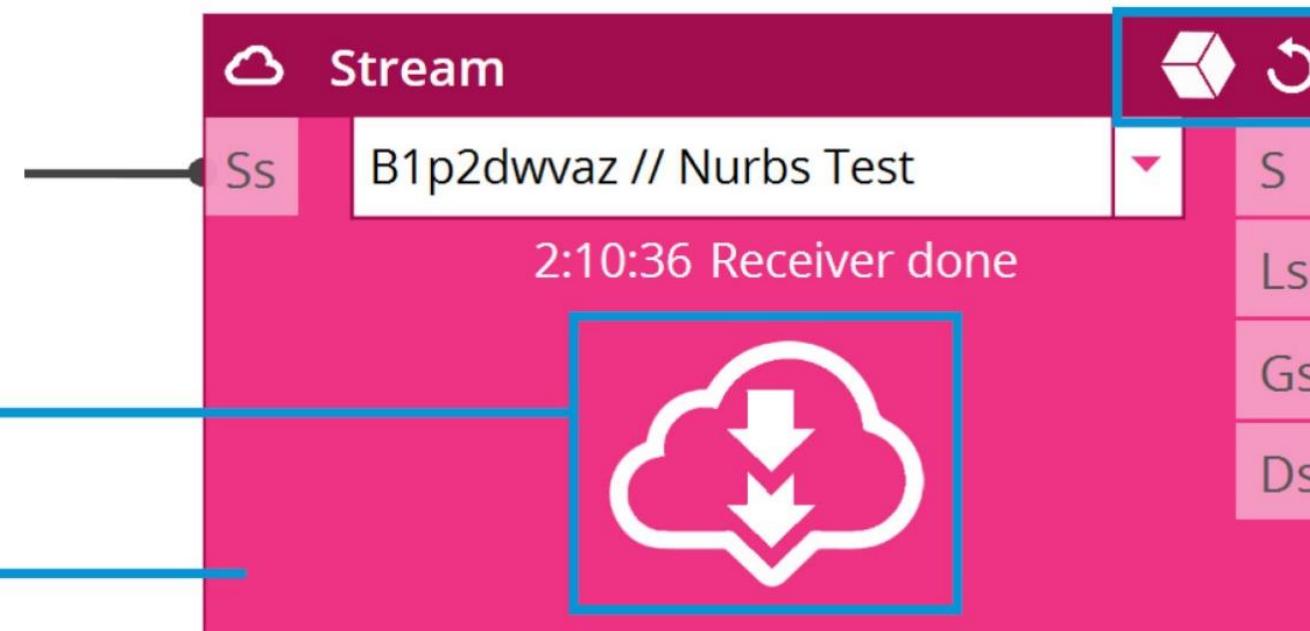
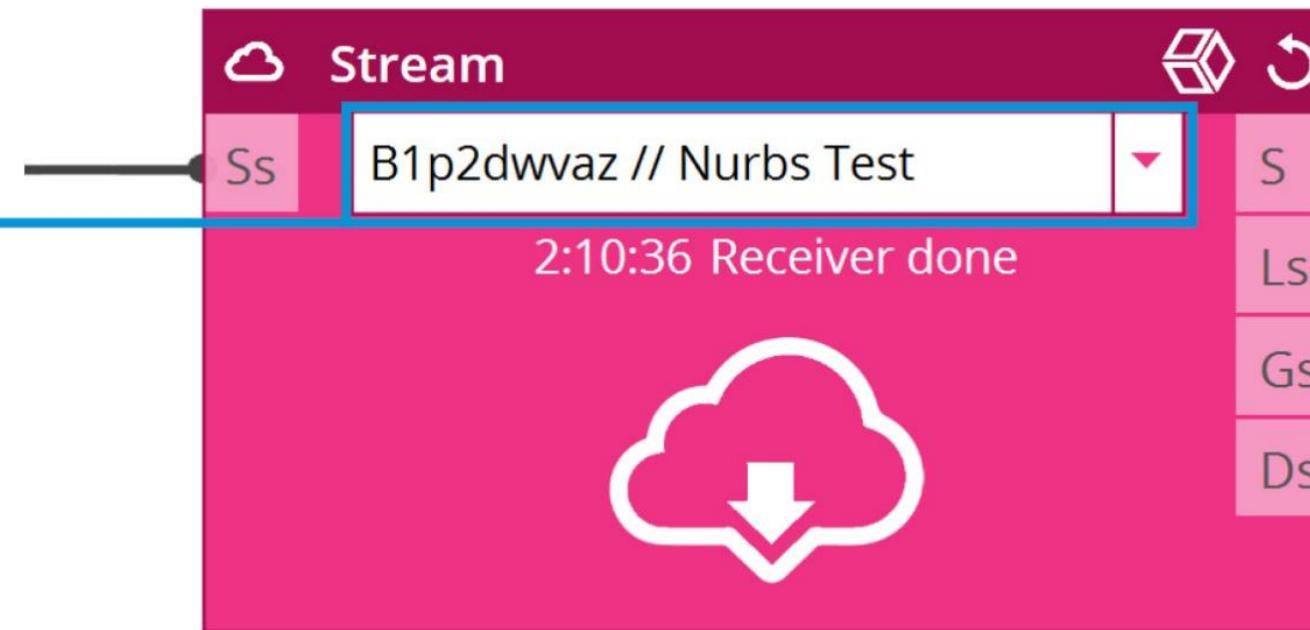
Manual Updates Mode

Automatic Updates Mode

Click icon to switch mode

Custom colour scheme

Live messages from executing code



Stream

Layers

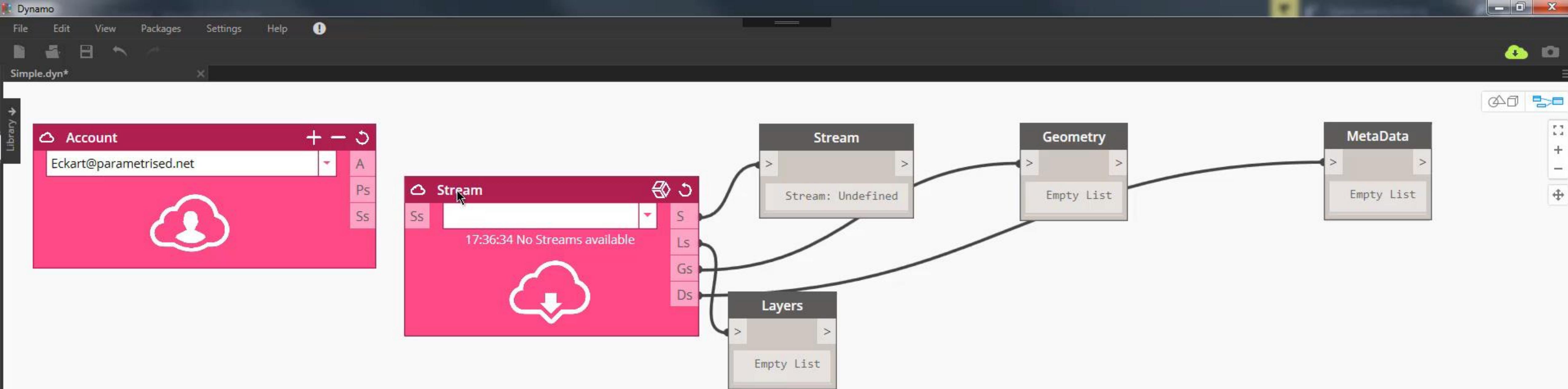
Geometries

Dictionaries

Adaptive windows-like control buttons for additional functions

e.g.  
Load geometry,  
reload

Animation triggered on server interaction



# Dynamo . Custom Nodes

## Cloud Plugin

### Stream Node

Custom user interface node

Responsive colour schemes

Visualise node status and events

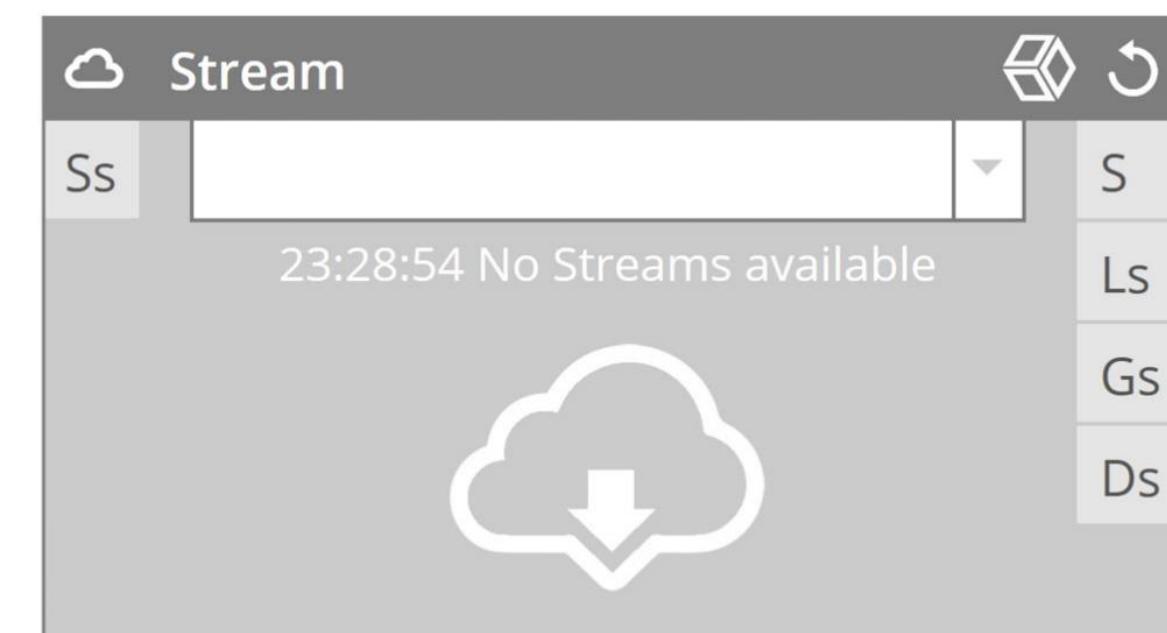
Enable user customisation

Inactive Mode

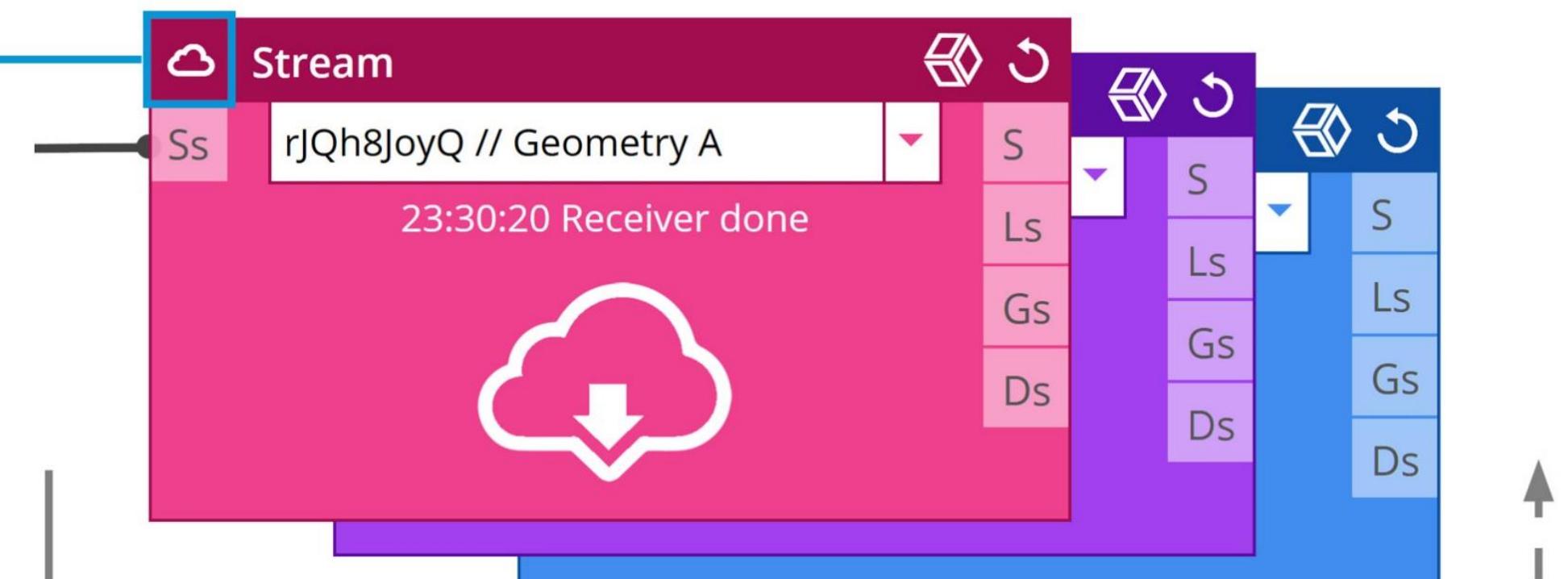
Colour scheme can be individualised and is stored in Dynamo file

Active Mode

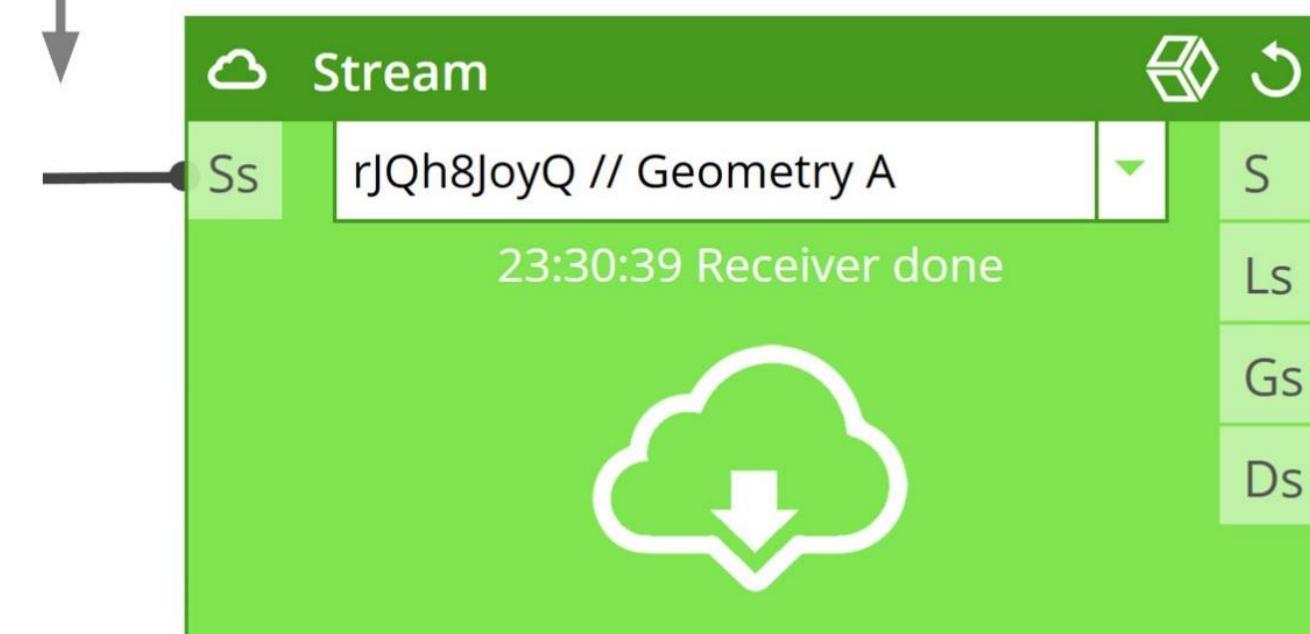
Elevated Mode



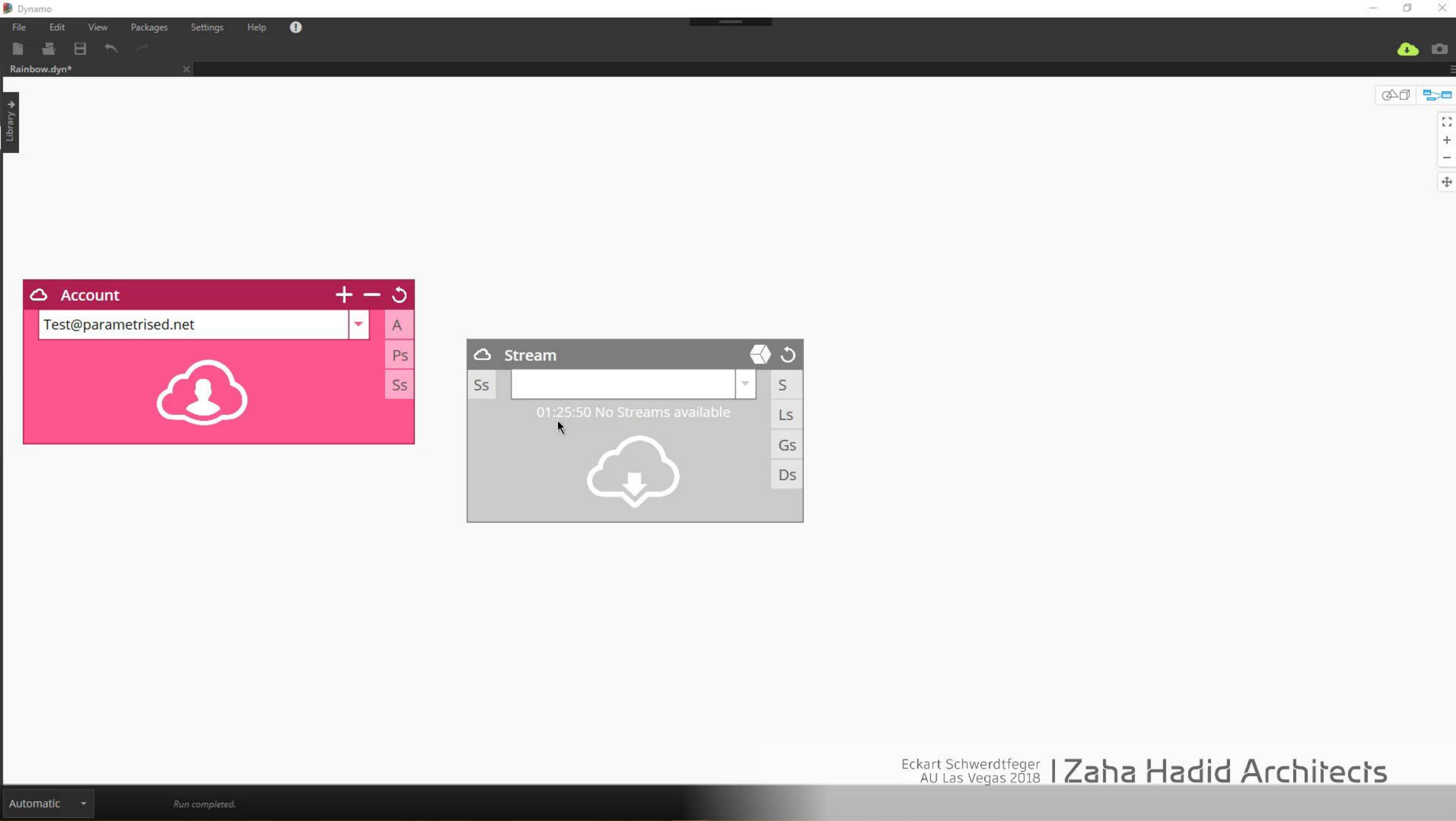
Node colour greyed out  
e.g. missing input



Base colour active when node runs normally



Node colour flashes green and fades back to normal  
e.g. to display event



# Dynamo . Extensions

## ViewExtension Plugin

### Custom Nodes

can integrate new user interfaces + functionality within Dynamo nodes

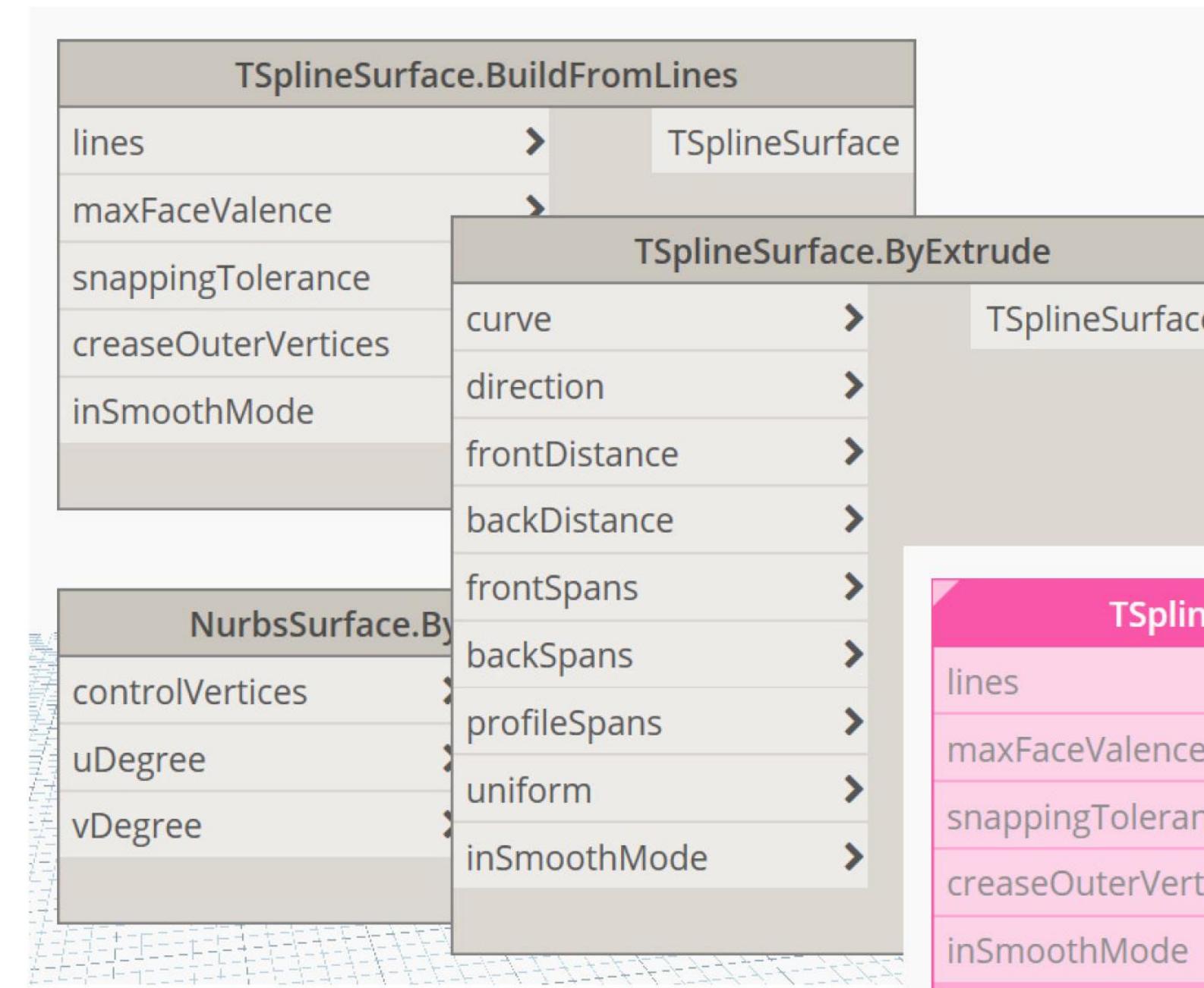
Access is restricted to the current node

### Extensions

have access to Dynamo + the open script and enable global functionalities and adaptations

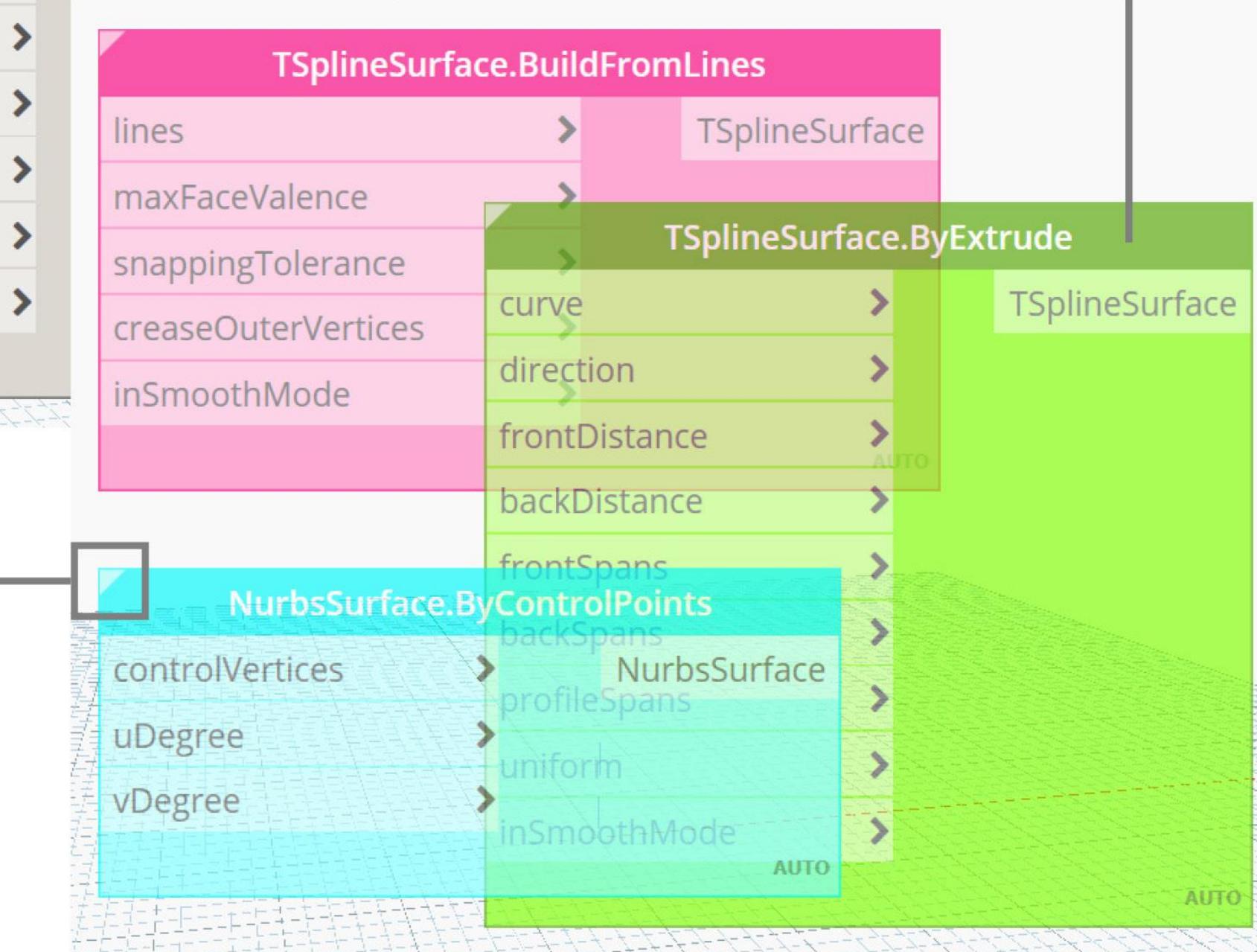
e.g.  
Individualisation of standard nodes

Out of the box nodes without extension

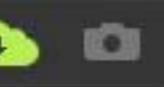


Node is transparent, colour scheme can be adjusted

Out of the box nodes with extension

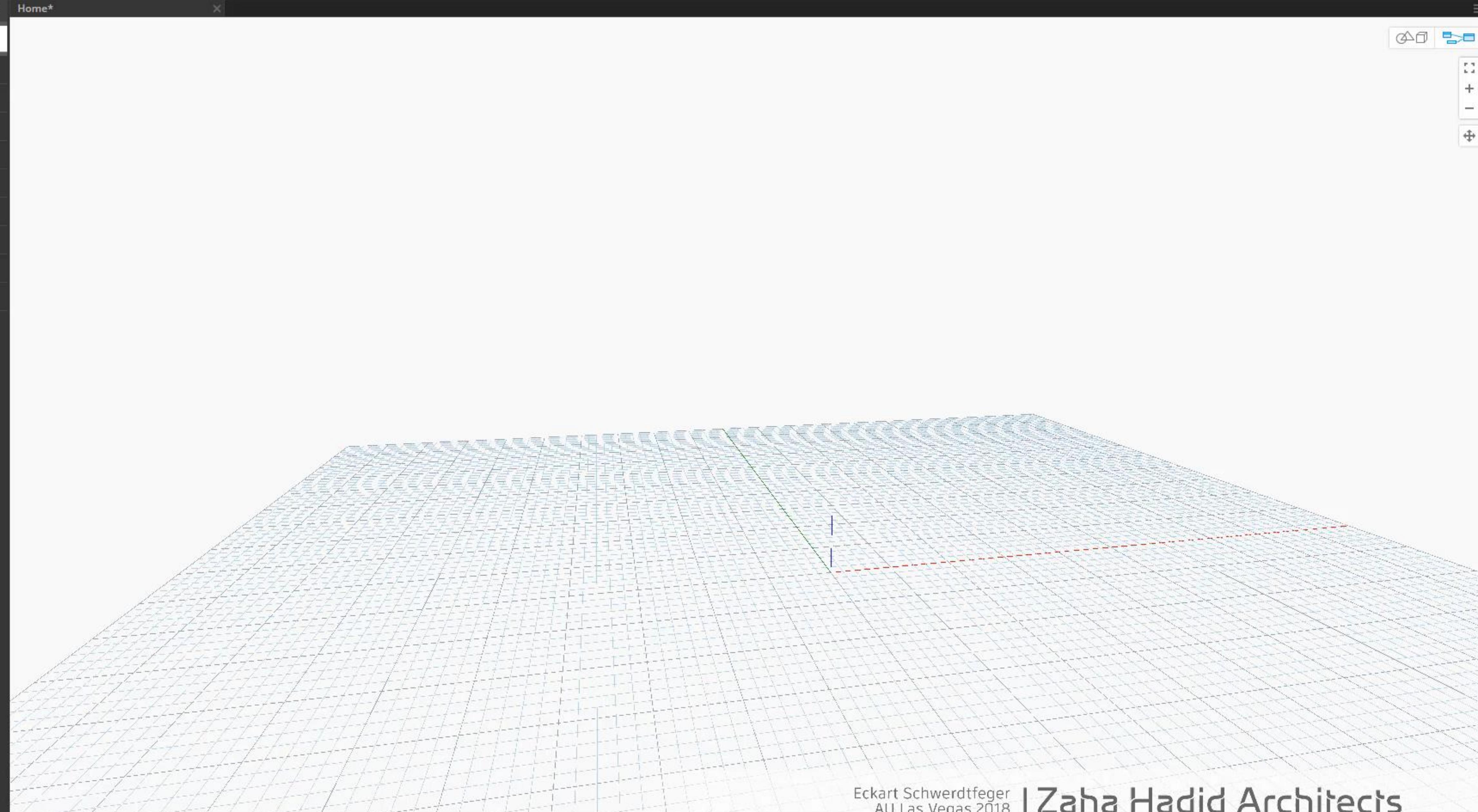


All nodes receive a button for changing the colour scheme



## Library

- Search...
- Dictionary
- Display
- Geometry
- ImportExport
- Input
- List
- Math
- Script
- String



# Adaptive Elements



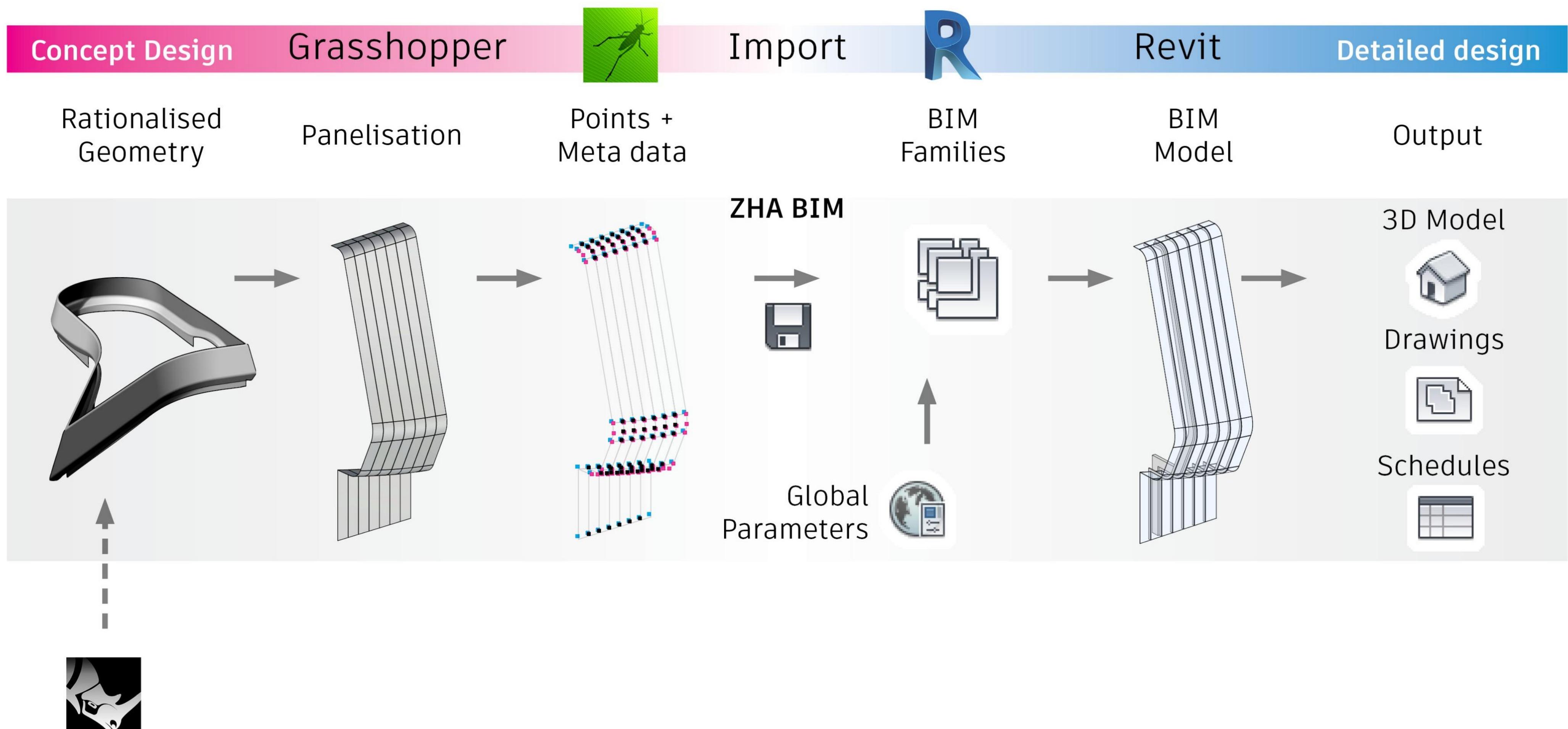
# Adaptive Elements



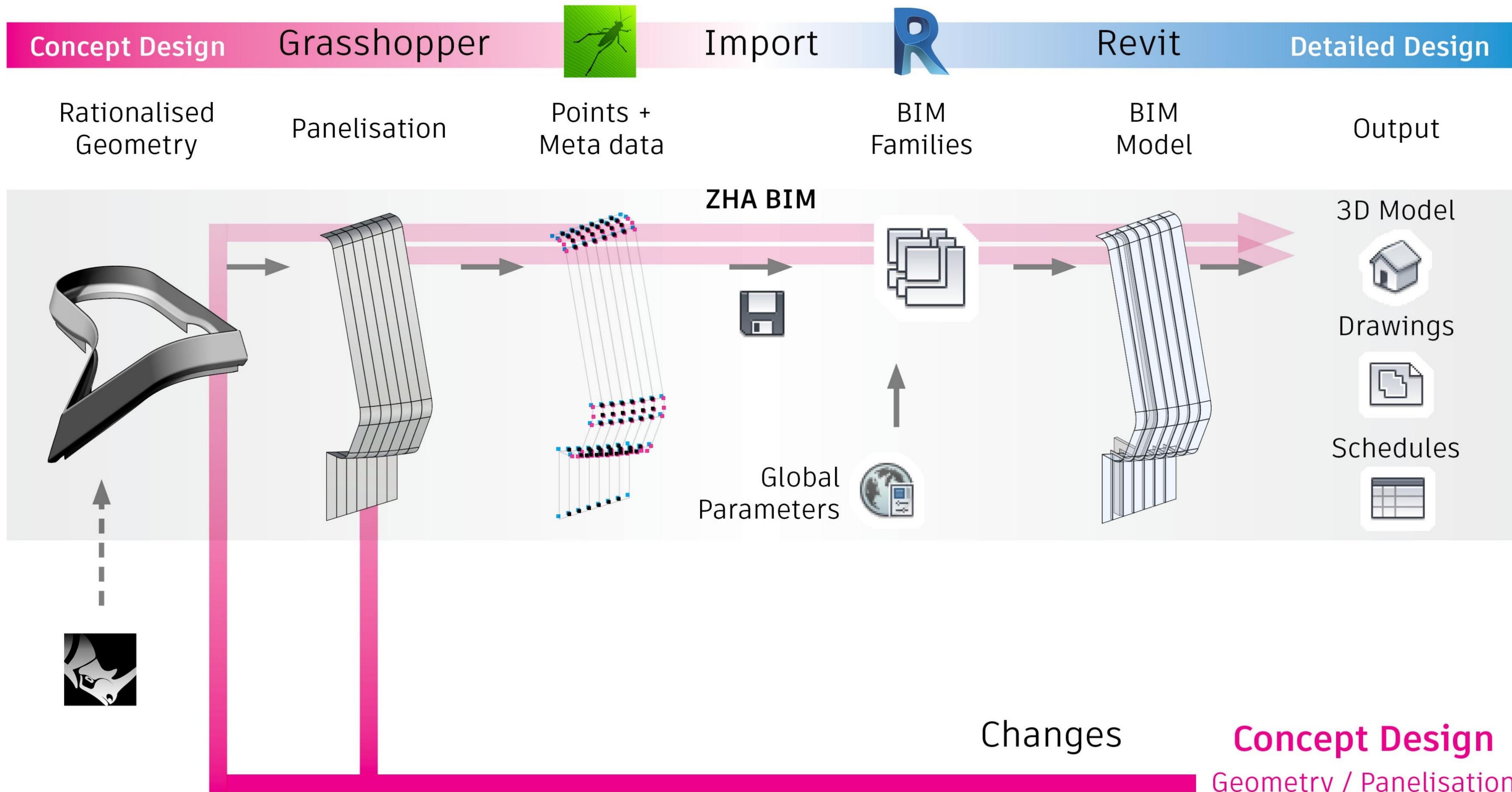
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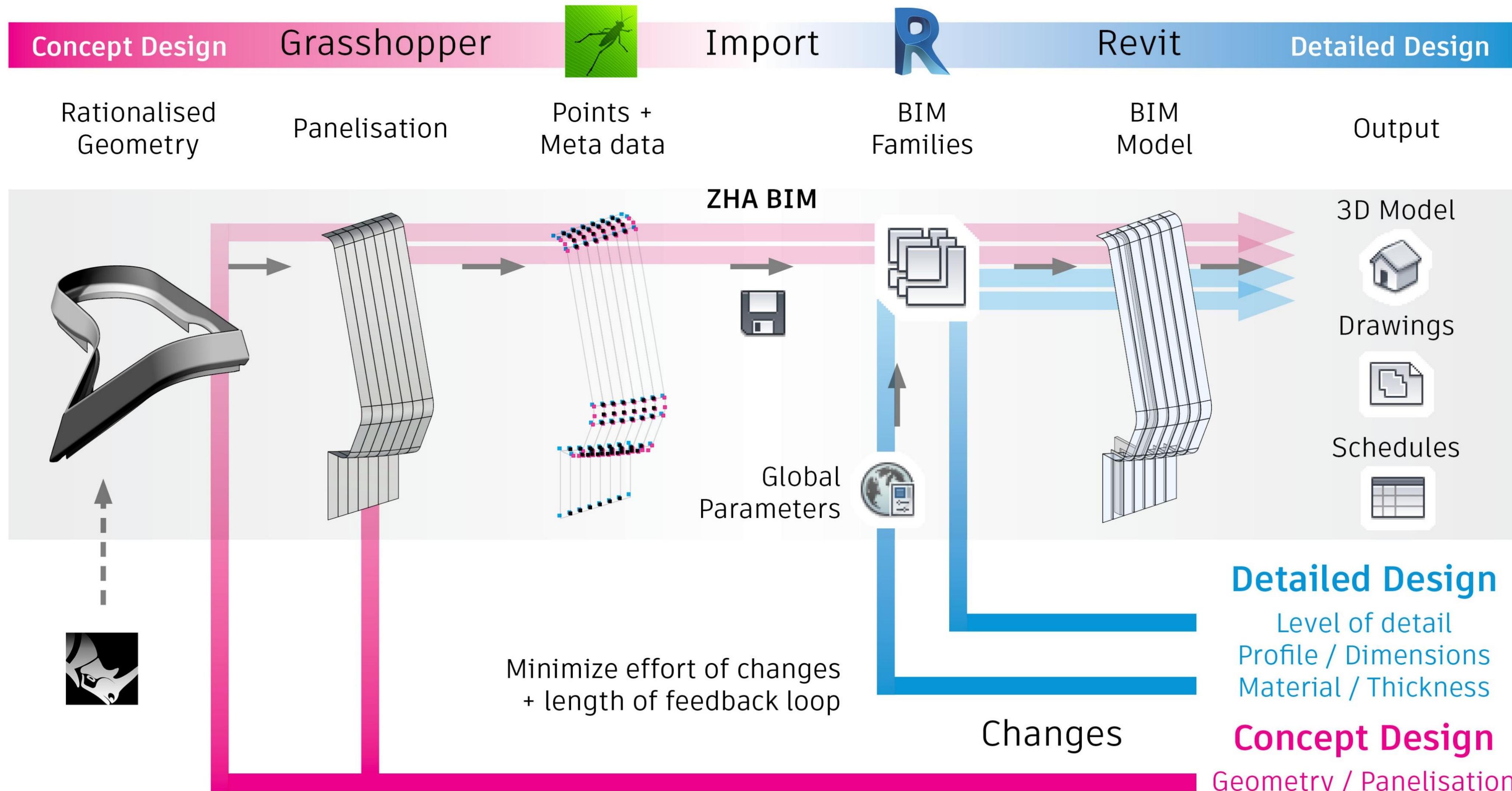
# Adaptive Elements . Process



# Adaptive Elements . Process



# Adaptive Elements . Process



# Adaptive Elements

## Geometry for Revit

### 3D Surfaces + Solids

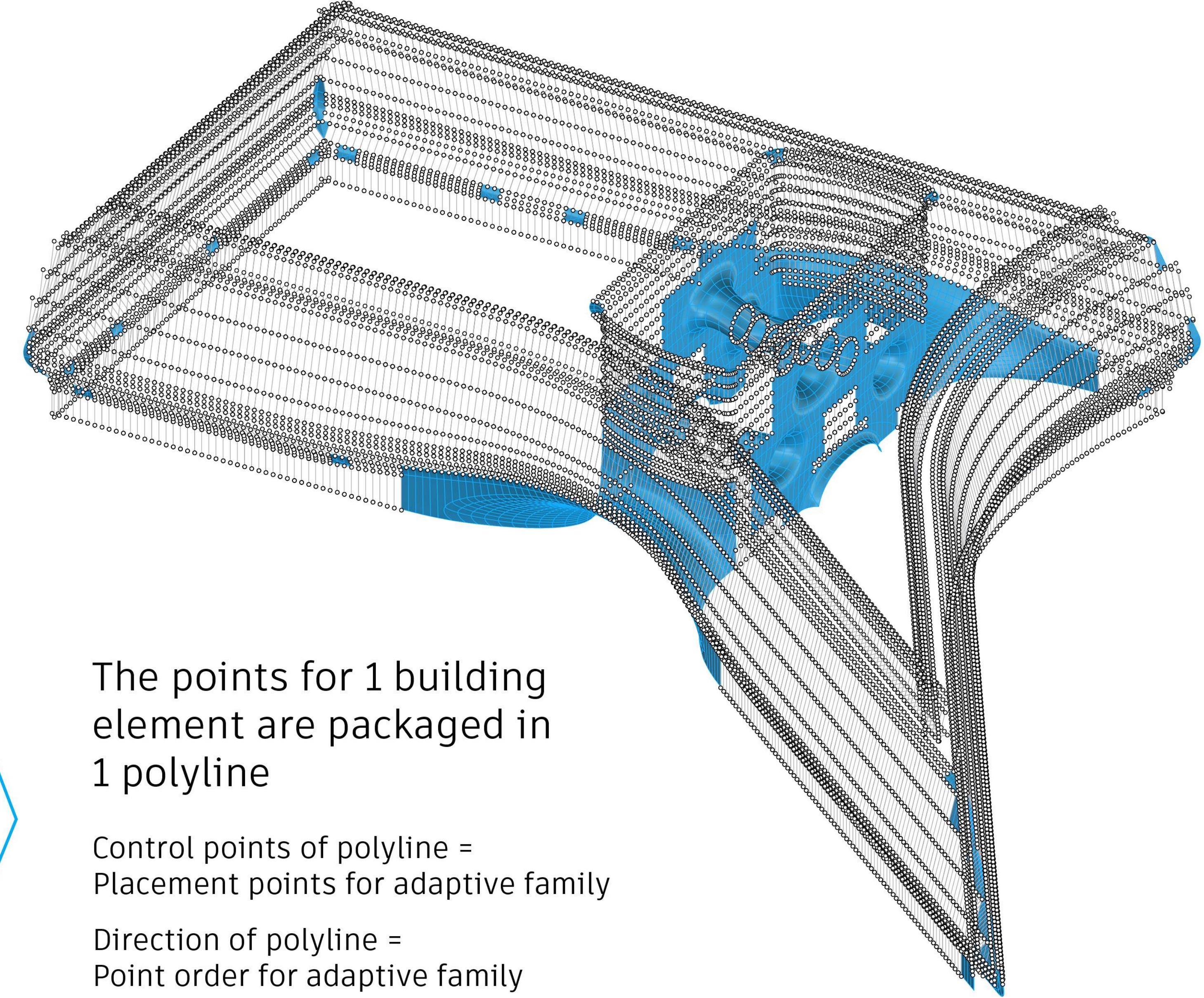
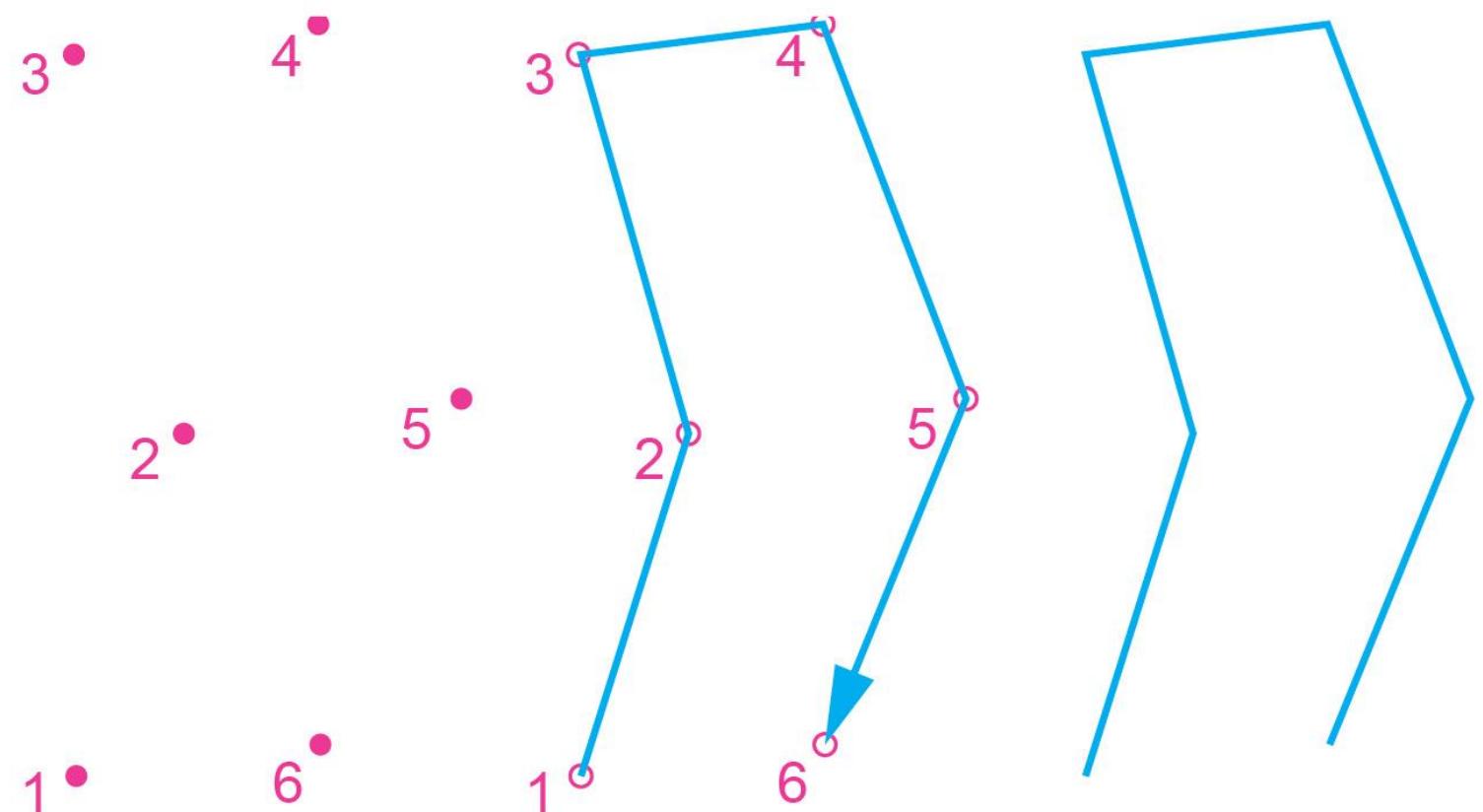
for form-based families

Freeform / double curved

### Point cloud

for adaptive families

Rational / rule-based



The points for 1 building element are packaged in 1 polyline

Control points of polyline =  
Placement points for adaptive family

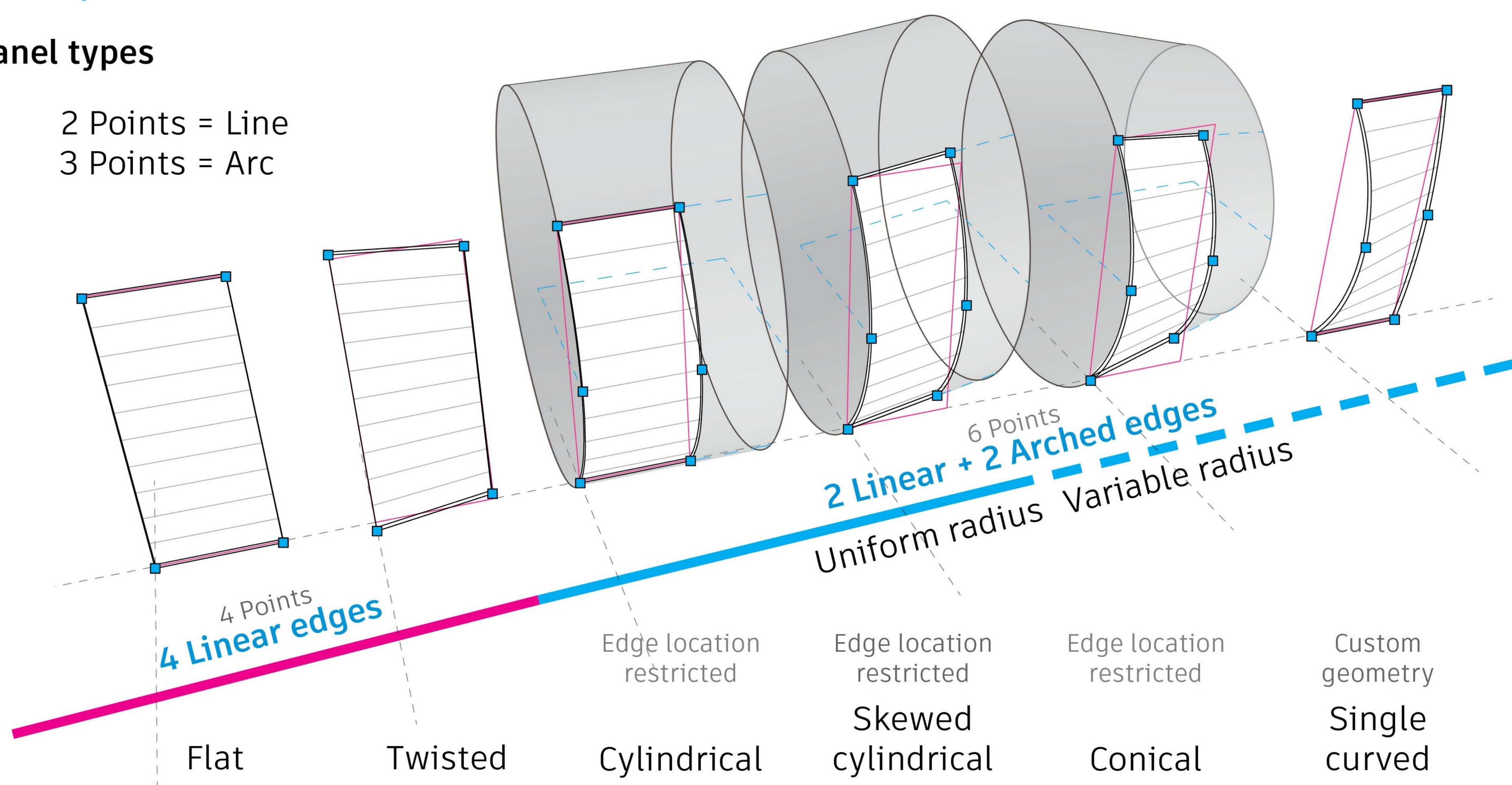
Direction of polyline =  
Point order for adaptive family

# Adaptive Elements . Facade Panels

## Panel types

2 Points = Line

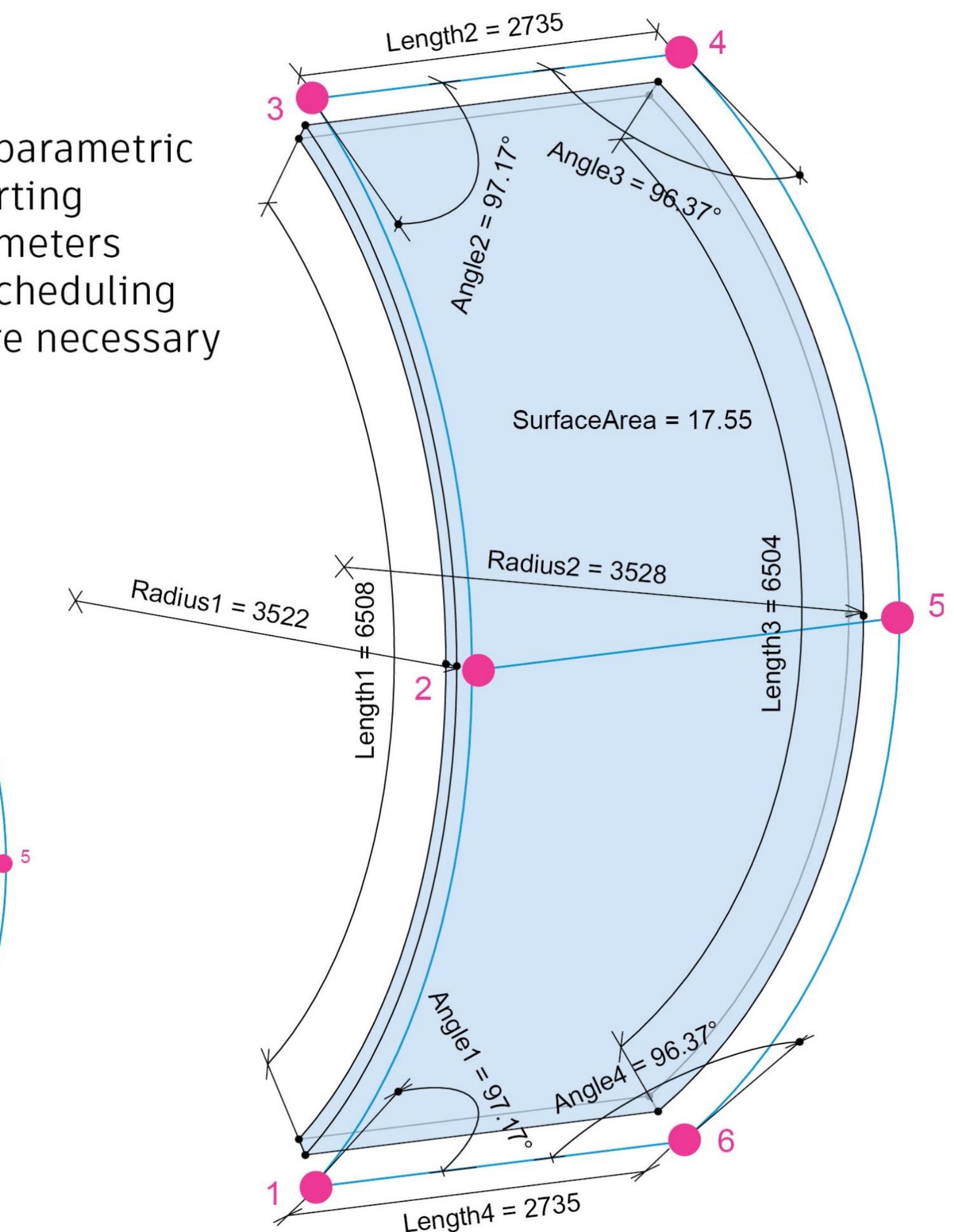
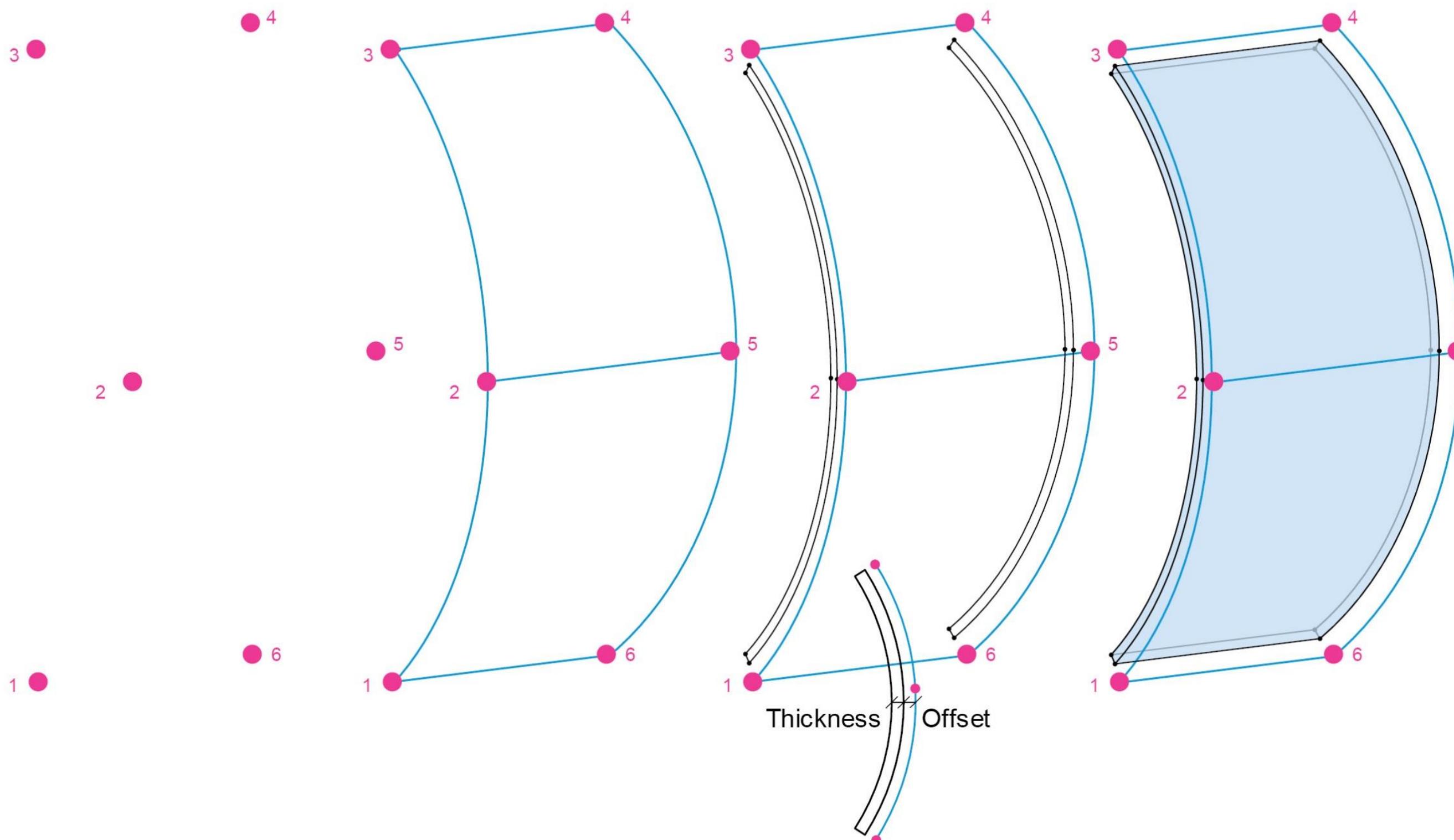
3 Points = Arc



# Adaptive Elements . Facade Panels

## Adaptive Family

- |                                                  |                                                                                                  |                                                                                         |                                                   |                                                                         |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|---------------------------------------------------|-------------------------------------------------------------------------|
| 1<br>Set up adaptive points, order and placement | 2<br>Create frame out of lines [2 points] and arcs [3 points] that allows for panel edge offsets | 3<br>Place edge profiles using nested family that deals with panel offset and thickness | 4<br>Blend both edge profiles into a solid object | 5<br>Add parametric reporting parameters for scheduling where necessary |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|---------------------------------------------------|-------------------------------------------------------------------------|



# Adaptive Elements

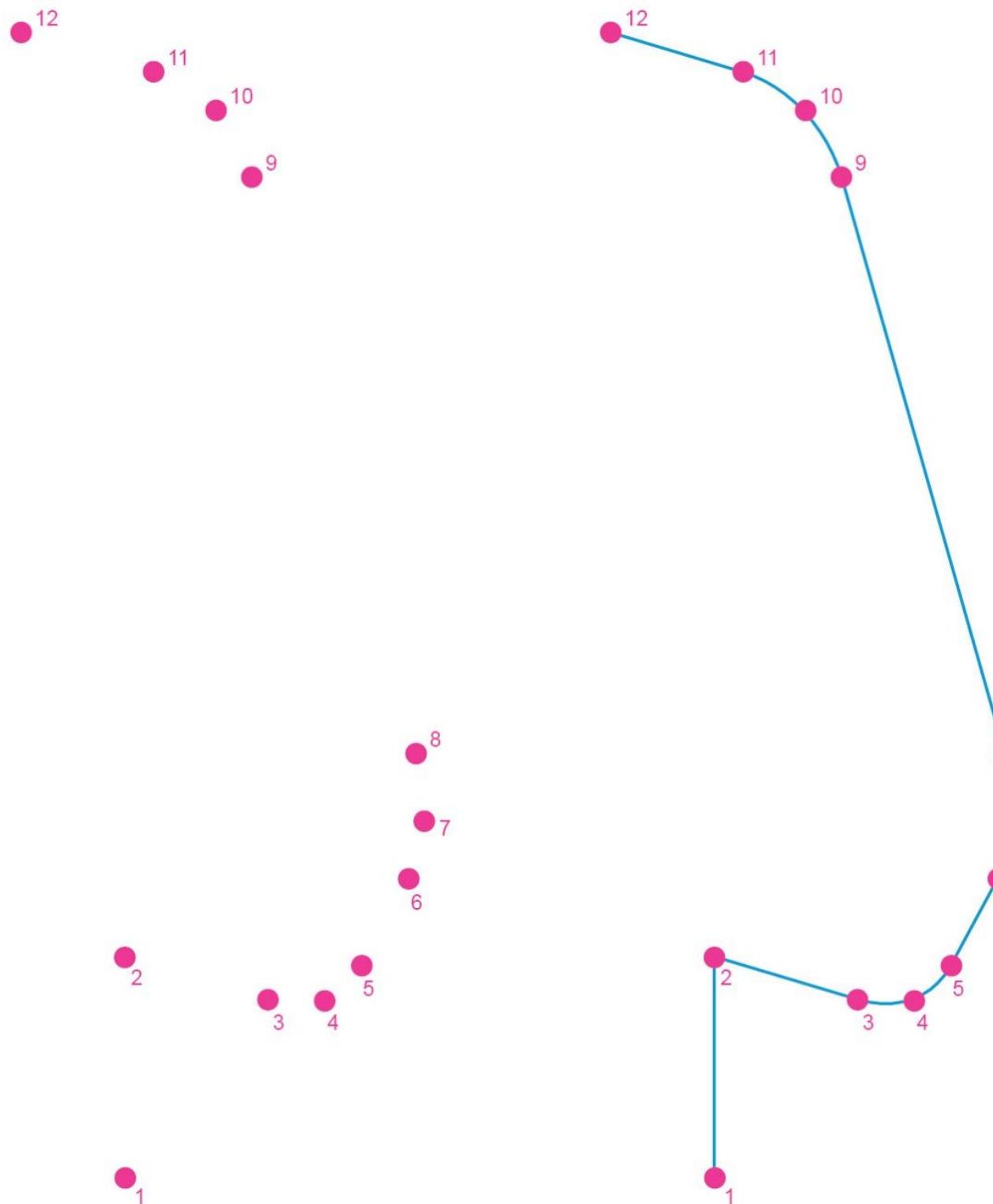


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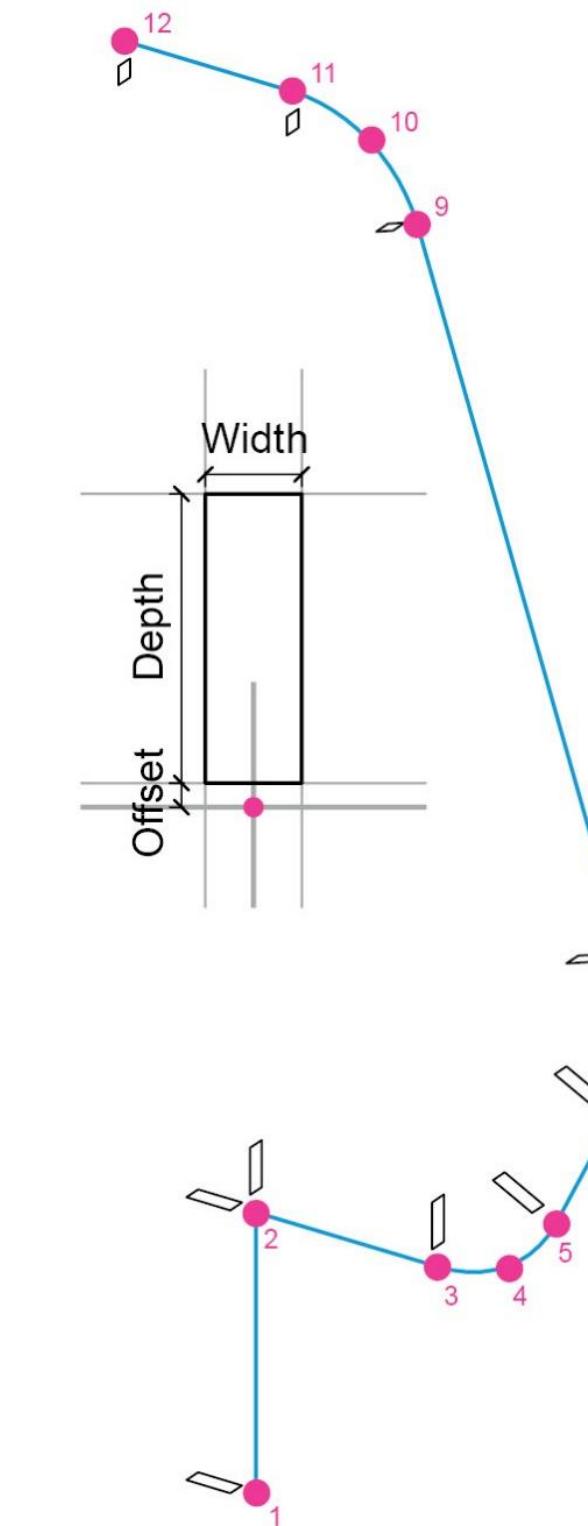
# Adaptive Elements . Facade Columns

## Adaptive Family

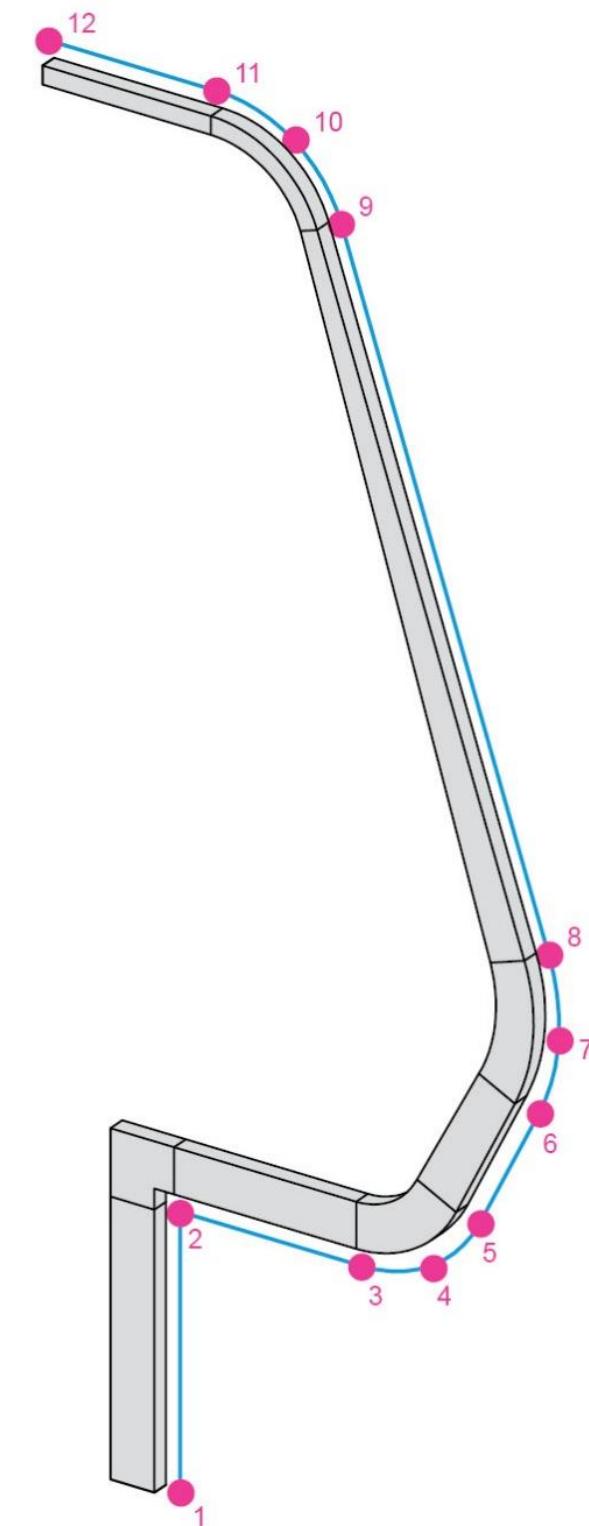
1  
Set up adaptive points, order and placement



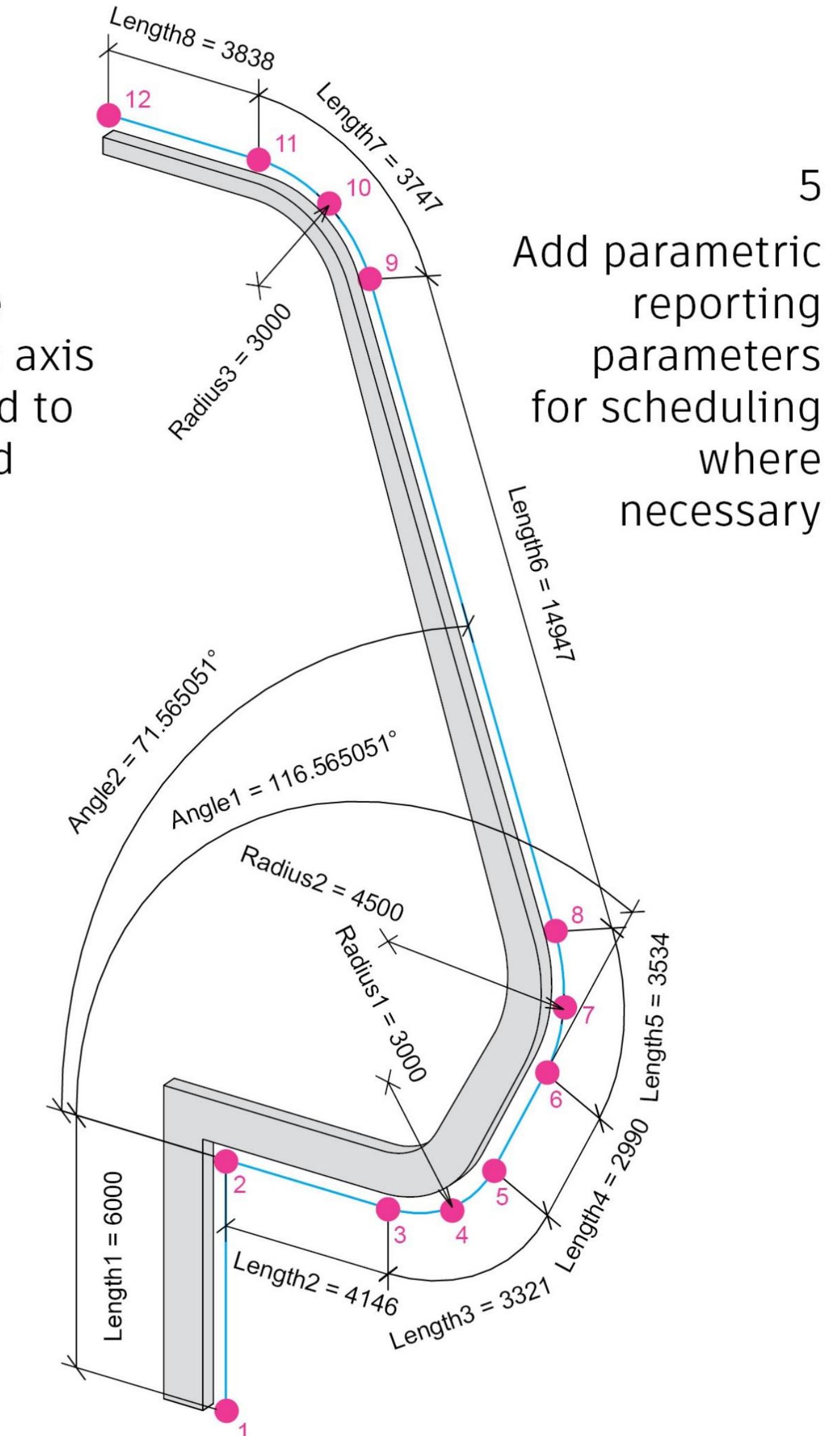
2  
Create column axis out of lines [2 points] and arcs [3 points]



3  
Place column profiles using nested family that controls offset and dimensions



4  
Formulas are used to generate variable dimensions. Column axis and profiles are used to create a swept blend



5  
Add parametric reporting parameters for scheduling where necessary

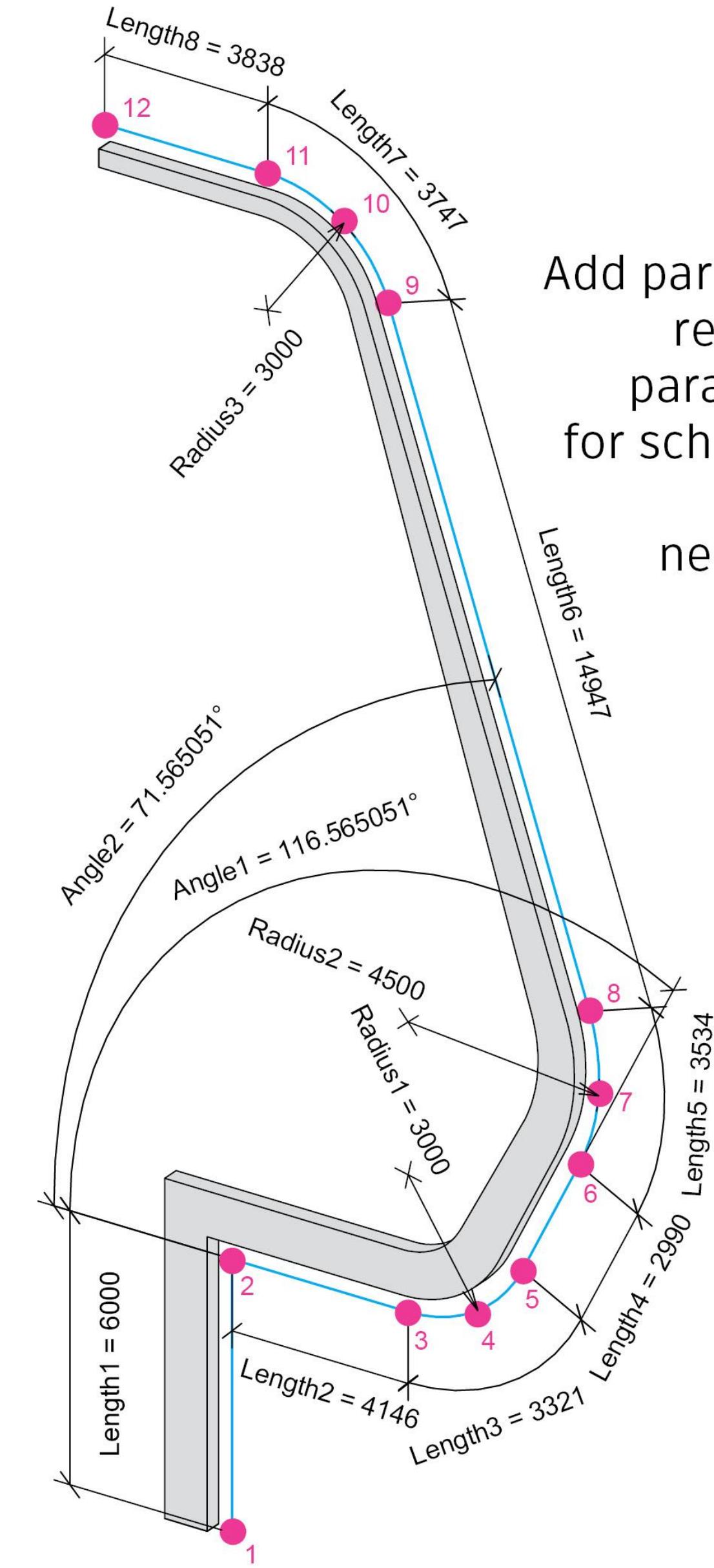
# Adaptive Elements . Facade Columns

# Schedule for Column geometry and dimensions

## FACADE CLADDING - COLUMNS

PROFI

| NAME        | ANGLE 1 | ANGLE 2 | WIDTH  | DEPTH MAX | DEPTH #5 | DEPTH #6 | DEPTH #8 | DEPTH #9 | DEPTH MIN | LENGTH 1  | LENGTH 2 | LENGTH 3 |
|-------------|---------|---------|--------|-----------|----------|----------|----------|----------|-----------|-----------|----------|----------|
| FColumn0001 | 115,00° | 75,00°  | 350 mm | 900 mm    | 900 mm   | 802 mm   | 751 mm   | 350 mm   | 350 mm    | 8.580 mm  | 2.736 mm | 1.361 mm |
| FColumn0002 | 115,00° | 75,00°  | 350 mm | 900 mm    | 900 mm   | 803 mm   | 750 mm   | 350 mm   | 350 mm    | 9.705 mm  | 2.736 mm | 1.361 mm |
| FColumn0003 | 115,00° | 75,00°  | 350 mm | 900 mm    | 900 mm   | 805 mm   | 749 mm   | 350 mm   | 350 mm    | 10.920 mm | 2.736 mm | 1.361 mm |
| FColumn0004 | 115,00° | 75,00°  | 350 mm | 900 mm    | 900 mm   | 798 mm   | 752 mm   | 350 mm   | 350 mm    | 5.805 mm  | 2.736 mm | 1.361 mm |
| FColumn0005 | 115,00° | 75,00°  | 350 mm | 900 mm    | 900 mm   | 798 mm   | 752 mm   | 350 mm   | 350 mm    | 5.805 mm  | 2.736 mm | 1.361 mm |
| FColumn0006 | 115,00° | 75,00°  | 350 mm | 900 mm    | 900 mm   | 798 mm   | 752 mm   | 350 mm   | 350 mm    | 5.805 mm  | 2.736 mm | 1.361 mm |
| FColumn0007 | 115,00° | 75,00°  | 350 mm | 900 mm    | 900 mm   | 798 mm   | 752 mm   | 350 mm   | 350 mm    | 5.820 mm  | 2.736 mm | 1.361 mm |



Add parametric reporting parameters for scheduling where necessary

RVT 3D View: {3D} - FacadePiecea-Detailed-OK Elevation: Elevation 1 - b - FacadePiecea...

1 : 100

1 : 20

**<PANELS>**

| A                    | B        | C        | D        | E        |
|----------------------|----------|----------|----------|----------|
| Mark                 | Length1  | Length2  | Length3  | Length4  |
| Glass_4sidedFlat_250 | 6,840 mm | 1,548 mm | 6,630 mm | 1,533 mm |
| Glass_4sidedFlat_247 | 7,065 mm | 1,550 mm | 6,840 mm | 1,533 mm |
| Glass_4sidedFlat_244 | 7,335 mm | 1,557 mm | 7,065 mm | 1,533 mm |
| Glass_4sidedFlat_241 | 7,620 mm | 1,560 mm | 7,335 mm | 1,533 mm |

1 : 100

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# Facade . Perimeter

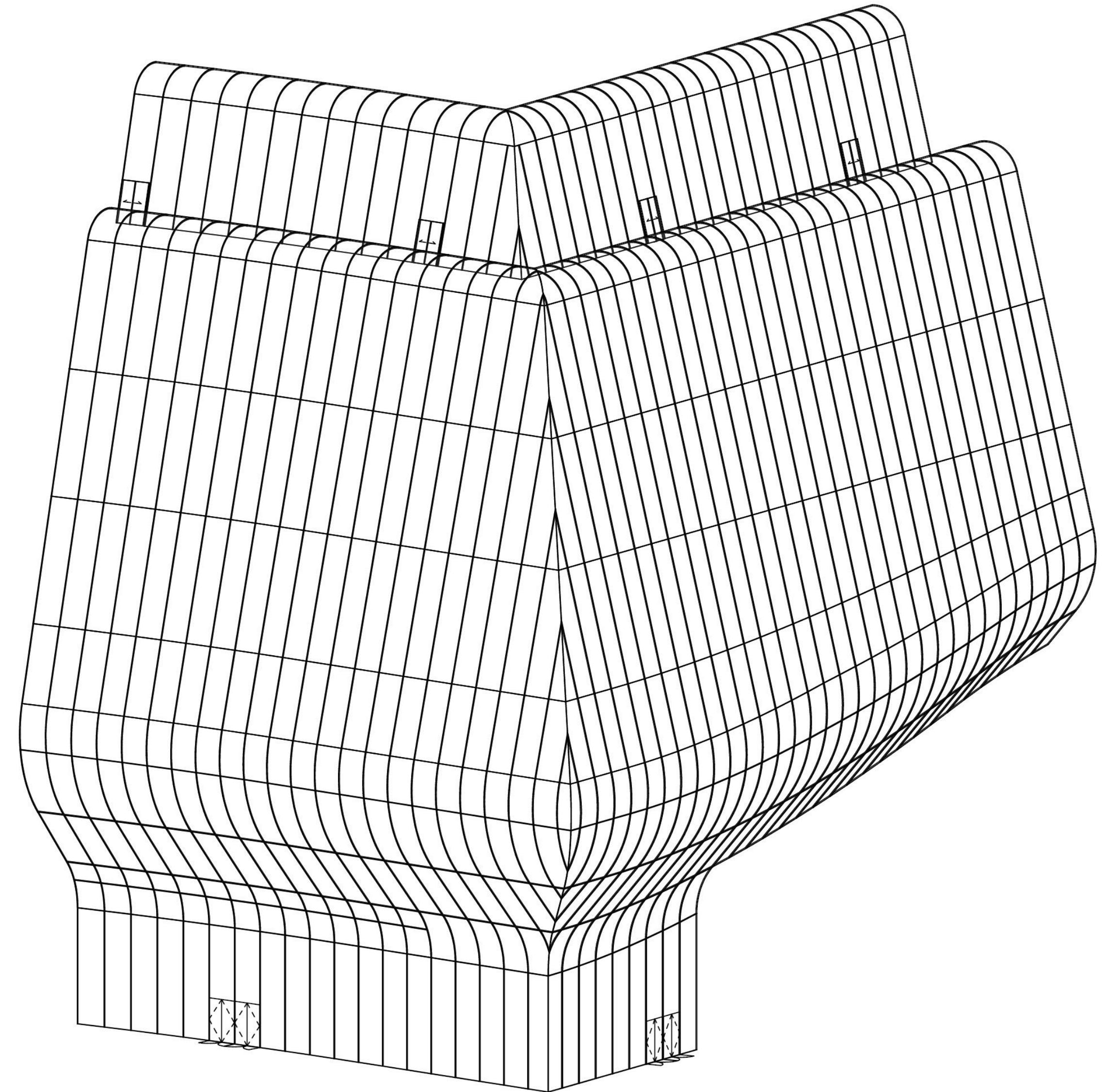
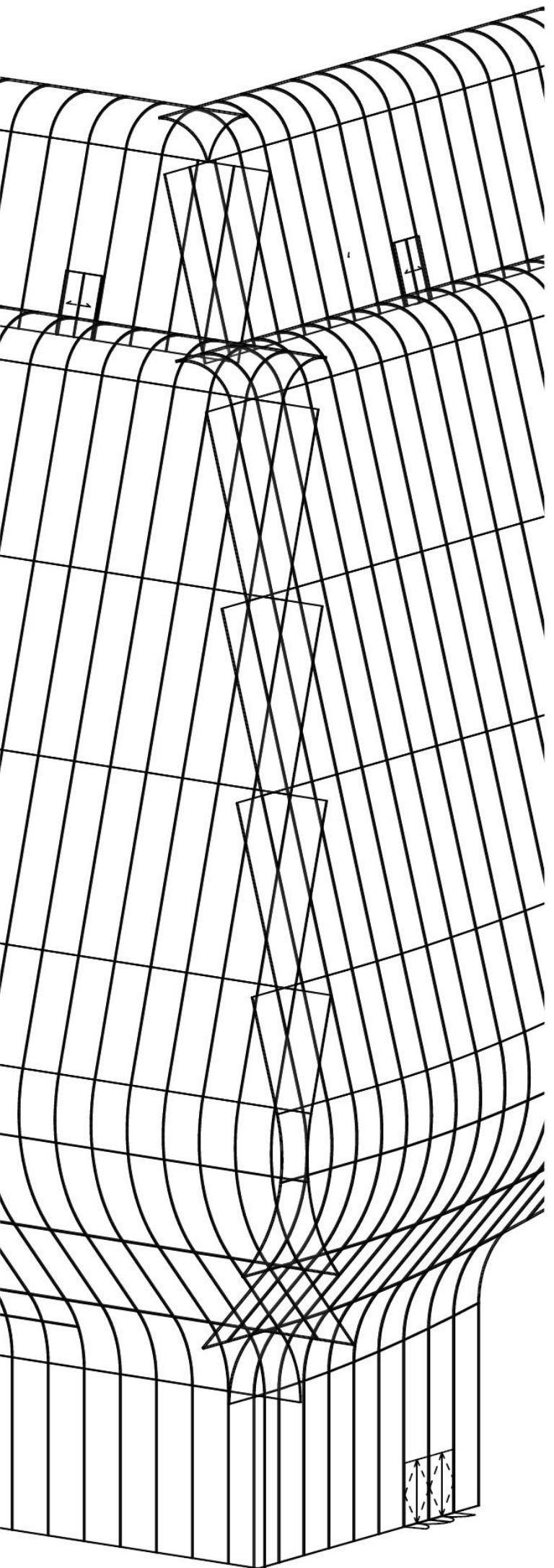
## Custom panels

Use standardised families only + cut corners with voids

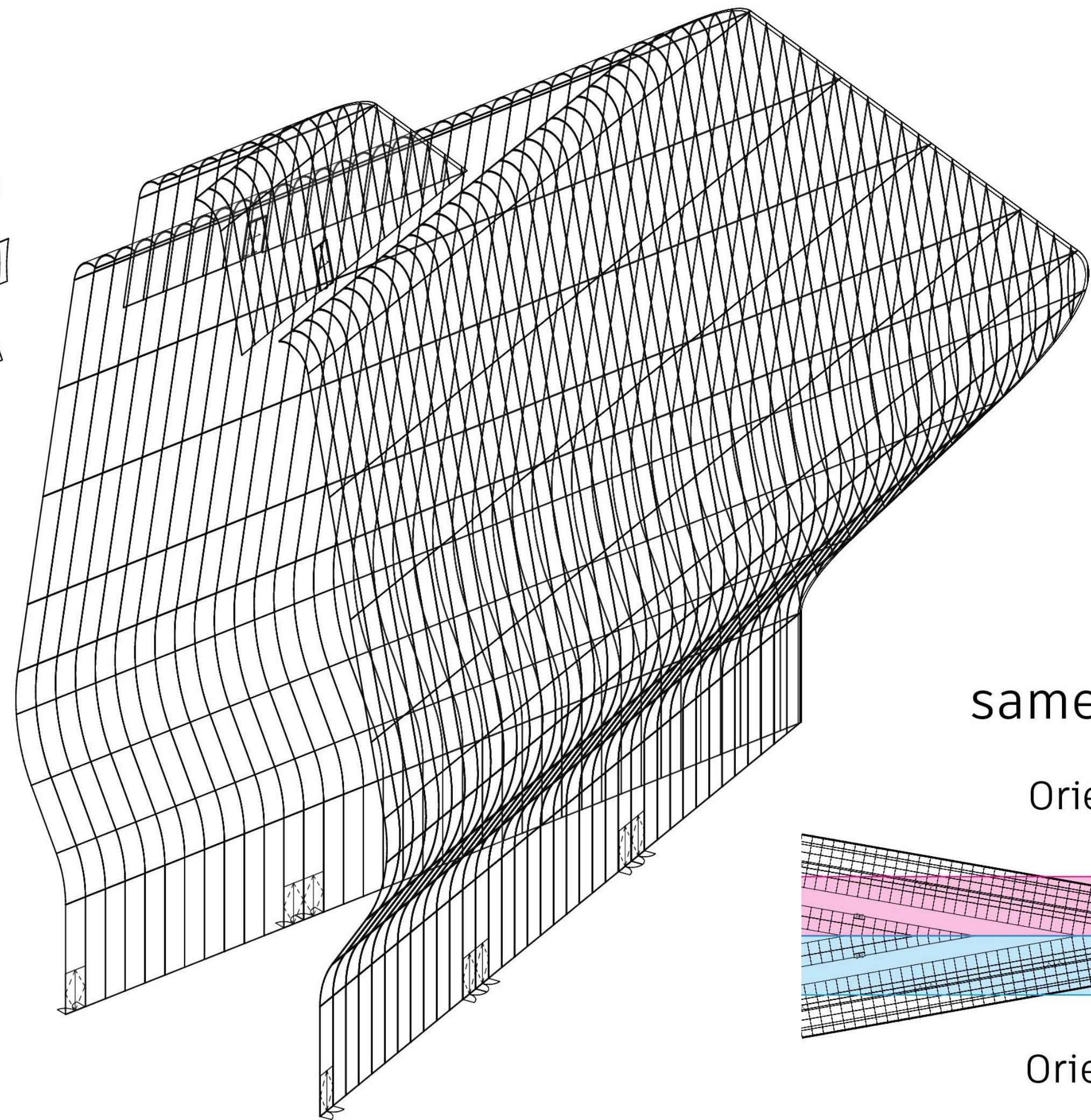
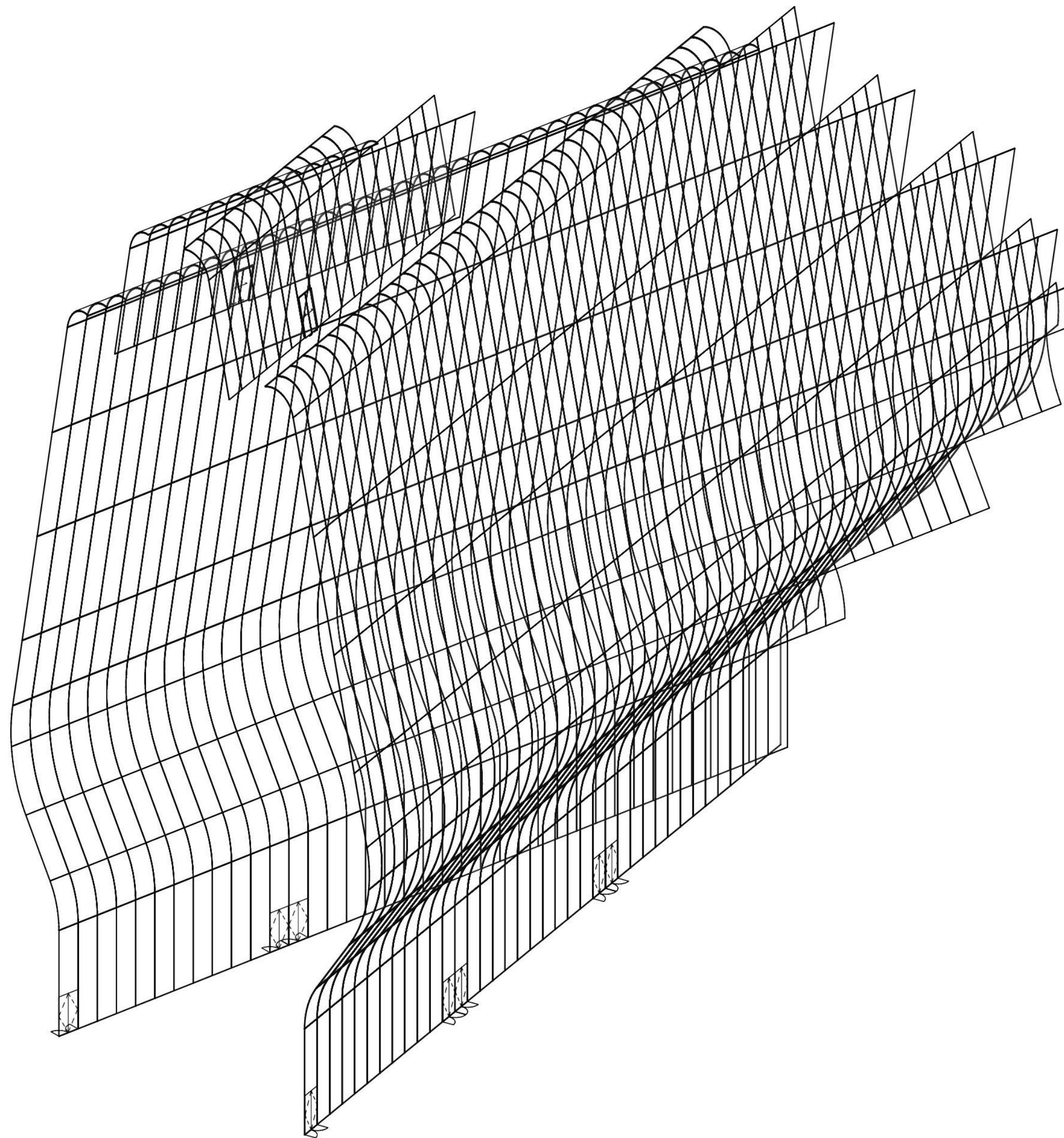
### C# Macro

For every panel...

- Read parameter 'Orientation'
- Check intersection of panel with void of same 'Orientation'
- Upon intersection...  
Subtract void from element  
Update parameters 'Cut' + 'Area'

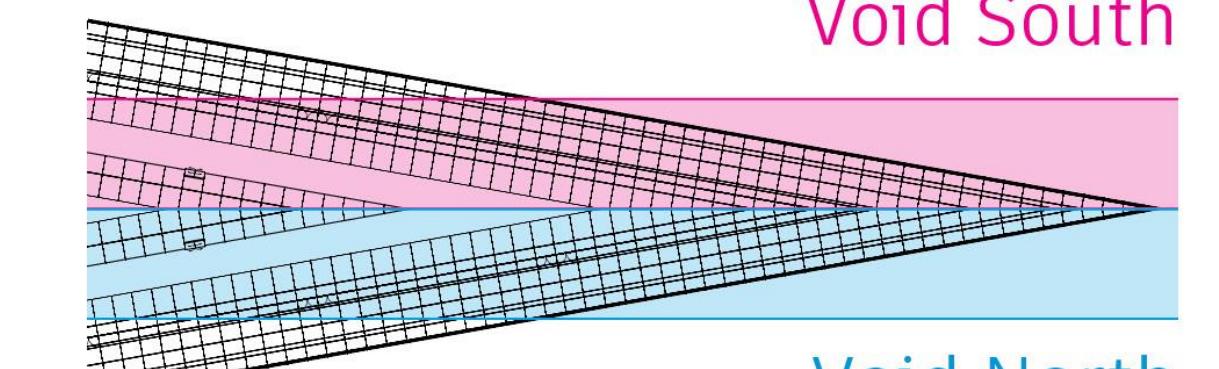


# Facade . Perimeter



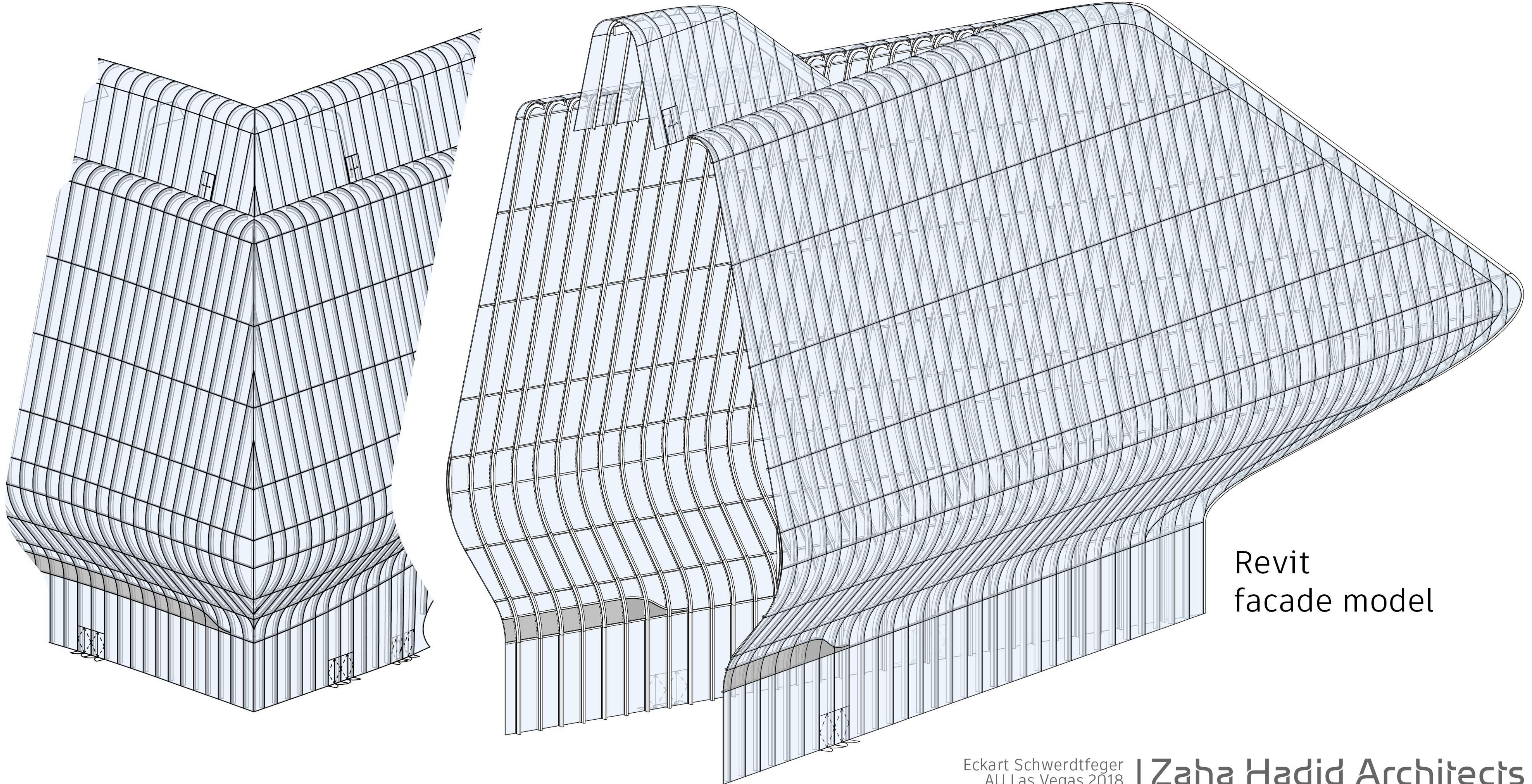
Cut panels  
with void of  
same orientation

Orientation = North  
Void South



Void North  
Orientation = South

# Facade . Perimeter



Revit  
facade model

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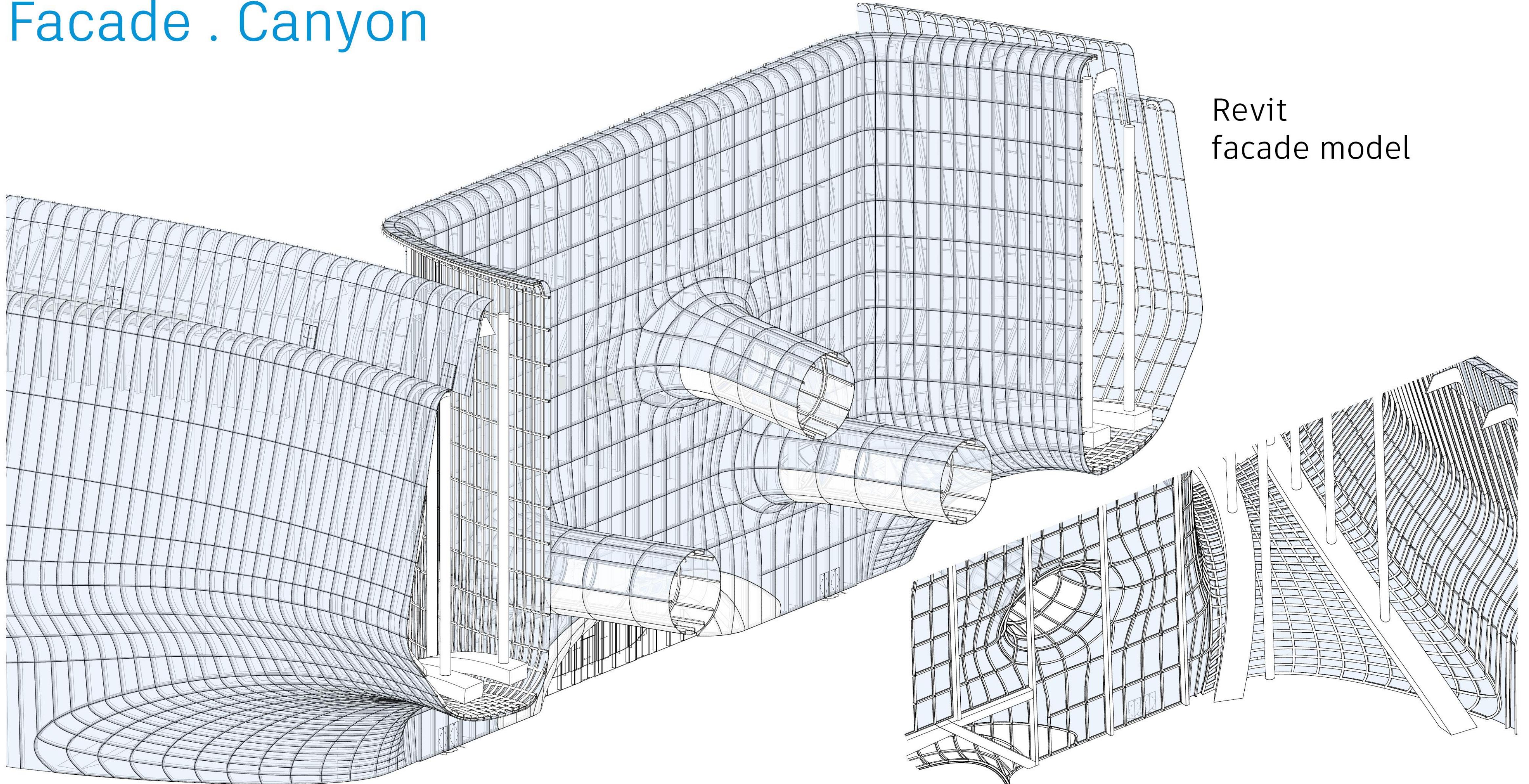
# Facade . Canyon



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# Facade . Canyon

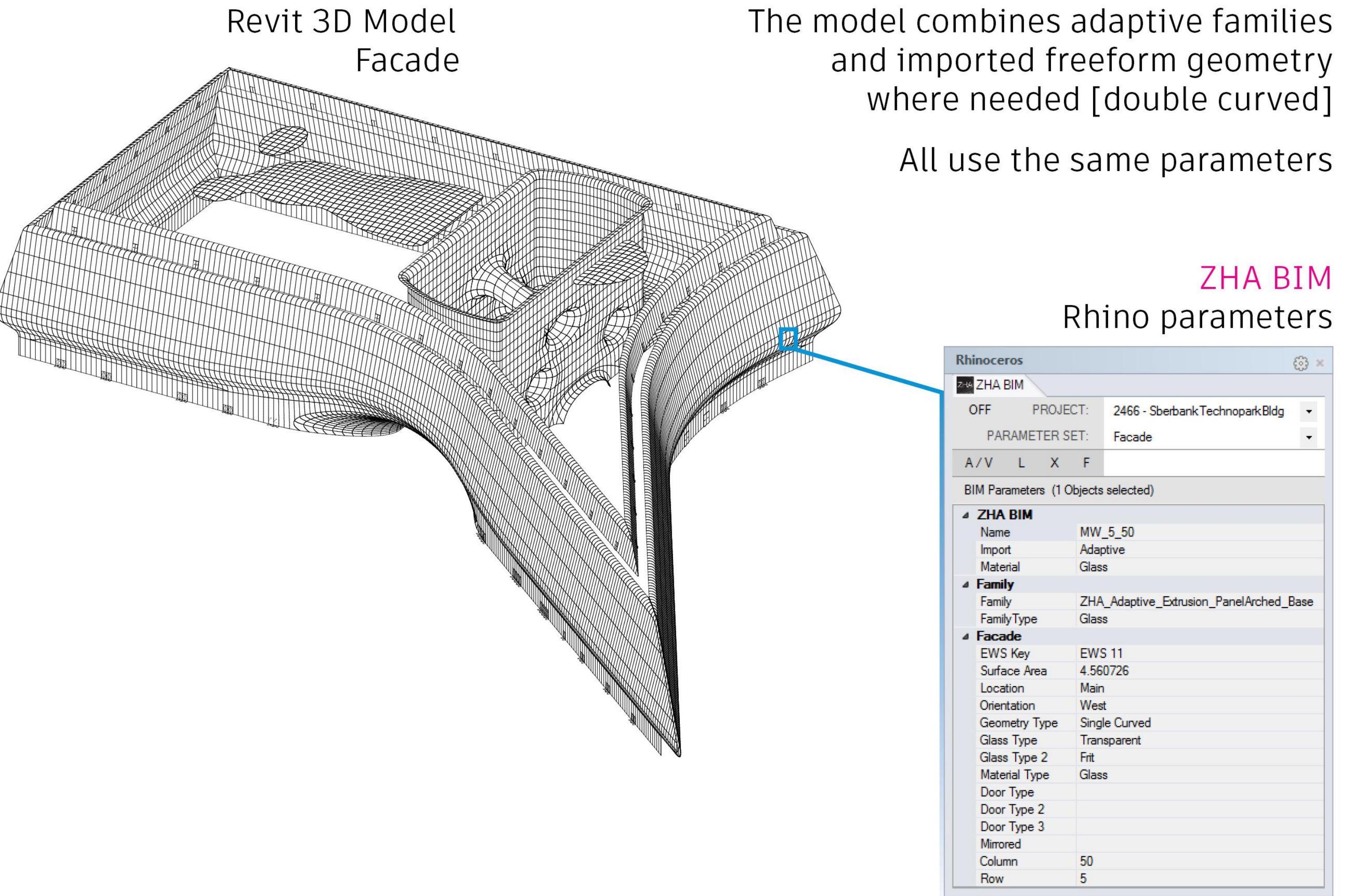


Revit  
facade model

# Facade . BIM Model

## Building information model

- 3D model + meta data
- Custom parameters can be added to all building elements
- Using **ZHA BIM** this can already be done in Rhino + Grasshopper

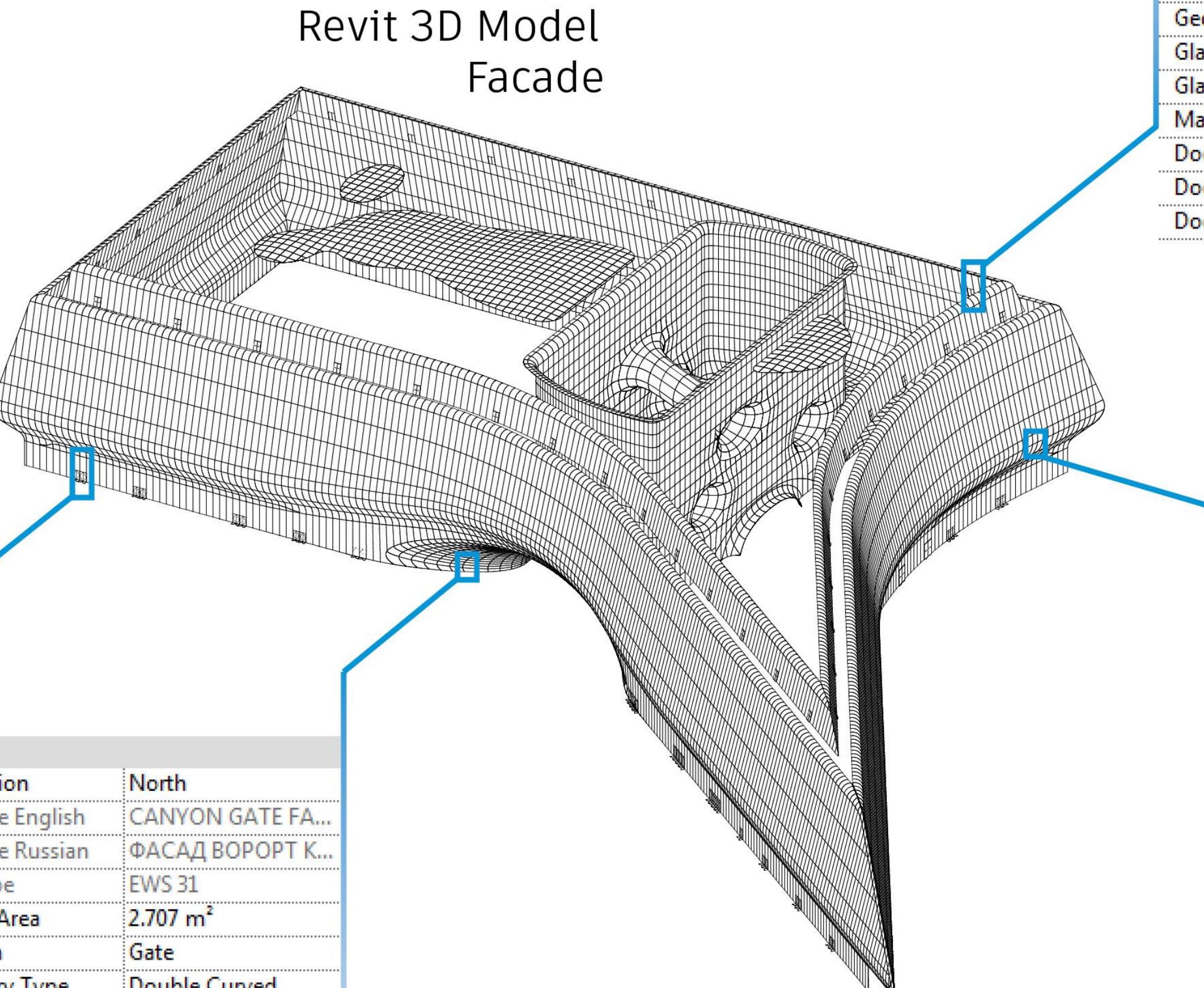


# Facade . BIM Model

## Building information model

- 3D model + meta data
- Custom parameters can be added to all building elements
- Using **ZHA BIM** this can already be done in Rhino + Grasshopper

| Data              |                       |
|-------------------|-----------------------|
| Orientation       | North                 |
| EWS Title English | BASE FAÇADE           |
| EWS Title Russian | НИЖНИЙ ФАСАД          |
| EWS Type          | EWS 13                |
| Surface Area      | 11.976 m <sup>2</sup> |
| Location          | Main                  |
| Geometry Type     | Flat                  |
| Glass Type        | Transparent           |
| Glass Type 2      | No Frit               |
| Material Type     | Glass                 |
| Door Type         | D5 - Escape Door      |
| Door Type 2       | Swing Door            |
| Door Type 3       | Double Door           |



Revit parameters

| Data              |                       |
|-------------------|-----------------------|
| Orientation       | South                 |
| EWS Title English | TERRACE FACADE        |
| EWS Title Russian | ФАСАД ТЕРРАСЫ         |
| EWS Type          | EWS 15                |
| Surface Area      | 13.193 m <sup>2</sup> |
| Location          | Terrace               |
| Geometry Type     | Flat                  |
| Glass Type        | Transparent           |
| Glass Type 2      | No Frit               |
| Material Type     | Glass                 |
| Door Type         | D6 - Terrace Door     |
| Door Type 2       | Sliding Door          |
| Door Type 3       | Double Door           |

ZHA BIM  
Rhino parameters

| Rhinoceros                          |                                         |
|-------------------------------------|-----------------------------------------|
| ZHA BIM                             |                                         |
| OFF                                 | PROJECT:                                |
|                                     | 2466 - SberbankTechnoparkBldg           |
|                                     | PARAMETER SET: Facade                   |
| A/V                                 | L X F                                   |
| BIM Parameters (1 Objects selected) |                                         |
| ↳ ZHA BIM                           |                                         |
| Name                                | MW_5_50                                 |
| Import                              | Adaptive                                |
| Material                            | Glass                                   |
| ↳ Family                            |                                         |
| Family                              | ZHA_Adaptive_Extrusion_PanelArched_Base |
| FamilyType                          | Glass                                   |
| ↳ Facade                            |                                         |
| EWS Key                             | EWS 11                                  |
| Surface Area                        | 4.560726                                |
| Location                            | Main                                    |
| Orientation                         | West                                    |
| Geometry Type                       | Single Curved                           |
| Glass Type                          | Transparent                             |
| Glass Type 2                        | Frit                                    |
| Material Type                       | Glass                                   |
| Door Type                           |                                         |
| Door Type 2                         |                                         |
| Door Type 3                         |                                         |
| Mirrored                            |                                         |
| Column                              | 50                                      |
| Row                                 | 5                                       |

# Facade . BIM Model

## Filter

Filter Rules

Filter by: EWS Type

equals  
does not equal  
is greater than  
is greater than or equal to  
is less than  
is less than or equal to  
contains  
does not contain  
begins with  
does not begin with  
ends with  
does not end with  
is associated with  
is not associated with

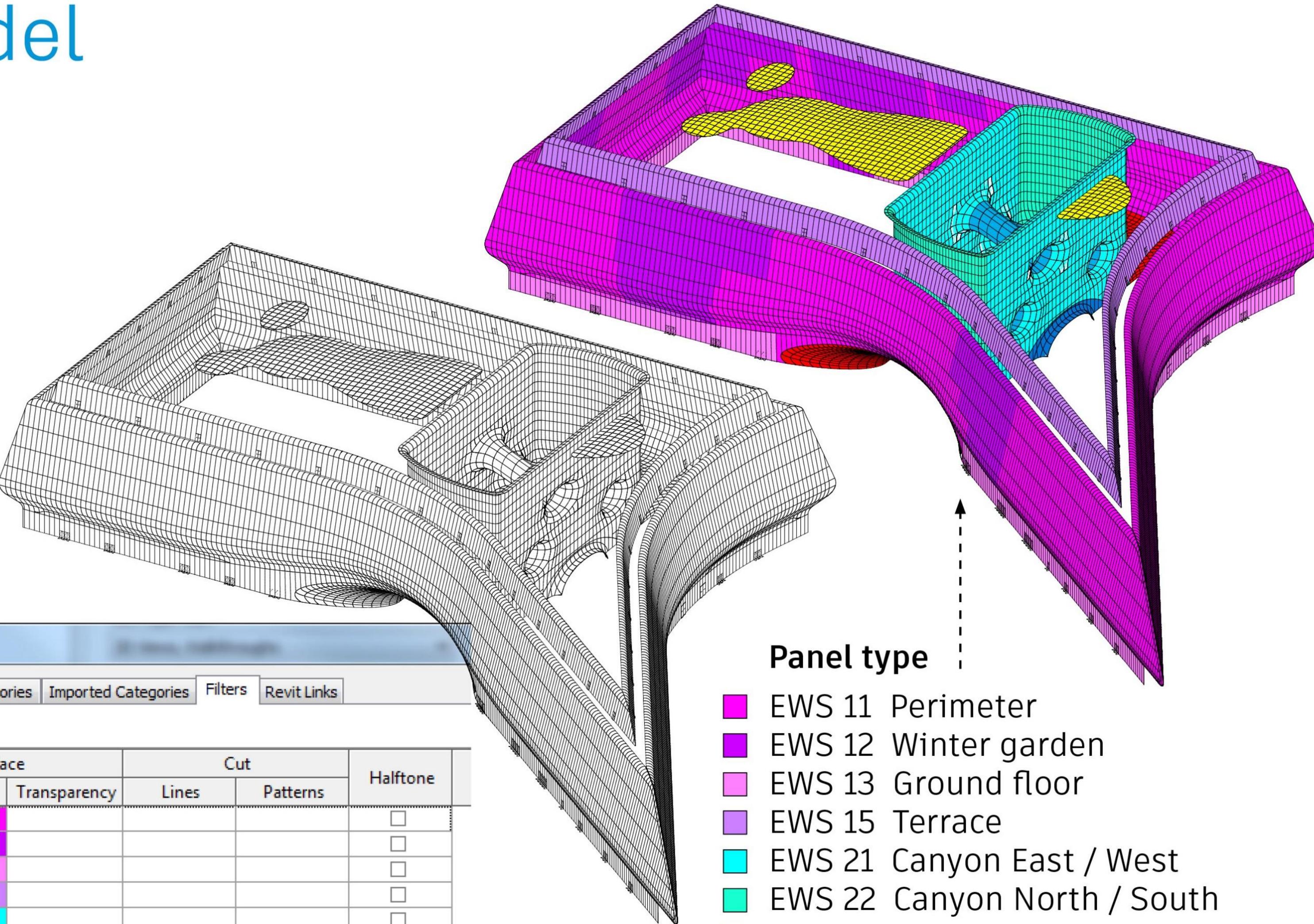
And:

And:

Visibility/Graphic Overrides for 3D\_COL\_EWS\_Type

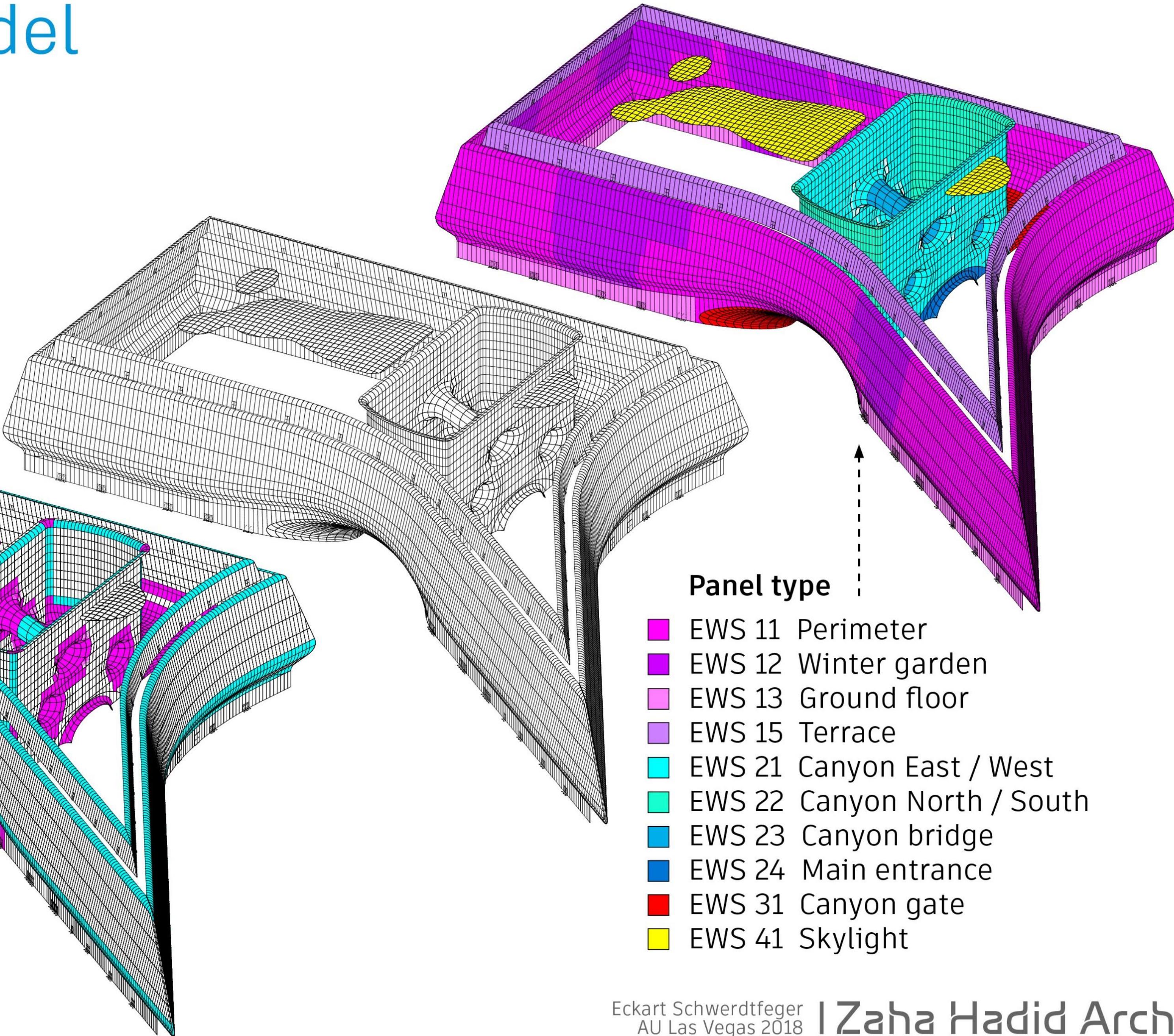
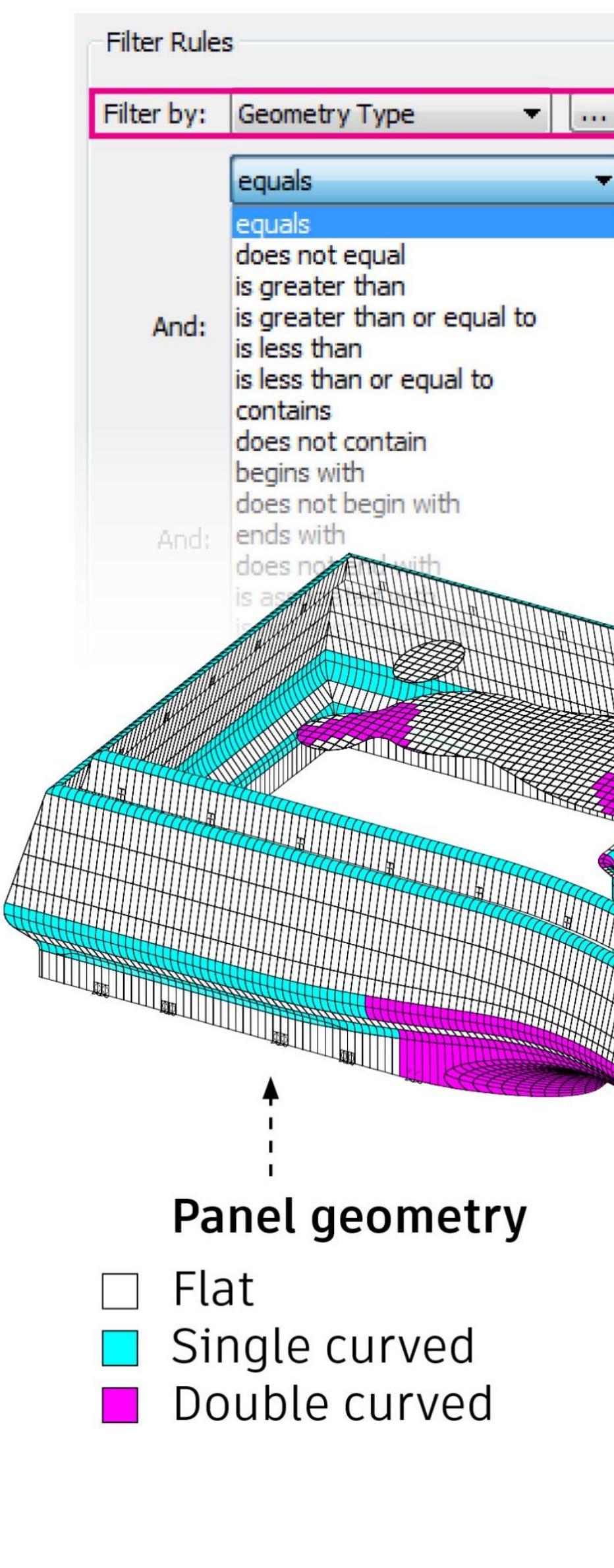
Model Categories Annotation Categories Analytical Model Categories Imported Categories Filters Revit Links

| Name         | Visibility                          | Projection/Surface |          |              | Cut   |                          | Halftone |
|--------------|-------------------------------------|--------------------|----------|--------------|-------|--------------------------|----------|
|              |                                     | Lines              | Patterns | Transparency | Lines | Patterns                 |          |
| Param_EWS_11 | <input checked="" type="checkbox"/> |                    |          |              |       | <input type="checkbox"/> |          |
| Param_EWS_12 | <input checked="" type="checkbox"/> |                    |          |              |       | <input type="checkbox"/> |          |
| Param_EWS_13 | <input checked="" type="checkbox"/> |                    |          |              |       | <input type="checkbox"/> |          |
| Param_EWS_15 | <input checked="" type="checkbox"/> |                    |          |              |       | <input type="checkbox"/> |          |
| Param_EWS_21 | <input checked="" type="checkbox"/> |                    |          |              |       | <input type="checkbox"/> |          |
| Param_EWS_22 | <input checked="" type="checkbox"/> |                    |          |              |       | <input type="checkbox"/> |          |
| Param_EWS_23 | <input checked="" type="checkbox"/> |                    |          |              |       | <input type="checkbox"/> |          |
| Param_EWS_24 | <input checked="" type="checkbox"/> |                    |          |              |       | <input type="checkbox"/> |          |
| Param_EWS_31 | <input checked="" type="checkbox"/> |                    |          |              |       | <input type="checkbox"/> |          |
| Param_EWS_41 | <input checked="" type="checkbox"/> |                    |          |              |       | <input type="checkbox"/> |          |



# Facade . BIM Model

## Filter

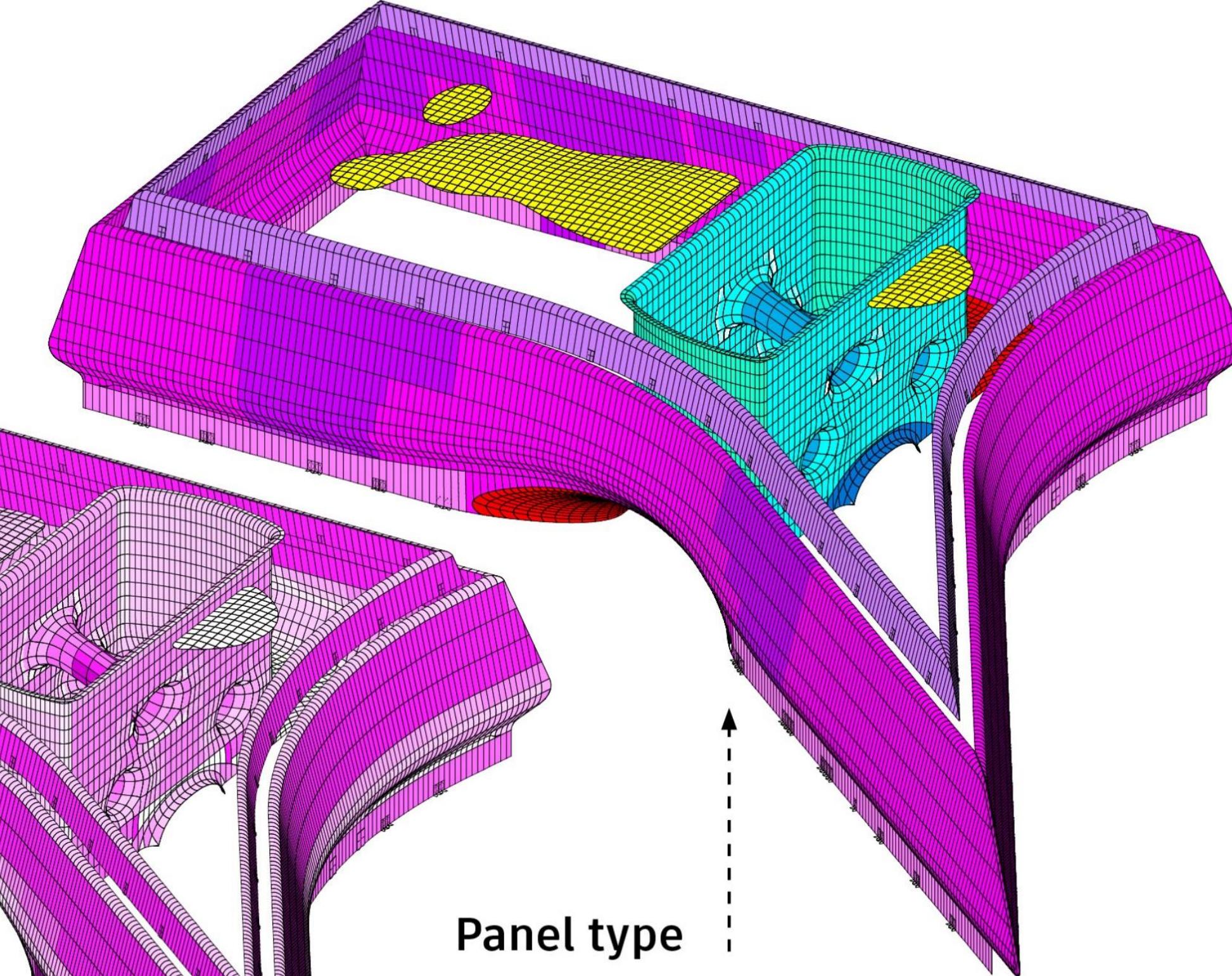
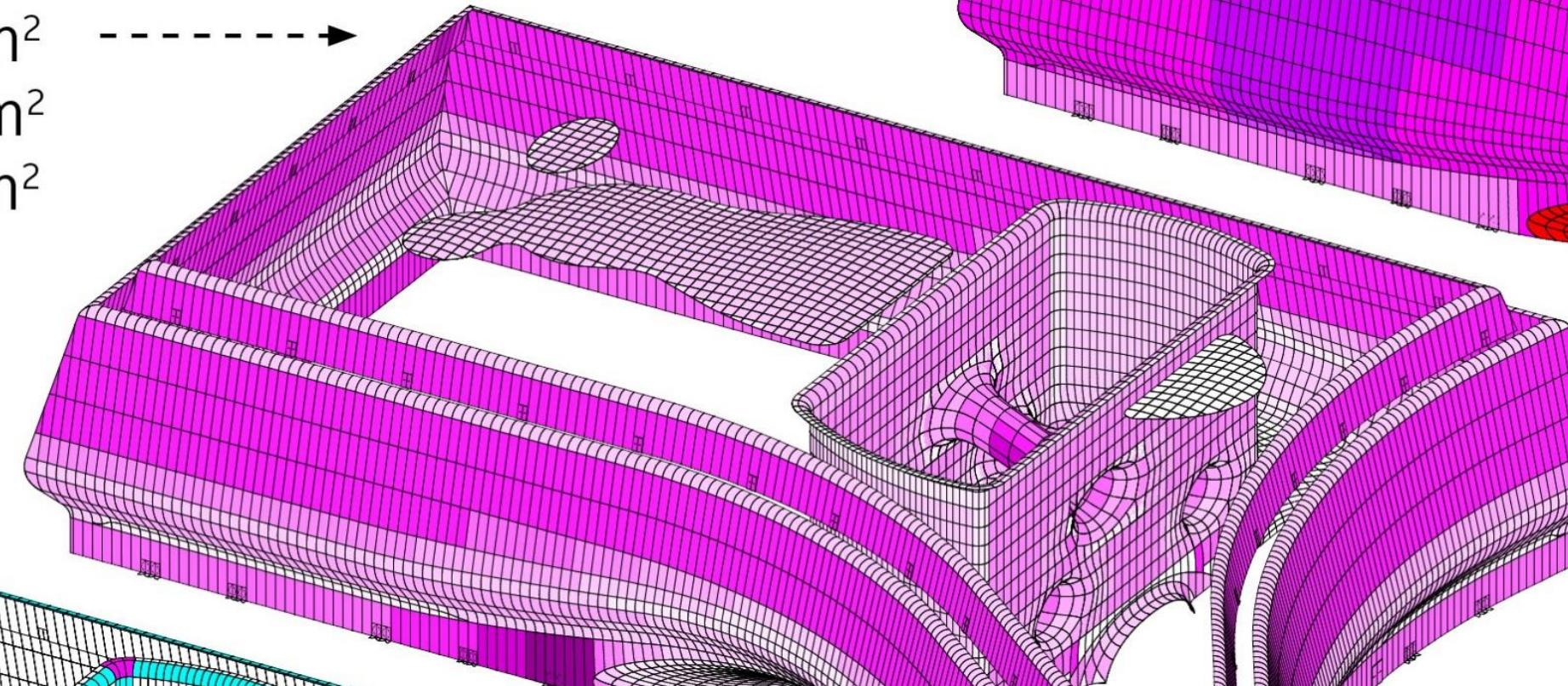


# Facade . BIM Model

## Filter

### Panel size

- 00 - 02 m<sup>2</sup>
- 02 - 04 m<sup>2</sup>
- 04 - 06 m<sup>2</sup>
- 06 - 08 m<sup>2</sup>
- 08 - 10 m<sup>2</sup>
- 10 - 12 m<sup>2</sup>
- 12 - 14 m<sup>2</sup>
- 14 - 16 m<sup>2</sup>
- 16 - m<sup>2</sup>

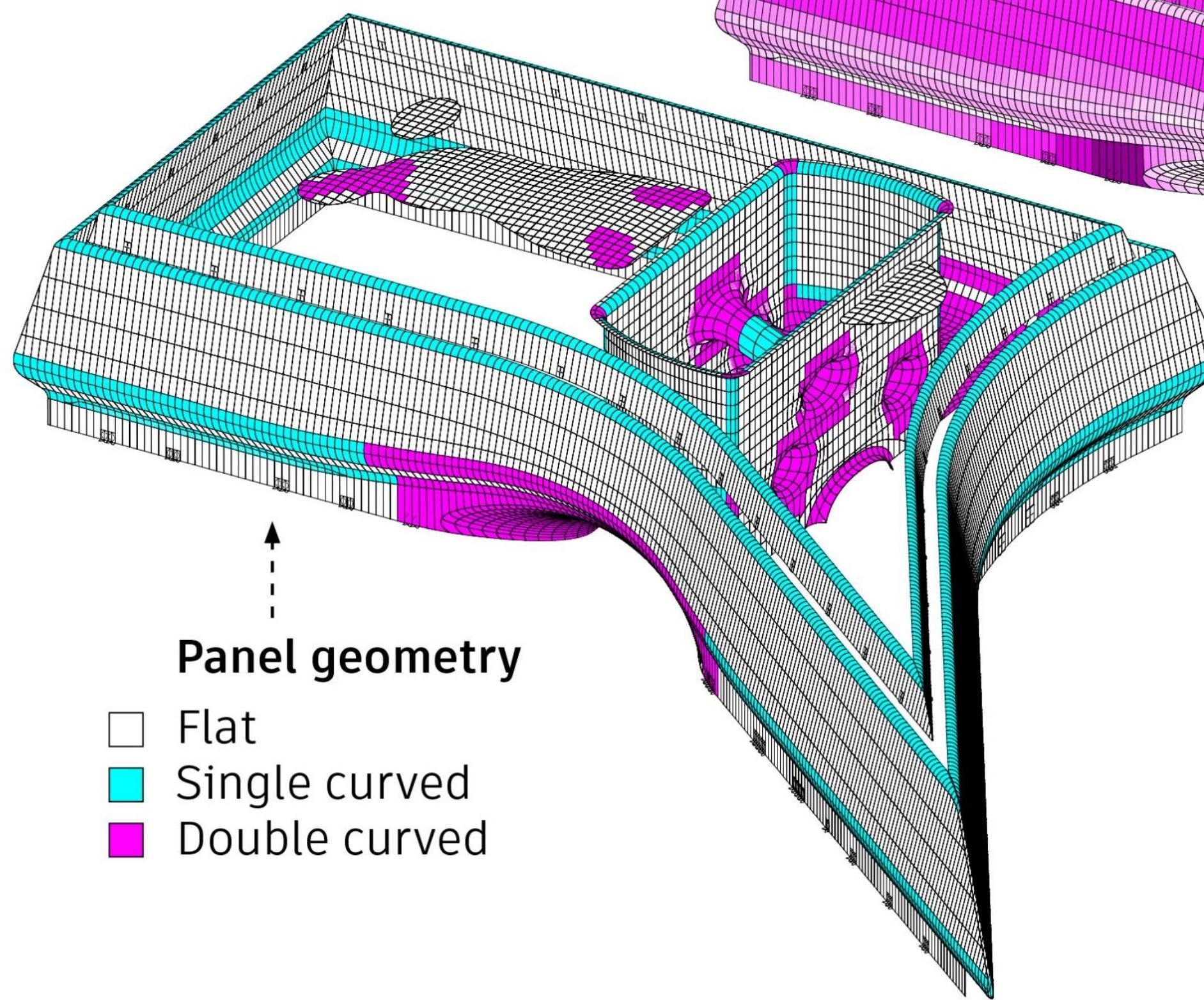


### Panel type

- EWS 11 Perimeter
- EWS 12 Winter garden
- EWS 13 Ground floor
- EWS 15 Terrace
- EWS 21 Canyon East / West
- EWS 22 Canyon North / South
- EWS 23 Canyon bridge
- EWS 24 Main entrance
- EWS 31 Canyon gate
- EWS 41 Skylight

### Panel geometry

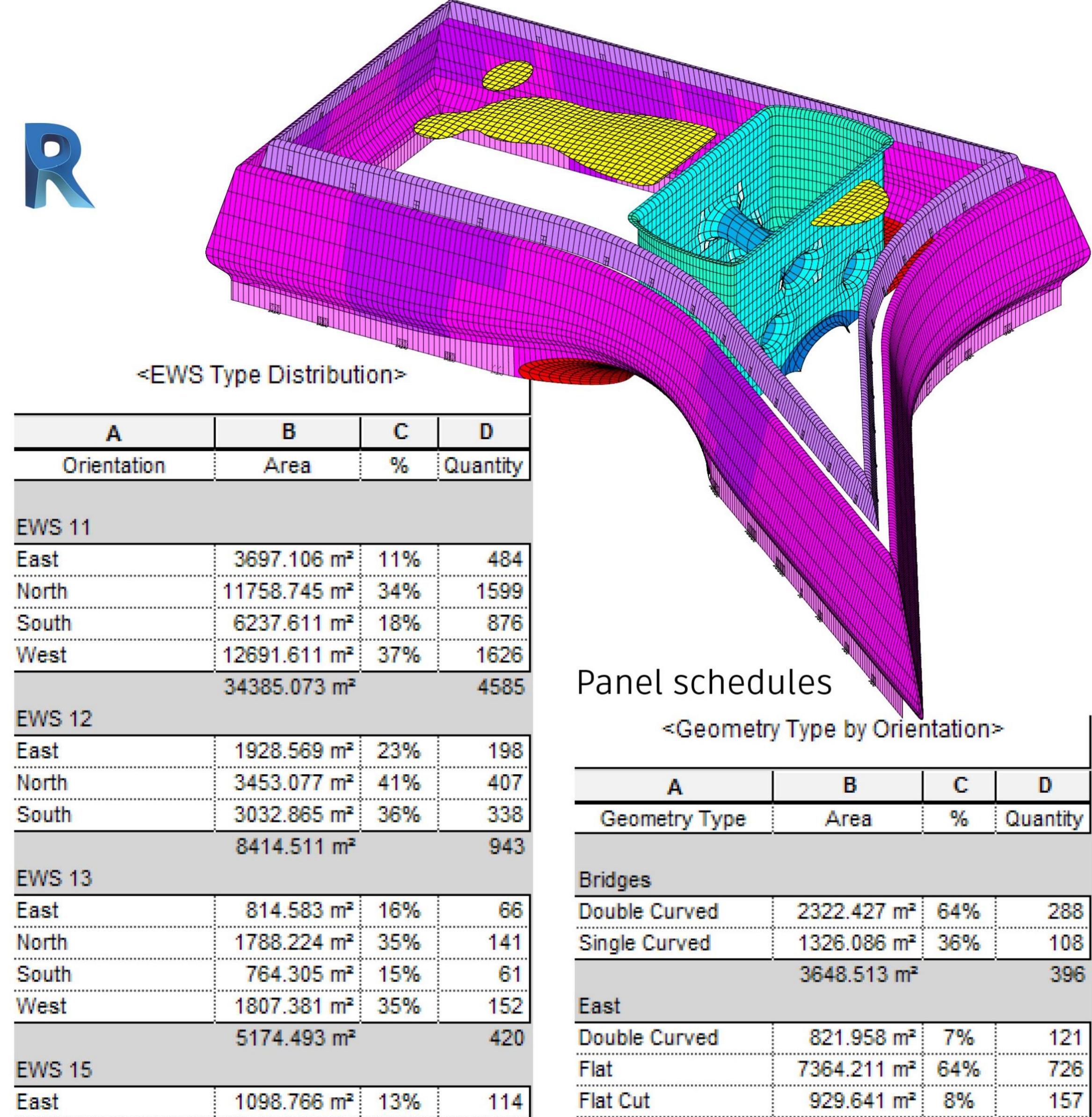
- Flat
- Single curved
- Double curved



# Facade . BIM Model

## Building information

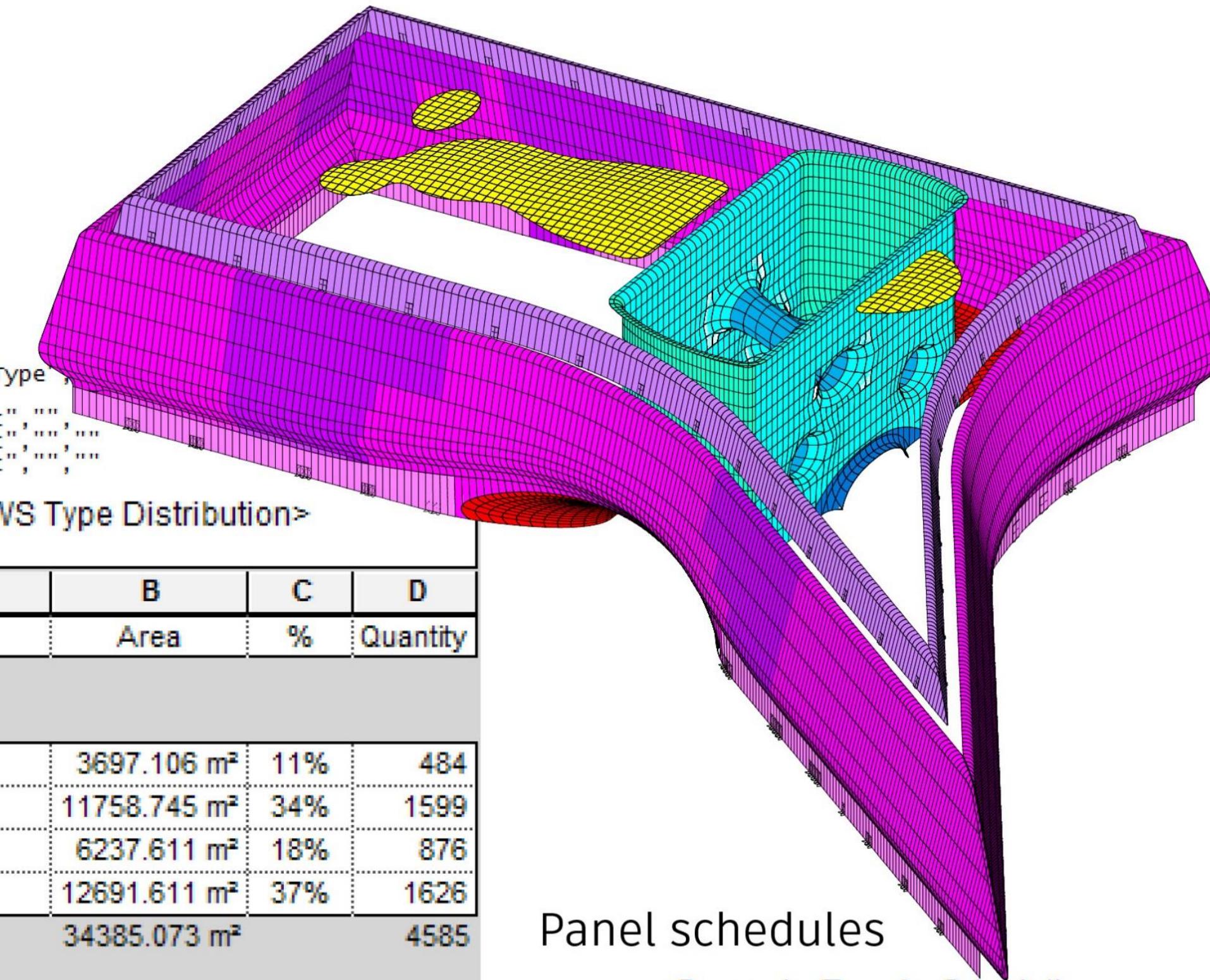
- Meta data + custom parameters are used to set up schedules
- Revit keeps all schedules up to date at all times
- All data can be exported for further analysis + visualisation



# Facade . BIM Model



← - - -



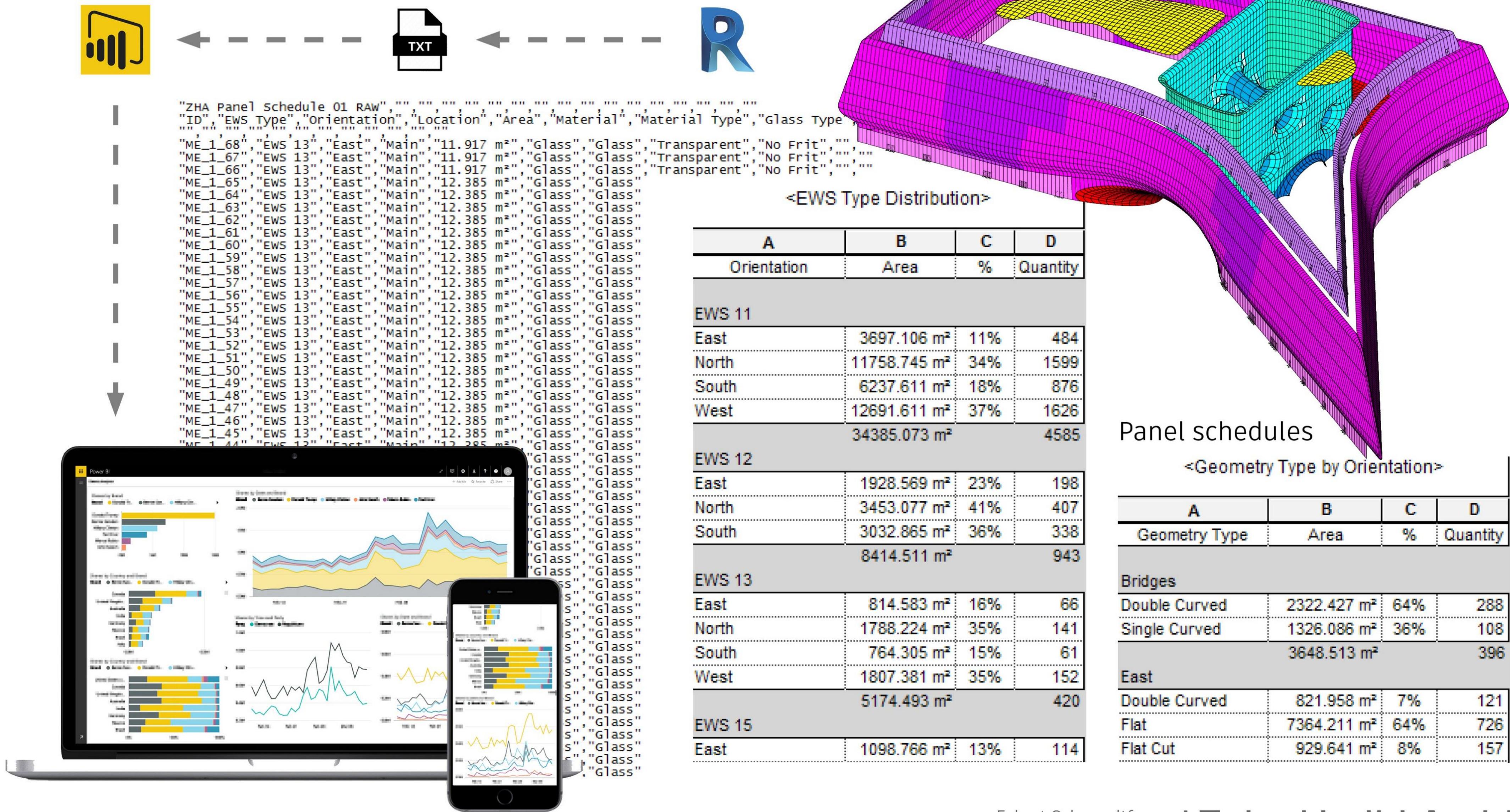
## Panel schedules

### <Geometry Type by Orientation:

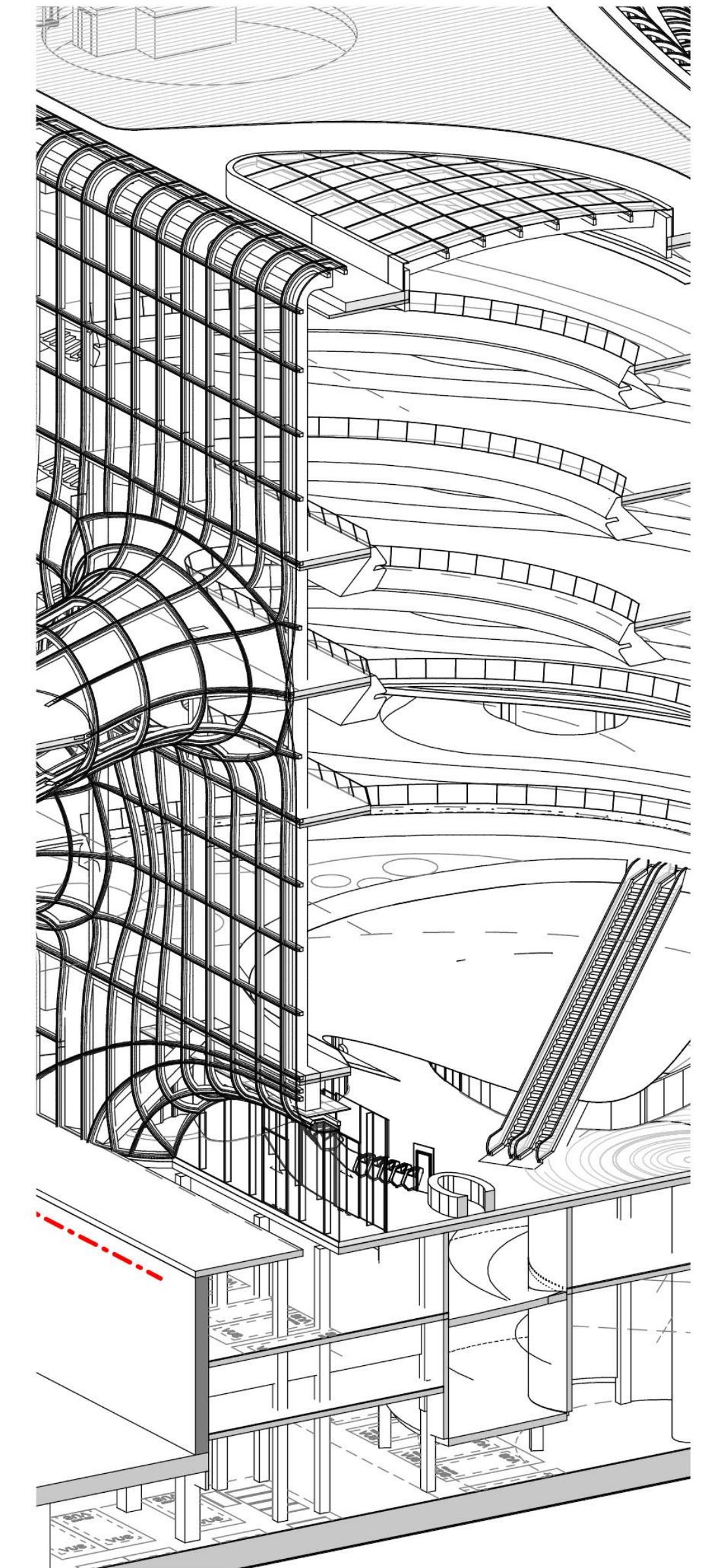
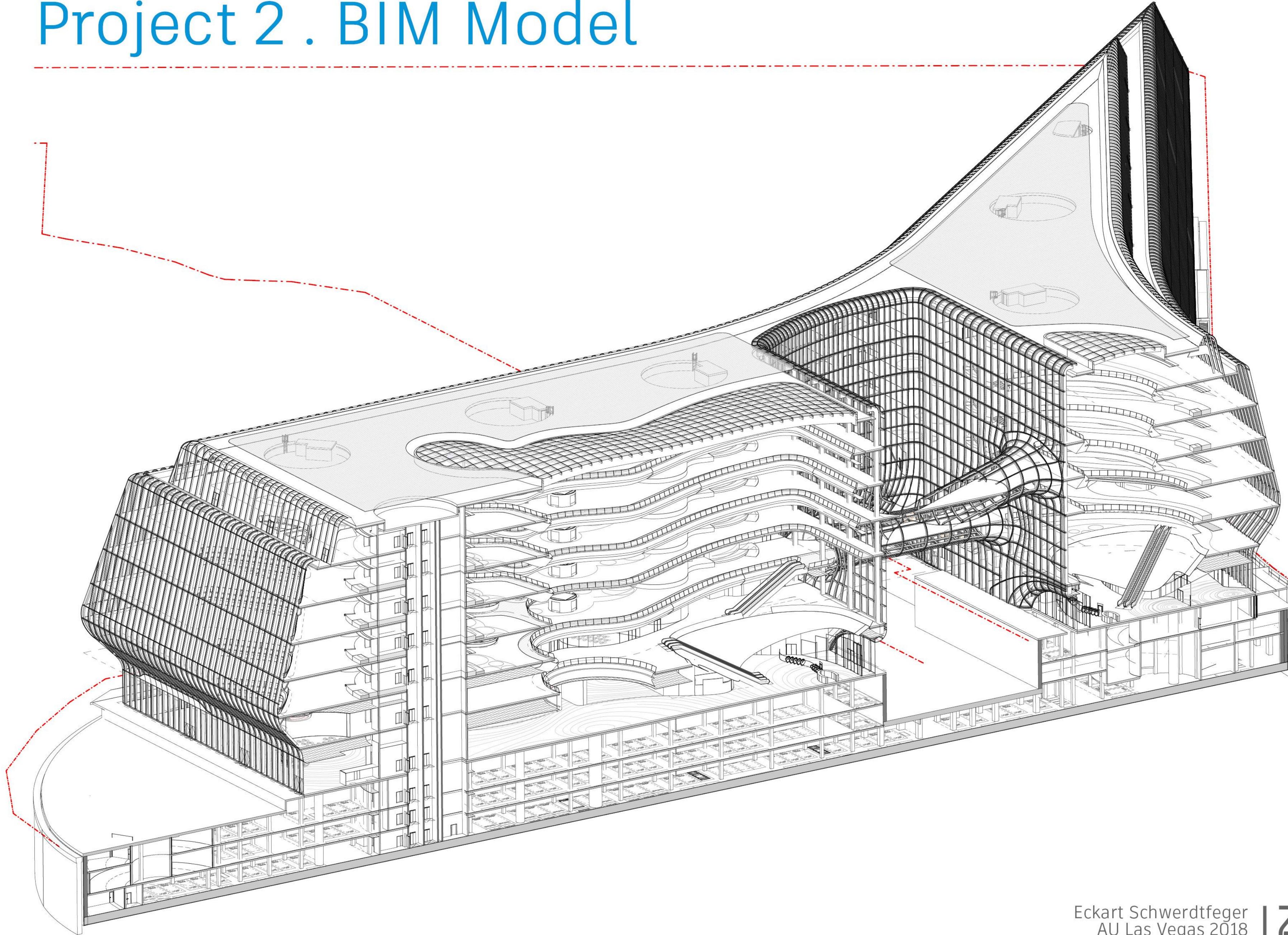
| A             | B                        | C   | D        |
|---------------|--------------------------|-----|----------|
| Orientation   | Area                     | %   | Quantity |
| <b>EWS 11</b> |                          |     |          |
| East          | 3697.106 m <sup>2</sup>  | 11% | 48       |
| North         | 11758.745 m <sup>2</sup> | 34% | 159      |
| South         | 6237.611 m <sup>2</sup>  | 18% | 87       |
| West          | 12691.611 m <sup>2</sup> | 37% | 162      |
|               | 34385.073 m <sup>2</sup> |     | 458      |
| <b>EWS 12</b> |                          |     |          |
| East          | 1928.569 m <sup>2</sup>  | 23% | 19       |
| North         | 3453.077 m <sup>2</sup>  | 41% | 40       |
| South         | 3032.865 m <sup>2</sup>  | 36% | 33       |
|               | 8414.511 m <sup>2</sup>  |     | 94       |
| <b>EWS 13</b> |                          |     |          |
| East          | 814.583 m <sup>2</sup>   | 16% | 6        |
| North         | 1788.224 m <sup>2</sup>  | 35% | 14       |
| South         | 764.305 m <sup>2</sup>   | 15% | 6        |
| West          | 1807.381 m <sup>2</sup>  | 35% | 15       |
|               | 5174.493 m <sup>2</sup>  |     | 42       |
| <b>EWS 15</b> |                          |     |          |
| East          | 1098.766 m <sup>2</sup>  | 13% | 11       |

| A              | B                             | C   | D         |
|----------------|-------------------------------|-----|-----------|
| Geometry Type  | Area                          | %   | Quantity  |
| <b>Bridges</b> |                               |     |           |
| Double Curved  | 2322.427 m <sup>2</sup>       | 64% | 28        |
| Single Curved  | 1326.086 m <sup>2</sup>       | 36% | 10        |
|                | <b>3648.513 m<sup>2</sup></b> |     | <b>39</b> |
| <b>East</b>    |                               |     |           |
| Double Curved  | 821.958 m <sup>2</sup>        | 7%  | 12        |
| Flat           | 7364.211 m <sup>2</sup>       | 64% | 72        |
| Flat Cut       | 929.641 m <sup>2</sup>        | 8%  | 15        |

# Facade . BIM Model



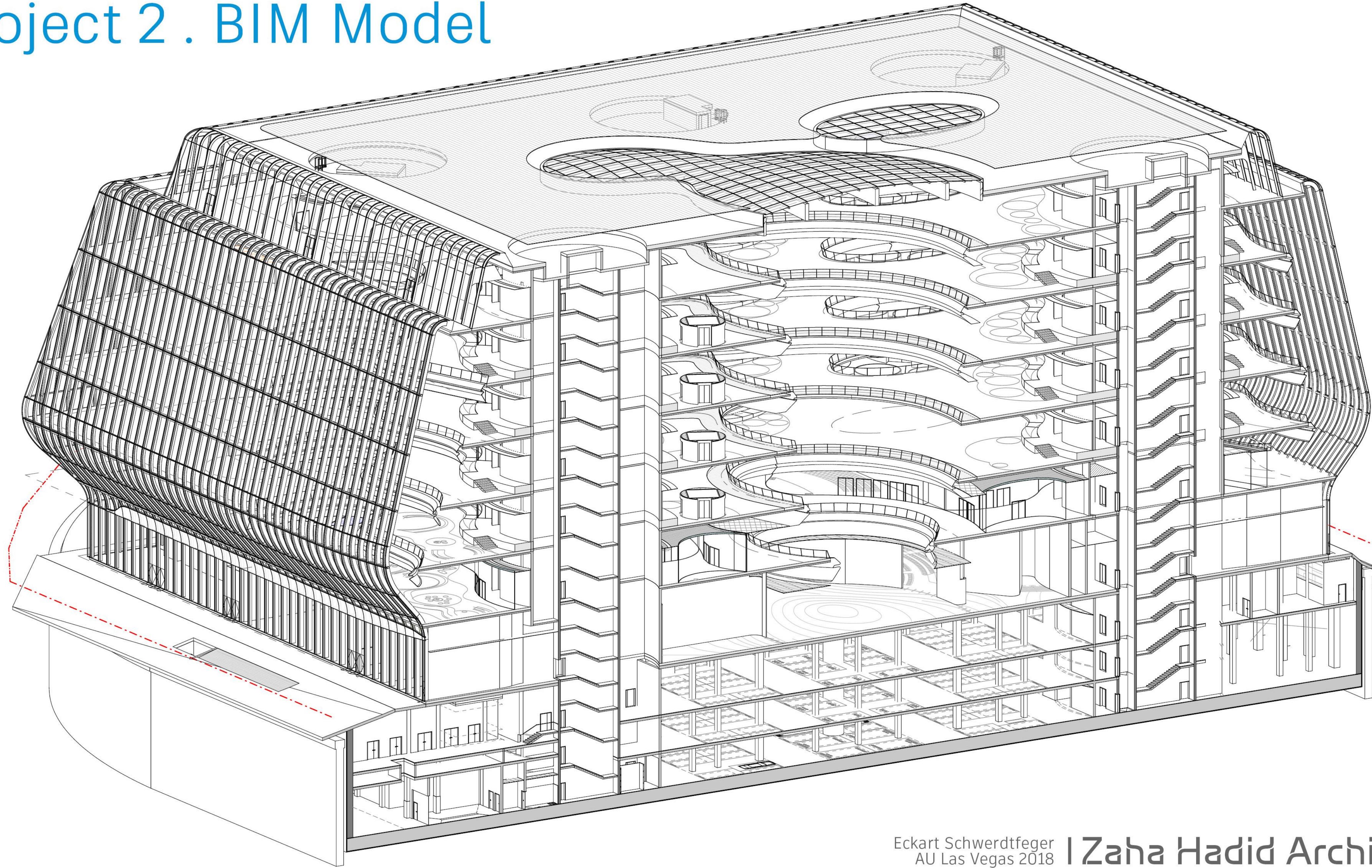
# Project 2 . BIM Model



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# Project 2 . BIM Model



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