Custom Computational Workflows for BIM Design Implementation

Eckart Schwerdtfeger

Zaha Hadid Architects

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AUTODESK UNIVERSITY

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Introduction

INTRODUCTION . SPEAKER

ETFE MEMBRANE FACADE
UNILEVER GERMANY HQ
BEHNISCH ARCHITECTS

ECKART SCHWERDTFEGER IS AN ARCHITECT WITH 12 YEARS OF EXPERIENCE IN ALL PROJECT PHASES AND WORKING ON LARGE-SCALE, HIGH-PROFILE INTERNATIONAL PROJECTS IN EUROPE, RUSSIA, CHINA AND THE MIDDLE EAST. PRIOR TO HIS TIME AT ZAHA HADID ARCHITECTS HE WORKED FOR LAVA, COOP HIMMELB(L)AU AND BEHNISCH ARCHITECTS. DURING THIS TIME, HE PARAMETRICALLY DESIGNED, OPTIMIZED AND IMPLEMENTED SEVERAL REMARKABLE FACADES. HE WORKED AS COMPUTATIONAL DESIGNER, BIM MANAGER AND PROGRAMMER OF CUSTOM SOFTWARE AND TOOLS.

CURRENTLY, ECKART IS BIM LEAD 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, OPTIMIZE AND AUTOMATE BIM AND CROSS-APPLICATION TASKS AND TO ENABLE THE DESIGN TEAM TO CONTRIBUTE TO THE BIM MODELS MORE DIRECTLY AND FLUENTLY.

INTRODUCTION . GOALS

MORE DIRECT + FLUENT CROSS APPLICATION WORKFLOW FROM DESIGN TO BIM

- BE ABLE TO USE CONTENT CREATED IN 3RD PARTY SOFTWARE
- PREVENT DUPLICATED WORK

AUTOMATE AND PARAMETRISE AS MUCH AS POSSIBLE

- ENABLE + ACCELERATE CREATION OF DESIGN ITERATIONS AND IMPLEMENTATION OF CHANGES
- SAVE TIME SPENT ON REPETITIVE TASKS

CUSTOM ...

- SOFTWARE / PLUGINS
- SCRIPTS / MACROS
- BIM ELEMENTS

INTRODUCTION . PROCESS

ZHA BIM
FOR RHINO + REVIT

DESIGN MODEL

BIM + DOCUMENTATION MODEL

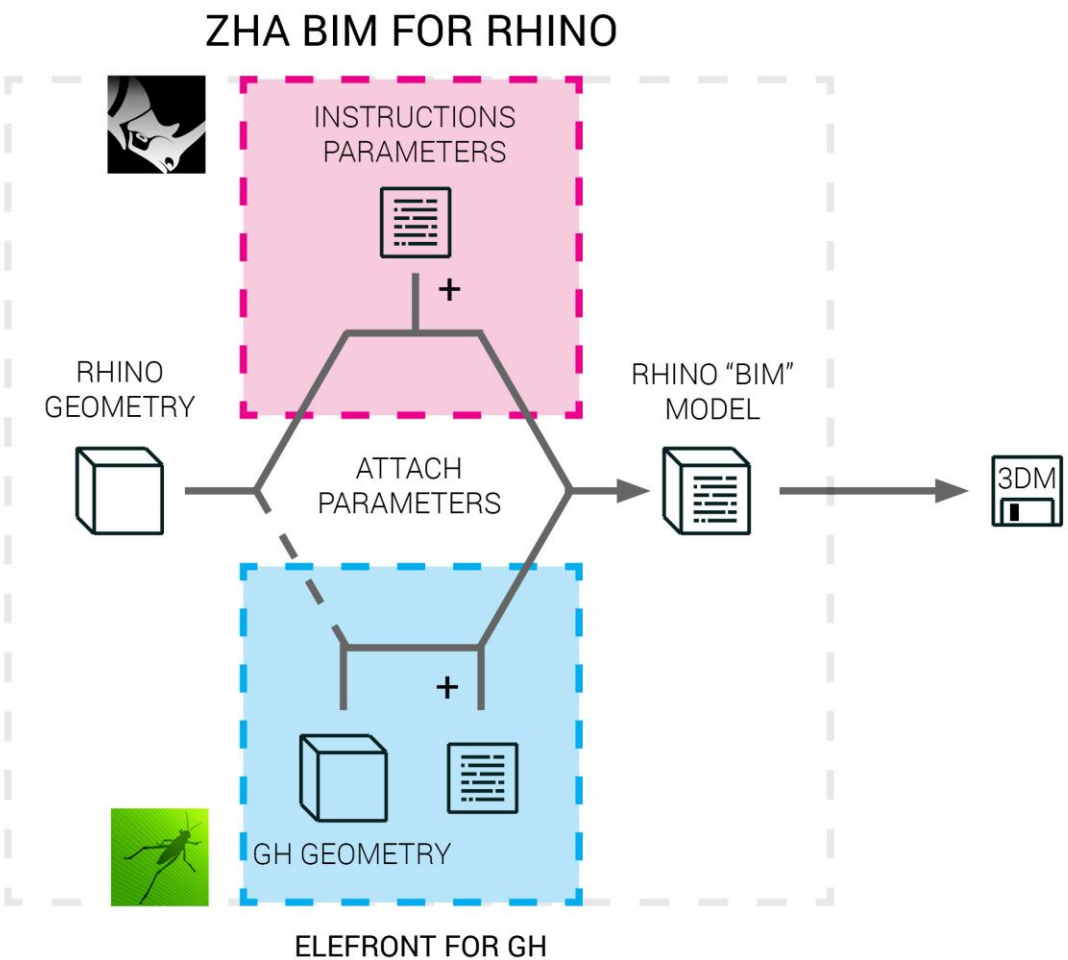
TO TRANSFER AN ELEMENT CROSS-APPLICATION WE NEED

GEOMETRY
OF ELEMENT OR IT'S UNDERLYING GEOMETRY

INSTRUCTIONS
FOR TRANSFER PROCESS AND TARGETED SOFTWARE

BUILDING ELEMENT INFORMATION
PARAMETERS, DATA [OPTIONAL]

INTRODUCTION . PROCESS



TO TRANSFER AN ELEMENT
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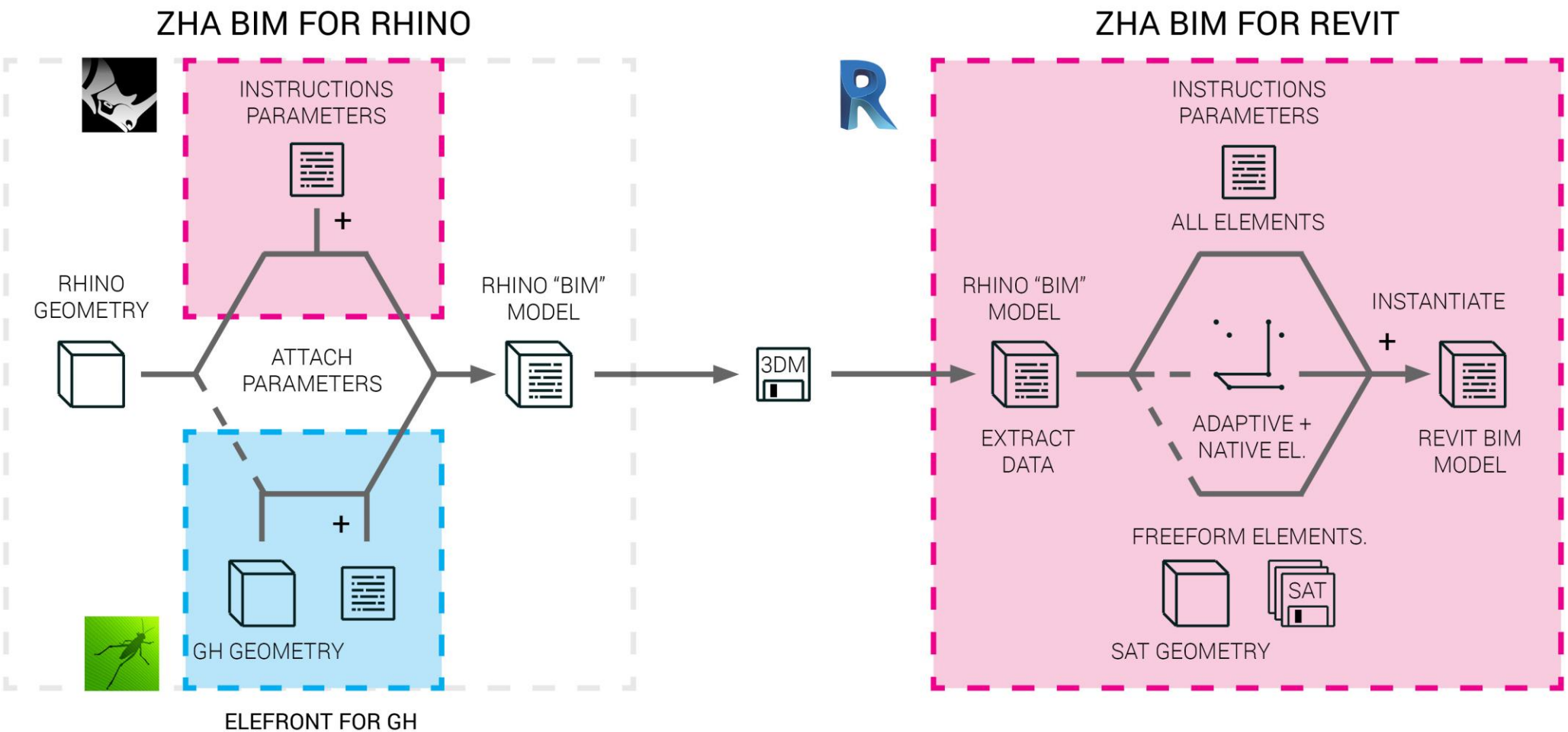
BUILDING ELEMENT INFORMATION
PARAMETERS, DATA
[OPTIONAL]

INTRODUCTION . PROCESS



Project 1

PROJECT 1

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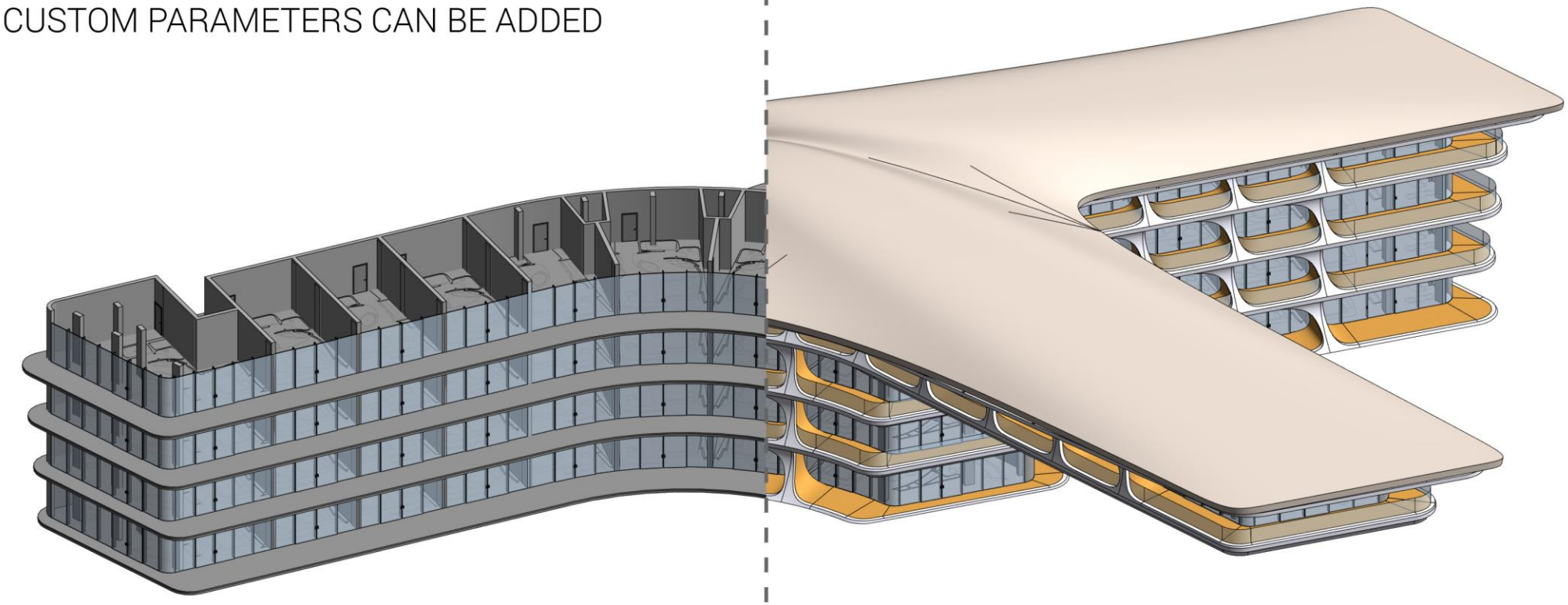
Native Elements

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 [SIMILAR TO CAD]
- MANUAL PICKING OF EXISTING CAD LINES
- AUTOMATED CUSTOM WORKFLOW

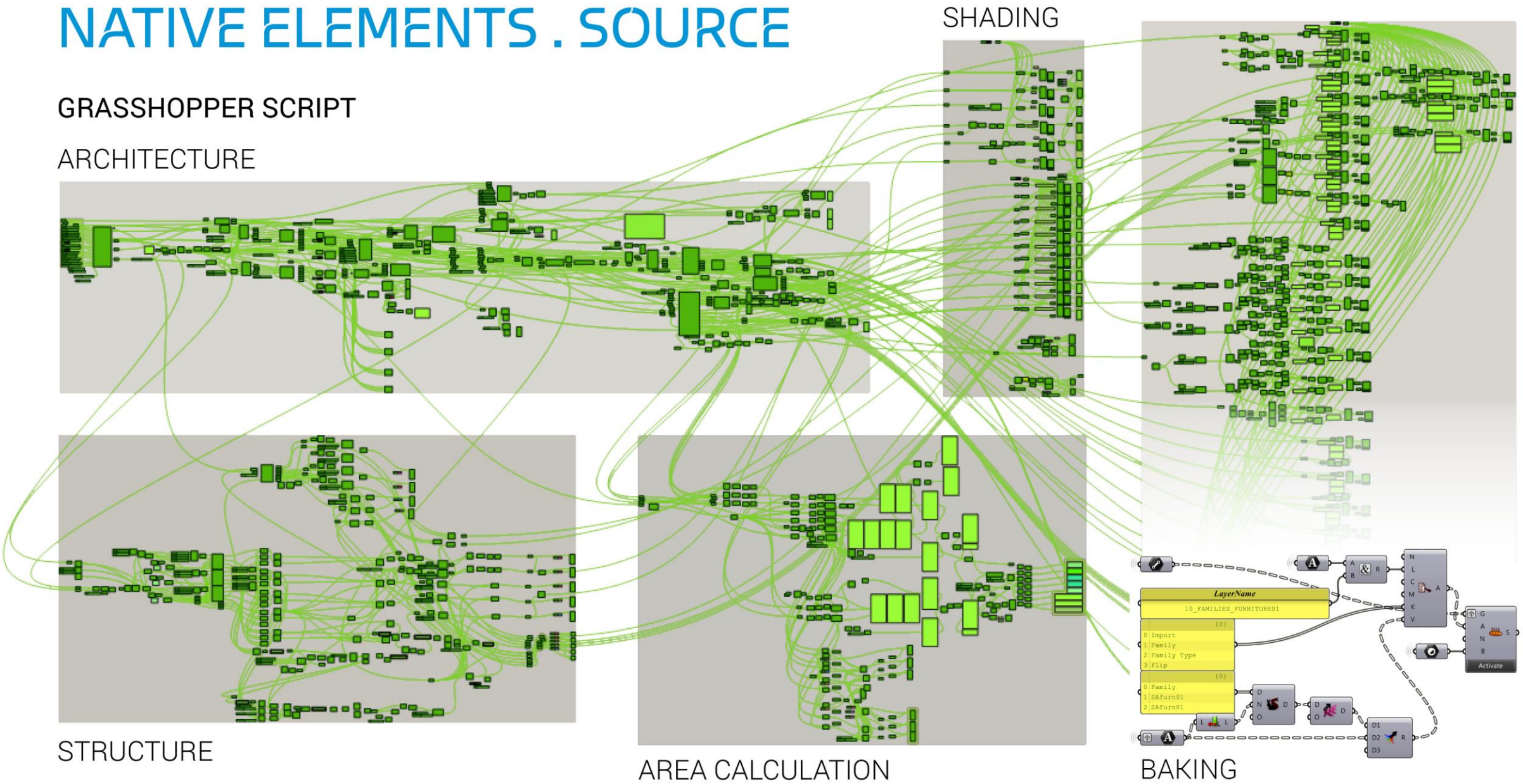


NATIVE ELEMENTS

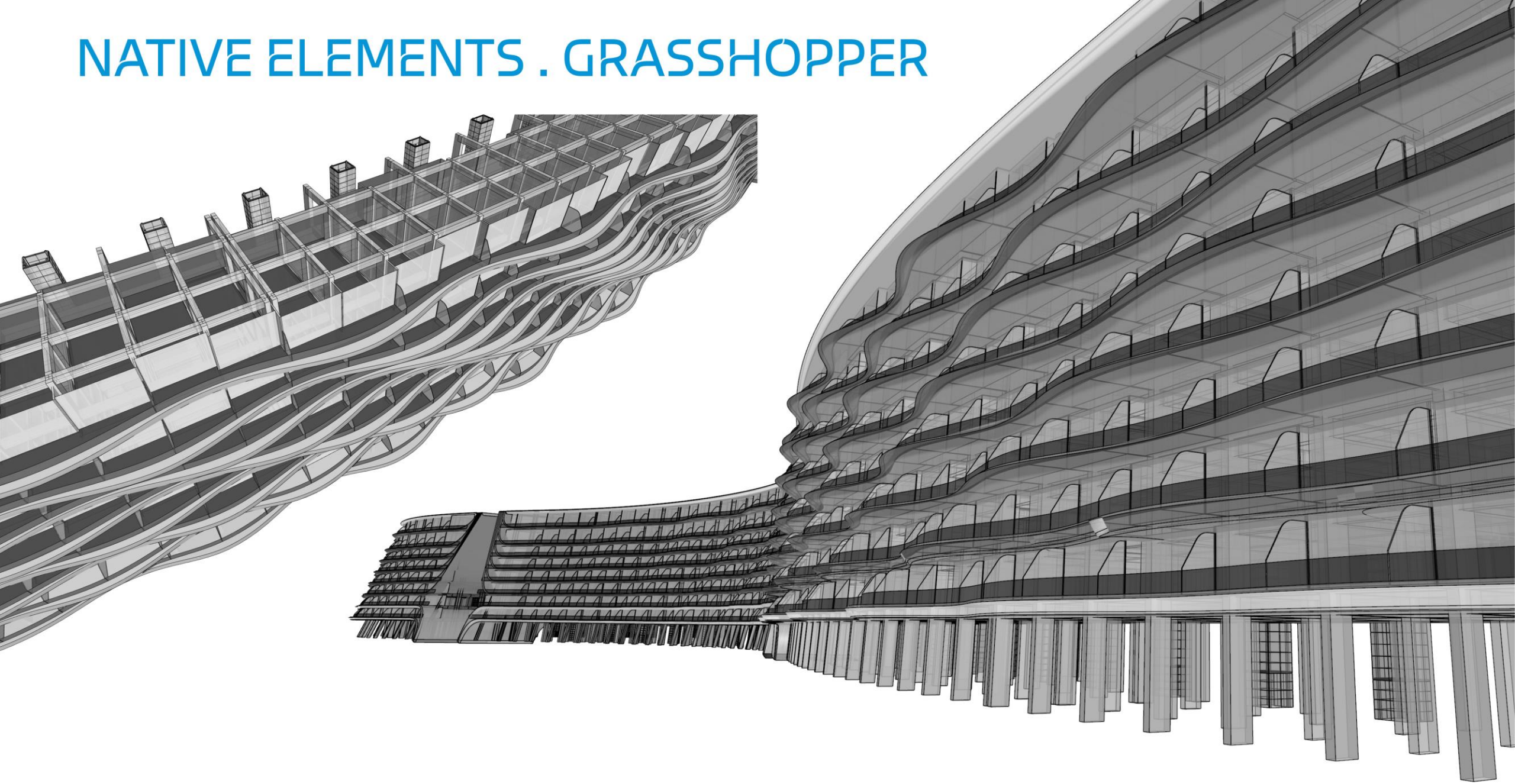
190 **FLOORS**
5760 **WALLS**
4000 **DOORS**
1725 **FURNITURE BLOCKS**
940 **APARTMENTS**
2925 **TEXT TAGS**
ETC.

NATIVE ELEMENTS . SOURCE

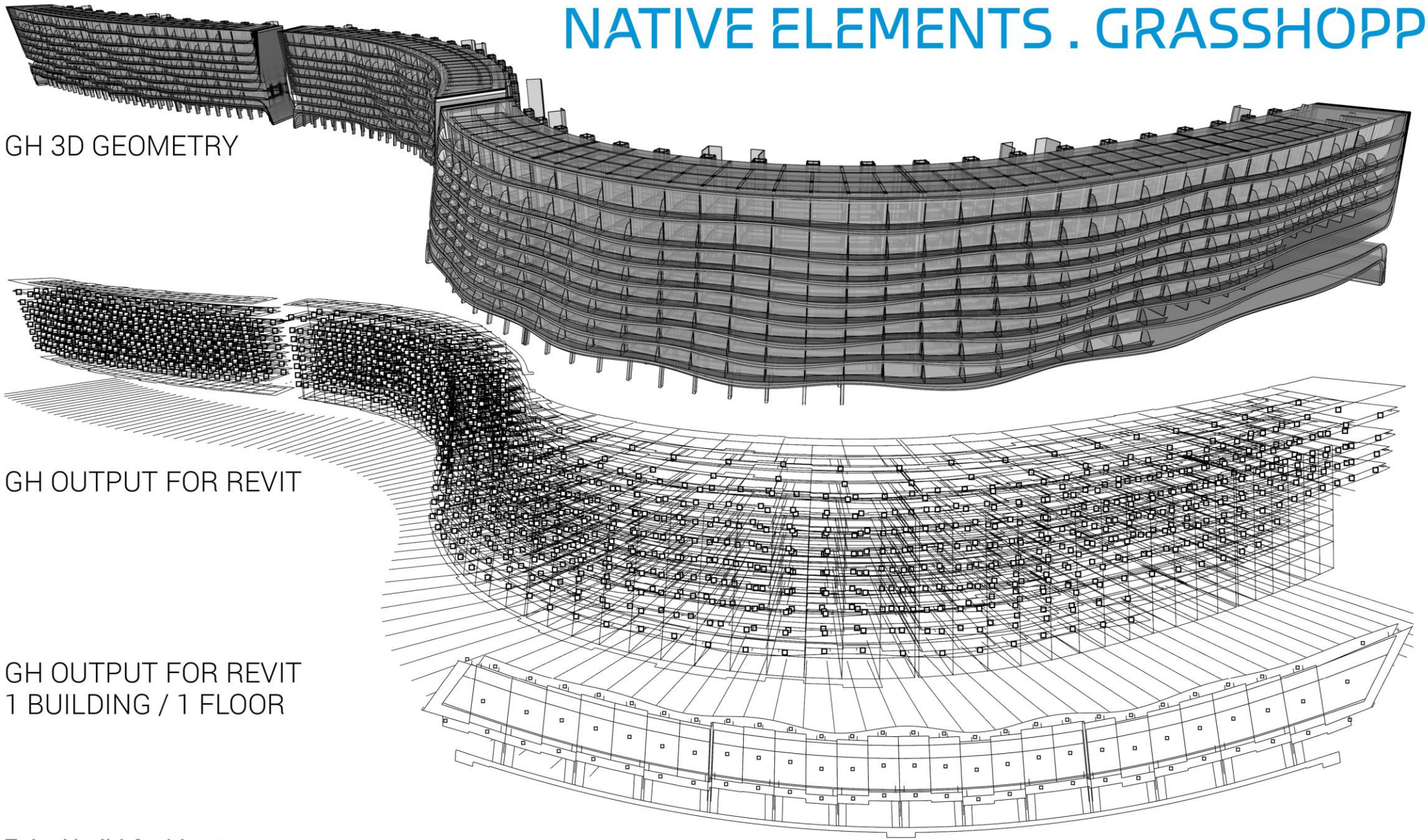
GRASSHOPPER SCRIPT



NATIVE ELEMENTS . GRASSHOPPER



NATIVE ELEMENTS . GRASSHOPPER



File Edit View Curve Surface Solid Mesh Dimension Transform Tools Analyze Render Panels Paneling Tools T-Splines VisualARQ Help

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	

Rhinoceros

ZHA BIM

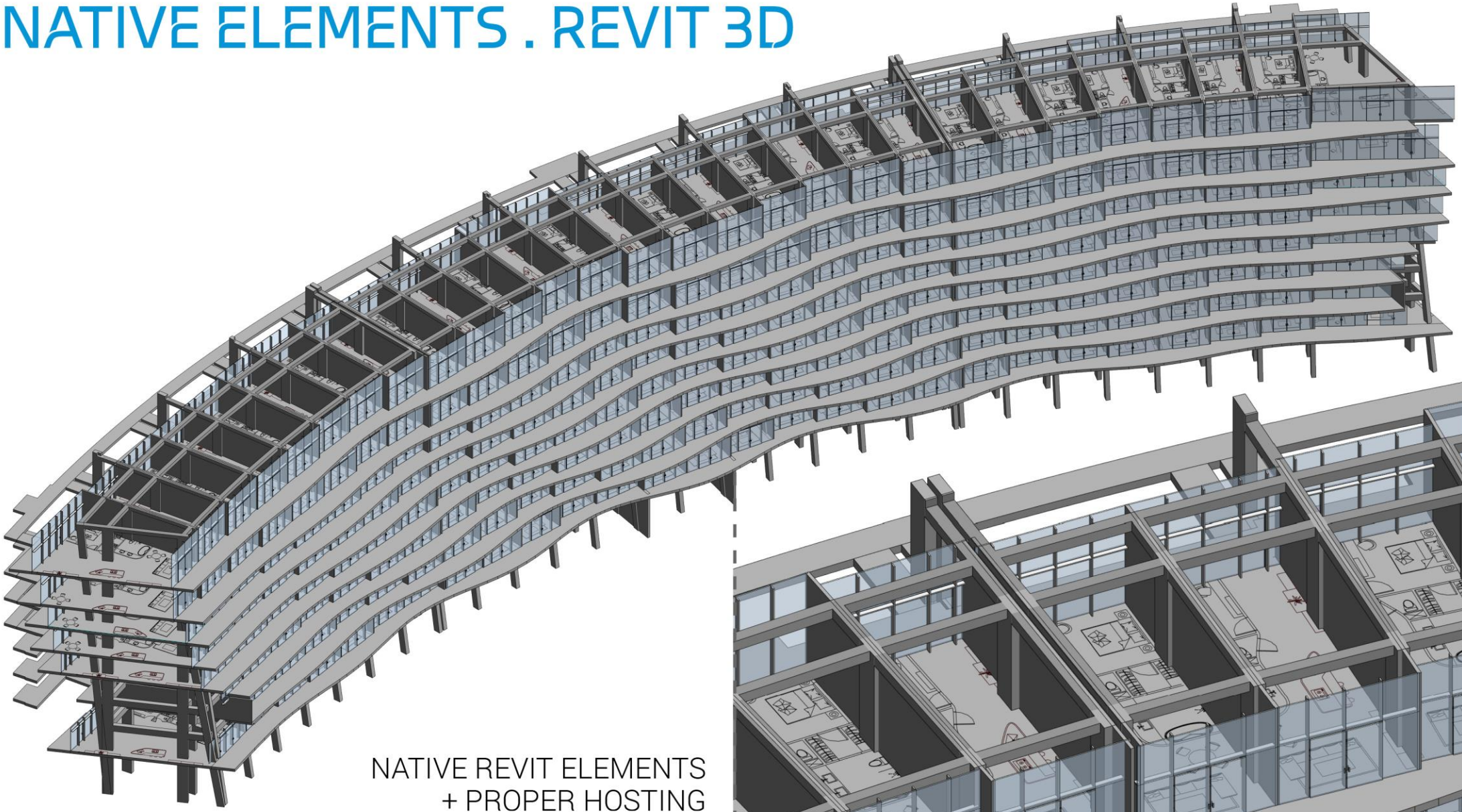
OFF PROJECT:

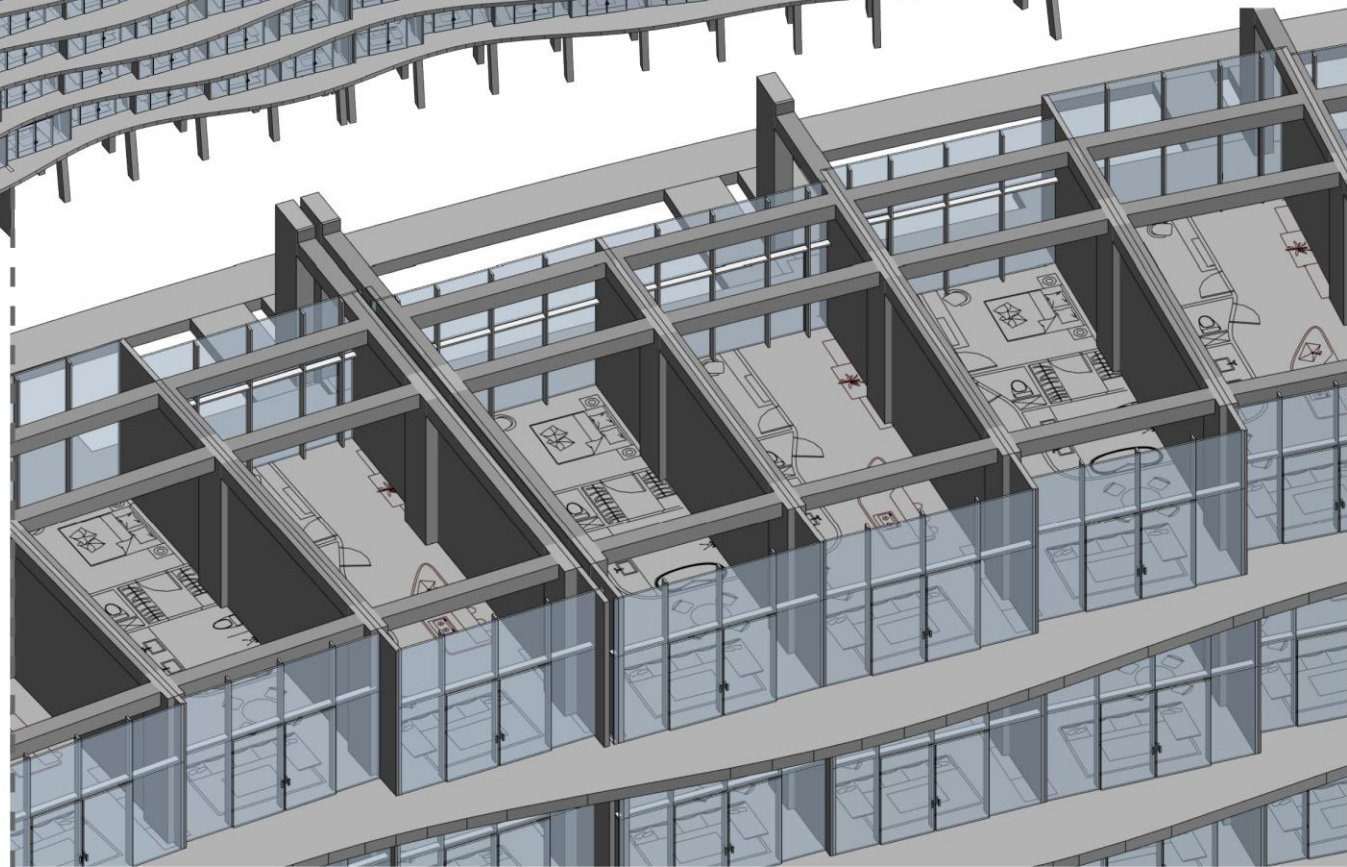
PARAMETER SET: Extended

A / V L X F

BIM Parameters

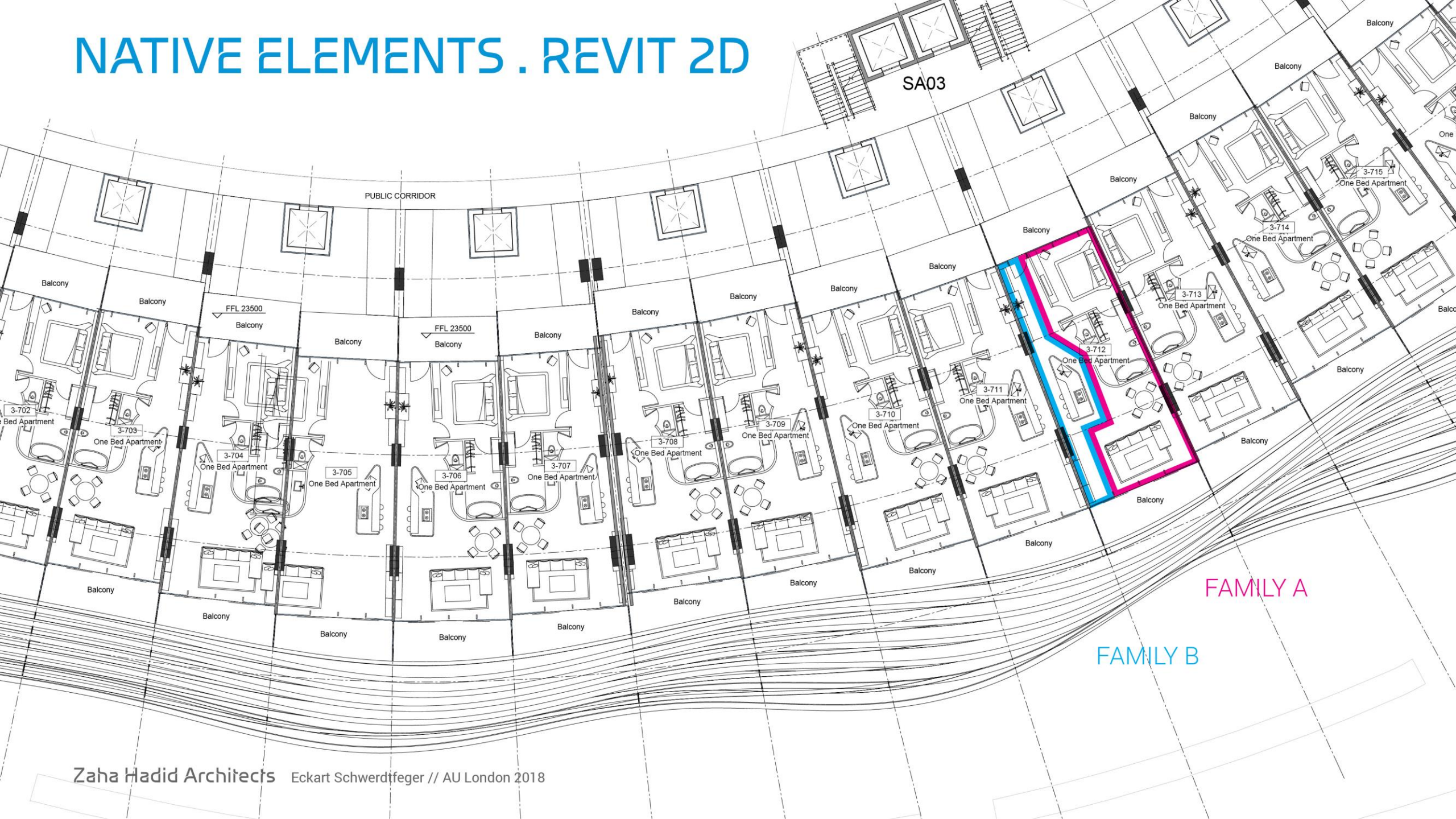
NATIVE ELEMENTS . REVIT 3D



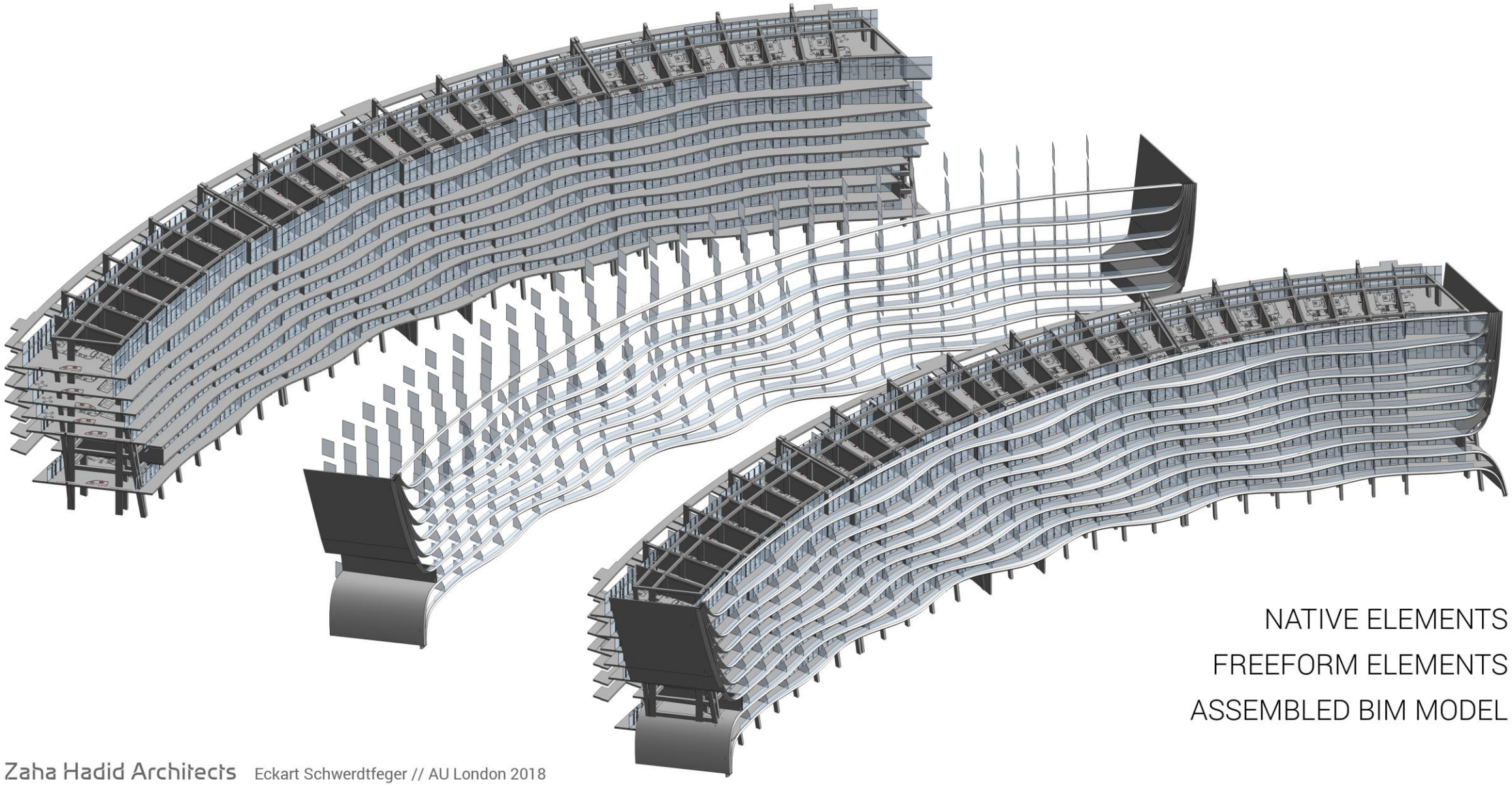


NATIVE REVIT ELEMENTS
+ PROPER HOSTING

NATIVE ELEMENTS . REVIT 2D



NATIVE ELEMENTS . REVIT



NATIVE ELEMENTS

FREEFORM ELEMENTS

ASSEMBLED BIM MODEL

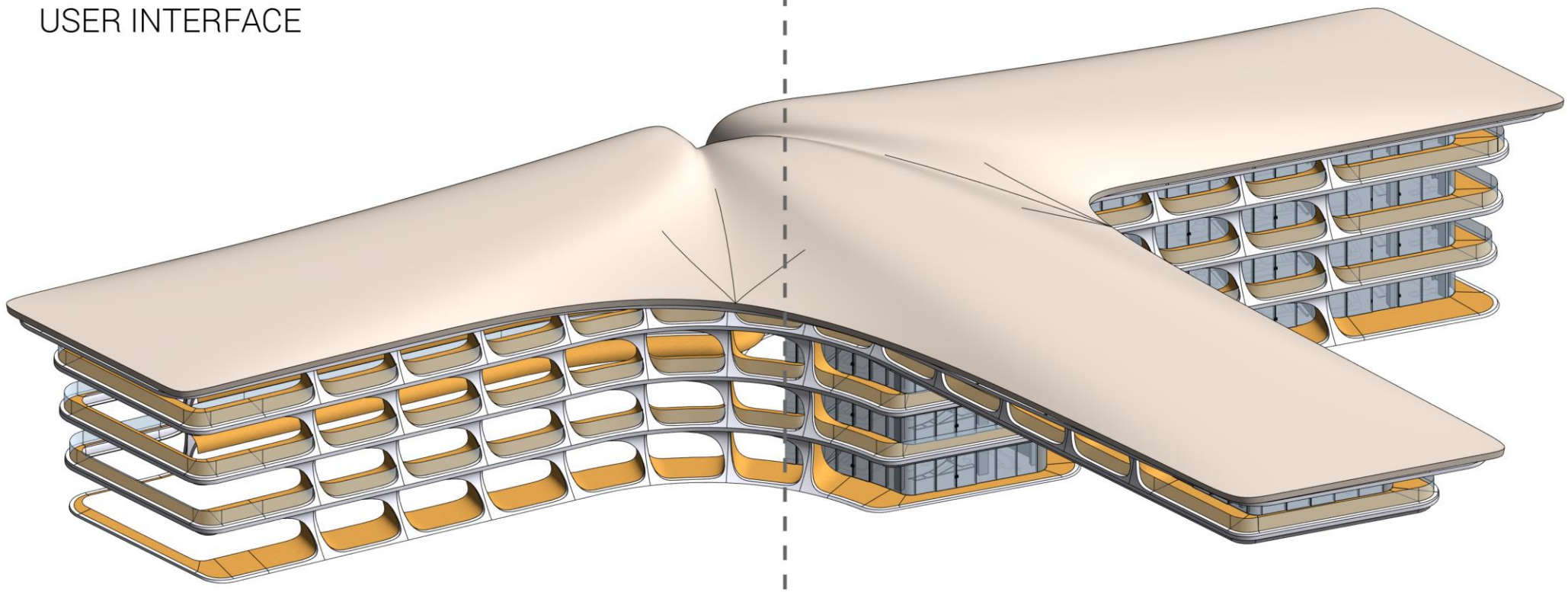
Freeform Elements

FREEFORM ELEMENTS

- E.G. SCULPTED ROOF, FACADE / BALCONY CLADDING, BALUSTRADES, ETC.
- FREEFORM GEOMETRY NOT SUPPORTED BY PRESET BUILDING ELEMENTS
- NOT ALL FEATURES ACCESSIBLE BY REVIT USER INTERFACE

CREATION

- MANUAL IMPORT
  [TEDIOUS PROCESS, SLOW, LIMITATIONS]
- AUTOMATED CUSTOM WORKFLOW



FREEFORM ELEMENTS

File Edit View Curve Surface Solid Mesh Dimension Transform Tools Analyze Render Panels Paneling Tools T-Splines VisualARQ Help

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

Rhinoceros

ZHA BIM

OFF PROJECT:

PARAMETER SET: Generic

A / V L X F

BIM Parameters

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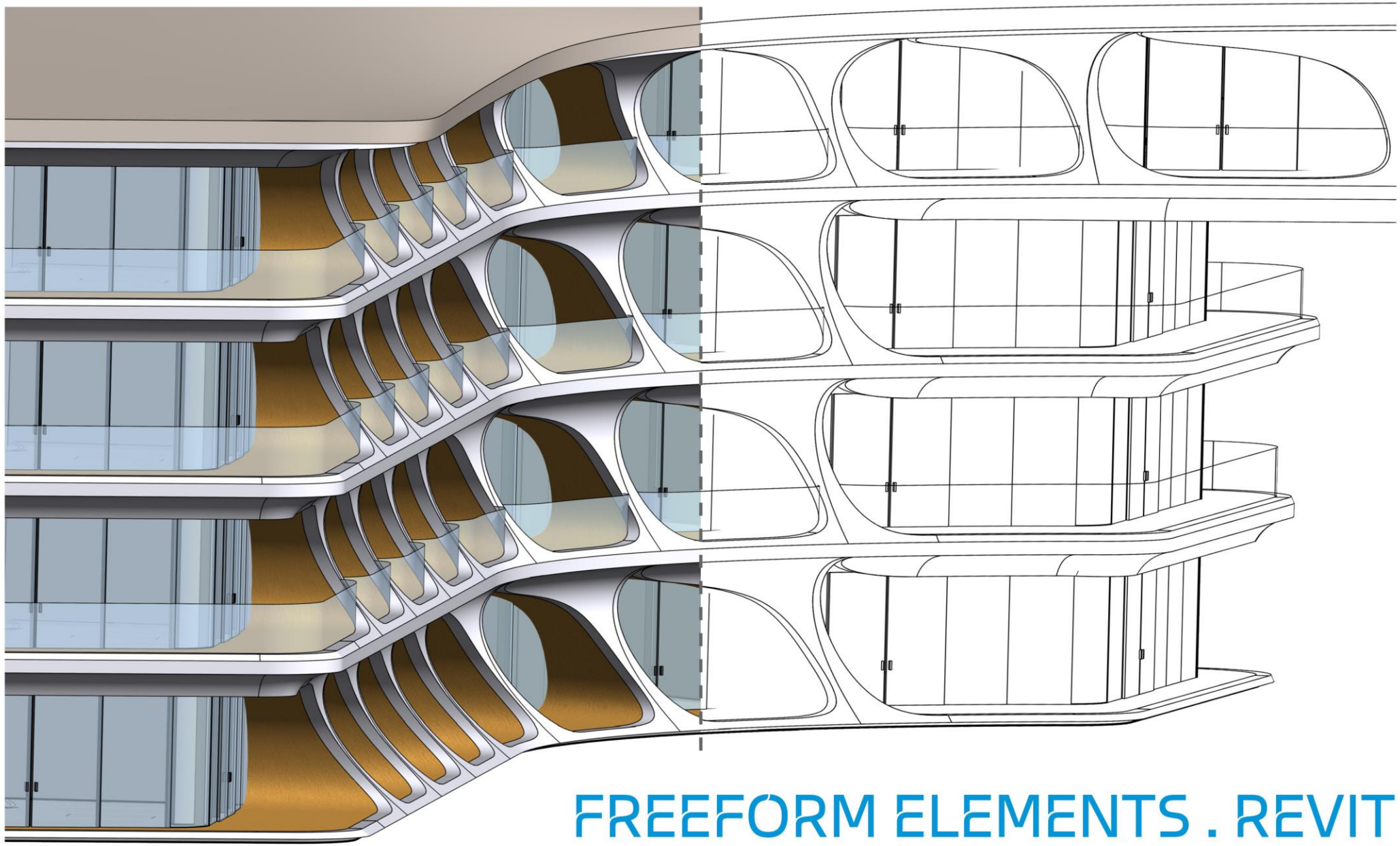
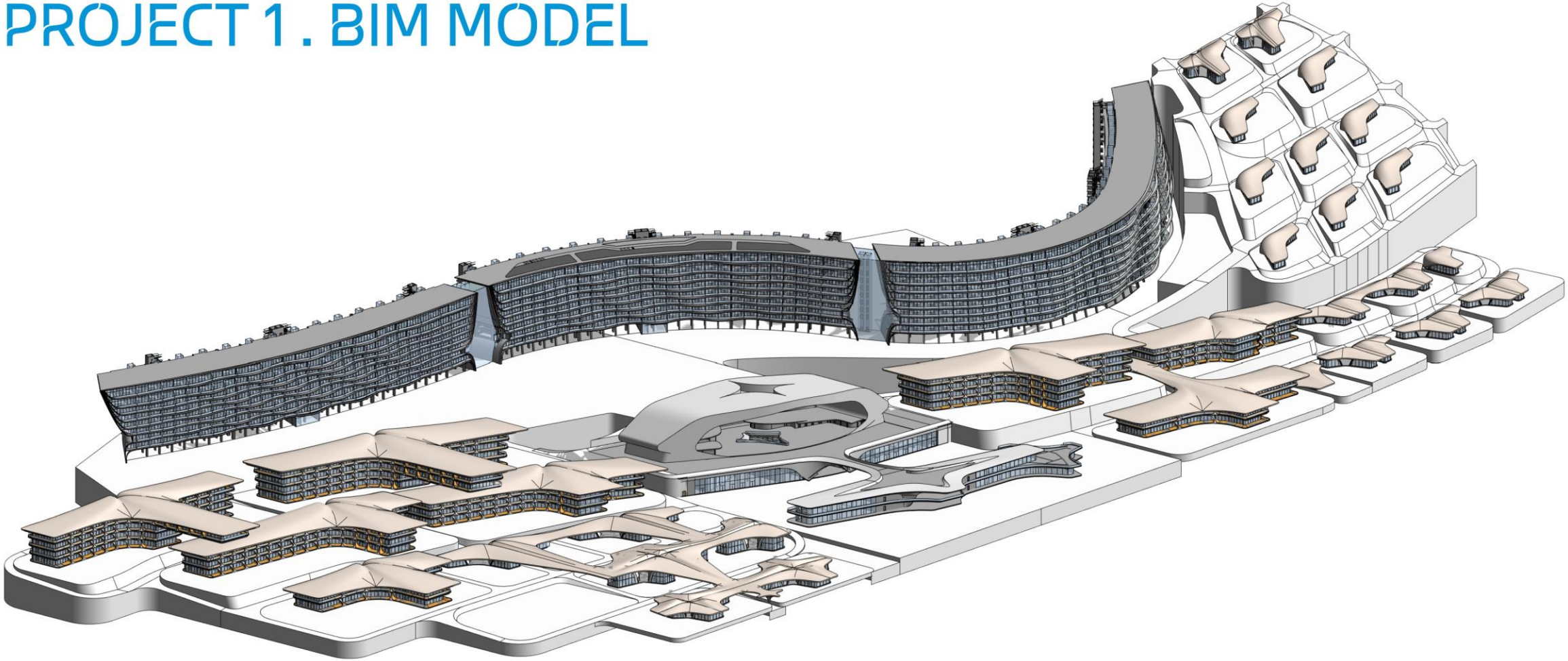
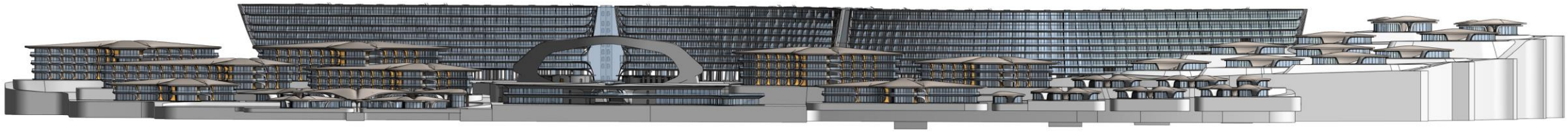


FREEFORM ELEMENTS . REVIT 3D

PROJECT 1 . BIM MODEL



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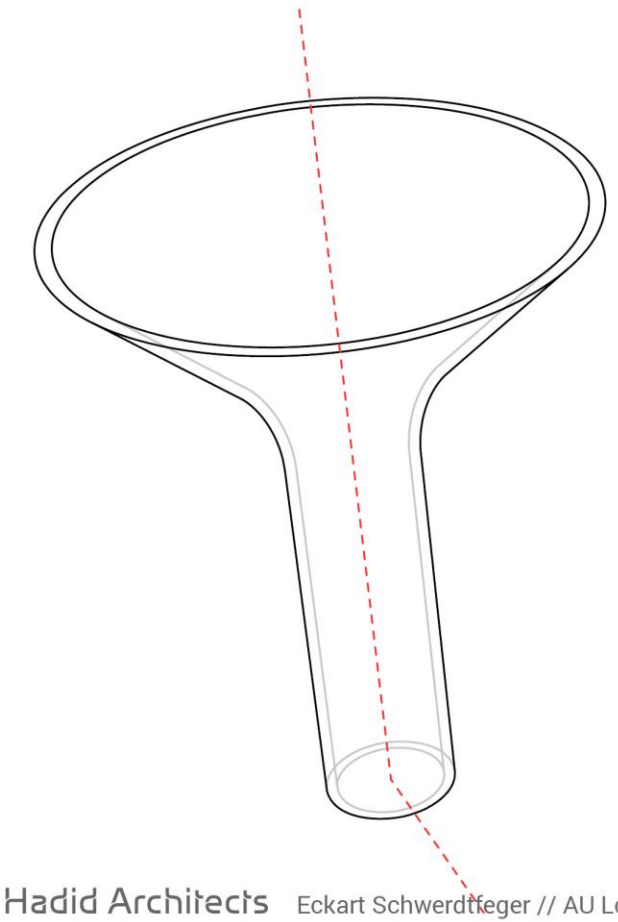
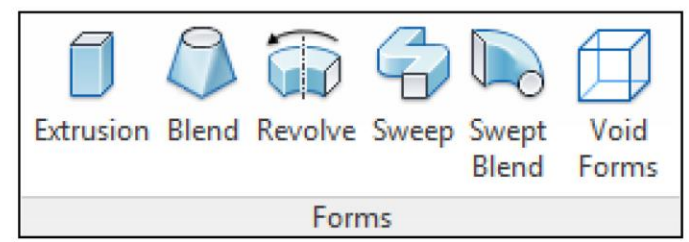
Project 2

Freeform Elements In Revit

FREEFORM ELEMENTS . FORMS

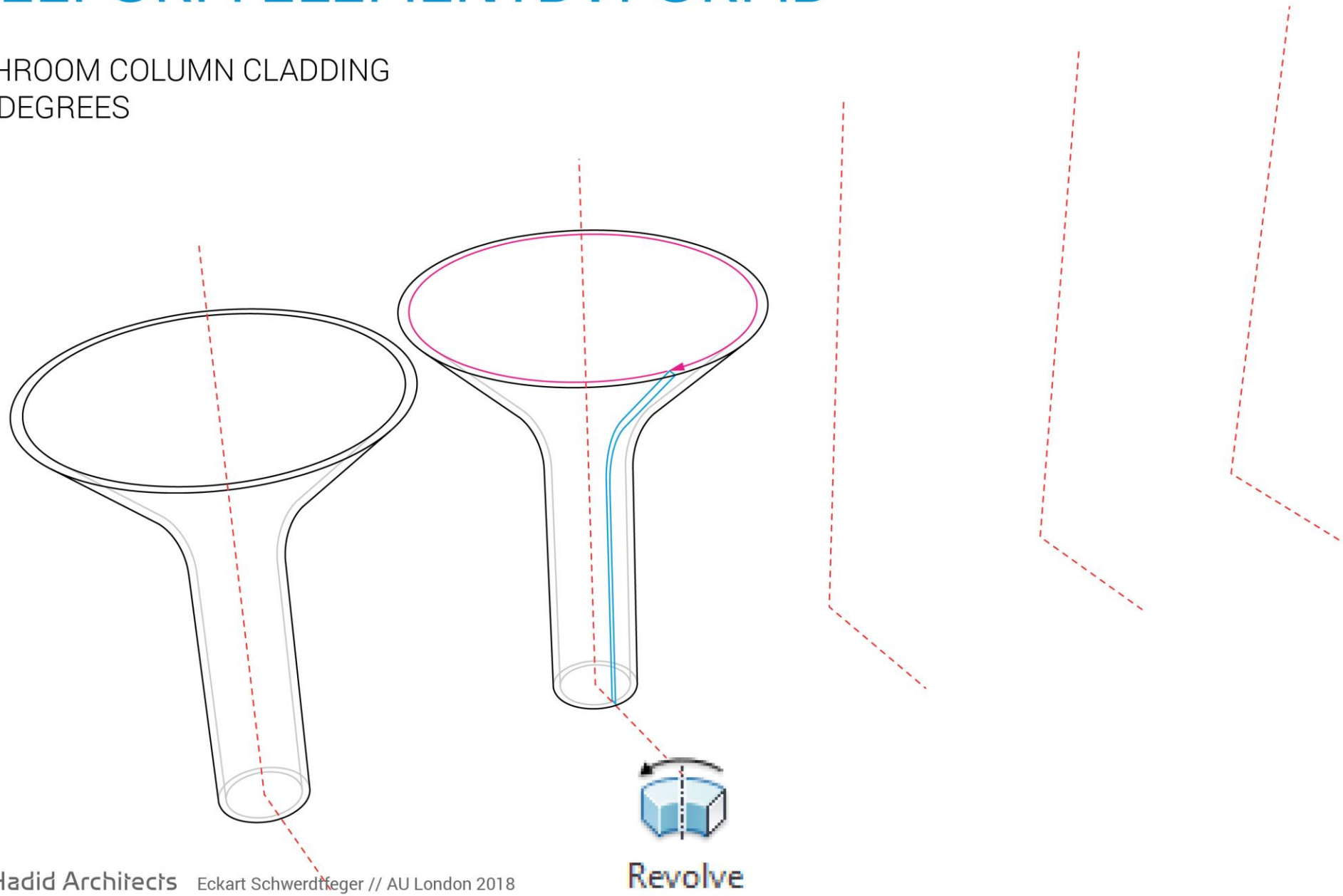
MUSHROOM COLUMN CLADDING
360° DEGREES





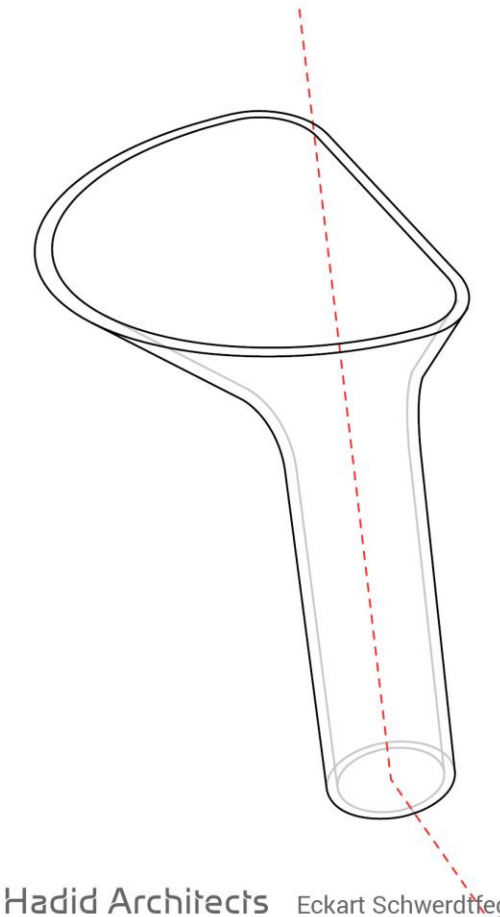
FREEFORM ELEMENTS . FORMS

MUSHROOM COLUMN CLADDING
360° DEGREES



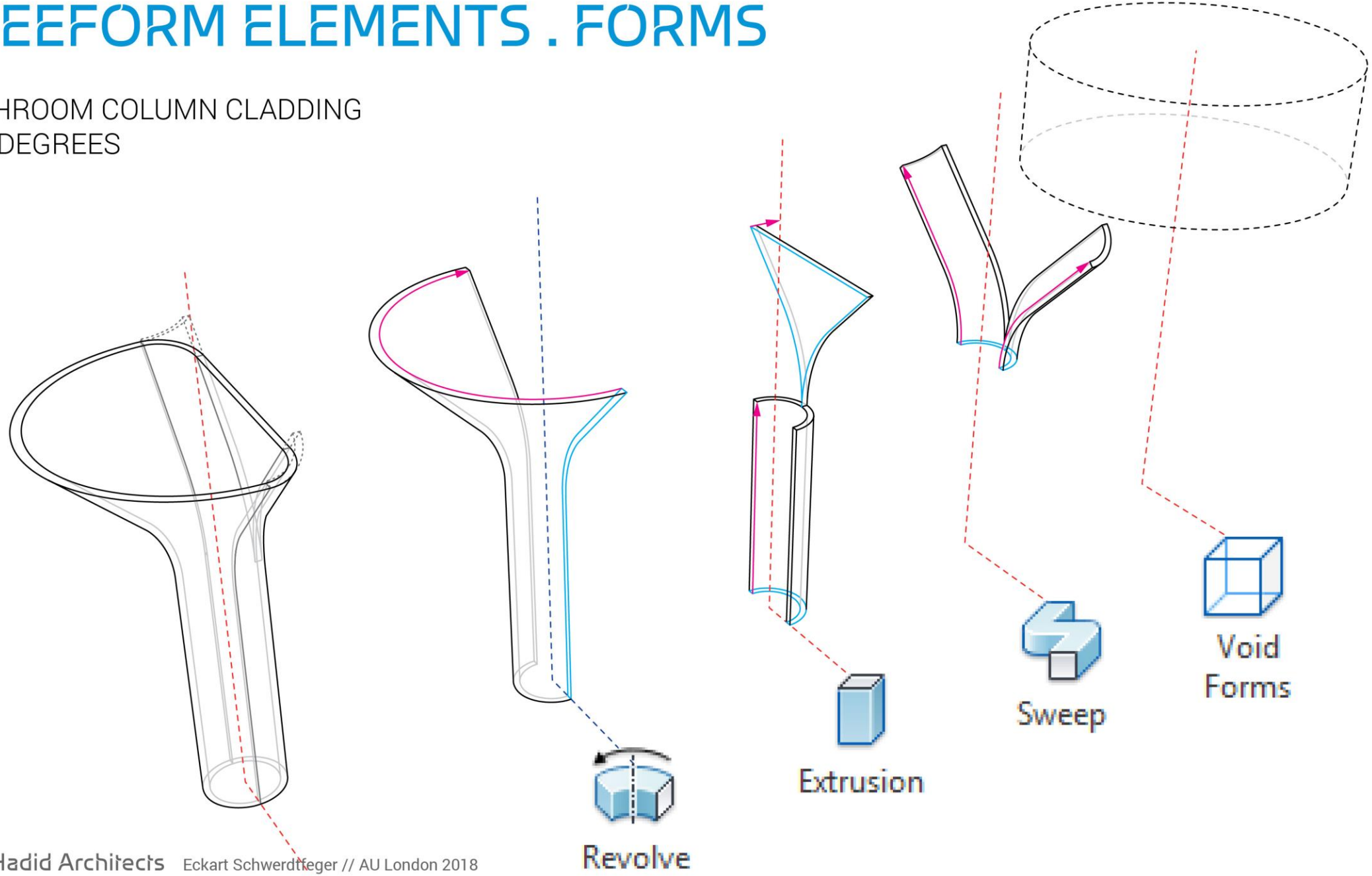
FREEFORM ELEMENTS . FORMS

MUSHROOM COLUMN CLADDING
180° DEGREES



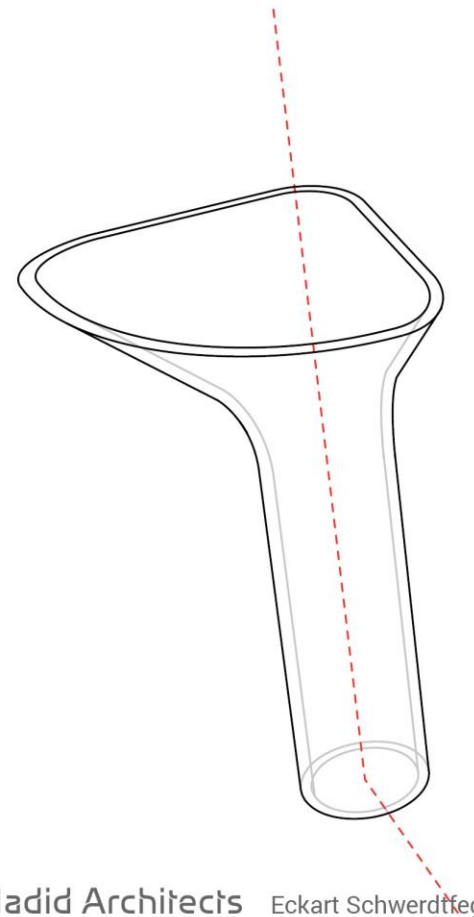
FREEFORM ELEMENTS . FORMS

MUSHROOM COLUMN CLADDING
180° DEGREES



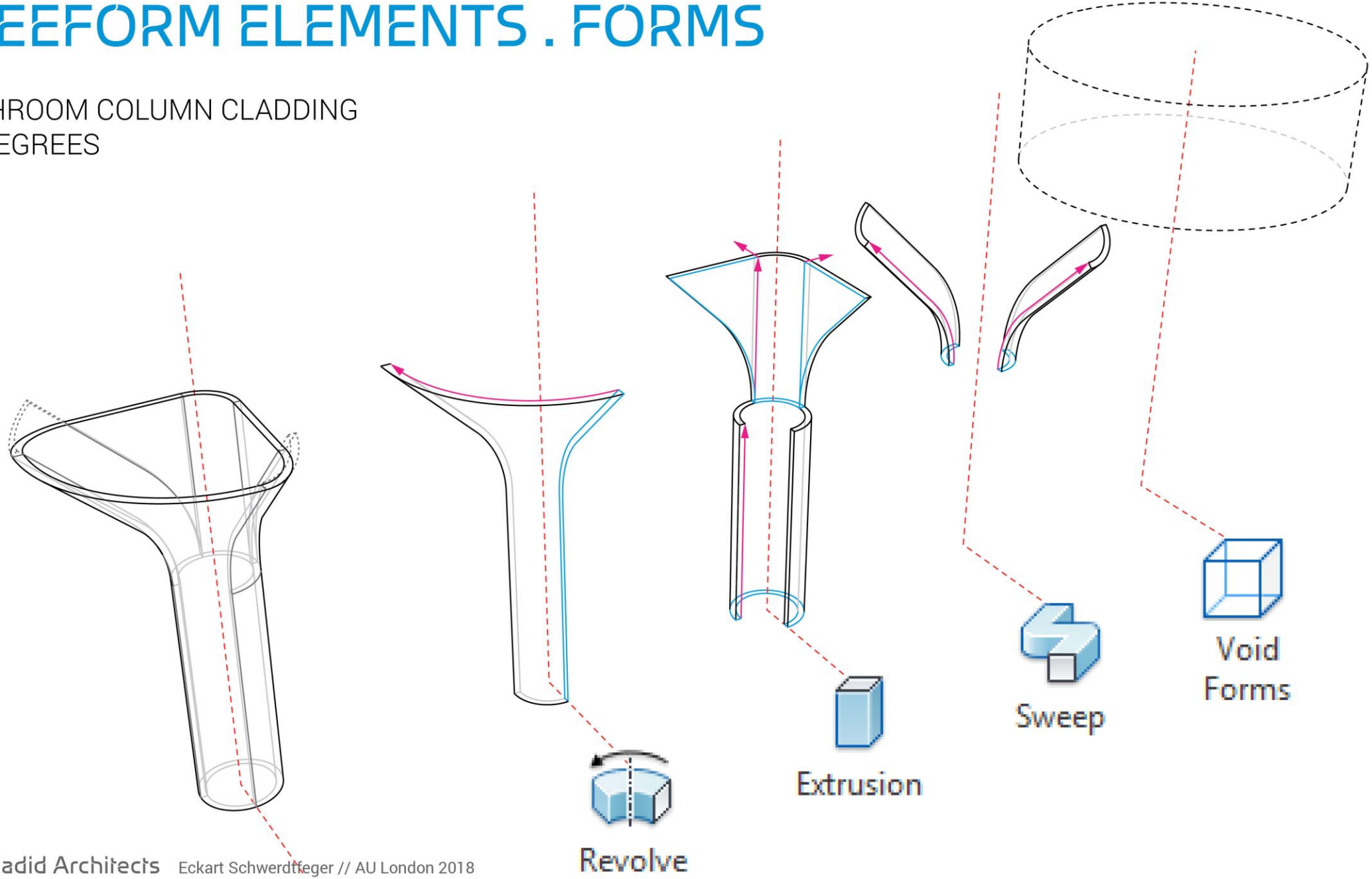
FREEFORM ELEMENTS . FORMS

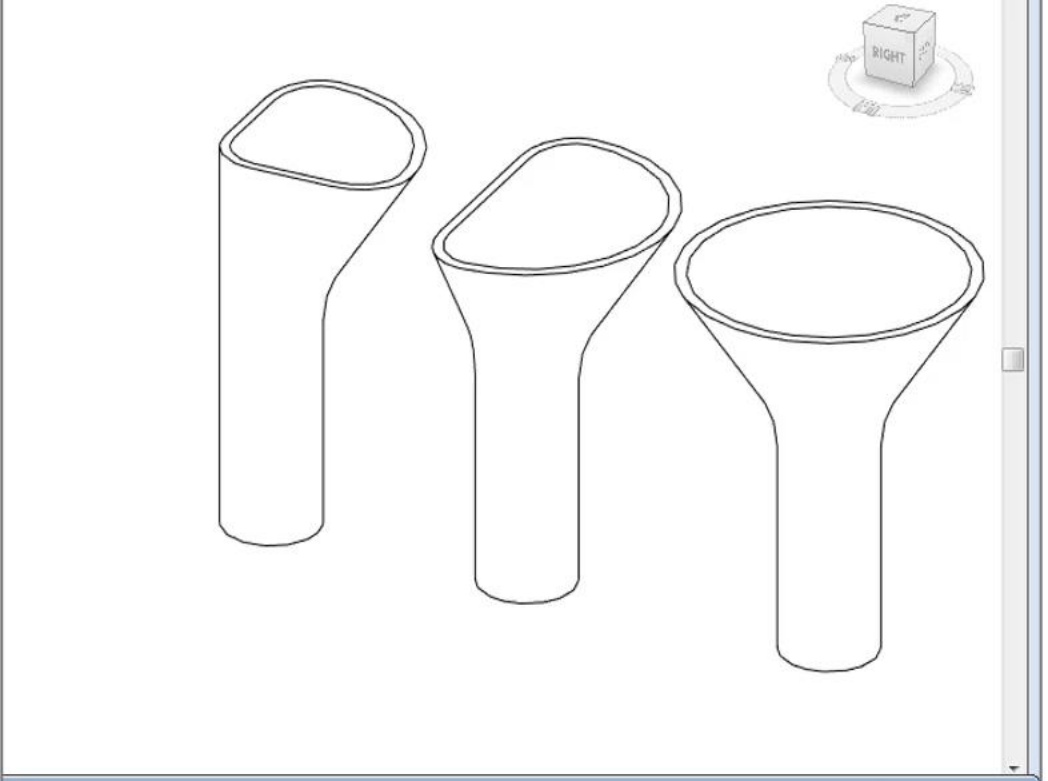
MUSHROOM COLUMN CLADDING
90° DEGREES



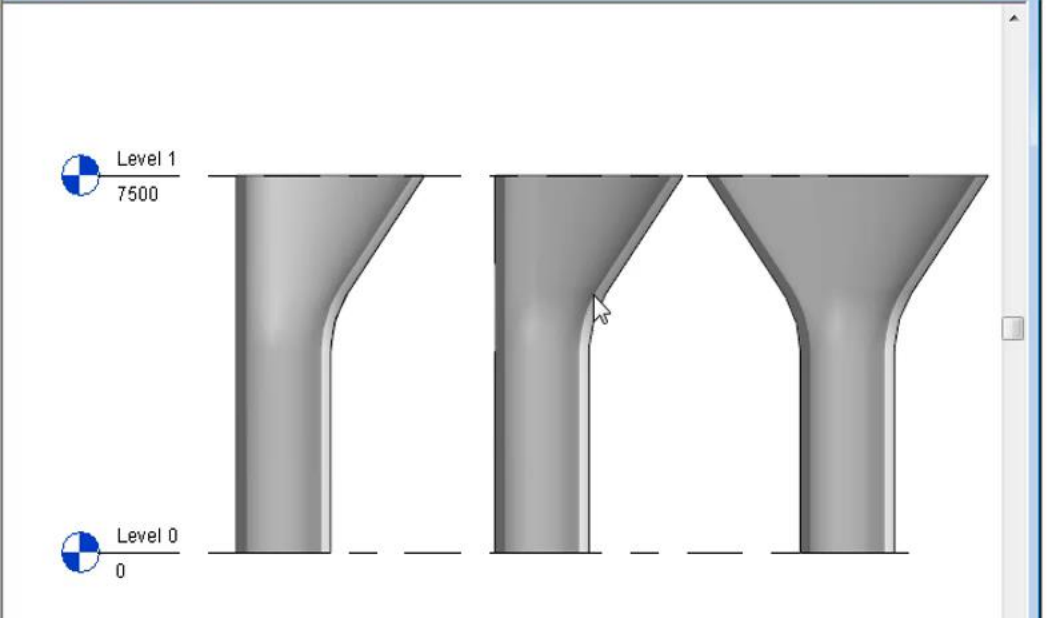
FREEFORM ELEMENTS . FORMS

MUSHROOM COLUMN CLADDING
90° DEGREES





Elevation: East - AllPieces



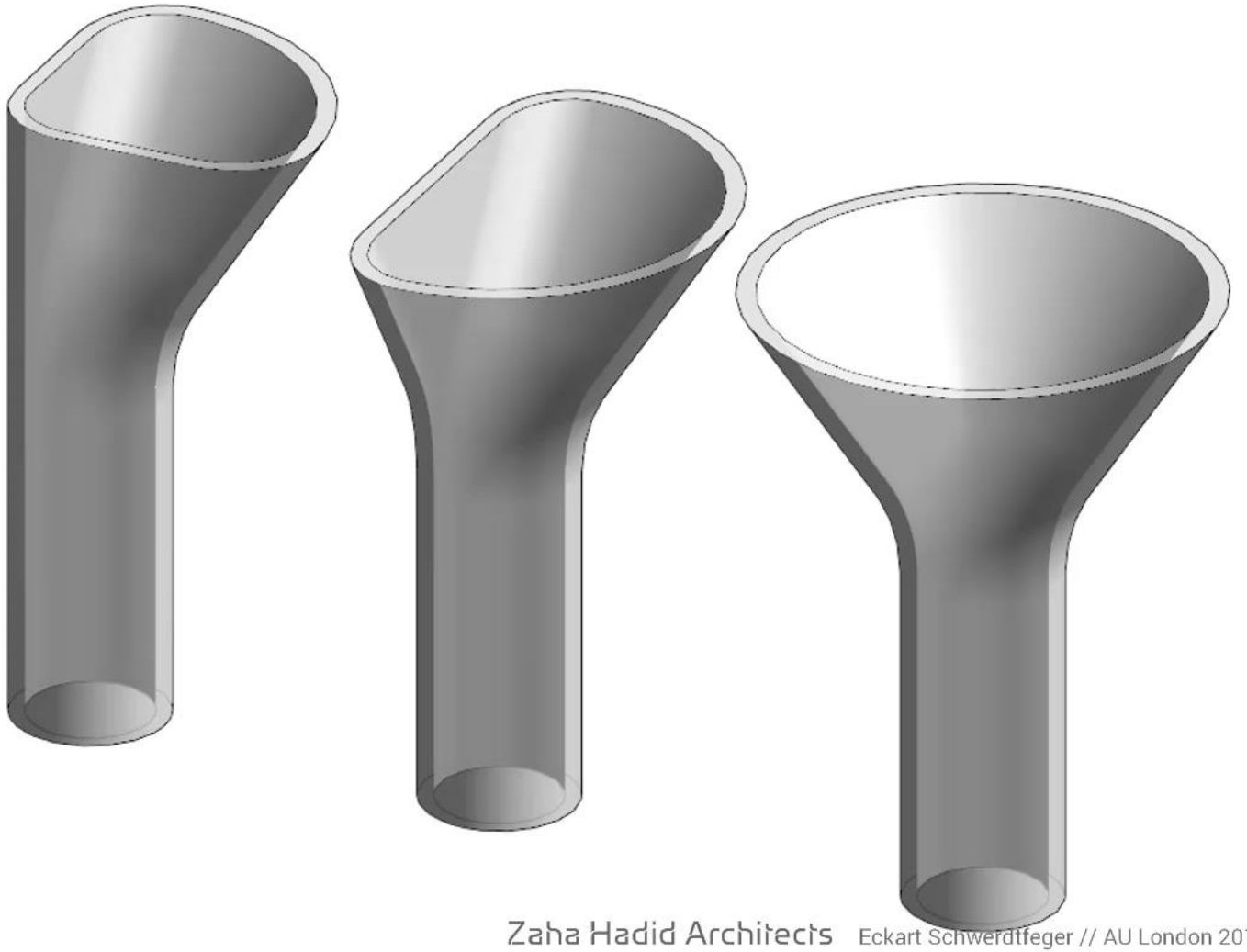
Dimensions

Angle	55.00°	=
Radius1Top	3000.0	=
Radius2Middle	2000.0	=
Radius3Bottom	1000.0	=
Thickness	200.0	=

Show

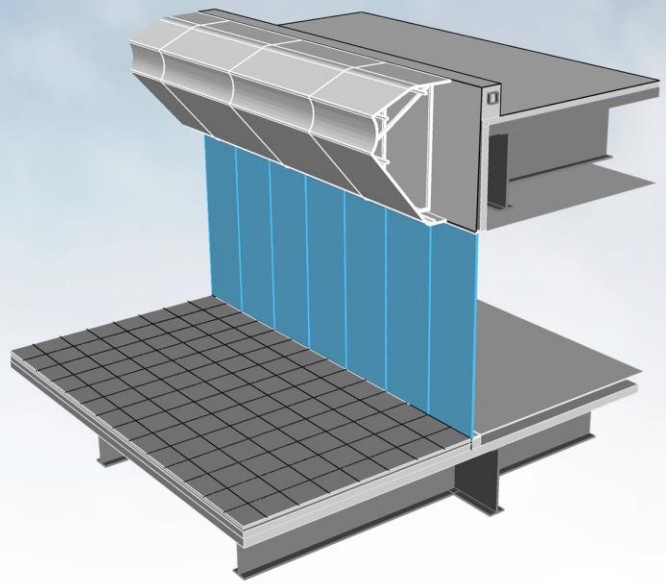
How do I manage global parameters?

OK Cancel Apply



FREEFORM ELEMENTS . ADAPTIVE

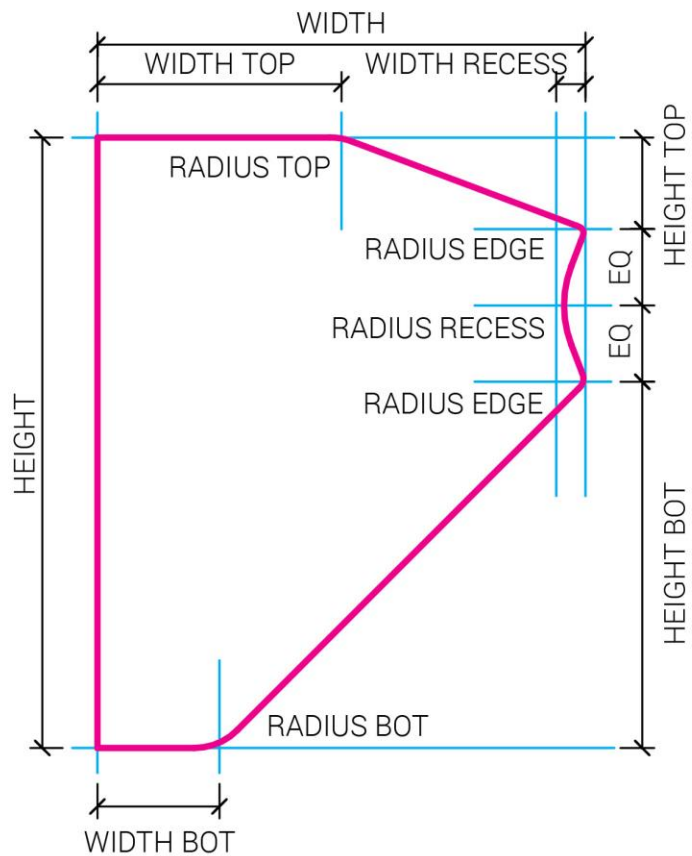
FACADE CLADDING
3D MODEL

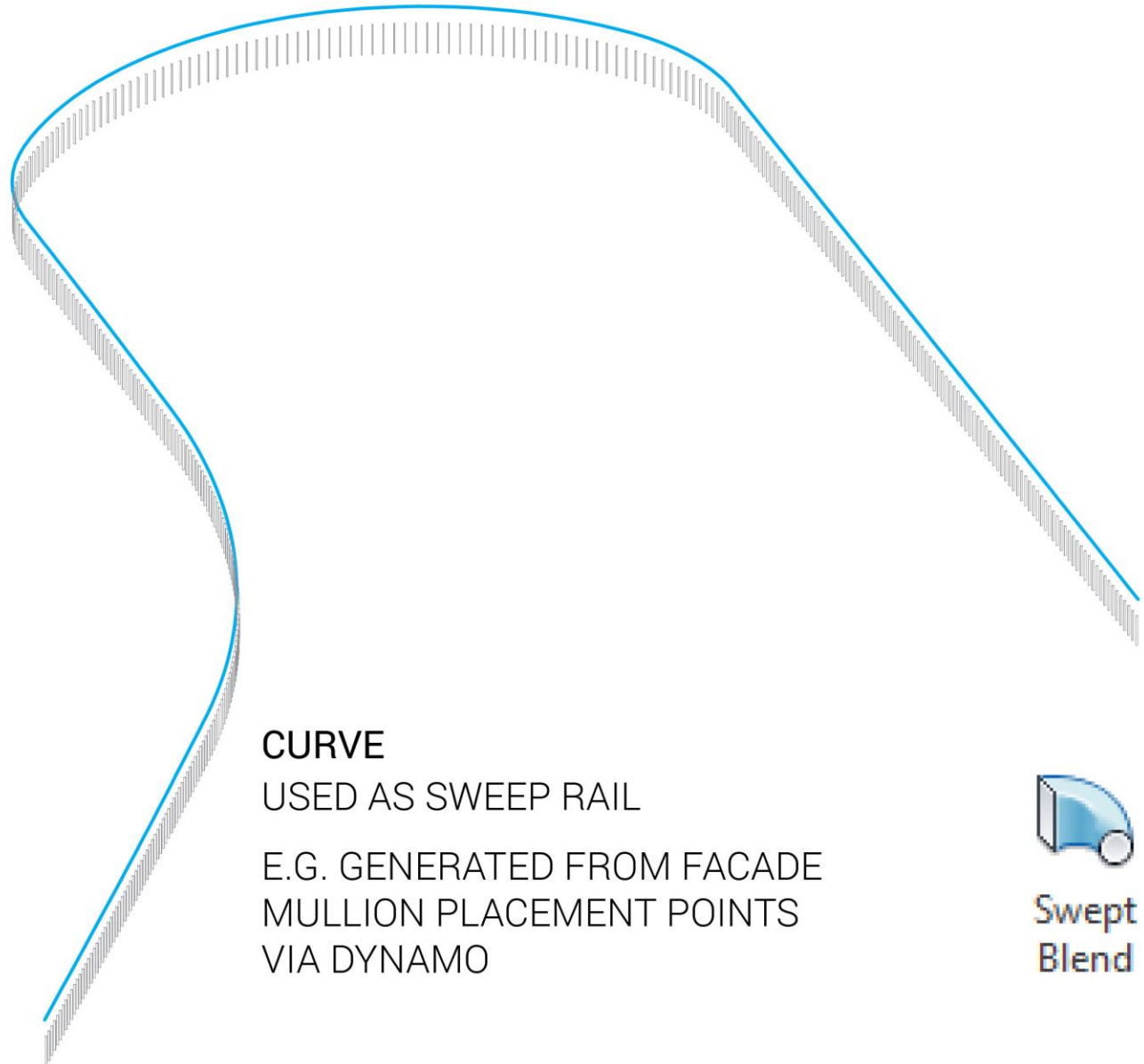


FREEFORM ELEMENTS . ADAPTIVE

FACADE CLADDING

CURVE
+ PARAMETER BASED PROFILE





CURVE

USED AS SWEEP RAIL

E.G. GENERATED FROM FACADE
MULLION PLACEMENT POINTS
VIA DYNAMO

Swept
Blend

Autodesk Revit 2017 - FILLET - Floor Plan: Ref. Level

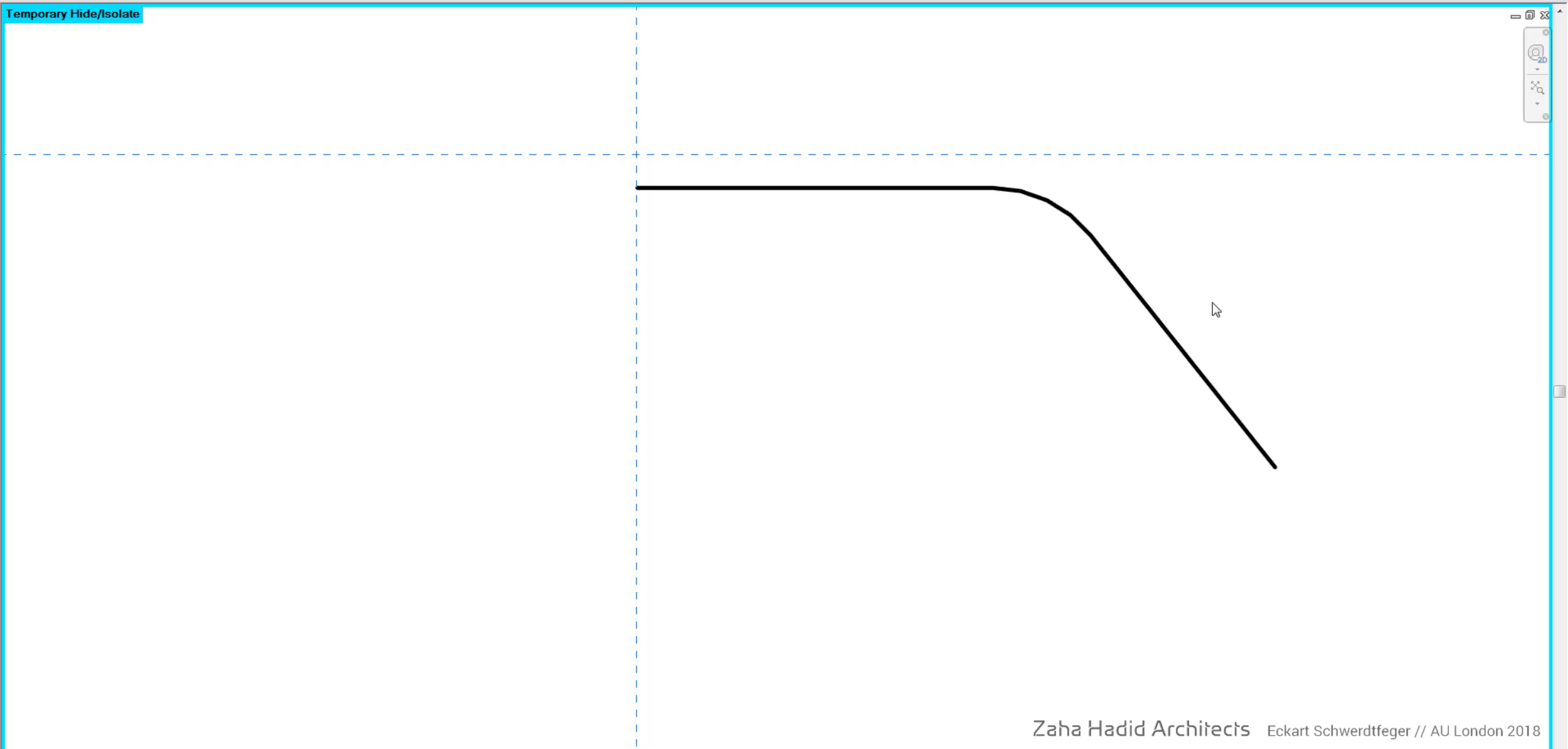
Type a keyword or phrase

Sign In

Create | Insert | View | Manage | Add-Ins | ZHA BIM | Modify

Modify | Select | Properties | Model | Reference | Plane | Draw | Set | Show | Viewer | Work Plane | Paste | Clipboard | Cut | Join | Geometry | Modify | Measure | Load into Project | Load into Project and Close | Family Editor

Temporary Hide/Isolate



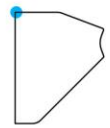
FREEFORM ELEMENTS . ADAPTIVE

FACADE CLADDING

CURVE
+ PARAMETER BASED PROFILE
+ PROFILE INSTANCES

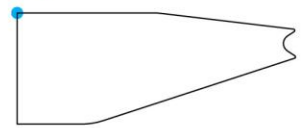
TYPE	R	H	W
WIDTH	2000	2000	6300
WIDTH TOP	1000	1000	3150
WIDTH BOT	500	500	1700
WIDTH RECESS	120	475	475
HEIGHT	2500	7000	2500
HEIGHT TOP	375	1900	375
HEIGHT BOT	1500	3250	1500
RADIUS TOP	250	250	2000
RADIUS BOT	250	250	1600
RADIUS EDGE	30	100	30
RADIUS RECESS	450	1150	200

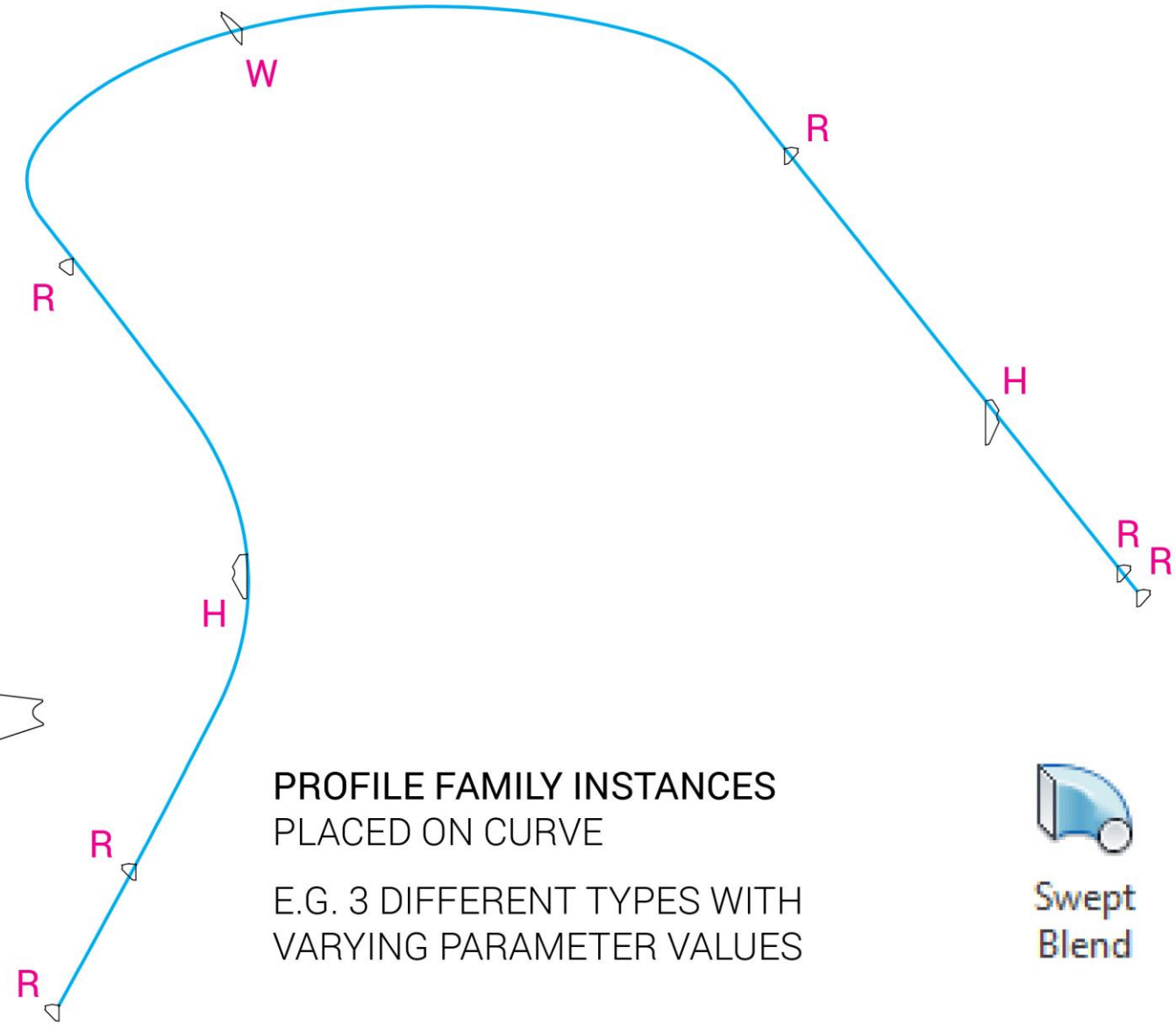
REGULAR



HIGH

WIDE

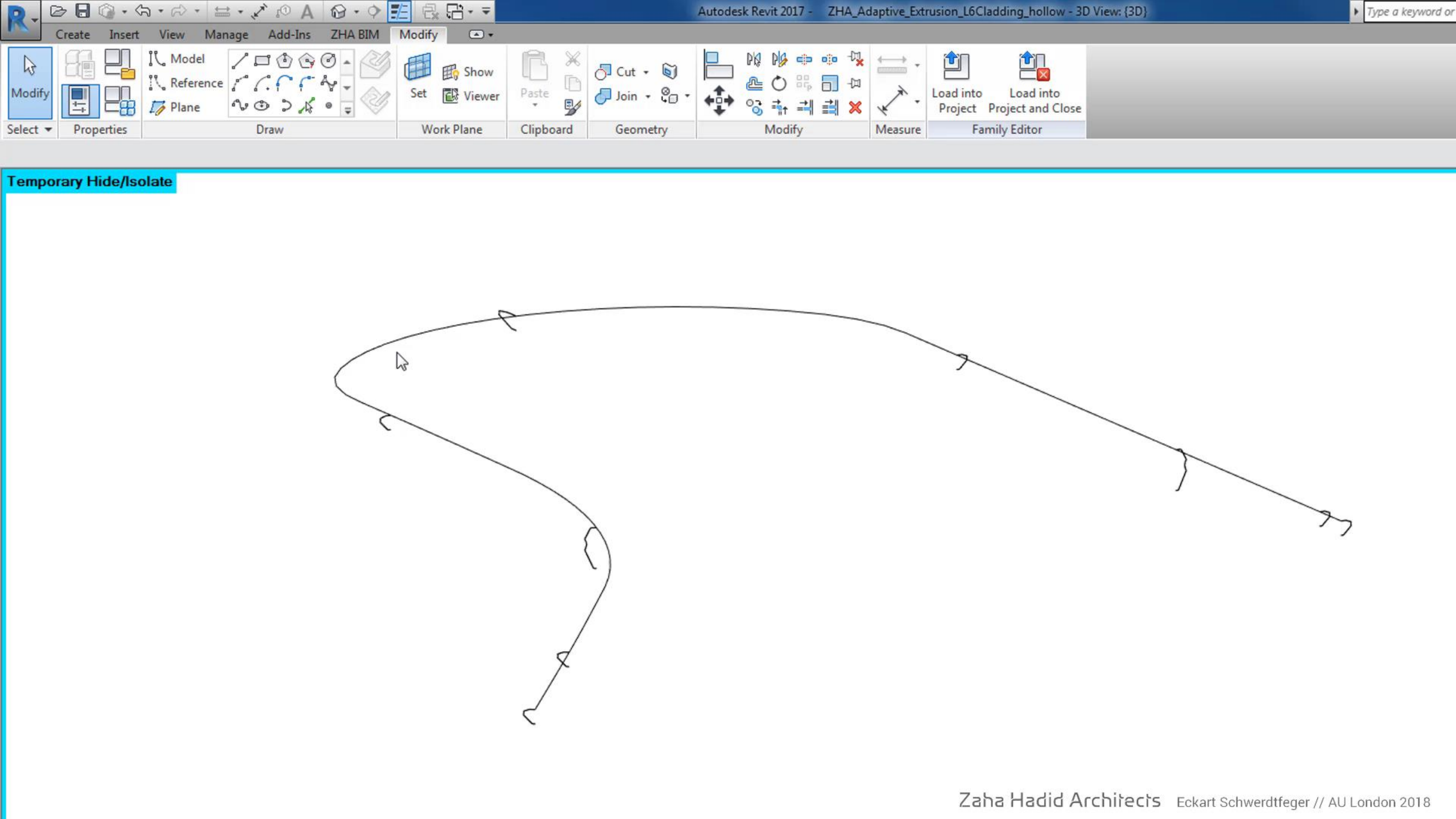




PROFILE FAMILY INSTANCES
PLACED ON CURVE

E.G. 3 DIFFERENT TYPES WITH
VARYING PARAMETER VALUES

Swept
Blend


Autodesk Revit 2017 - ZHA_Adaptive_Extrusion_L6Cladding_hollow - 3D View: {3D}
Type a keyword or
Create
Insert
View
Manage
Add-Ins
ZHA BIM
Modify
Modify
Select
Properties
Model
Reference
Plane
Draw
Set
Show
Viewer
Work Plane
Paste
Clipboard
Cut
Join
Geometry
Modify
Measure
Load into Project
Load into Project and Close
Family Editor
Temporary Hide/Isolate

Dynamo
Visual Scripting

DYNAMO VISUAL SCRIPTING

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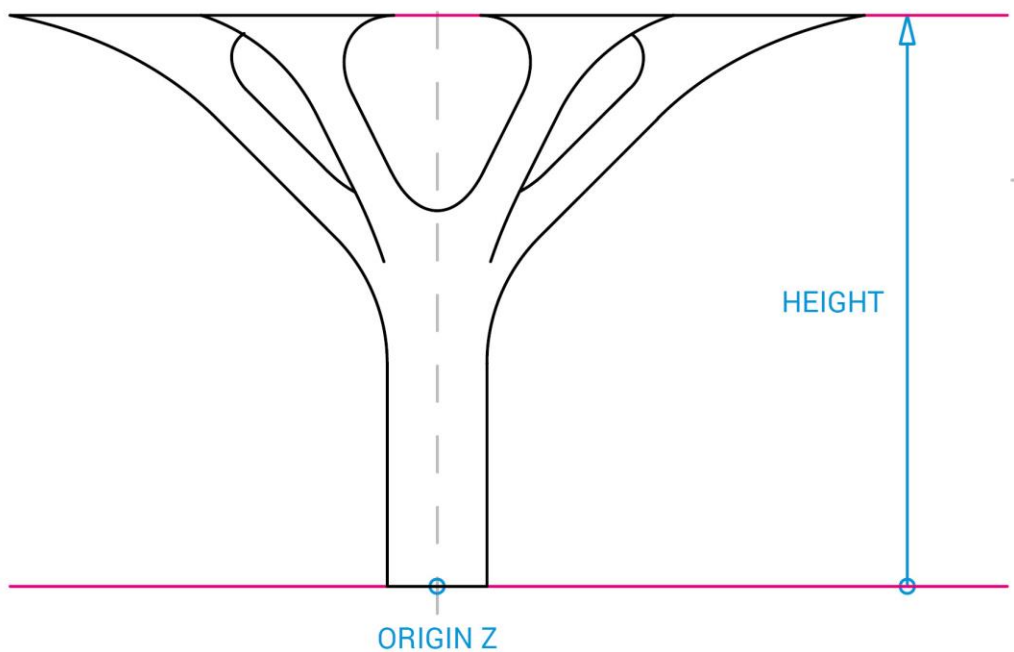
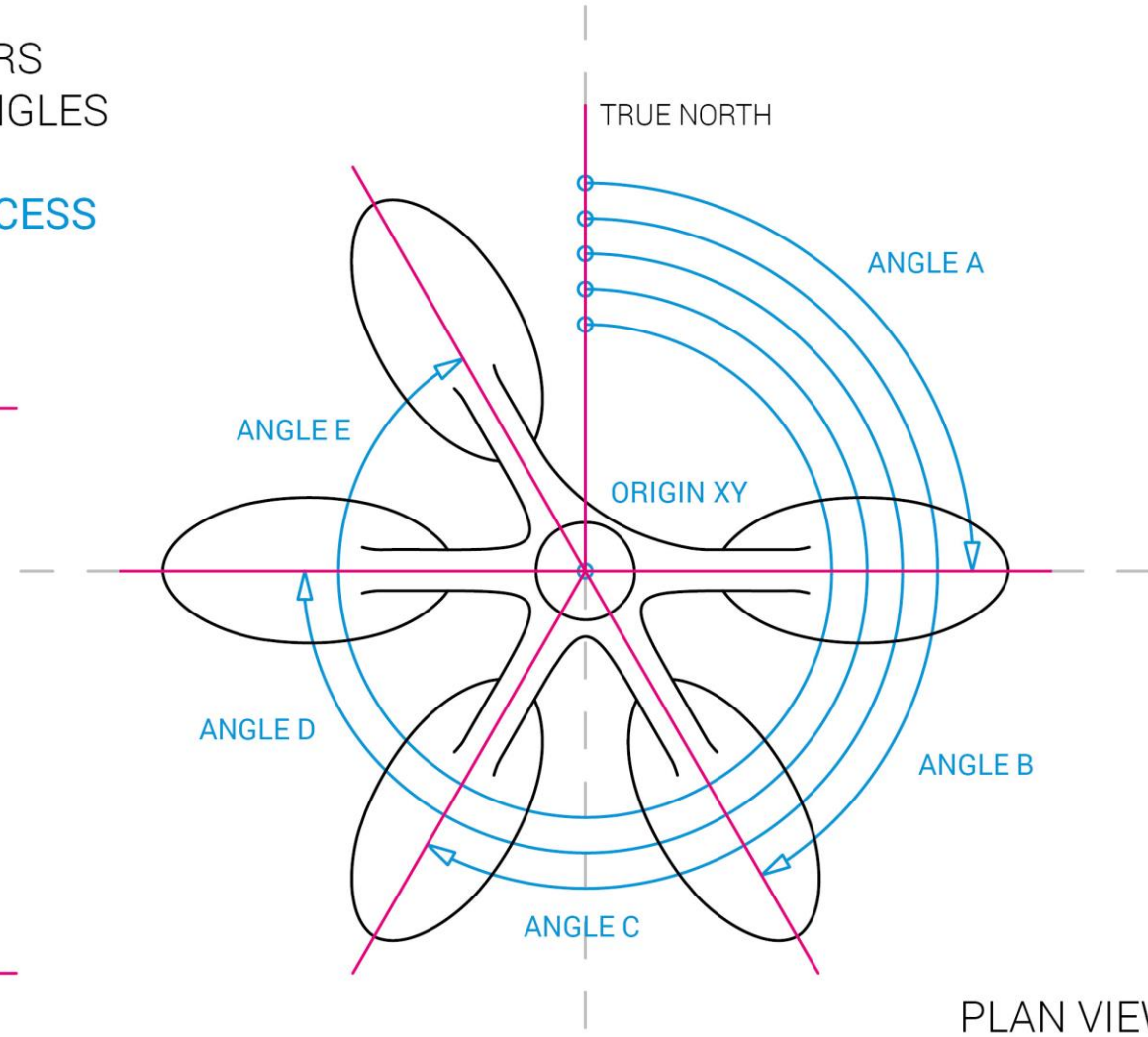
DYNAMO . TREE COLUMNS

PROCESS

- ANALYSE LIVE BUILDING MODEL - MAIN BEAMS, FLOORS
- COLLECT + SORT METADATA - ORIGIN XYZ, HEIGHT, ANGLES
- STORE METADATA - CSV SPREADSHEET FILE
- GENERATE STRUCTURE - AUTOMATED DYNAMO PROCESS
- ...

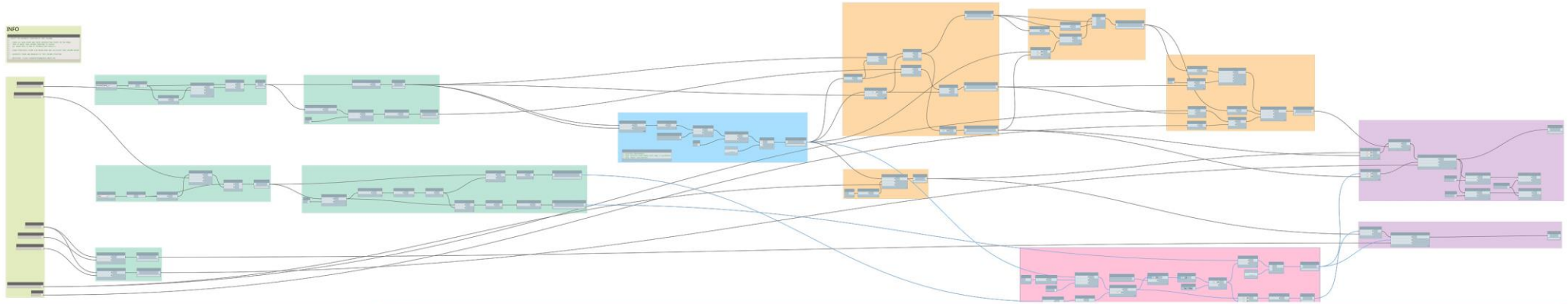
ELEVATION





PLAN VIEW

DYNAMO . TREE COLUMN STRUCTURE



[1] DEFINE PARAMETERS

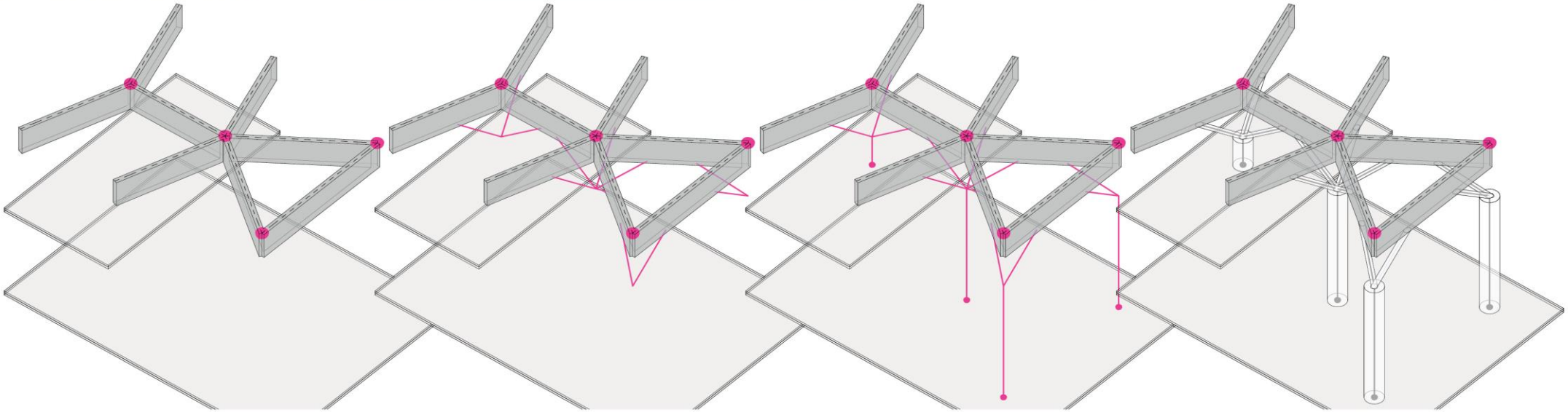
[2] READ BUILDING ELEMENTS AND THEIR PROPERTIES FROM CURRENT REVIT FILE, E.G. BEAMS, FLOORS

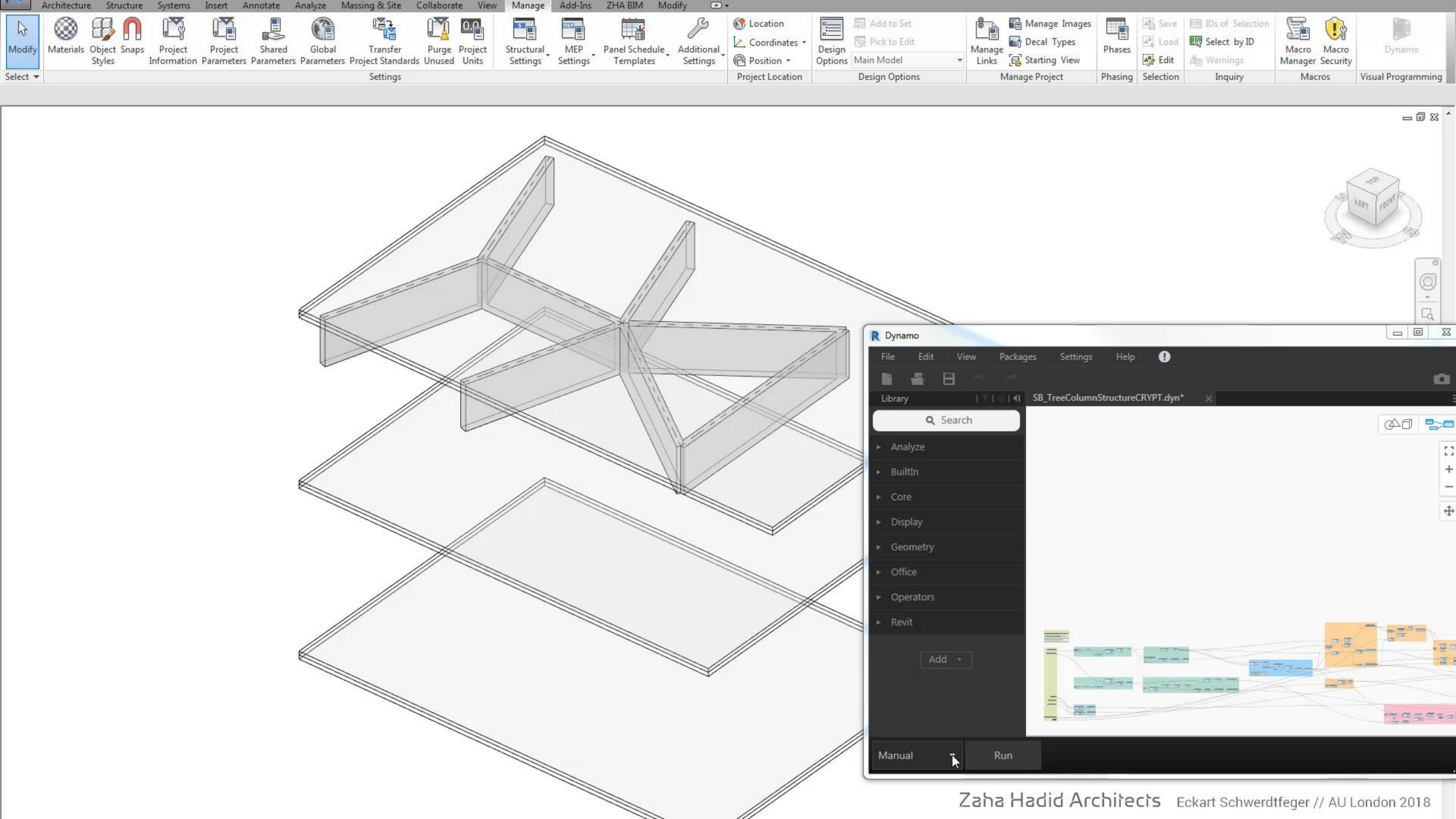
[3] FIND MAIN BEAM INTERSECTIONS FOR TREE COLUMN PLACEMENT

[4] GENERATE AXIS FOR TREE BRANCHES WITH GIVEN ANGLE

[5] FIND FLOOR SLAB BELOW AND CREATE AXIS FOR TREE TRUNKS

[6] CREATE BUILDING ELEMENTS FOR TREE BRANCHES AND TRUNKS




Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
ZHA BIM
Modify
Modify
Materials
Object Styles
Snaps
Project Information
Project Parameters
Shared Parameters
Global Parameters
Transfer Project Standards
Purge Unused
Project Units
Structural Settings
MEP Settings
Panel Schedule Templates
Additional Settings
Settings
Location
Coordinates
Position
Project Location
Design Options
Add to Set
Pick to Edit
Main Model
Design Options
Manage Links
Manage Images
Decal Types
Starting View
Manage Project
Phases
Phasing
Save
Load
Edit
Selection
IDs of Selection
Select by ID
Warnings
Inquiry
Macro Manager
Macro Security
Macros
Dynamo
Visual Programming
Dynamo
File
Edit
View
Packages
Settings
Help
Library
SB_TreeColumnStructureCRYPT.dyn*
Search
Analyze
BuiltIn
Core
Display
Geometry
Office
Operators
Revit
Add
Manual
Run
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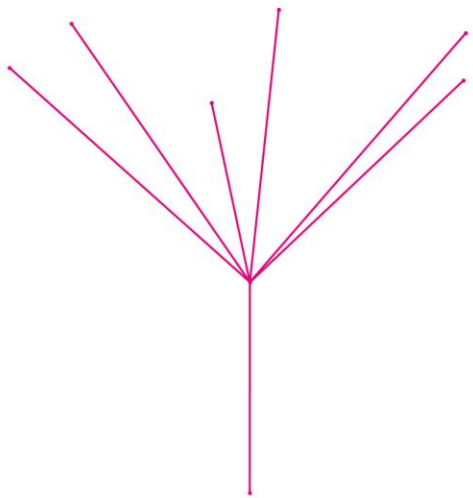
Eckart Schwerdtfeger // AU London 2018

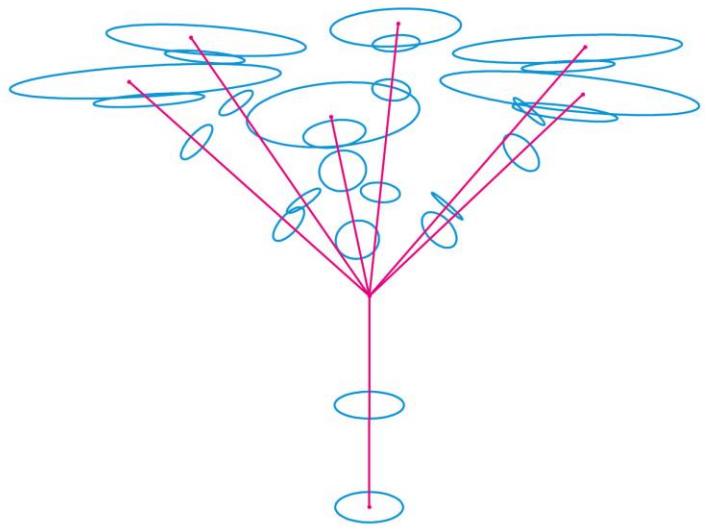
DYNAMO . TREE COLUMN CLADDING

PROCESS

- ANALYSE LIVE BUILDING MODEL - MAIN BEAMS, FLOORS
- COLLECT + SORT METADATA - ORIGIN XYZ, HEIGHT, ANGLES
- STORE METADATA - CSV SPREADSHEET FILE
- GENERATE STRUCTURE - AUTOMATED DYNAMO PROCESS
- GENERATE FREEFORM CLADDING
  AUTOMATED DYNAMO + T SPLINES PROCESS



AXIS LINES

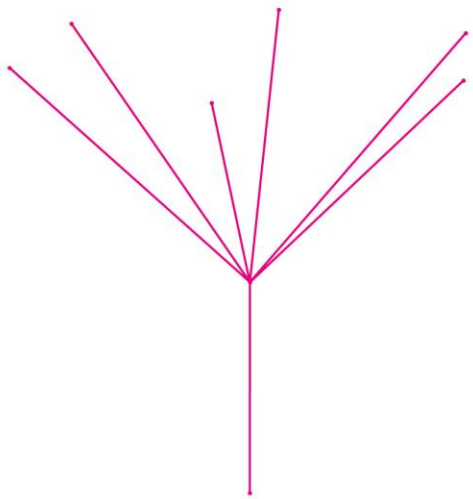


DIMENSIONS + DESIGN INTENT

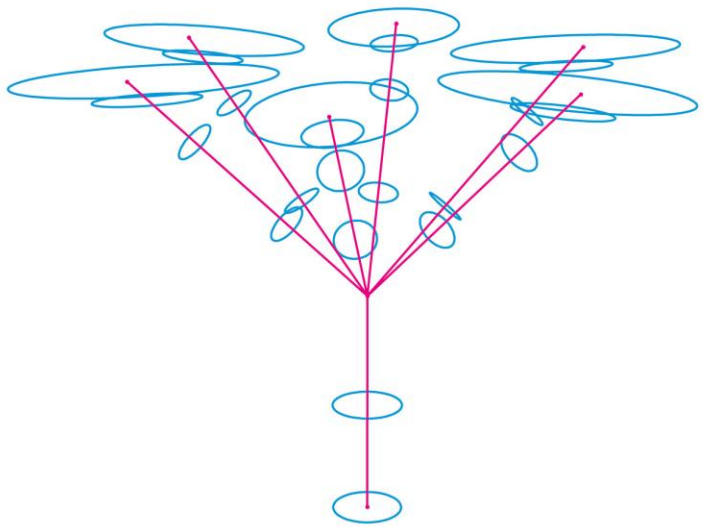
DYNAMO . TREE COLUMN CLADDING

PROCESS

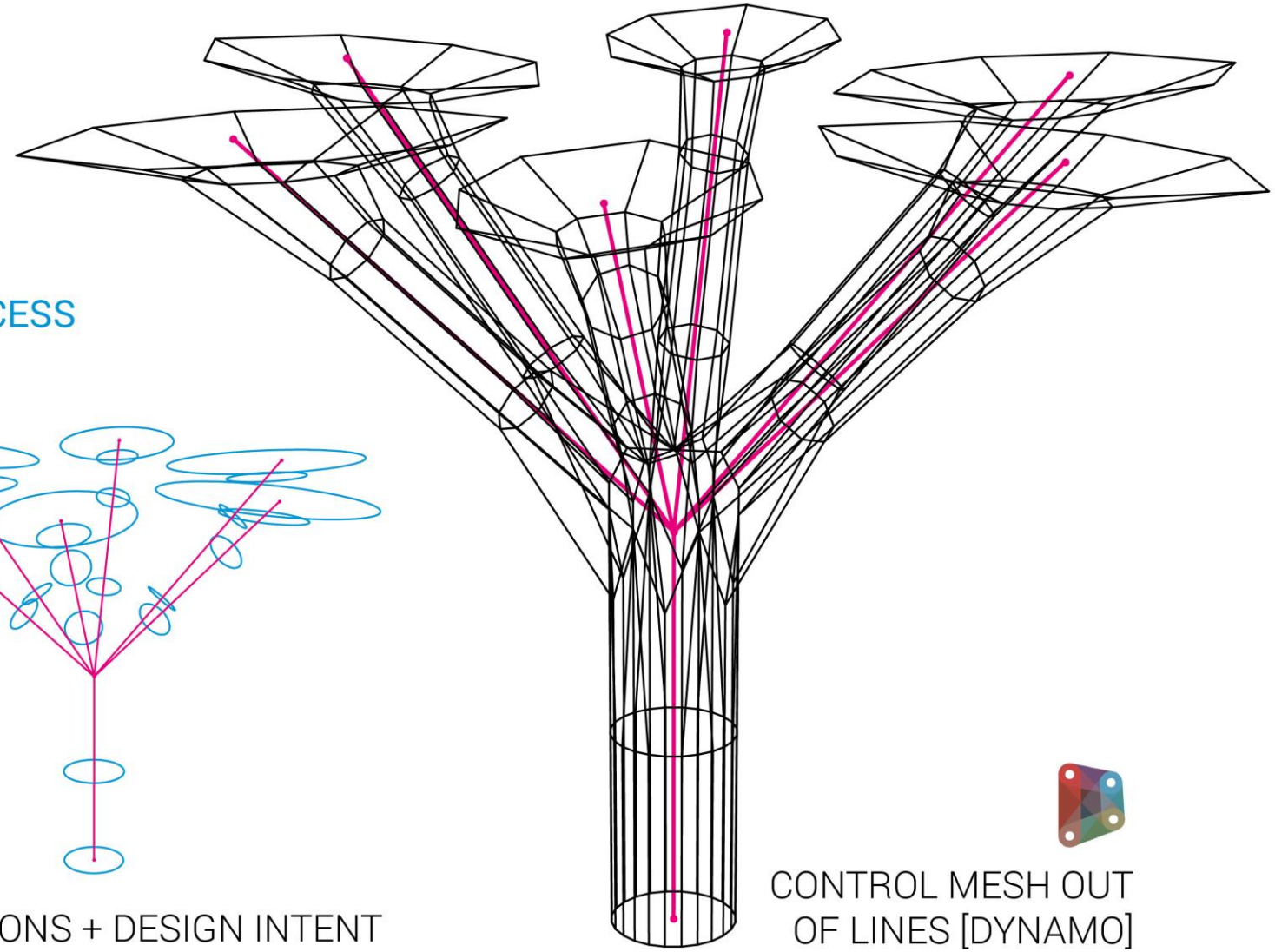
- ANALYSE LIVE BUILDING MODEL
- COLLECT + SORT METADATA
- STORE METADATA
- GENERATE STRUCTURE
- GENERATE FREEFORM CLADDING
  AUTOMATED DYNAMO + T SPLINES PROCESS



AXIS LINES



DIMENSIONS + DESIGN INTENT

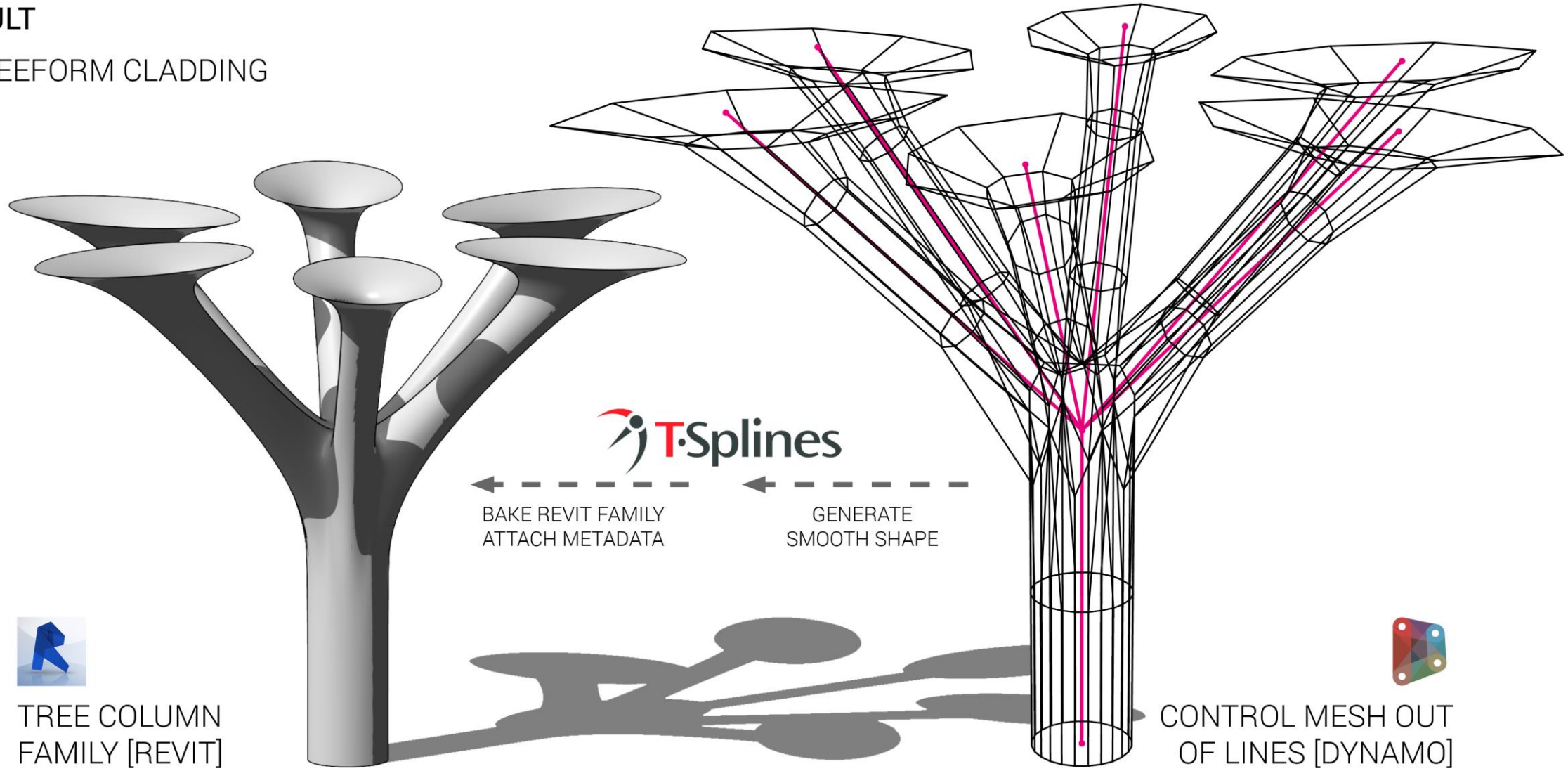


CONTROL MESH OUT
OF LINES [DYNAMO]

DYNAMO . TREE COLUMN CLADDING

RESULT

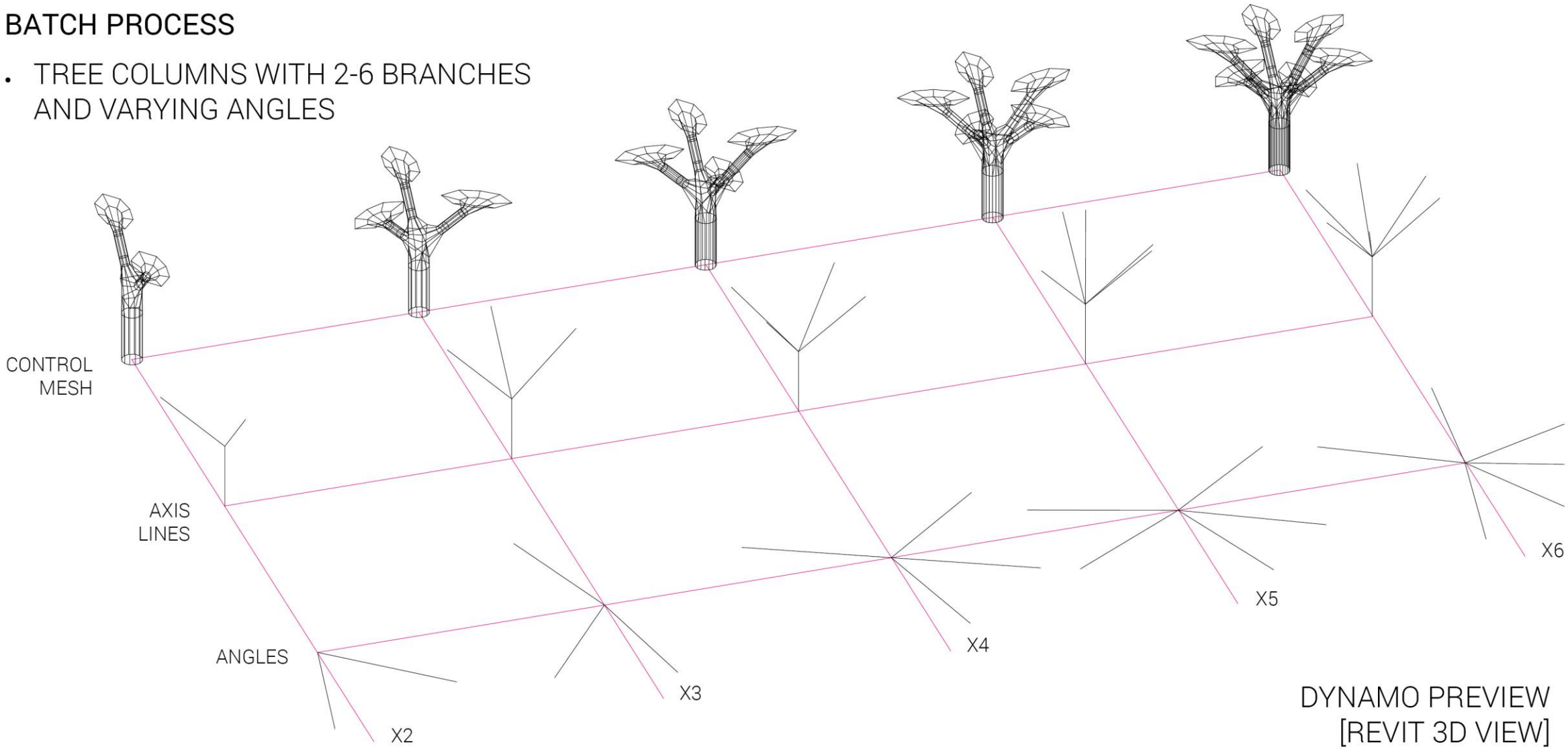
- FREEFORM CLADDING



DYNAMO . TREE COLUMN CLADDING

BATCH PROCESS

- TREE COLUMNS WITH 2-6 BRANCHES AND VARYING ANGLES



DYNAMO PREVIEW
[REVIT 3D VIEW]

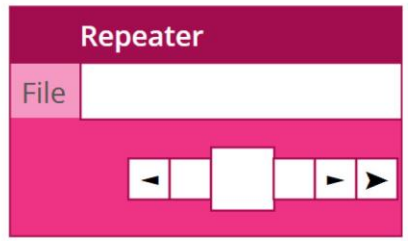
DYNAMO . CUSTOM NODES

UTILITY PLUGIN

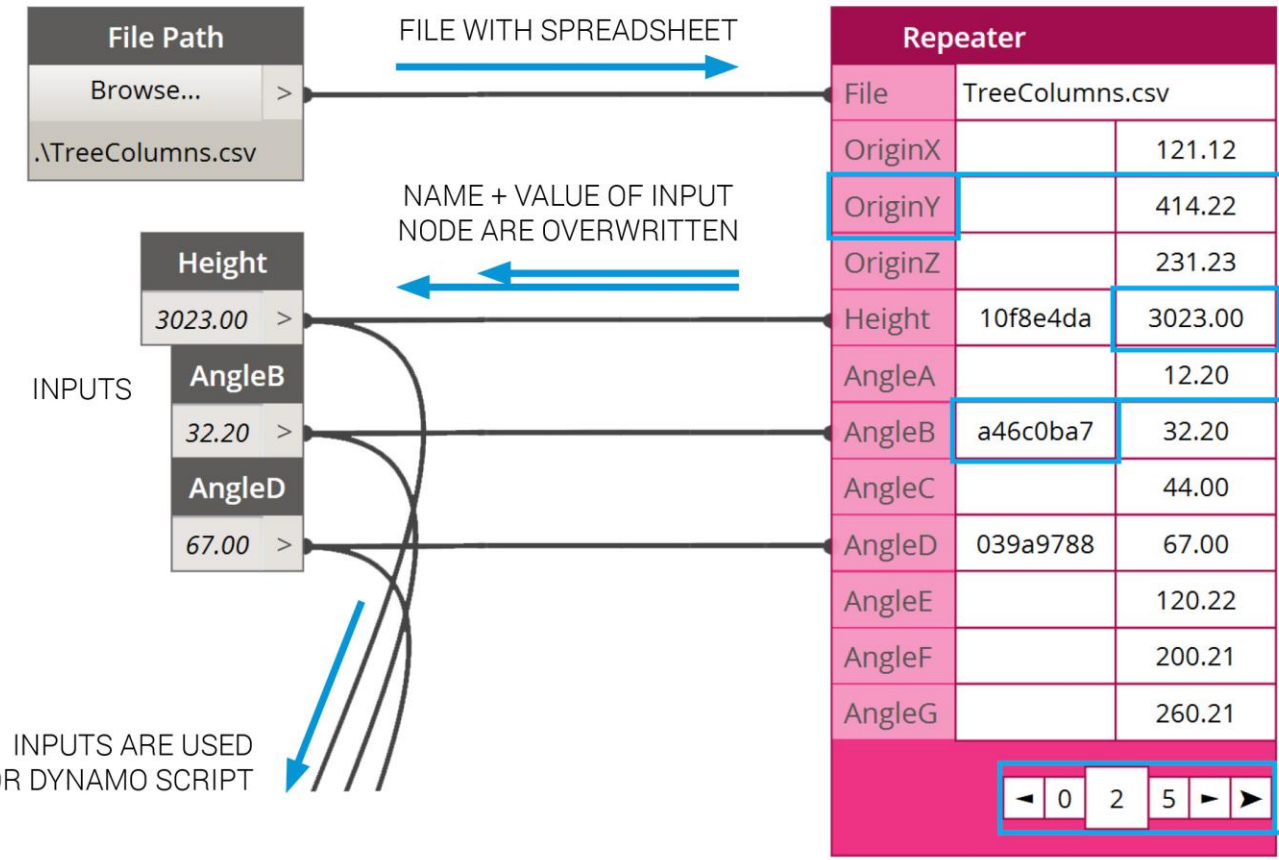
REPEATER NODE

CUSTOM USER INTERFACE NODE

RUN A DYNAMO SCRIPT REPEATEDLY AND WITH VARYING INPUT VALUES THAT ARE RECEIVED FROM A SPREADSHEET FILE



INACTIVE
MODE



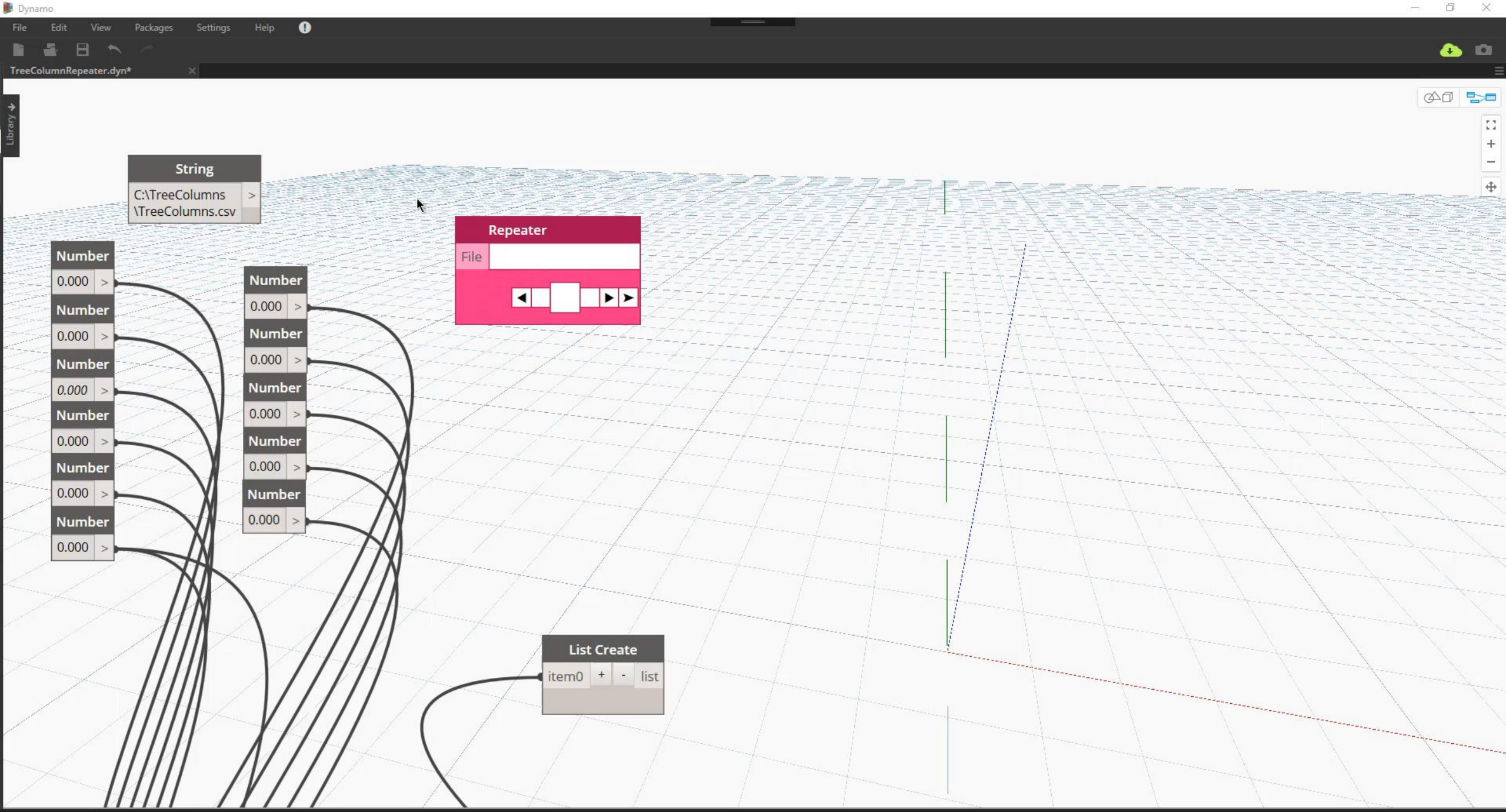
MODE
ACTIVE

SPREADSHEET COLUMNS ARE MIRRORED IN PORTS

VALUES FROM SPREADSHEET

ID OF CONNECTED INPUT NODES

CONTROLS
ENABLE PREVIOUS ROW
FIRST ROW NUMBER
CURRENT ROW NUMBER
LAST ROW NUMBER
ENABLE NEXT ROW
REPEAT


Dynamo
File
Edit
View
Packages
Settings
Help
TreeColumnRepeater.dyn*
Library
String
C:\TreeColumns
\TreeColumns.csv
Number
0.000
Repeater
File
List Create
item0
+
-
list
Automatic
Run completed with warnings.
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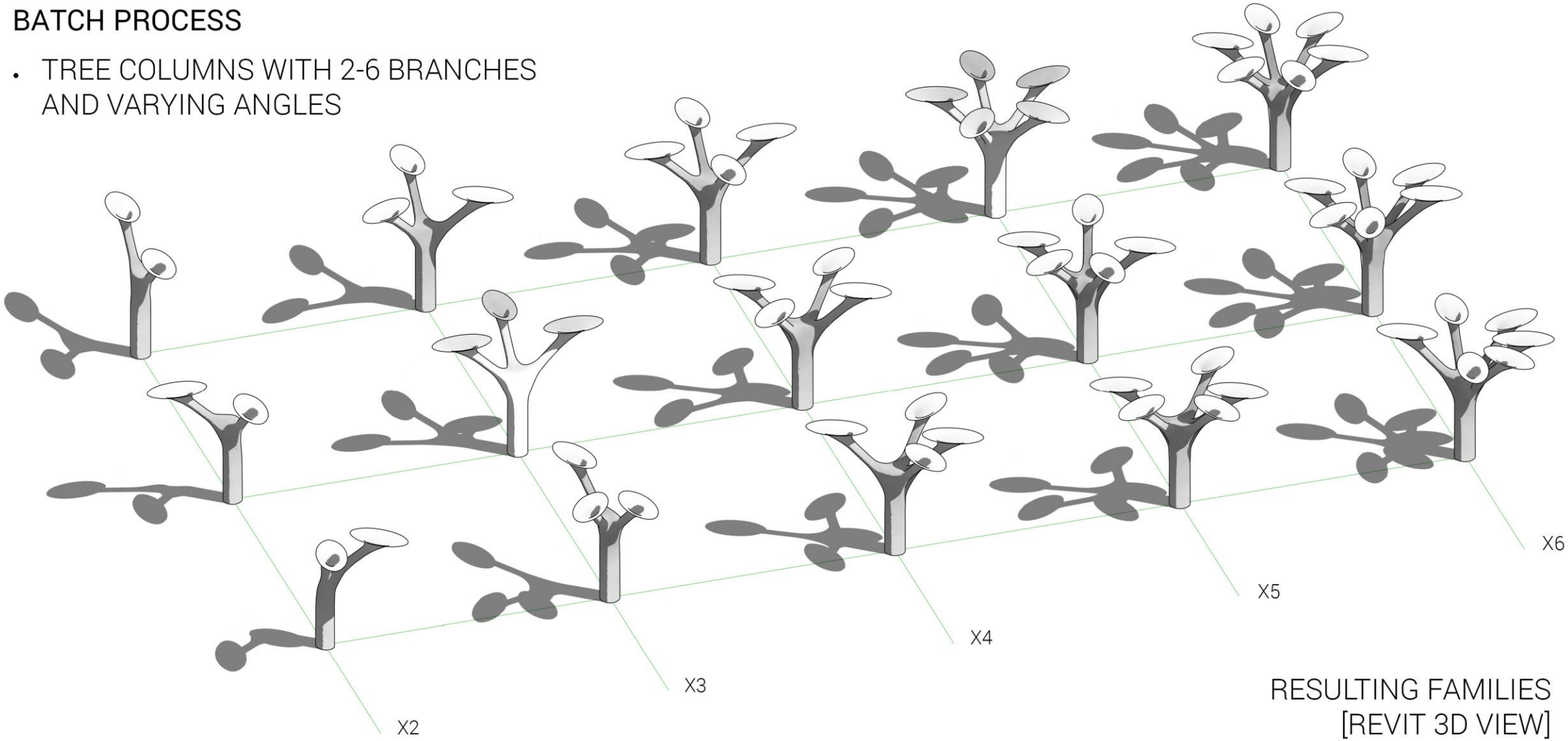
DYNAMO . TREE COLUMN CLADDING

BATCH PROCESS

- TREE COLUMNS WITH 2-6 BRANCHES AND VARYING ANGLES



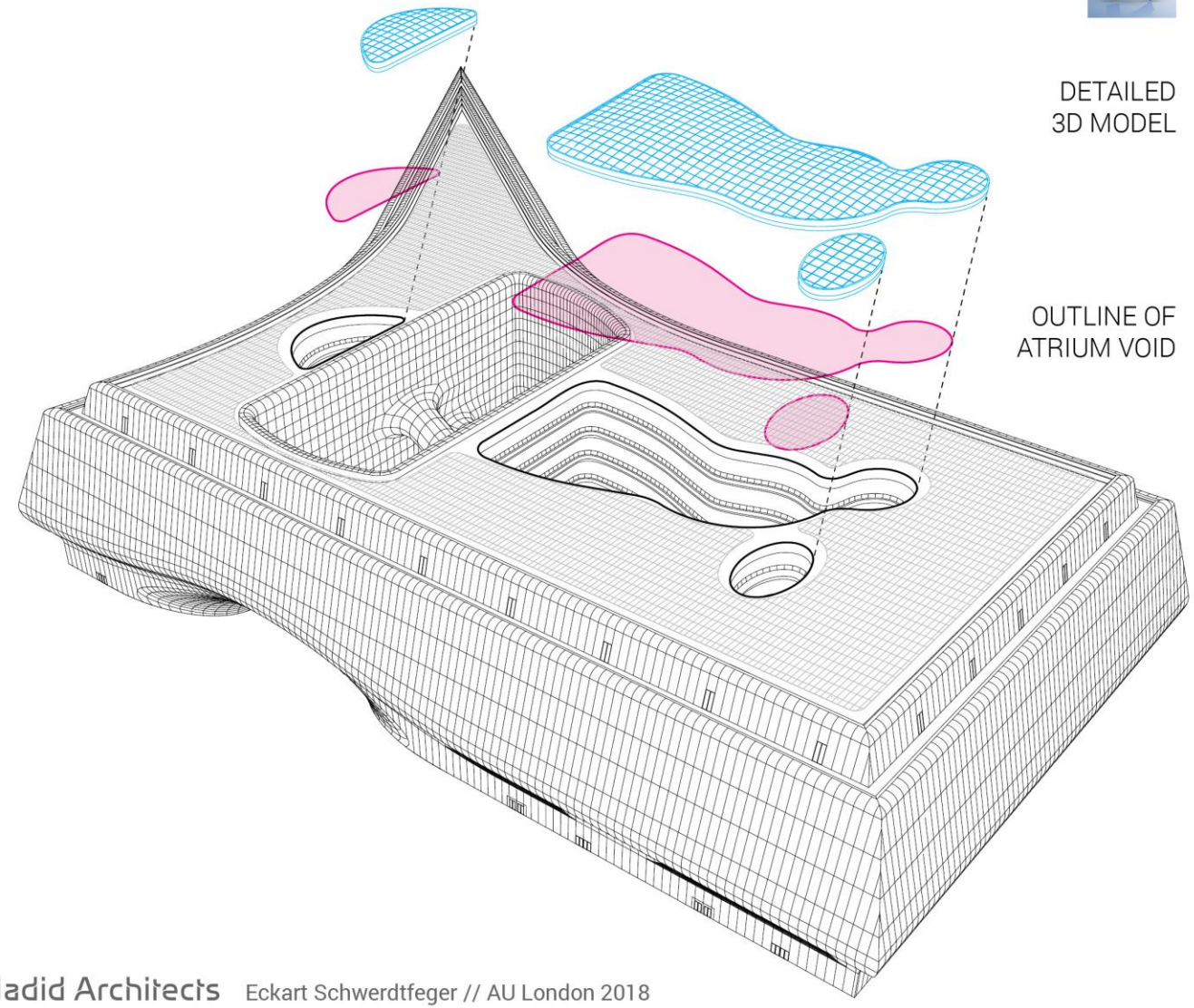
RESULTING FAMILIES
[REVIT 3D VIEW]

DYNAMO . SKYLIGHT

[1] BASE GEOMETRY
FROM RHINO

?

[4] BIM 3D MODEL
WITH METADATA &
SCHEDULES

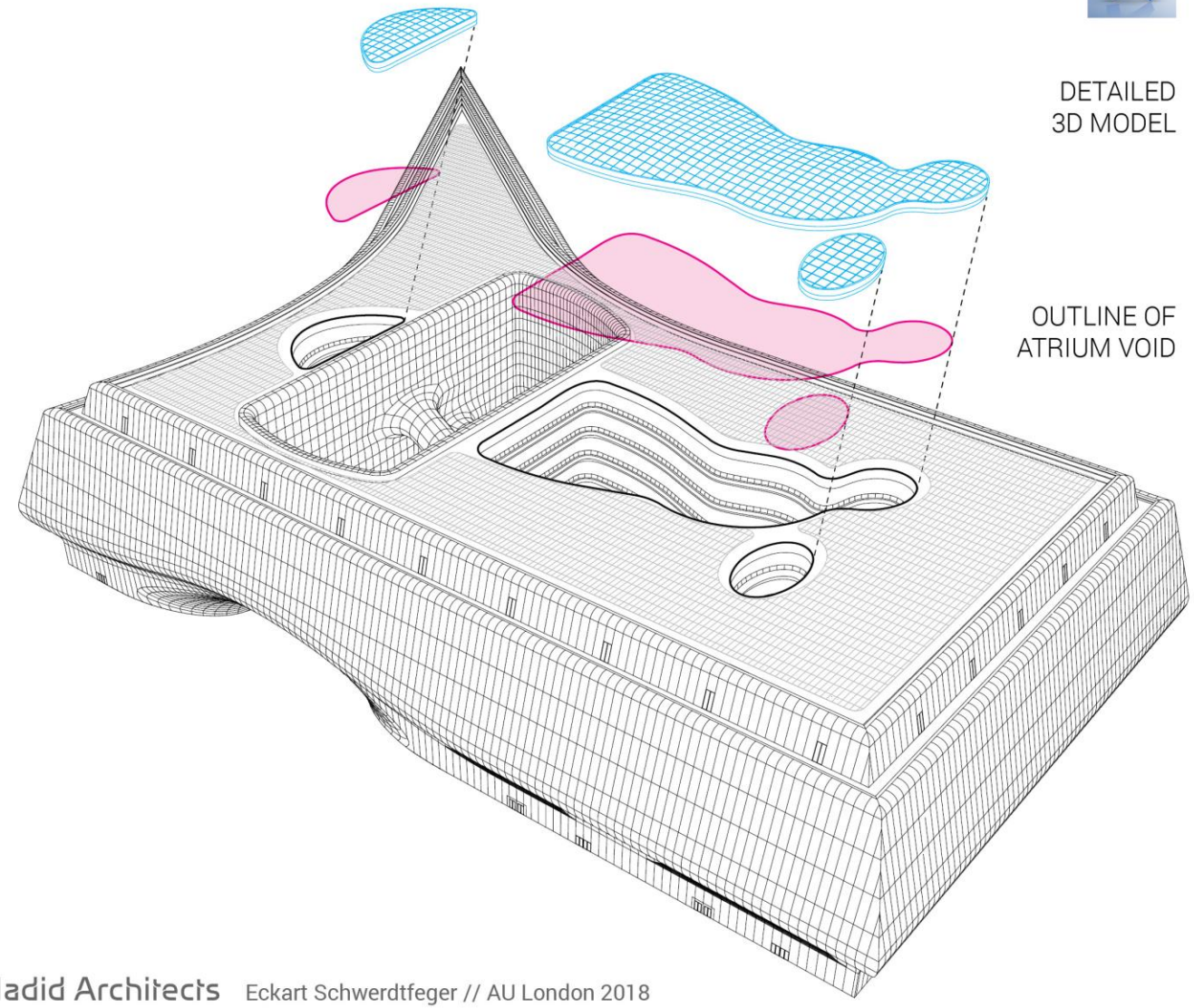


DYNAMO . SKYLIGHT

[1] BASE GEOMETRY FROM RHINO

?

[4] BIM 3D MODEL WITH METADATA & SCHEDULES



DETAILED 3D MODEL

OUTLINE OF ATRIUM VOID

AIMS

- EXCHANGE GEOMETRY USING CLOUD SERVER
- VISUAL SCRIPTING INSIDE REVIT (DYNAMO)
- STRUCTURALLY SOUND DESIGN VIA PHYSICS SOLVER
- DETAILED MODEL PRODUCED BY DYNAMO + REVIT

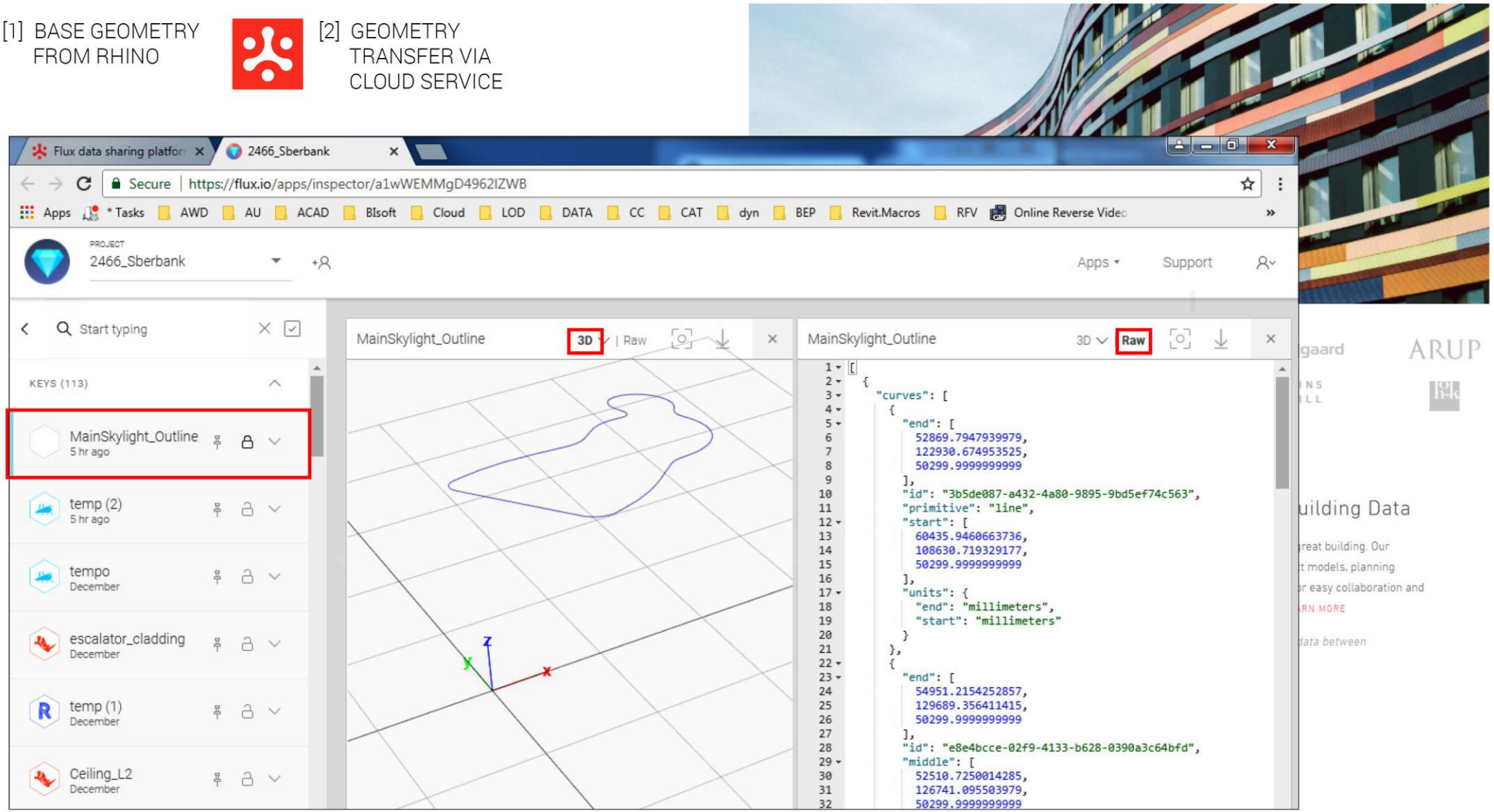
DYNAMO . SKYLIGHT

FLUX

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

[1] BASE GEOMETRY FROM RHINO

[2] GEOMETRY TRANSFER VIA CLOUD SERVICE

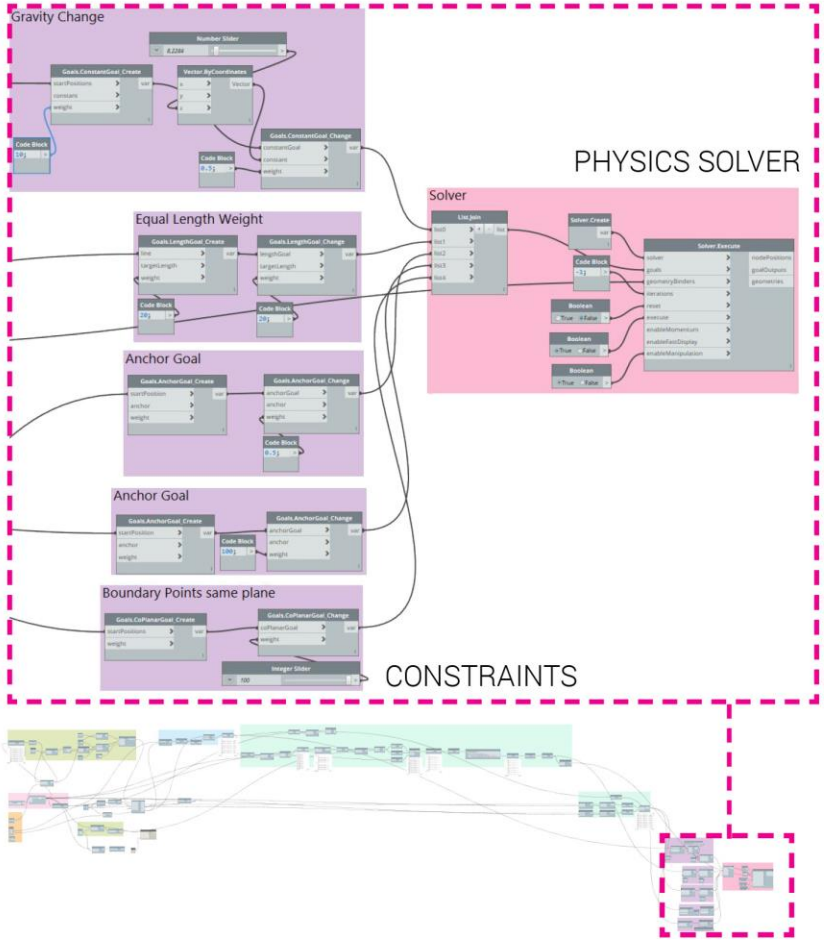


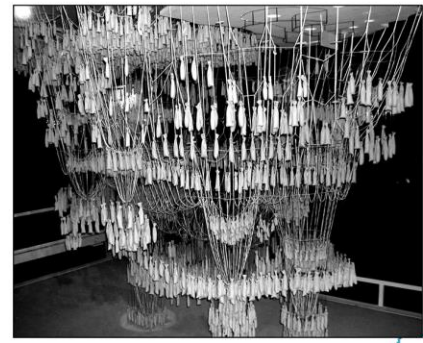
DYNAMO . SKYLIGHT

[1] BASE GEOMETRY FROM RHINO

[2] GEOMETRY TRANSFER VIA CLOUD SERVICE

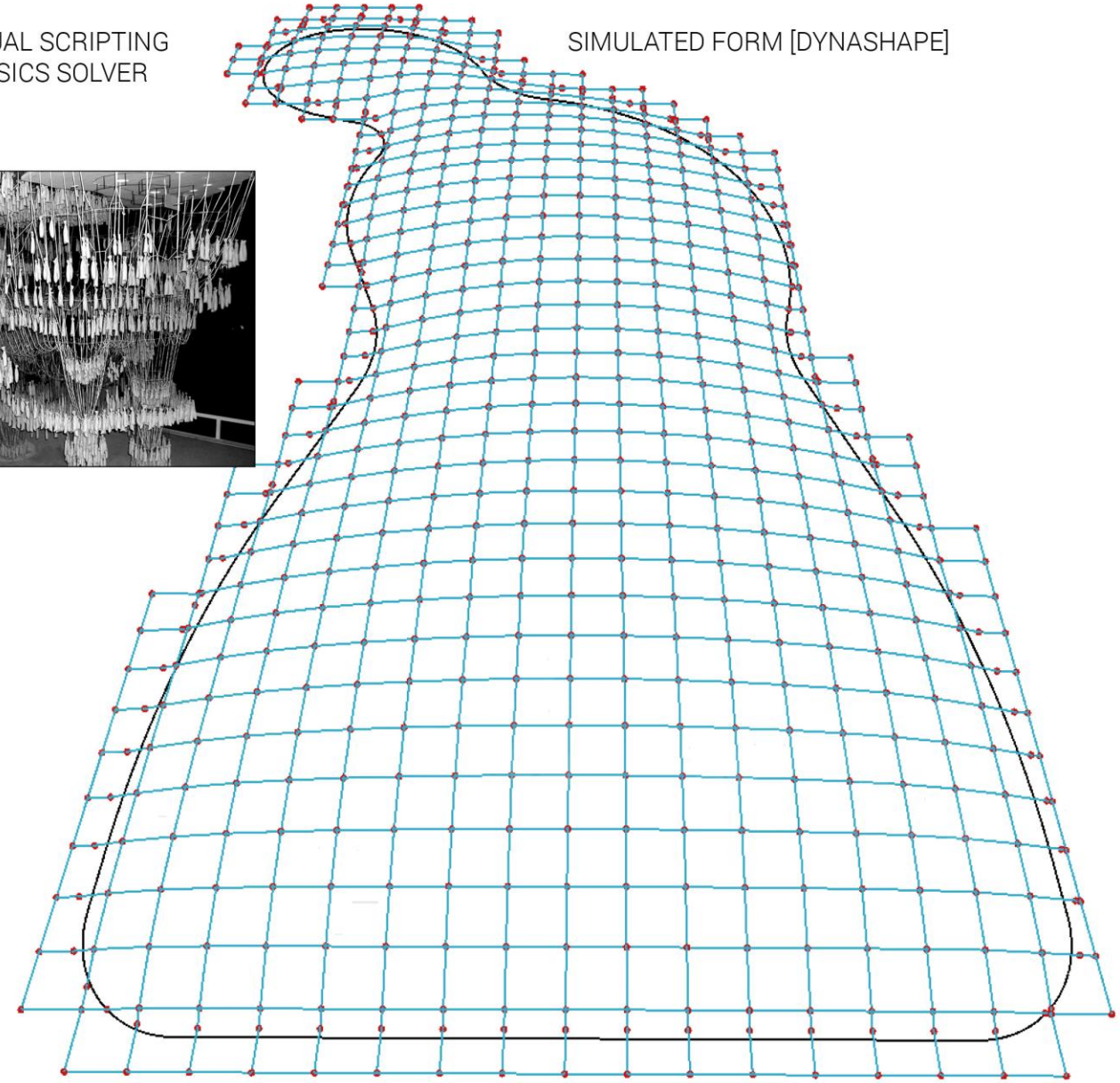
[3] VISUAL SCRIPTING PHYSICS SOLVER

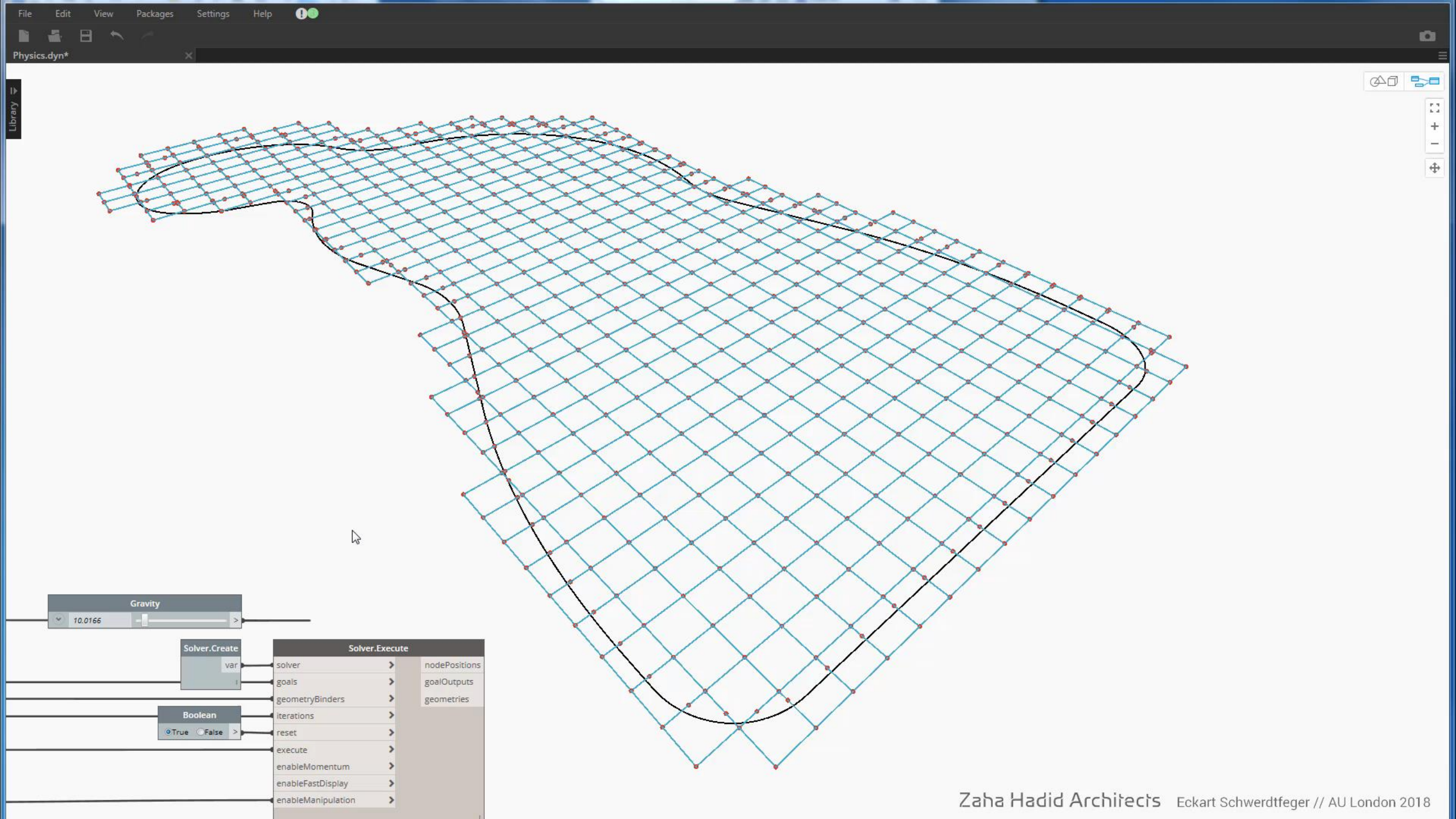




GAUDI

SIMULATED FORM [DYNASHAPE]





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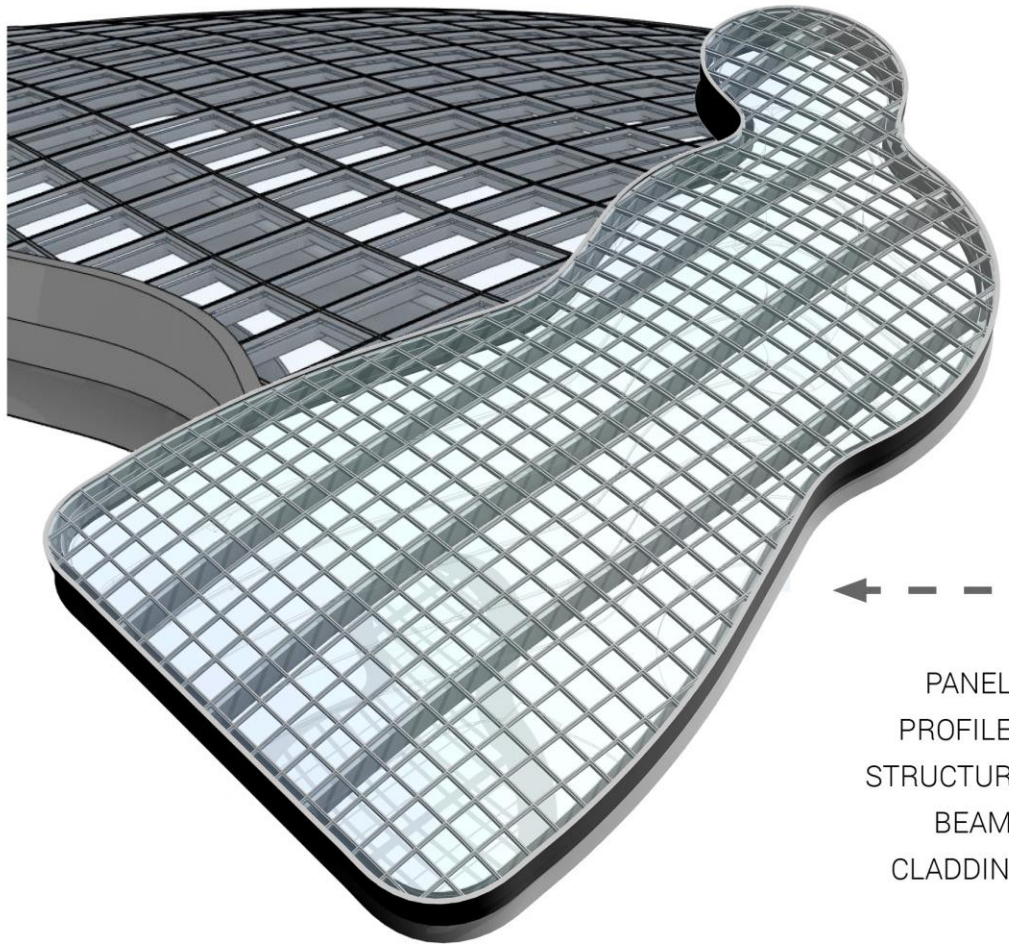
DYNAMO . SKYLIGHT

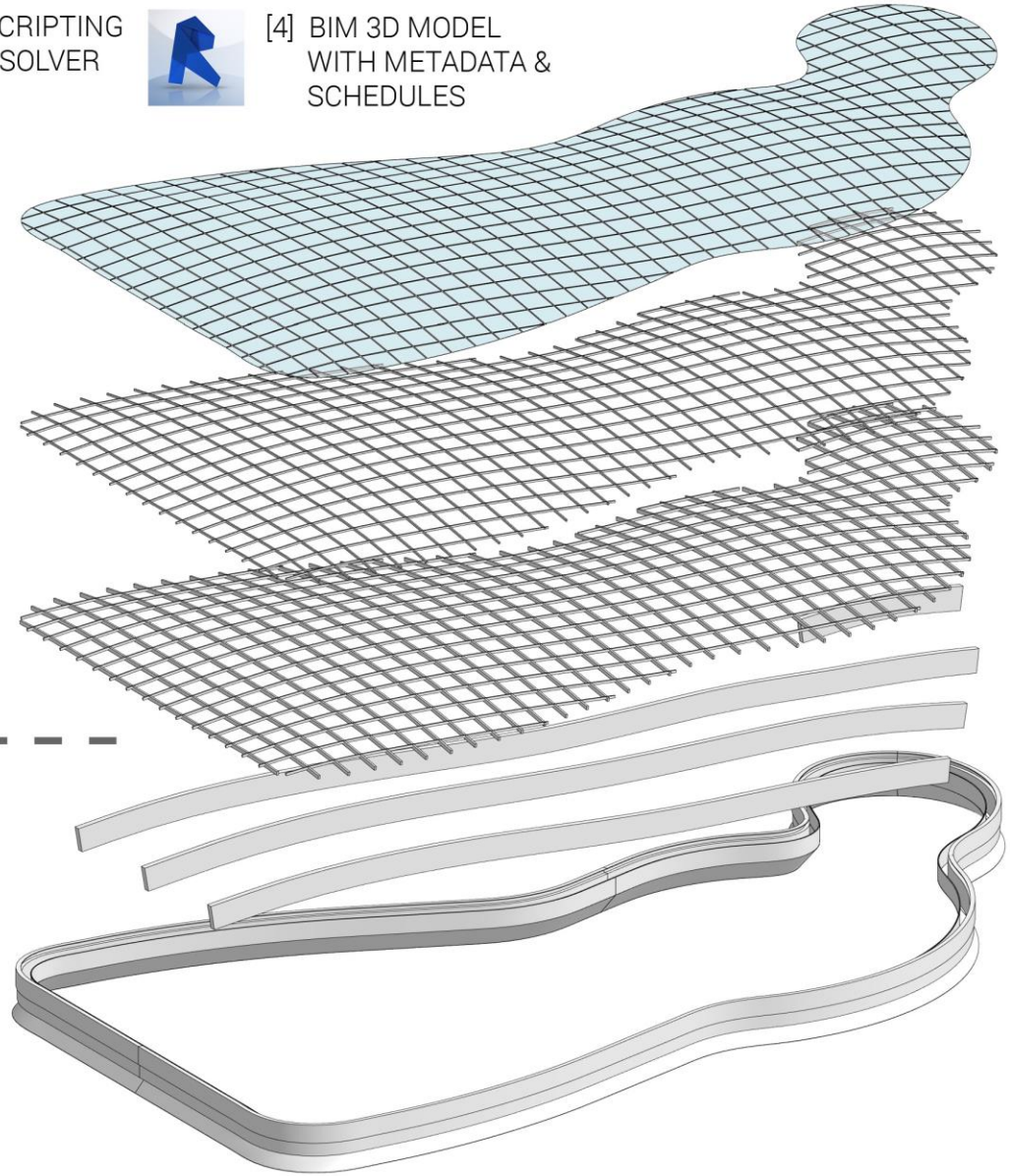
[1] BASE GEOMETRY FROM RHINO

[2] GEOMETRY TRANSFER VIA CLOUD SERVICE

[3] VISUAL SCRIPTING PHYSICS SOLVER

[4] BIM 3D MODEL WITH METADATA & SCHEDULES

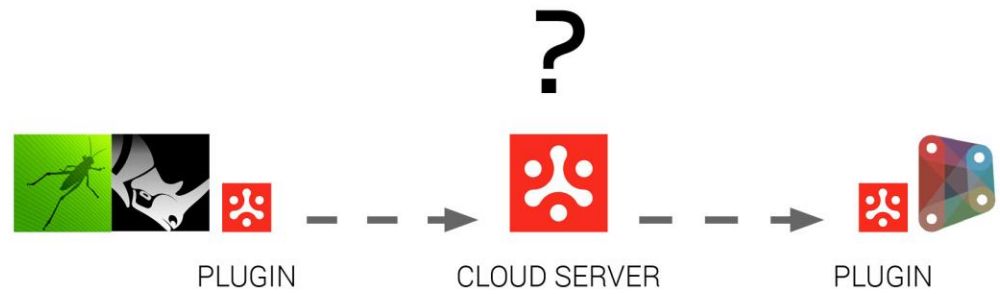


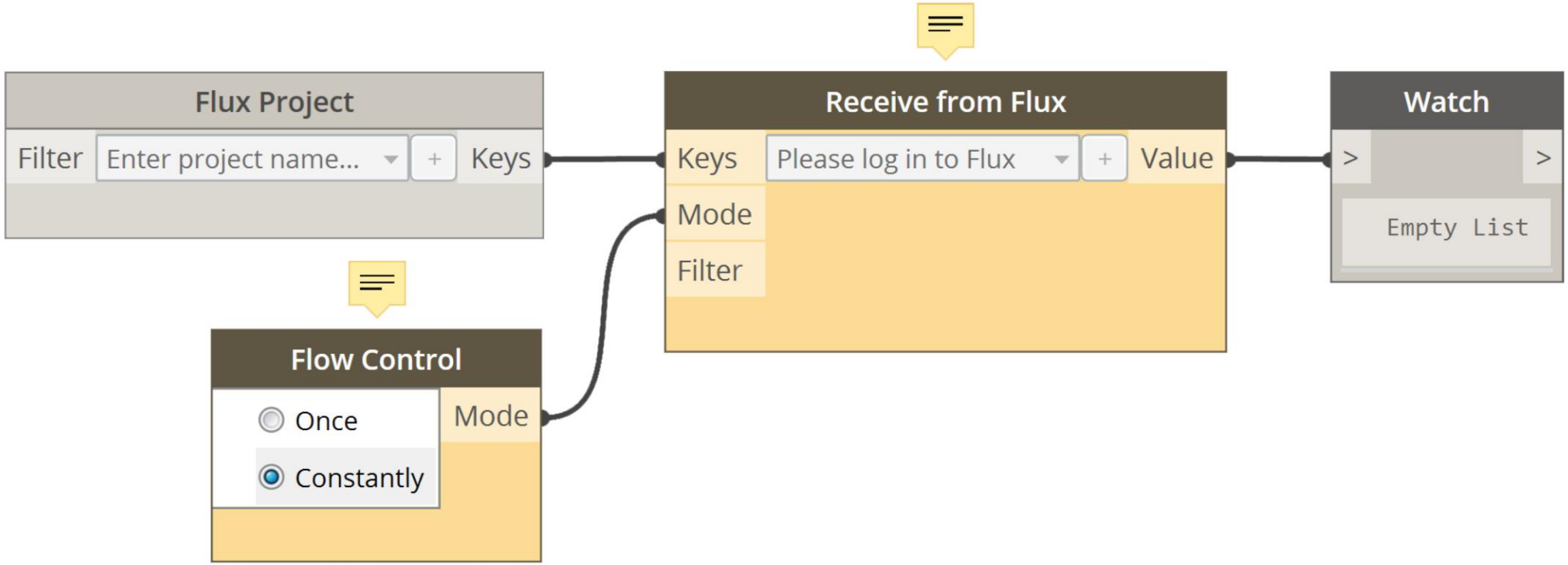


DYNAMO . CUSTOM NODES

CLOUD PLUGIN

FOR CROSS-APPLICATION TRANSFER
OF BASE GEOMETRY AND METADATA

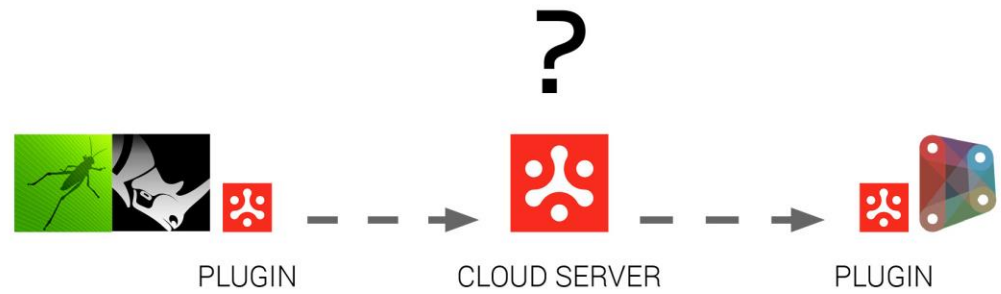


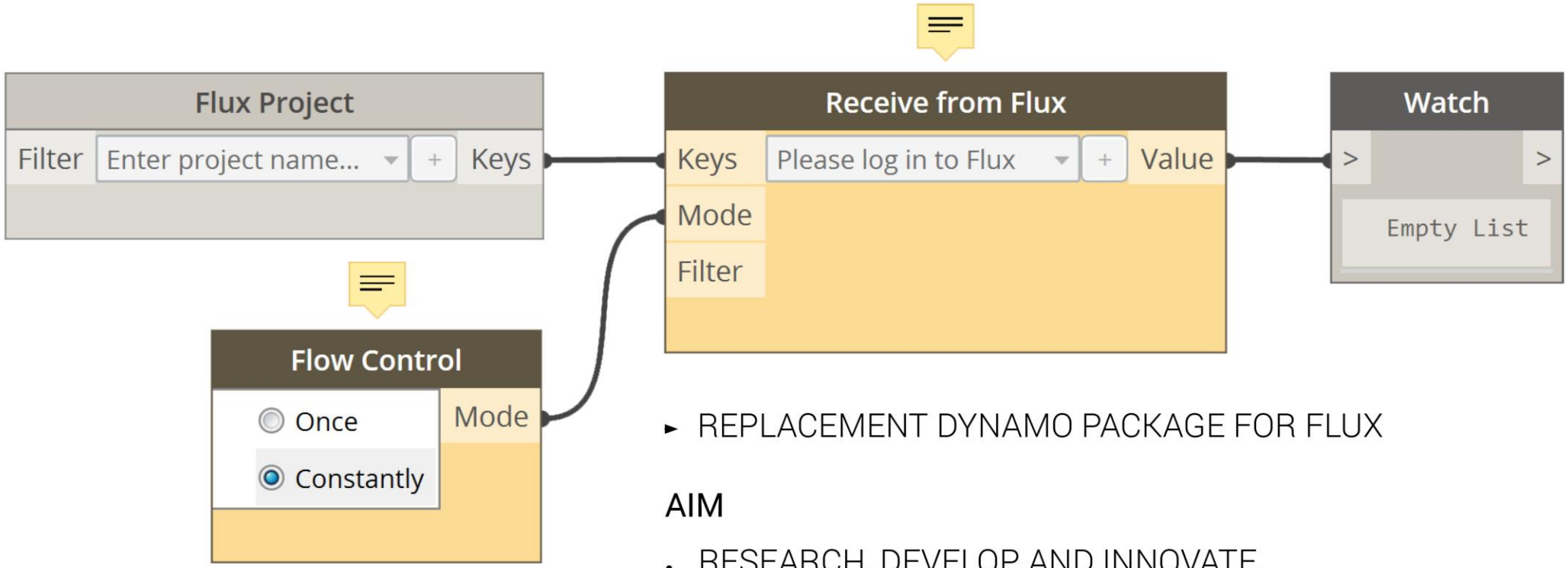


DYNAMO . CUSTOM NODES

CLOUD PLUGIN

FOR CROSS-APPLICATION TRANSFER
OF BASE GEOMETRY AND METADATA





- REPLACEMENT DYNAMO PACKAGE FOR FLUX

AIM

- RESEARCH, DEVELOP AND INNOVATE
- EFFICIENT, INTELLIGENT AND ADAPTABLE NODES
- BETTER USER INTERACTION AND USER FRIENDLINESS

DYNAMO . CUSTOM NODES

CLOUD PLUGIN

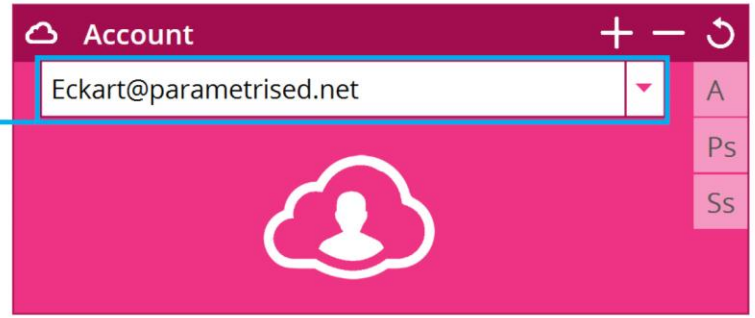
ACCOUNT NODE

CUSTOM USER INTERFACE NODE

SELECT AN EXISTING ACCOUNT OR LOGIN / REGISTER ONE

EASY ACCOUNT SELECTION

ACCOUNT SELECTION MODE

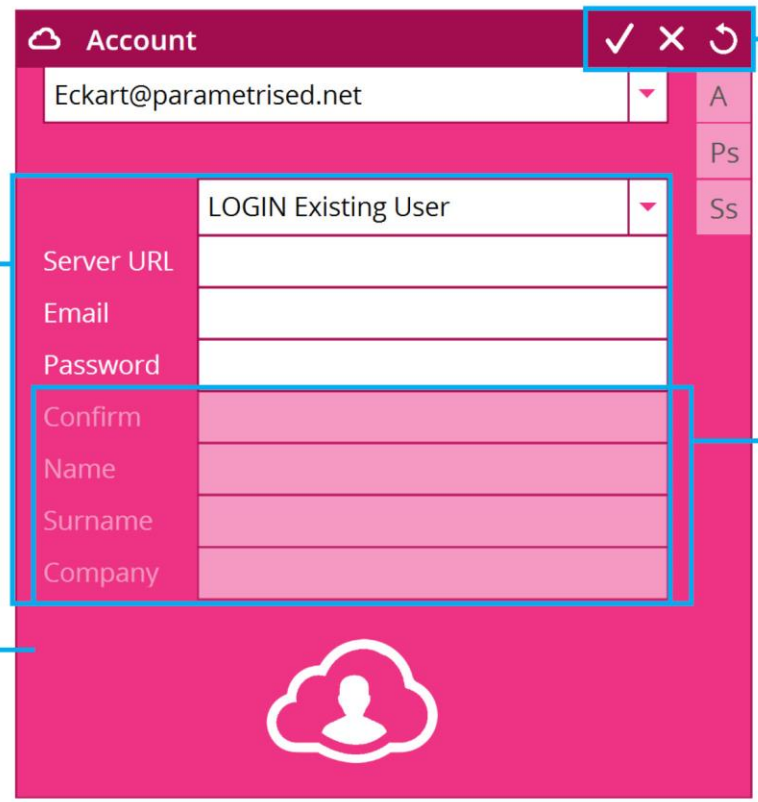


ACCOUNT →

PROJECTS →

STREAMS →

MODE ACCOUNT LOGIN + REGISTRATION



ADAPTIVE WINDOWS-LIKE CONTROL BUTTONS TO ACCESS ADDITIONAL NODE FUNCTIONALITY

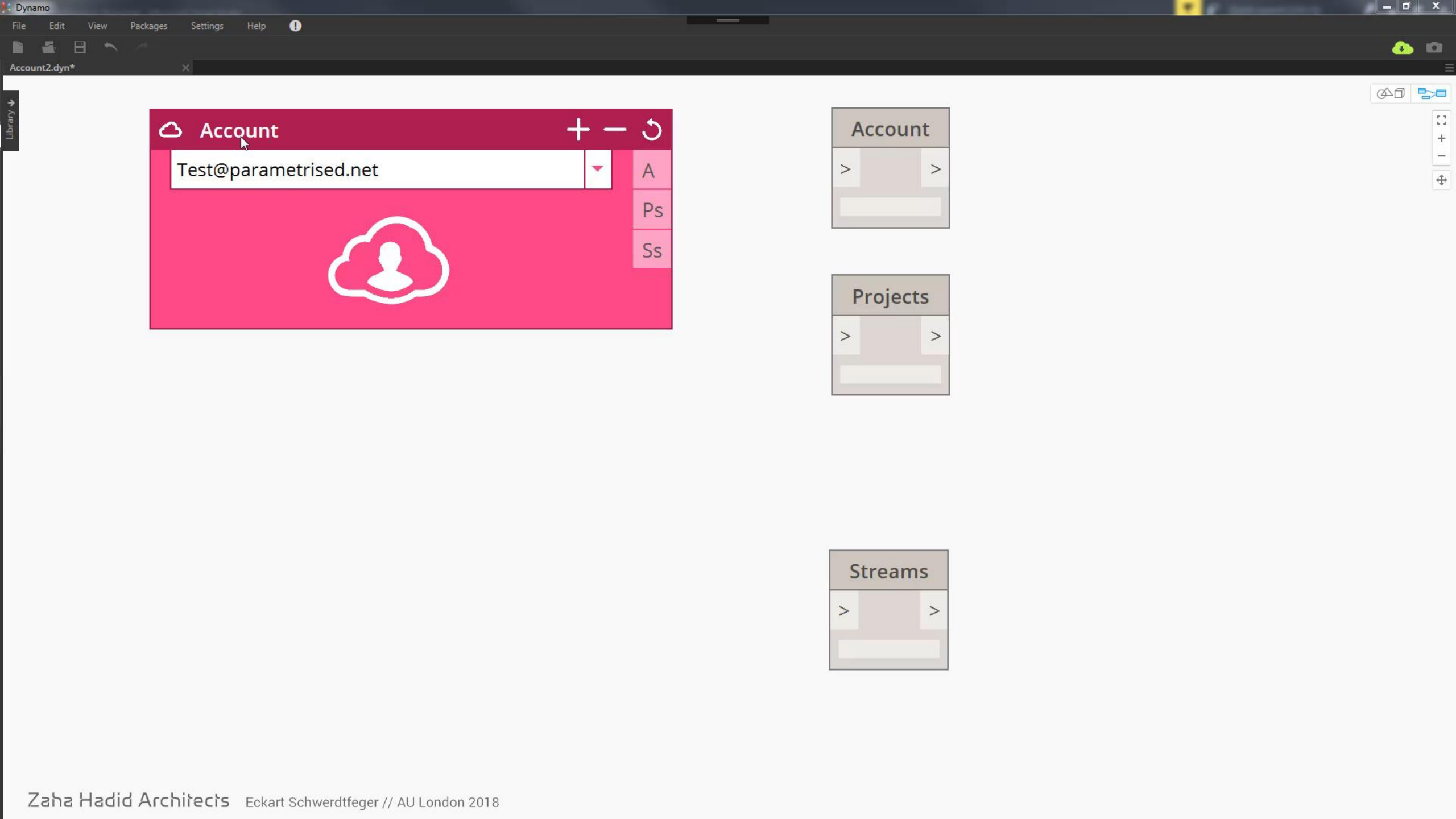
E.G.
ADD / DELETE ACCOUNT
SUBMIT / CANCEL / RELOAD

ALL NECESSARY FUNCTIONALITY EMBEDDED INSIDE NODE

NODE LAYOUT ADAPTS ON THE FLY

NODE CONTROLS ADAPT TO USER INTERACTION FOR GUIDANCE

CUSTOM COLOR SCHEME


Dynamo
File
Edit
View
Packages
Settings
Help
Account2.dyn*
Library
Account
Test@parametrised.net
A
Ps
Ss
Account
Projects
Streams

DYNAMO . CUSTOM NODES

CLOUD PLUGIN

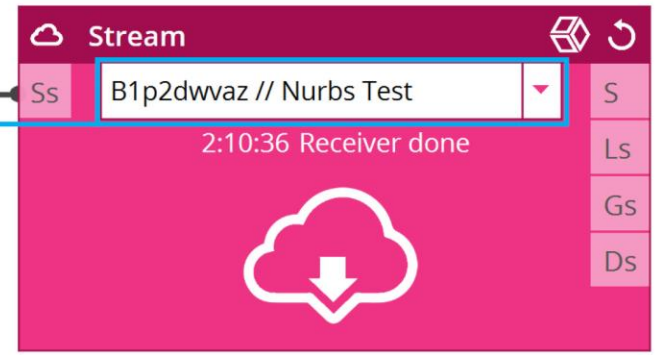
STREAM NODE

CUSTOM USER INTERFACE NODE

SELECT A DATA STREAM LINKED TO THE ACCOUNT AND RECEIVE ITS GEOMETRY + METADATA

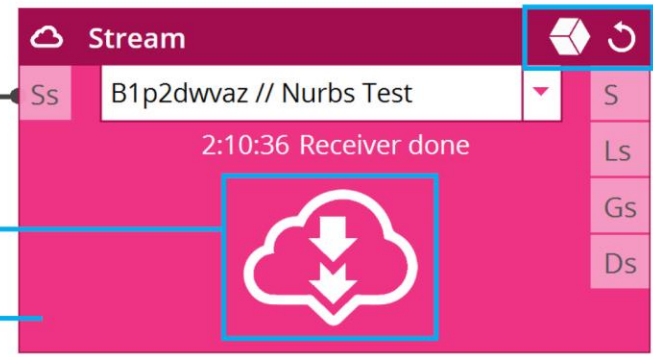
EASY STREAM SELECTION

MANUAL UPDATE MODE



STREAM
LAYERS
GEOMETRY
DICTIONARIES

MODE AUTOMATIC UPDATE

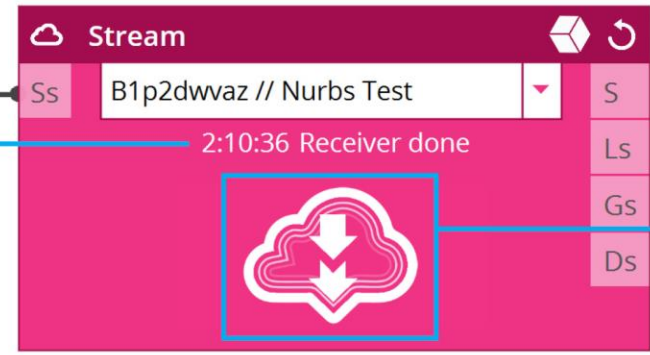


ADAPTIVE WINDOWS-LIKE CONTROL BUTTONS TO ACCESS ADDITIONAL NODE FUNCTIONALITY

E.G. LOAD GEOMETRY / RELOAD

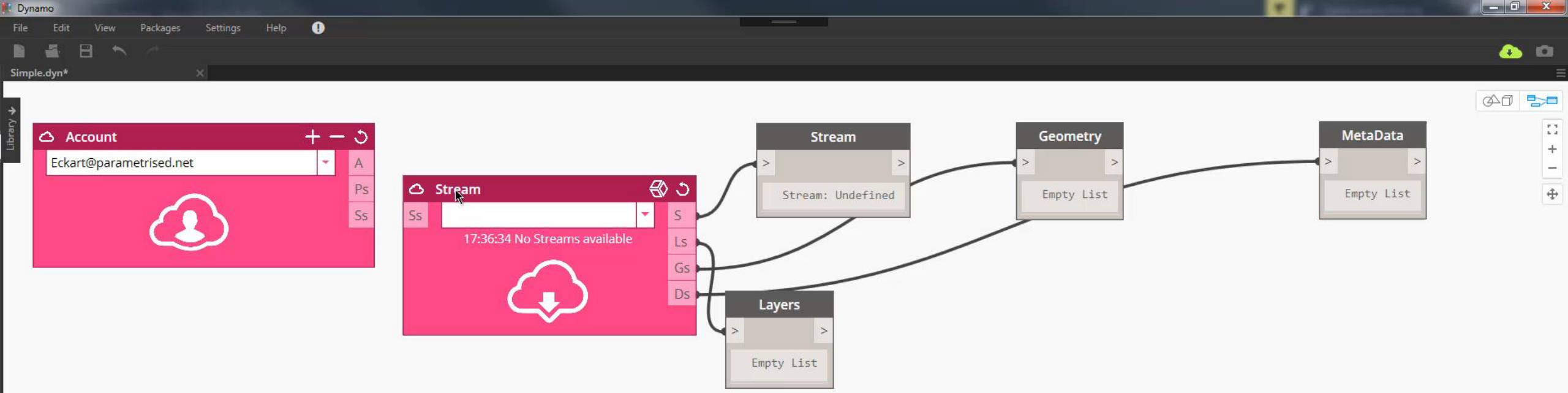
CLICK ICON TO CHANGE MODE

CUSTOM COLOR SCHEME



LIVE MESSAGES FROM FUNCTION CALL

ANIMATION TRIGGERED ON SERVER PING


Dynamo
File
Edit
View
Packages
Settings
Help
Simple.dyn*
Library
Account
Eckart@parametrised.net
A
Ps
Ss
Stream
Ss
17:36:34 No Streams available
S
Ls
Gs
Ds
Stream
Stream: Undefined
Geometry
Empty List
MetaData
Empty List
Layers
Empty List

DYNAMO . CUSTOM NODES

CLOUD PLUGIN

STREAM NODE

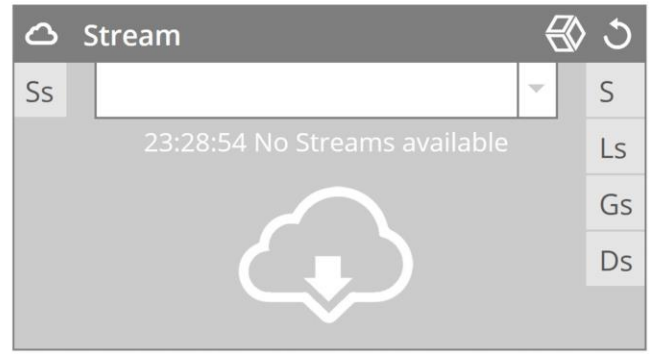
CUSTOM USER INTERFACE NODE

RESPONSIVE COLOR SCHEMES

VISUALISE NODE STATUS AND EVENTS

USER CUSTOMISATION

INACTIVE MODE



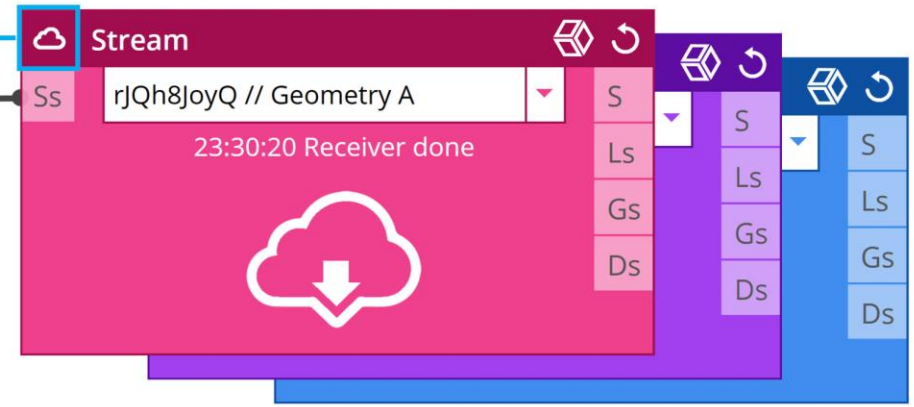
NODE COLOR GREYED OUT
E.G. INPUT MISSING

BASE COLOR ACTIVE WHEN NODE RUNS NORMALLY

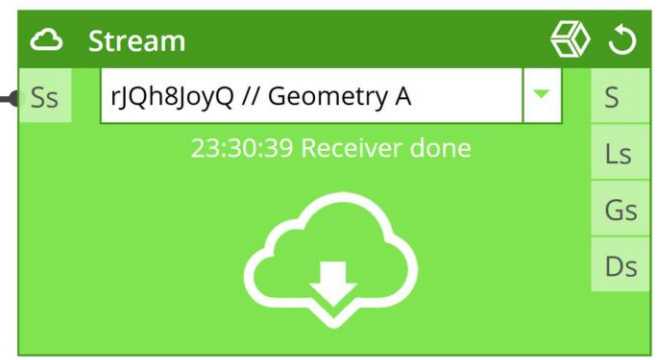
BASE COLOR CAN BE CUSTOMISED BY USER

COLOR IS SAVED IN DYNAMO FILE AND RESTORED ON LOAD

ACTIVE MODE



MODE ELEVATED



NODE COLOR FLASHES + FADES BACK TO NORMAL
E.G. TO SHOW EVENT

Dynamo

File Edit View Packages Settings Help

Rainbow.dyn*

Library

Account

Test@parametrised.net

A

Ps

Ss

Stream

Ss

01:25:50 No Streams available

S

Ls

Gs

Ds

Automatic

Run completed.

Adaptive Elements

ADAPTIVE ELEMENTS

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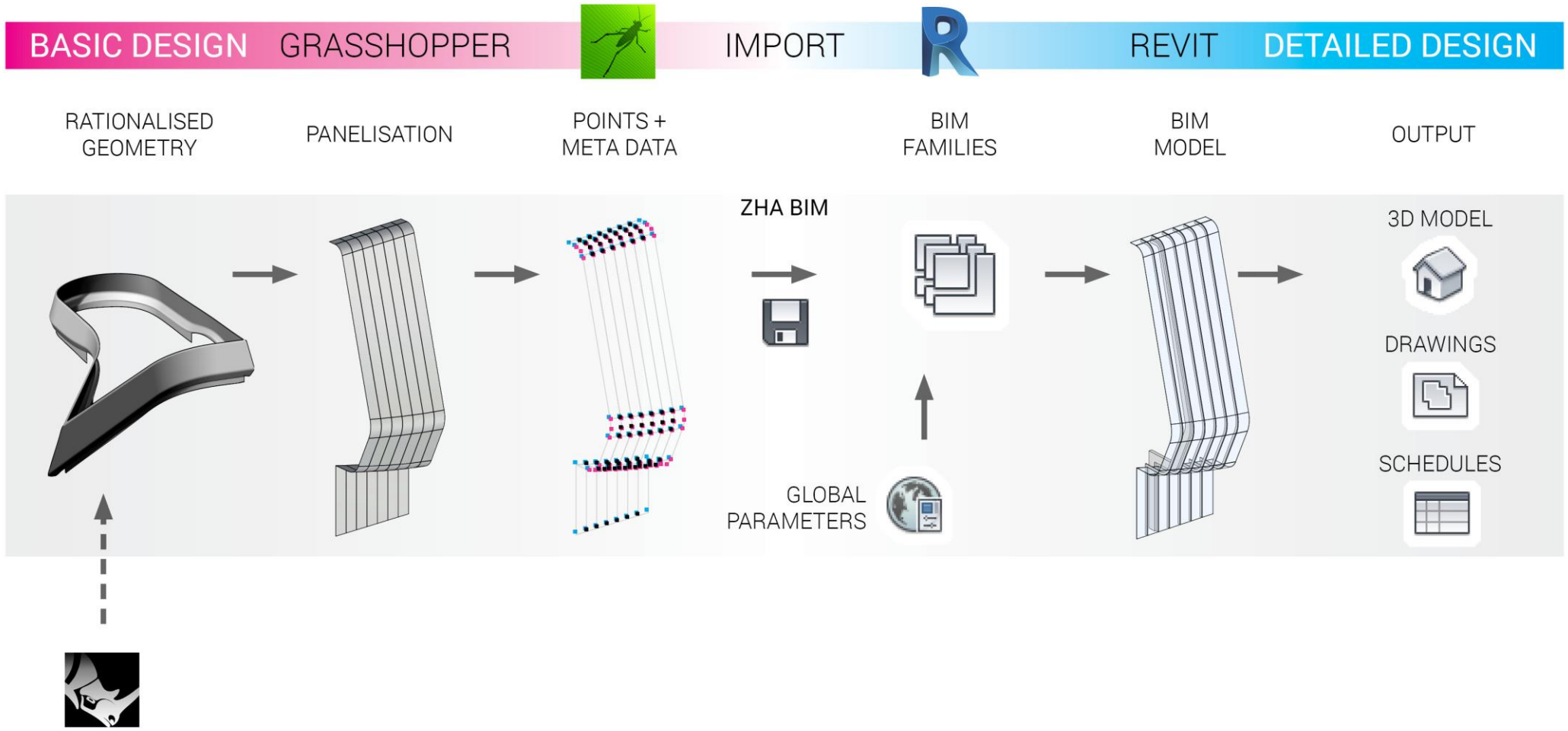
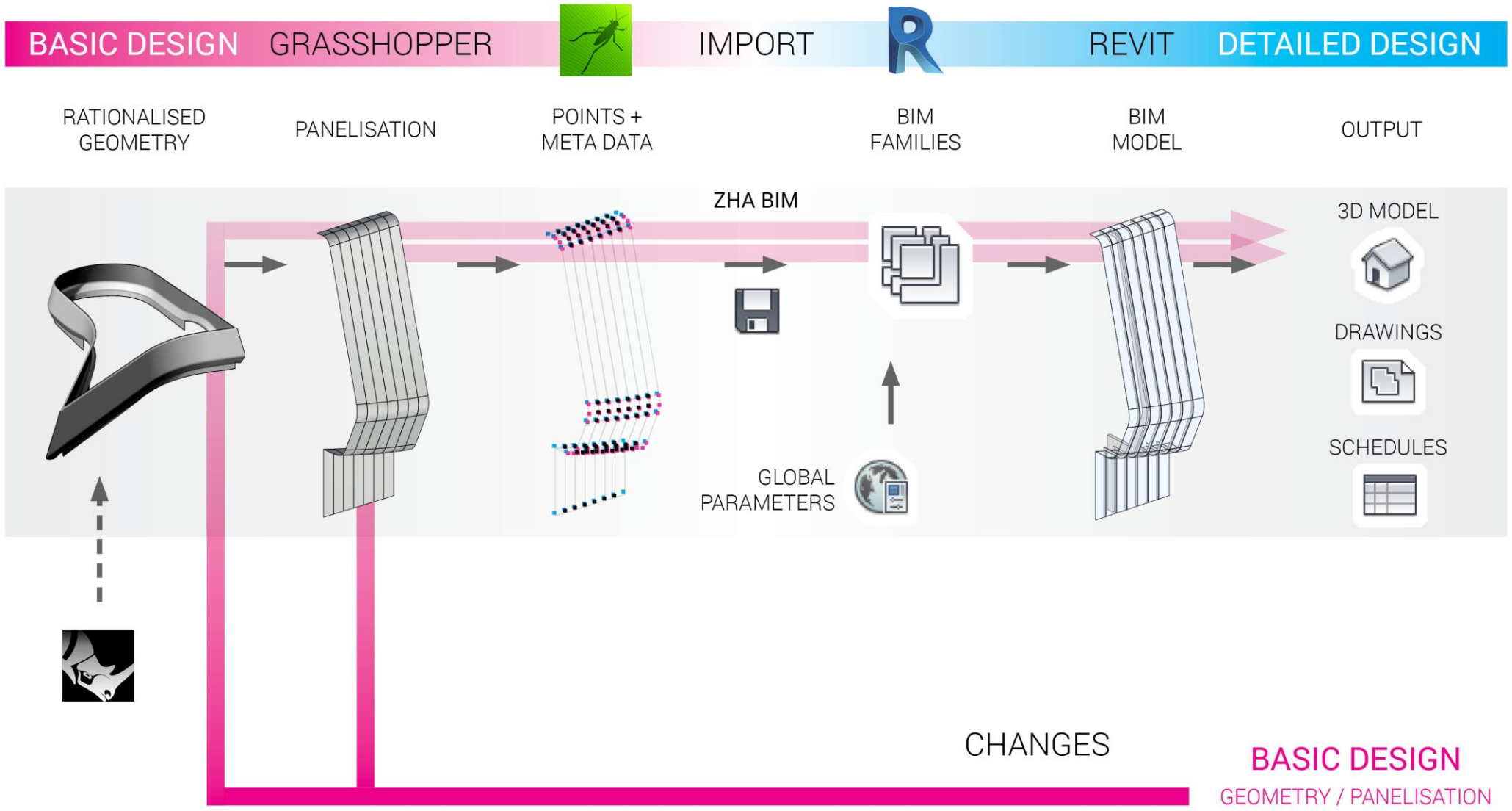
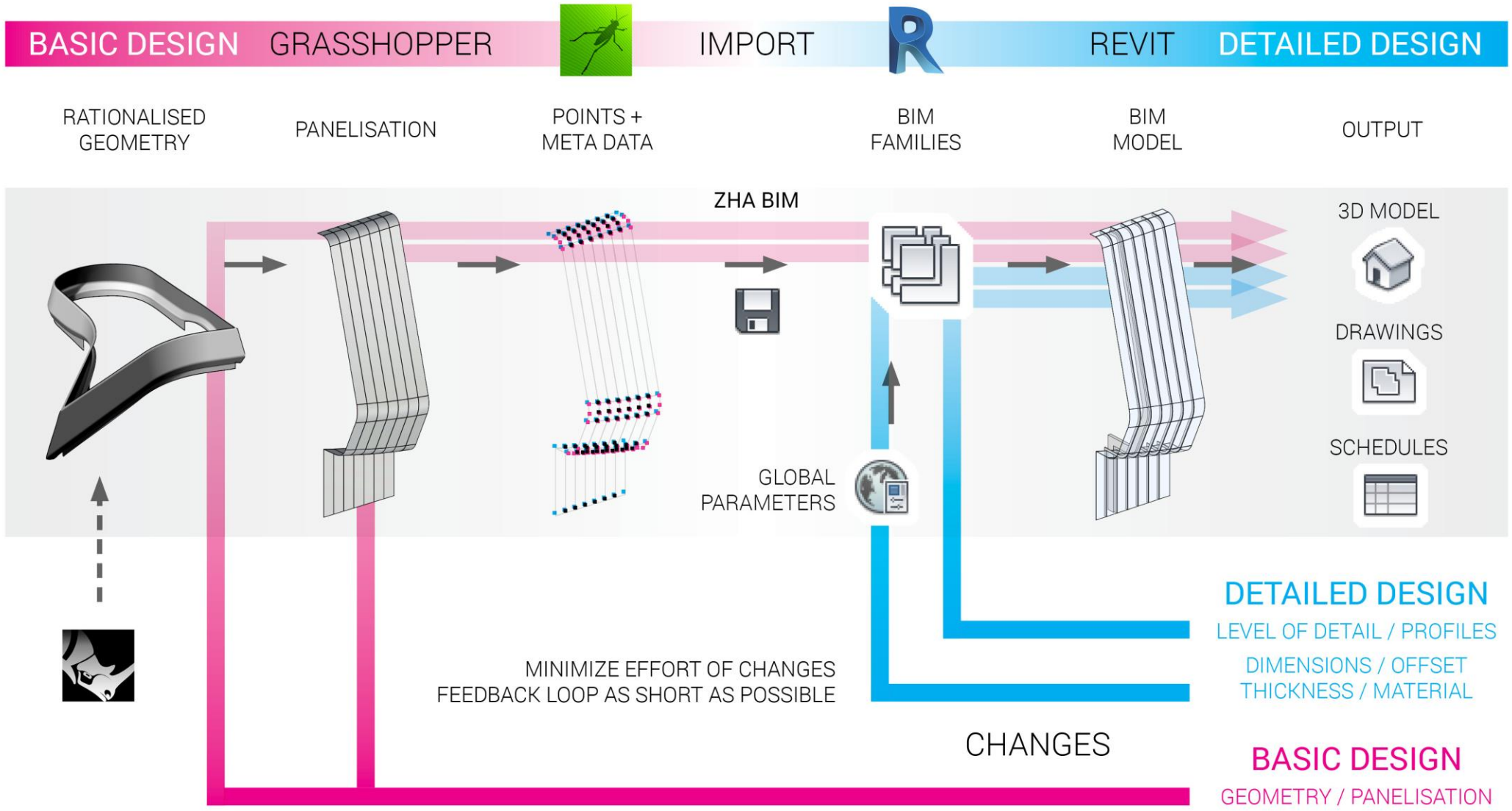
ADAPTIVE ELEMENTS . PROCESS



ADAPTIVE ELEMENTS . PROCESS



ADAPTIVE ELEMENTS . PROCESS



ADAPTIVE ELEMENTS

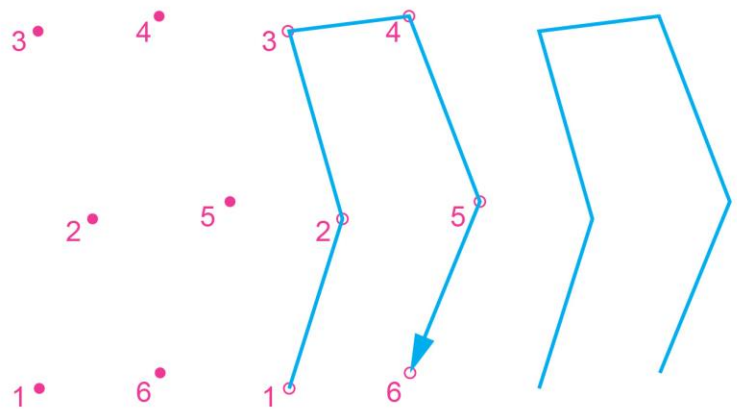
INPUT FOR REVIT

SOLIDS
FOR MASS FAMILIES

FREEFORM / DOUBLE CURVED GEOMETRY

POINTCLOUD
FOR ADAPTIVE FAMILIES

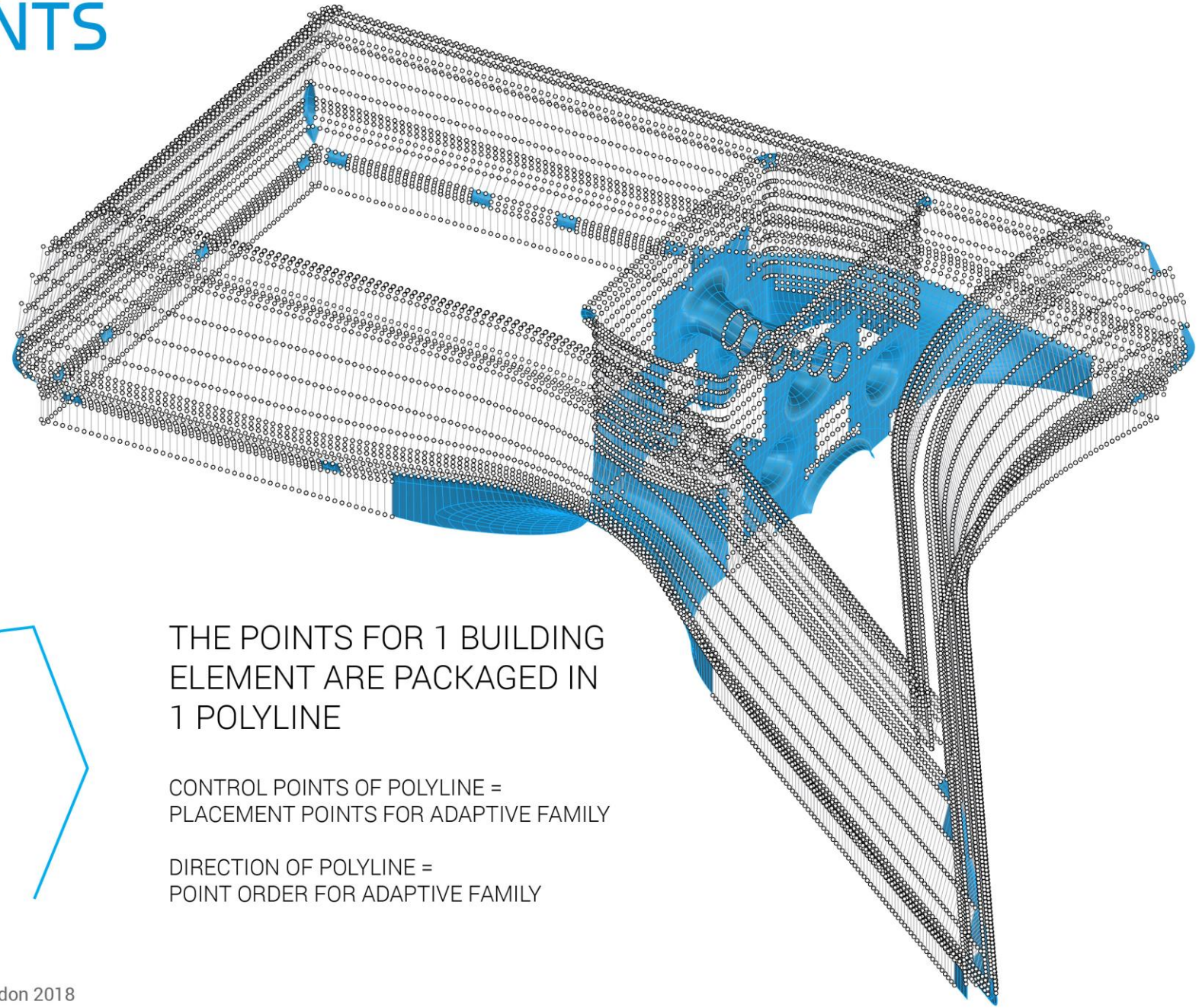
RATIONAL / RULE - BASED GEOMETRY



THE POINTS FOR 1 BUILDING ELEMENT ARE PACKAGED IN 1 POLYLINE

CONTROL POINTS OF POLYLINE =
PLACEMENT POINTS FOR ADAPTIVE FAMILY

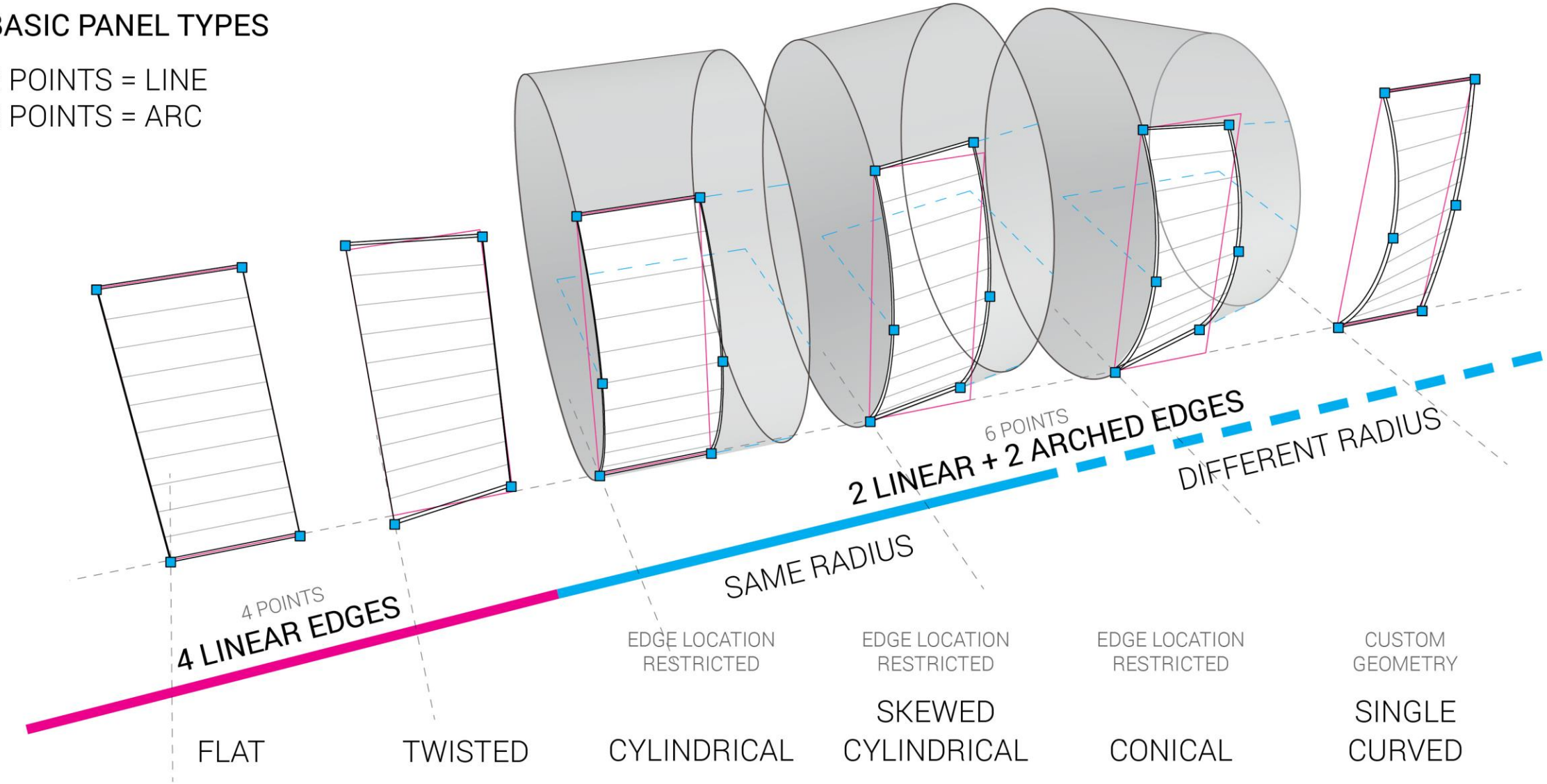
DIRECTION OF POLYLINE =
POINT ORDER FOR ADAPTIVE FAMILY



ADAPTIVE ELEMENTS . PANELS

BASIC PANEL TYPES

2 POINTS = LINE
3 POINTS = ARC



ADAPTIVE ELEMENTS . PANELS

ADAPTIVE FAMILY

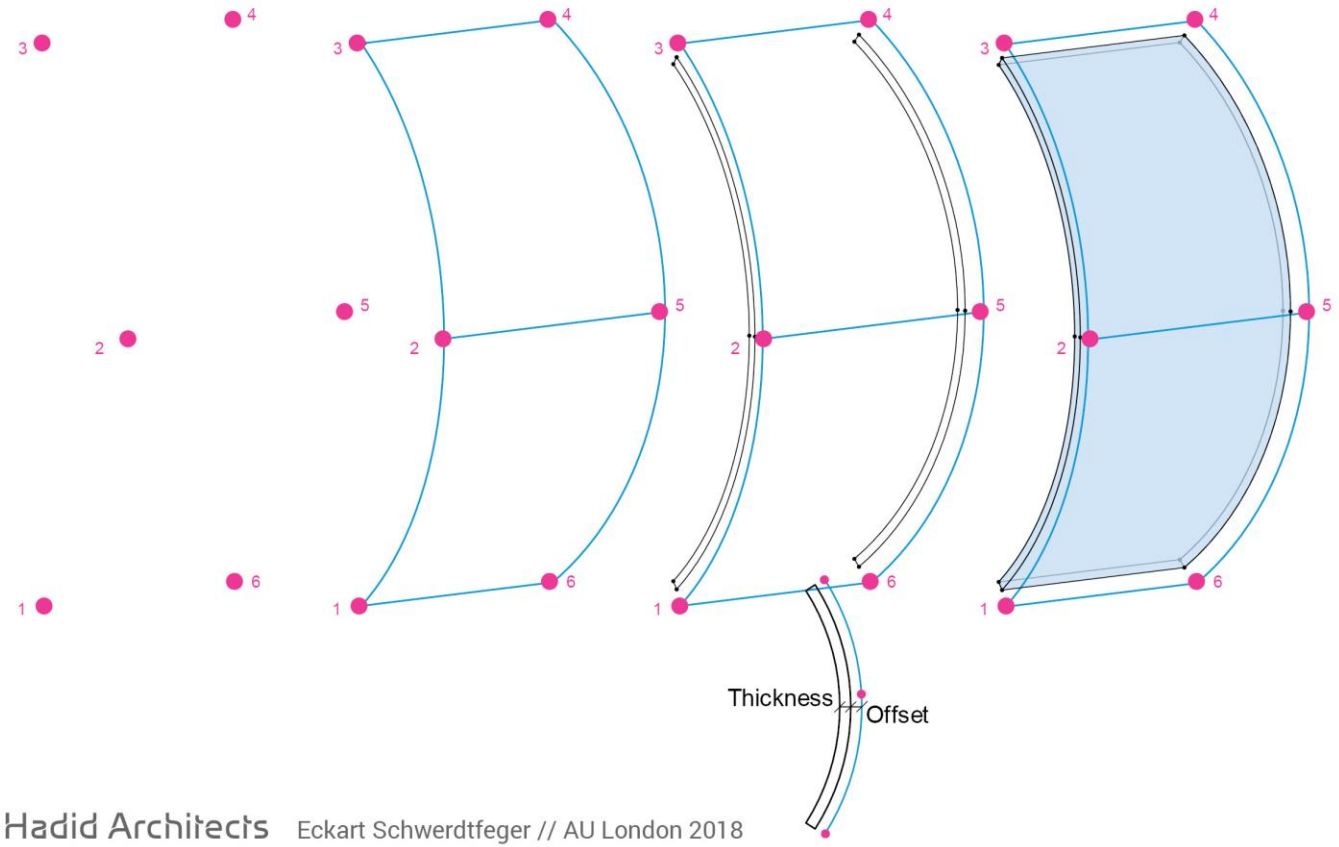
[1]
SET UP ADAPTIVE POINTS AND PLACEMENT ORDER

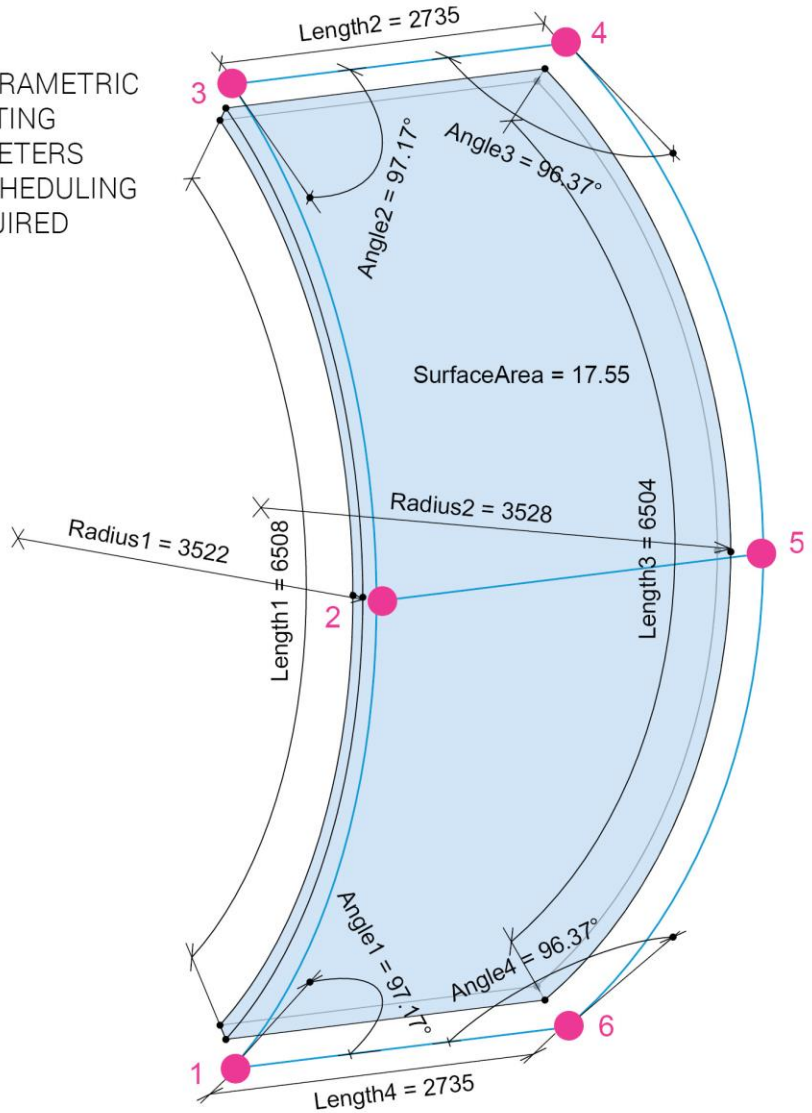
[2]
CREATE FRAME OUT OF LINES [2 POINTS] AND ARCS [3 POINTS] THAT ALLOWS FOR PANEL EDGE OFFSETS

[3]
PLACE EDGE PROFILES USING NESTED FAMILY THAT DEALS WITH PANEL OFFSET AND THICKNESS

[4]
BLEND BOTH EDGE PROFILES INTO SOLID OBJECT

[5]
ADD PARAMETRIC REPORTING PARAMETERS FOR SCHEDULING IF REQUIRED





ADAPTIVE ELEMENTS

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ADAPTIVE ELEMENTS . COLUMNS

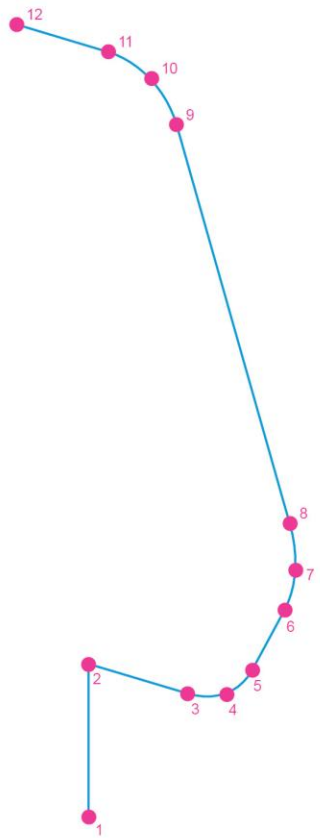
ADAPTIVE FAMILY

[1]

SET UP ADAPTIVE POINTS AND ORDER

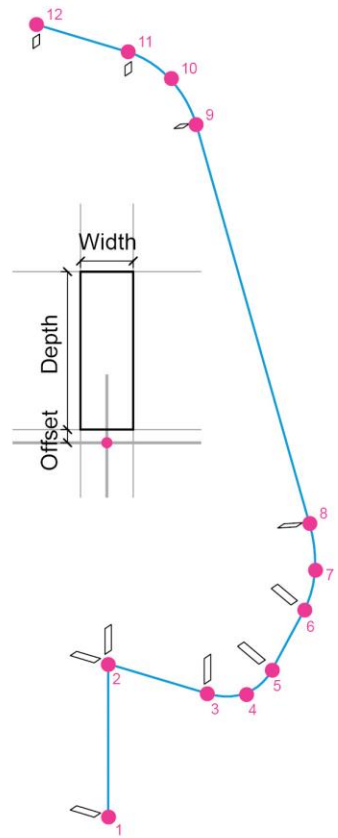
[2]

CREATE MULLION AXIS OUT OF LINES [2 POINTS] AND ARCS [3 POINTS]



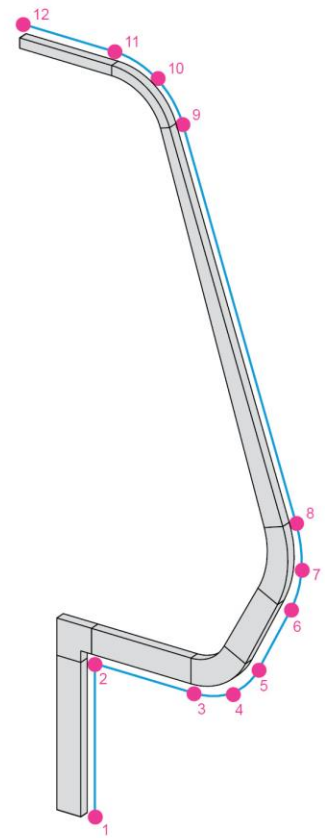
[3]

PLACE MULLION PROFILES USING NESTED FAMILY THAT DEALS WITH OFFSET AND DIMENSIONS



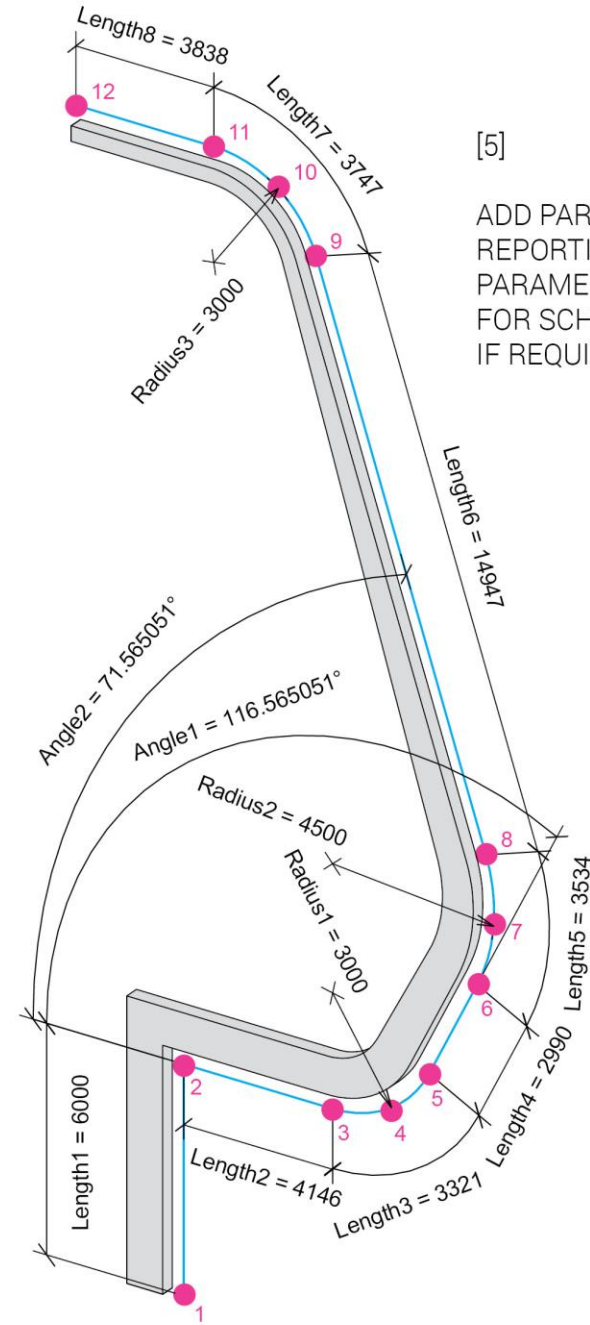
[4]

USE MULLION AXIS AND PROFILES TO CREATE SOLID OBJECT [SWEPT BLEND]



[5]

ADD PARAMETRIC REPORTING PARAMETERS FOR SCHEDULING IF REQUIRED



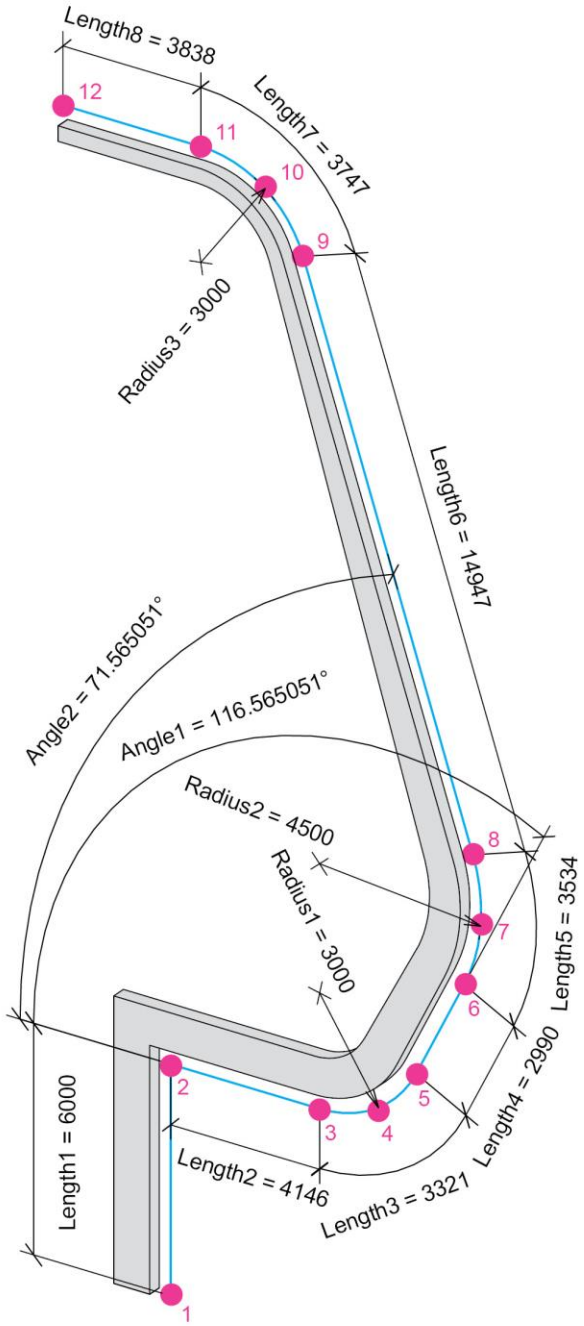
ADAPTIVE ELEMENTS . COLUMNS

SCHEDULING OF PARAMETERS

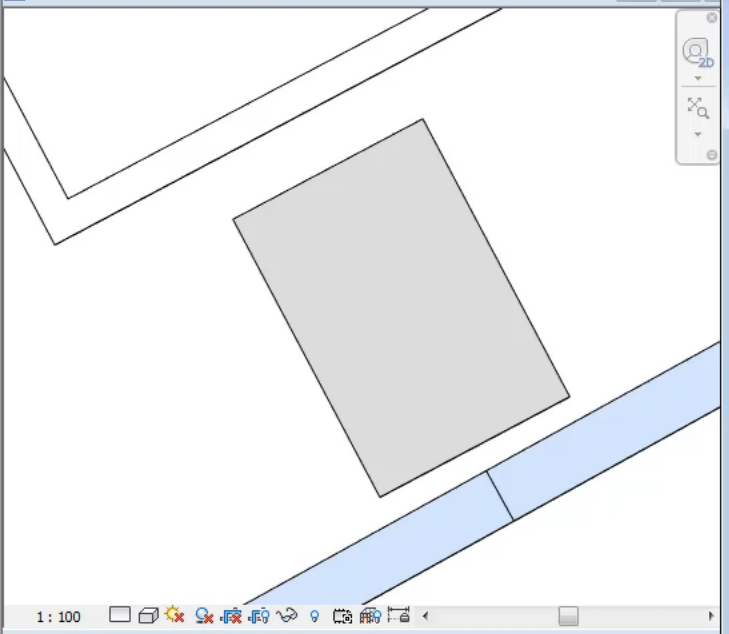
FACADE CLADDING - COLUMNS

	GEOMETRY					PROFILE									BEAMS						
NAME	ANGLE 1	ANGLE 2	WIDTH	DEPTH MAX	DEPTH #5	DEPTH #6	DEPTH #8	DEPTH #9	DEPTH MIN	LENGTH 1	LENGTH 2	LENGTH 3	LENGTH 4	LENGTH 5	LENGTH 6	LENGTH 7	LENGTH 8	LENGTH TOTAL	RADIUS 1	RADIUS 2	RADIUS 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	4.741 mm	2.443 mm	19.291 mm	1.963 mm	999 mm	42.115 mm	1.200 mm	3.500 mm	1.500 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	4.450 mm	2.443 mm	18.399 mm	1.963 mm	999 mm	42.057 mm	1.200 mm	3.500 mm	1.500 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	4.136 mm	2.443 mm	17.436 mm	1.963 mm	999 mm	41.995 mm	1.200 mm	3.500 mm	1.500 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	5.459 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 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	5.459 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 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	5.459 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 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	5.455 mm	2.443 mm	21.478 mm	1.963 mm	999 mm	42.256 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0008	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.850 mm	2.736 mm	1.361 mm	5.447 mm	2.443 mm	21.454 mm	1.963 mm	999 mm	42.255 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0009	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.910 mm	2.736 mm	1.361 mm	5.432 mm	2.443 mm	21.407 mm	1.963 mm	999 mm	42.252 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0010	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	6.060 mm	2.736 mm	1.361 mm	5.393 mm	2.443 mm	21.288 mm	1.963 mm	999 mm	42.244 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0011	115,00°	75,00°	350 mm	900 mm	900 mm	799 mm	752 mm	350 mm	350 mm	6.375 mm	2.736 mm	1.361 mm	5.312 mm	2.443 mm	21.038 mm	1.963 mm	999 mm	42.228 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0012	115,00°	75,00°	350 mm	900 mm	900 mm	799 mm	752 mm	350 mm	350 mm	7.110 mm	2.736 mm	1.361 mm	5.121 mm	2.443 mm	20.456 mm	1.963 mm	999 mm	42.190 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0013	115,00°	75,00°	350 mm	900 mm	900 mm	801 mm	751 mm	350 mm	350 mm	8.535 mm	2.736 mm	1.361 mm	4.753 mm	2.443 mm	19.326 mm	1.963 mm	999 mm	42.117 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0014	115,00°	75,00°	350 mm	900 mm	900 mm	799 mm	752 mm	350 mm	350 mm	6.930 mm	2.736 mm	1.361 mm	5.168 mm	2.443 mm	20.598 mm	1.963 mm	999 mm	42.199 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0015	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	6.315 mm	2.736 mm	1.361 mm	5.327 mm	2.443 mm	21.086 mm	1.963 mm	999 mm	42.231 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0016	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	6.060 mm	2.736 mm	1.361 mm	5.393 mm	2.443 mm	21.288 mm	1.963 mm	999 mm	42.244 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0017	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.940 mm	2.736 mm	1.361 mm	5.424 mm	2.443 mm	21.383 mm	1.963 mm	999 mm	42.250 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0018	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0019	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0020	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0021	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0022	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0023	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0024	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0025	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0026	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0027	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0028	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0029	115,00°	75,00°	350 mm	900 mm	900 mm	801 mm	751 mm	350 mm	350 mm	8.565 mm	2.736 mm	1.361 mm	4.745 mm	2.443 mm	19.303 mm	1.963 mm	999 mm	42.115 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0030	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0031	115,00°	75,00°	350 mm	900 mm	900 mm	800 mm	751 mm	350 mm	350 mm	7.635 mm	2.736 mm	1.361 mm	4.986 mm	2.443 mm	20.040 mm	1.963 mm	999 mm	42.163 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0032	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0033	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0034	115,00°	75,00°	350 mm	900 mm	900 mm	799 mm	752 mm	350 mm	350 mm	7.020 mm	2.736 mm	1.361 mm	5.145 mm	2.443 mm	20.527 mm	1.963 mm	999 mm	42.195 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0035	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0036	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0037	115,00°	75,00°	350 mm	900 mm	900 mm	799 mm	752 mm	350 mm	350 mm	6.630 mm	2.736 mm	1.361 mm	5.246 mm	2.443 mm	20.836 mm	1.963 mm	999 mm	42.215 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0038	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0039	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0040	115,00°	75,00°	350 mm	900 mm	900 mm	799 mm	752 mm	350 mm	350 mm	6.375 mm	2.735 mm	1.361 mm	5.312 mm	2.443 mm	21.038 mm	1.963 mm	999 mm	42.228 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0041	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	6.210 mm	2.735 mm	1.361 mm	5.354 mm	2.443 mm	21.169 mm	1.963 mm	999 mm	42.236 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0042	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm
FColumn0043	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.800 mm	2.736 mm	1.361 mm	5.465 mm	2.443 mm	21.490 mm	1.963 mm	999 mm	42.257 mm	1.200 mm	3.500 mm	1.500 mm

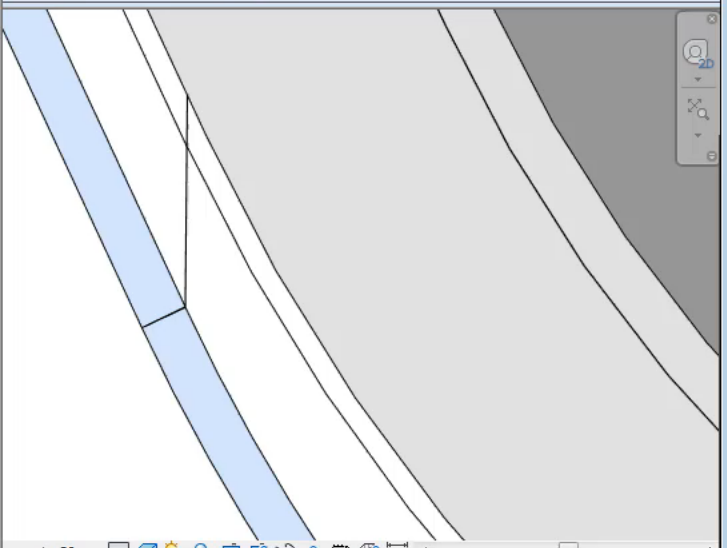
	GEOMETRY					PROFILE						
NAME	ANGLE 1	ANGLE 2	WIDTH	DEPTH MAX	DEPTH #5	DEPTH #6	DEPTH #8	DEPTH #9	DEPTH MIN	LENGTH 1	LENGTH 2	LENGTH 3
FColumn0001	115,00°	75,00°	350 mm	900 mm	900 mm	802 mm	751 mm	350 mm	350 mm	8.580 mm	2.736 mm	1.361 mm
FColumn0002	115,00°	75,00°	350 mm	900 mm	900 mm	803 mm	750 mm	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
FColumn0008	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.850 mm	2.736 mm	1.361 mm
FColumn0009	115,00°	75,00°	350 mm	900 mm	900 mm	798 mm	752 mm	350 mm	350 mm	5.910 mm	2.736 mm	1.361 mm



Floor Plan: 1 - FacadePiecea-Detailed-OK



1 : 100

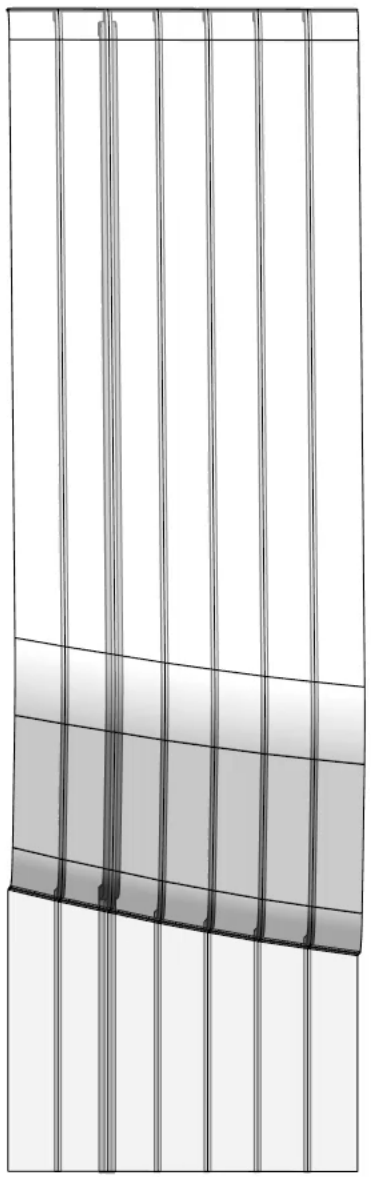


1 : 20

<PANELS>

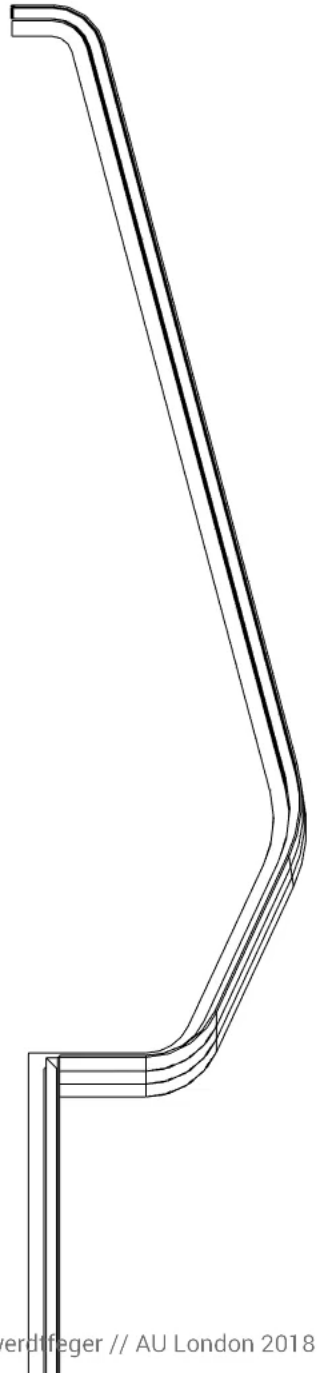
A	B	C	D	E
Mark	Length1	Length2	Length3	Length4
Glass_4sidedFlat_250	6,840 mm	1,548 mm	6,630 mm	1,533 mm
Glass_4sidedFlat_247	7,065 mm	1,550 mm	6,840 mm	1,533 mm
Glass_4sidedFlat_244	7,335 mm	1,557 mm	7,065 mm	1,533 mm

3D View: {3D} - FacadePiecea-Detailed-OK



1 : 100

Elevation: Elevation 1 - b - FacadePiecea-...



FACADE . MAIN

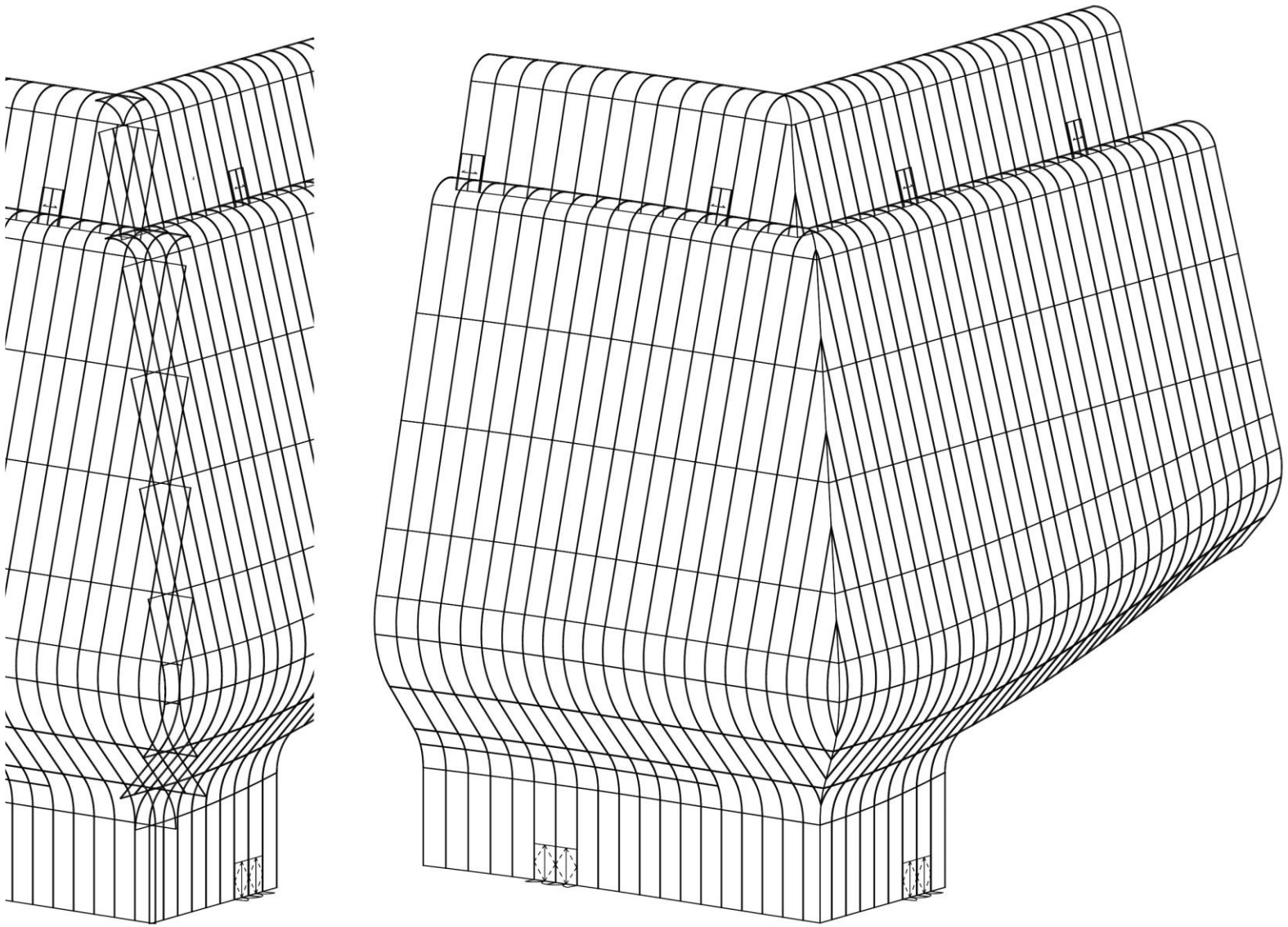
USE STANDARD FAMILIES +
CUT CORNERS USING VOIDS
TO GENERATE CUSTOM PANELS

C# MACRO

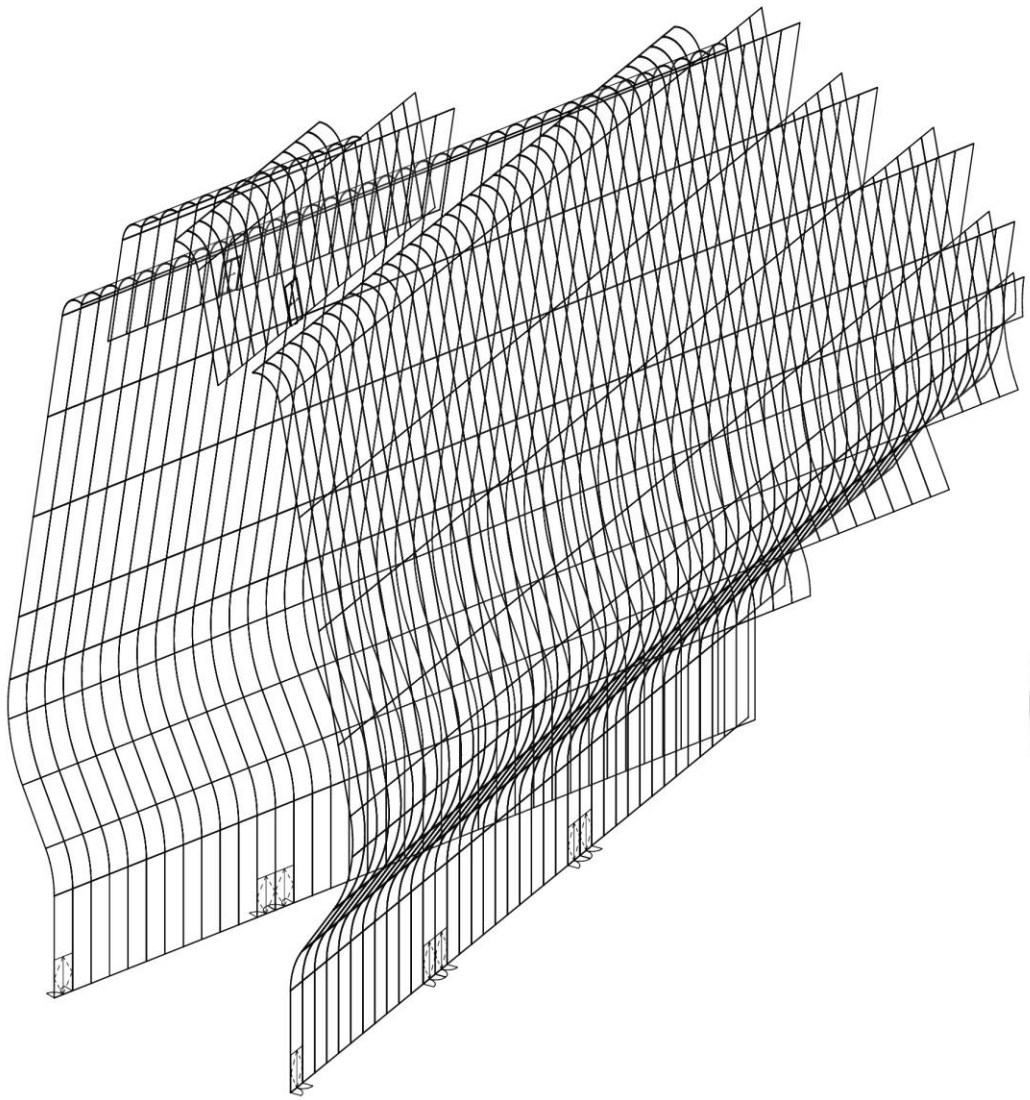
- READ PARAMETER "ORIENTATION" FOR EACH ELEMENT
- CHECK FOR INTERSECTION WITH VOID OF SAME ORIENTATION
- IF INTERSECTS...

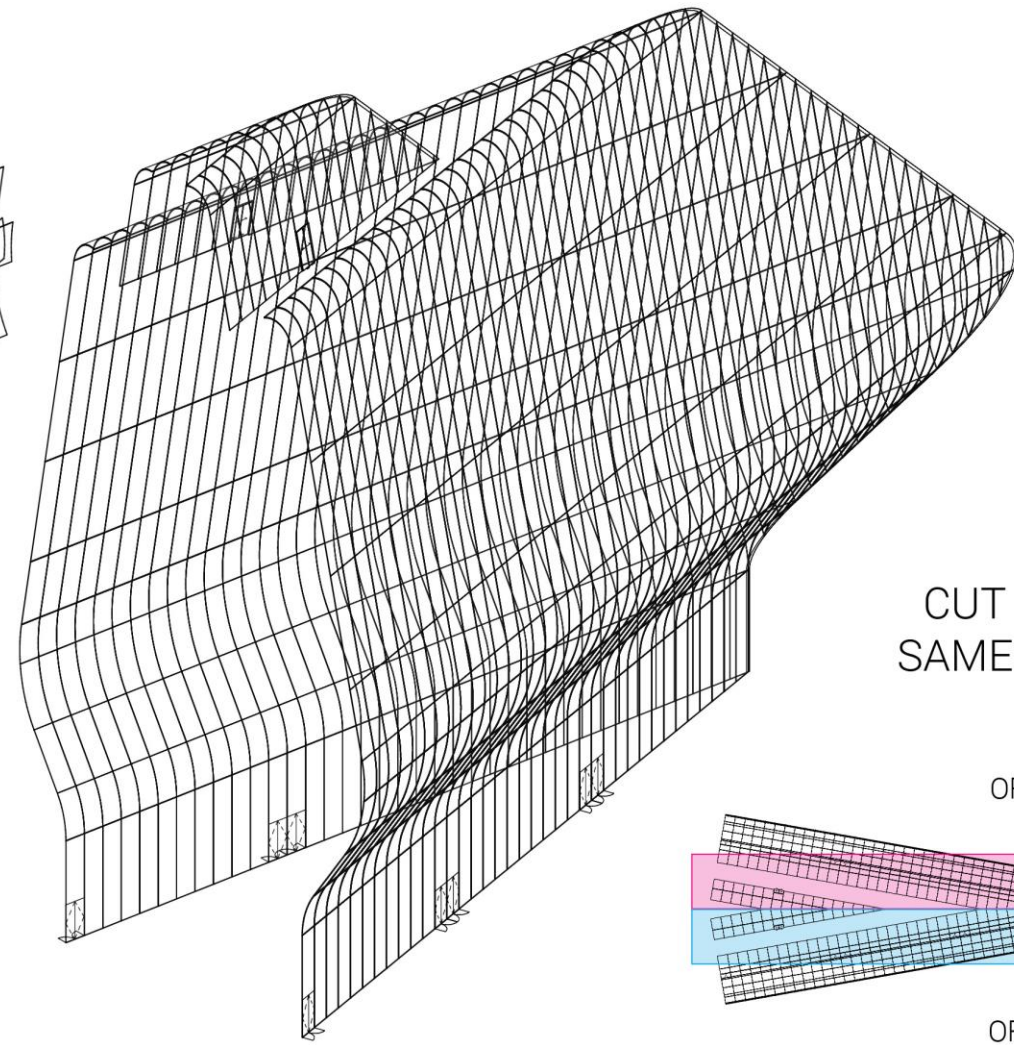
  CUT ELEMENT WITH VOID

  UPDATE PARAMETERS "CUT" + "SURFACE AREA"



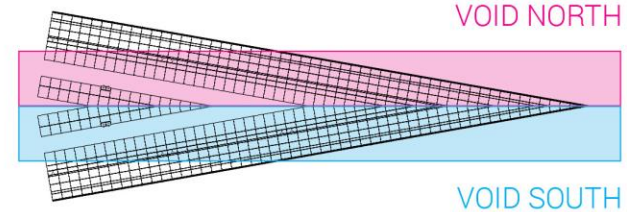
FACADE . MAIN





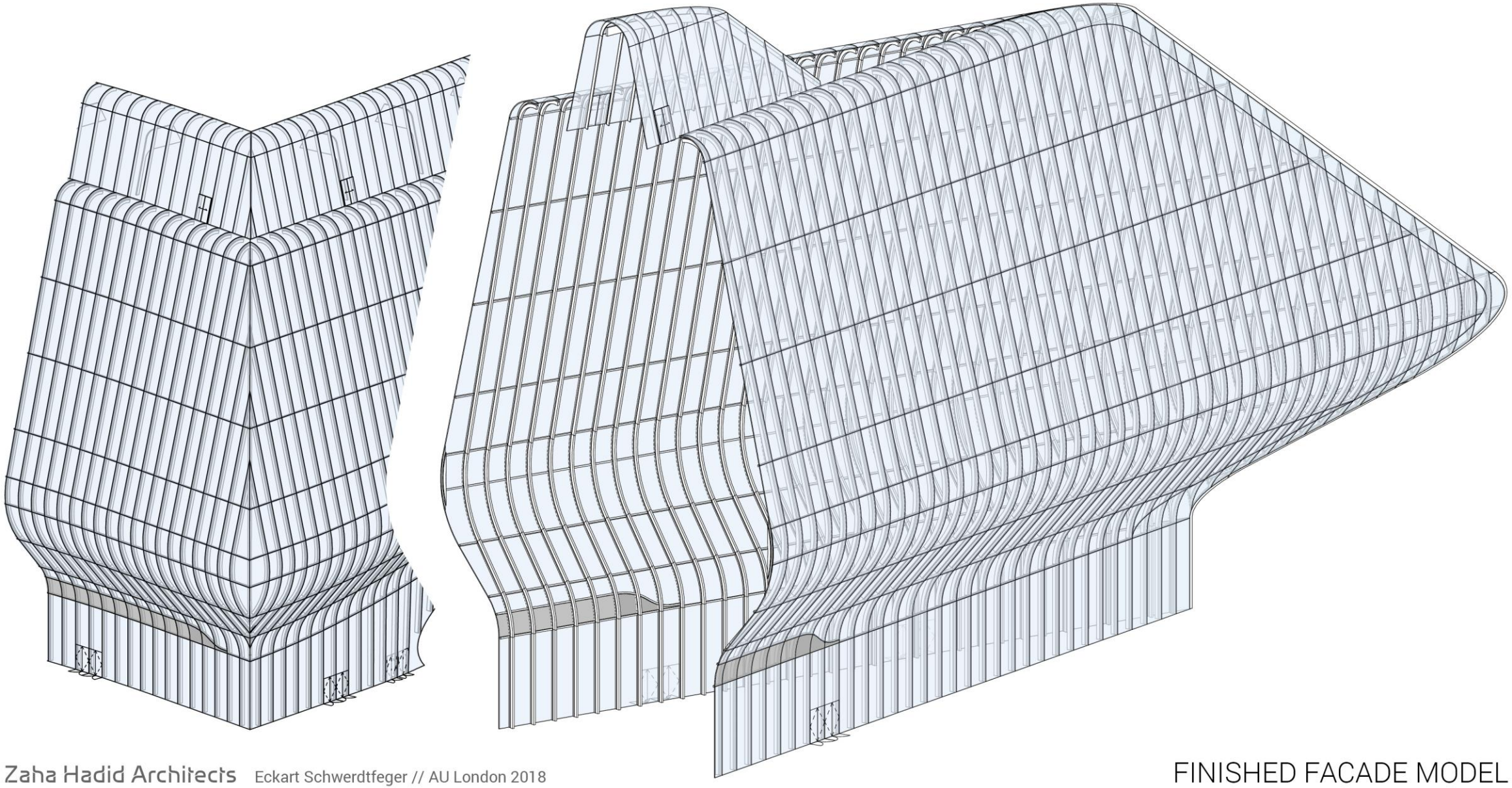
CUT WITH VOID OF
SAME ORIENTATION

ORIENTATION = SOUTH
VOID NORTH



VOID SOUTH
ORIENTATION = NORTH

FACADE . MAIN

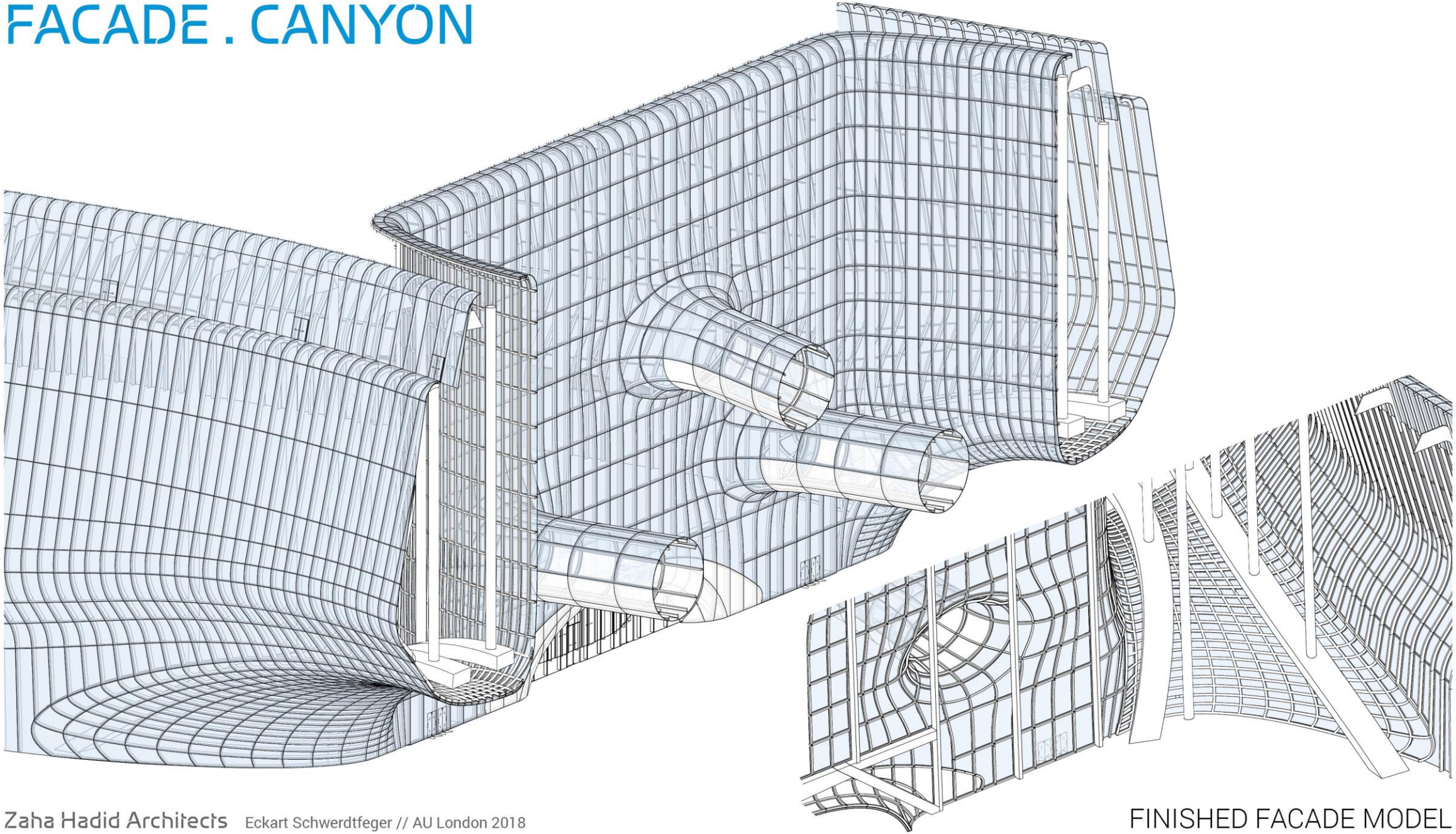


FINISHED FACADE MODEL

FACADE . CANYON

Zaha Hadid Architects Eckart Schwerdtfeger // AU London 2018

FACADE . CANYON



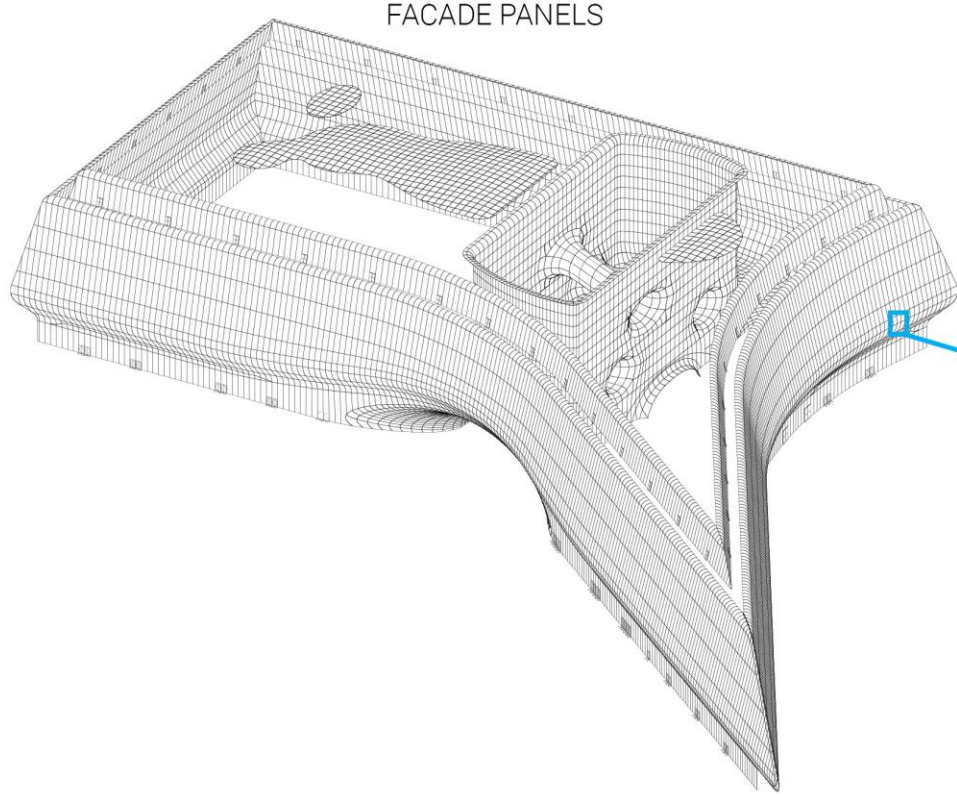
FINISHED FACADE MODEL

FACADE . BIM MODEL

BUILDING INFORMATION MODEL

- 3D MODEL + METADATA
- CUSTOM PARAMETERS CAN BE ADDED TO ALL BUILDING ELEMENTS
- USING ZHA BIM THIS CAN EVEN BE DONE IN RHINO & GH

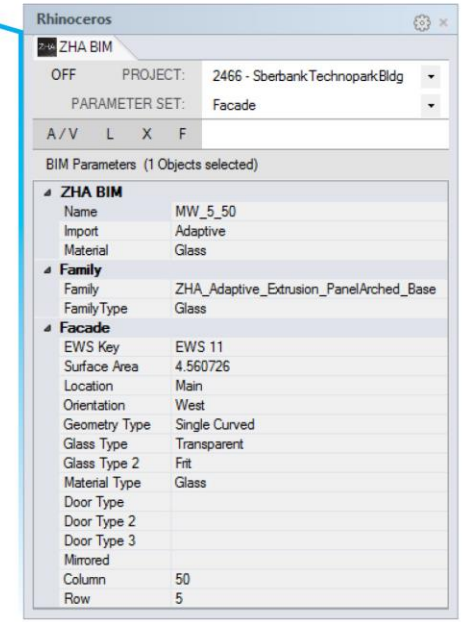
REVIT MODEL
FACADE PANELS



MODEL COMBINES ADAPTIVE FAMILIES AND IMPORTED FREEFORM GEOMETRY WHERE NEEDED [DOUBLE CURVED AREAS]

ALL USE THE SAME PARAMETERS

ZHA BIM
RHINO PARAMETERS

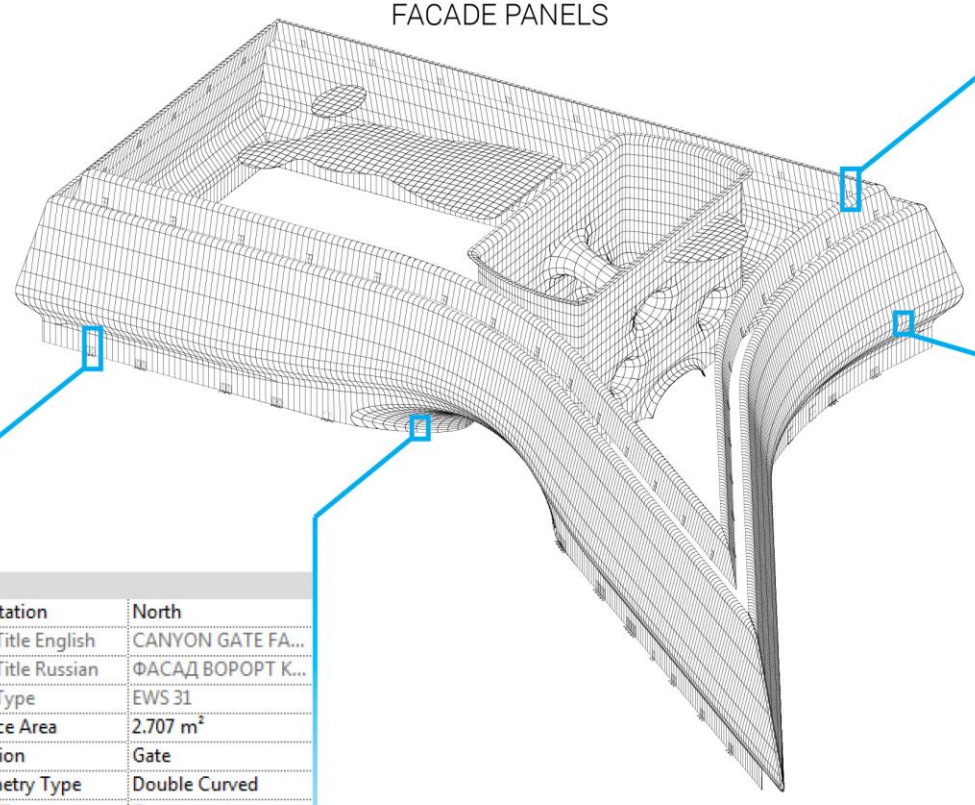


FACADE . BIM MODEL

BUILDING INFORMATION MODEL

- 3D MODEL + METADATA
- CUSTOM PARAMETERS CAN BE ADDED TO ALL BUILDING ELEMENTS
- USING ZHA BIM THIS CAN EVEN BE DONE IN RHINO & GH

REVIT MODEL
FACADE PANELS



Data	
Orientation	South
EWS Title English	TERRACE FACADE
EWS Title Russian	ФАСАД ТЕРРАС
EWS Type	EWS 15
Surface Area	13.193 m²
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

Data	
Orientation	North
EWS Title English	BASE FACADE
EWS Title Russian	НИЖНИЙ ФАСА
EWS Type	EWS 13
Surface Area	11.976 m²
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

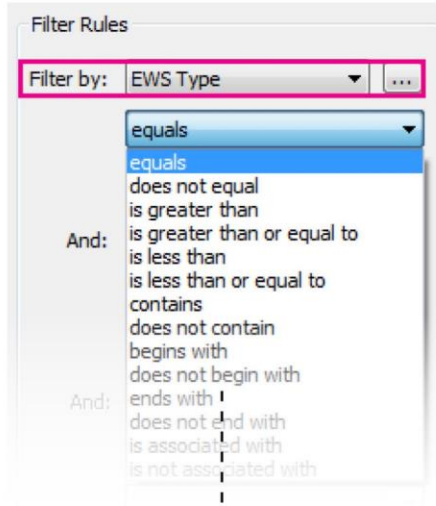
Data	
Orientation	North
EWS Title English	CANYON GATE FA...
EWS Title Russian	ФАСАД ВОРОРТ К...
EWS Type	EWS 31
Surface Area	2.707 m²
Location	Gate
Geometry Type	Double Curved
Glass Type	Transparent
Glass Type 2	No Frit
Material Type	Glass
Door Type	
Door Type 2	
Door Type 3	

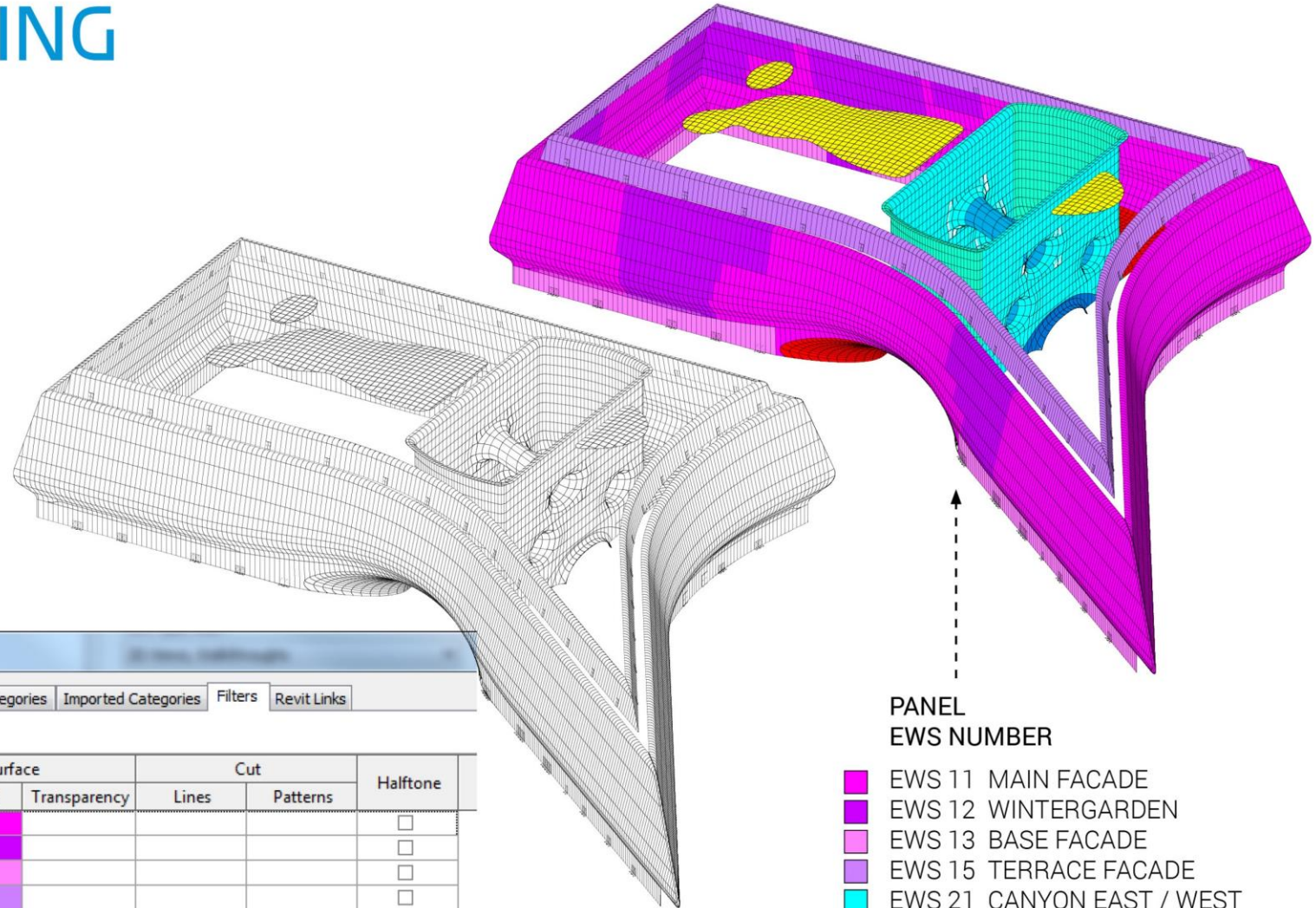
REVIT PARAMETERS

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 . FILTERING





Visibility/Graphic Overrides for 3D_COL_EWS_Type

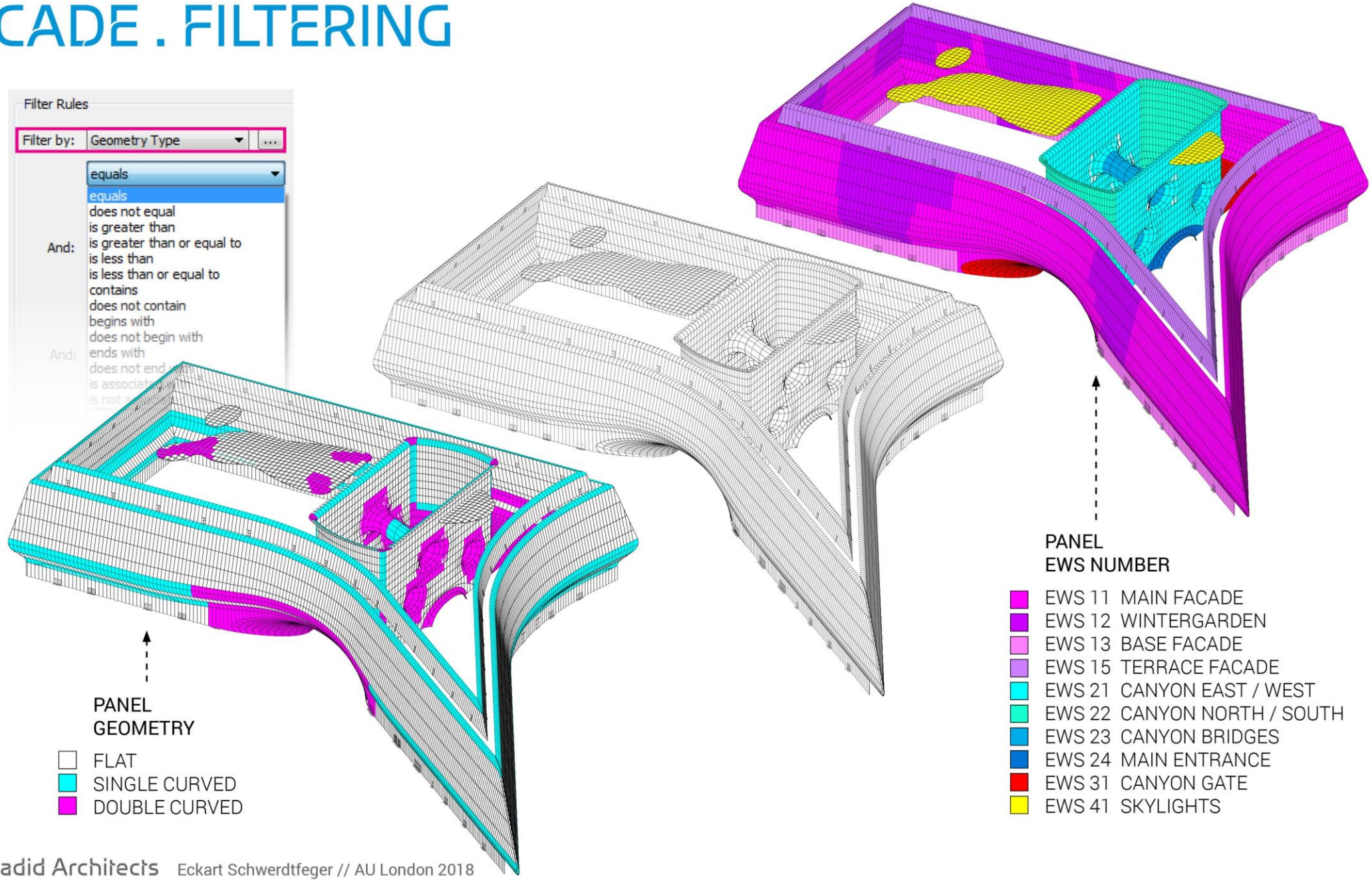
Model Categories | Annotation Categories | Analytical Model Categories | Imported Categories | Filters | Revit Links

Name	Visibility	Projection/Surface			Cut		Halftone
		Lines	Patterns	Transparency	Lines	Patterns	
Param_EWS_11	☑						☐
Param_EWS_12	☑						☐
Param_EWS_13	☑						☐
Param_EWS_15	☑						☐
Param_EWS_21	☑						☐
Param_EWS_22	☑						☐
Param_EWS_23	☑						☐
Param_EWS_24	☑						☐
Param_EWS_31	☑						☐
Param_EWS_41	☑						☐

PANEL
EWS NUMBER

- EWS 11 MAIN FACADE
- EWS 12 WINTERGARDEN
- EWS 13 BASE FACADE
- EWS 15 TERRACE FACADE
- EWS 21 CANYON EAST / WEST
- EWS 22 CANYON NORTH / SOUTH
- EWS 23 CANYON BRIDGES
- EWS 24 MAIN ENTRANCE
- EWS 31 CANYON GATE
- EWS 41 SKYLIGHTS

FACADE . FILTERING



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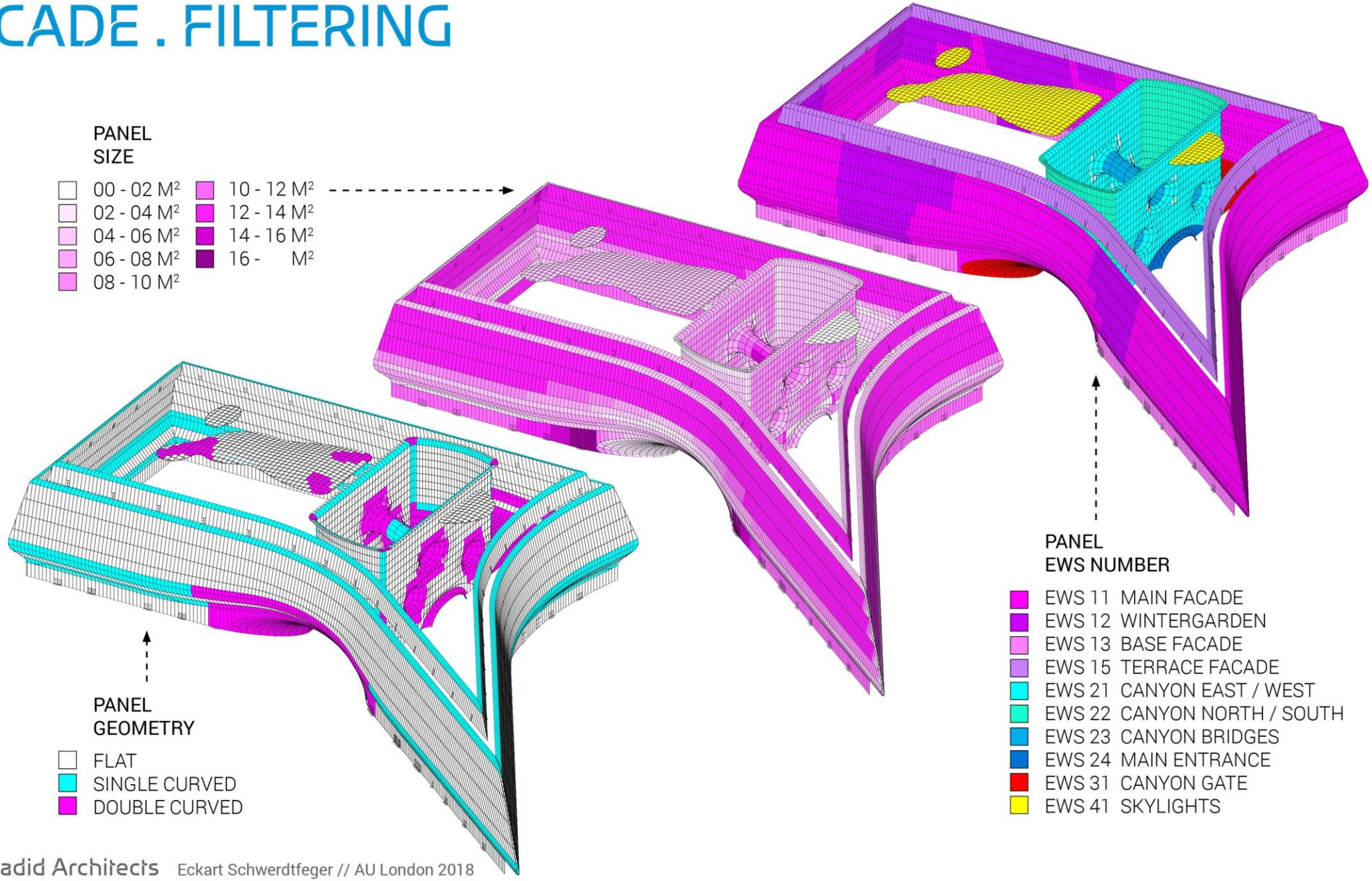
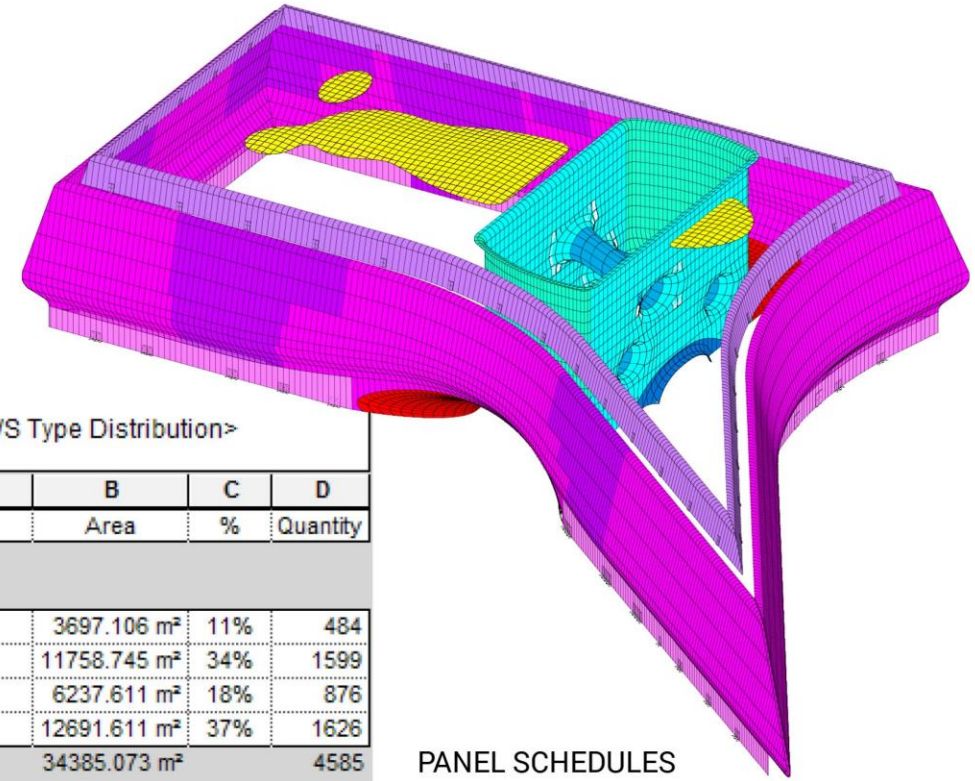


FACADE . SCHEDULING

BUILDING INFORMATION MODEL

- METADATA + CUSTOM PARAMETERS ARE USED TO SET UP SCHEDULES
- ALL SCHEDULES ARE KEPT UP-TO-DATE BY REVIT AT ALL TIMES
- RAW METADATA CAN BE EXPORTED FOR FURTHER ANALYSIS OR VISUALISATION



<EWS Type Distribution>

A	B	C	D
Orientation	Area	%	Quantity
EWS 11			
East	3697.106 m²	11%	484
North	11758.745 m²	34%	1599
South	6237.611 m²	18%	876
West	12691.611 m²	37%	1626
	34385.073 m²		4585
EWS 12			
East	1928.569 m²	23%	198
North	3453.077 m²	41%	407
South	3032.865 m²	36%	338
	8414.511 m²		943
EWS 13			
East	814.583 m²	16%	66
North	1788.224 m²	35%	141
South	764.305 m²	15%	61
West	1807.381 m²	35%	152
	5174.493 m²		420
EWS 15			
East	1098.766 m²	13%	114

PANEL SCHEDULES

<Geometry Type by Orientation>

A	B	C	D
Geometry Type	Area	%	Quantity
Bridges			
Double Curved	2322.427 m²	64%	288
Single Curved	1326.086 m²	36%	108
	3648.513 m²		396
East			
Double Curved	821.958 m²	7%	121
Flat	7364.211 m²	64%	726
Flat Cut	929.641 m²	8%	157

FACADE . SCHEDULING

TXT

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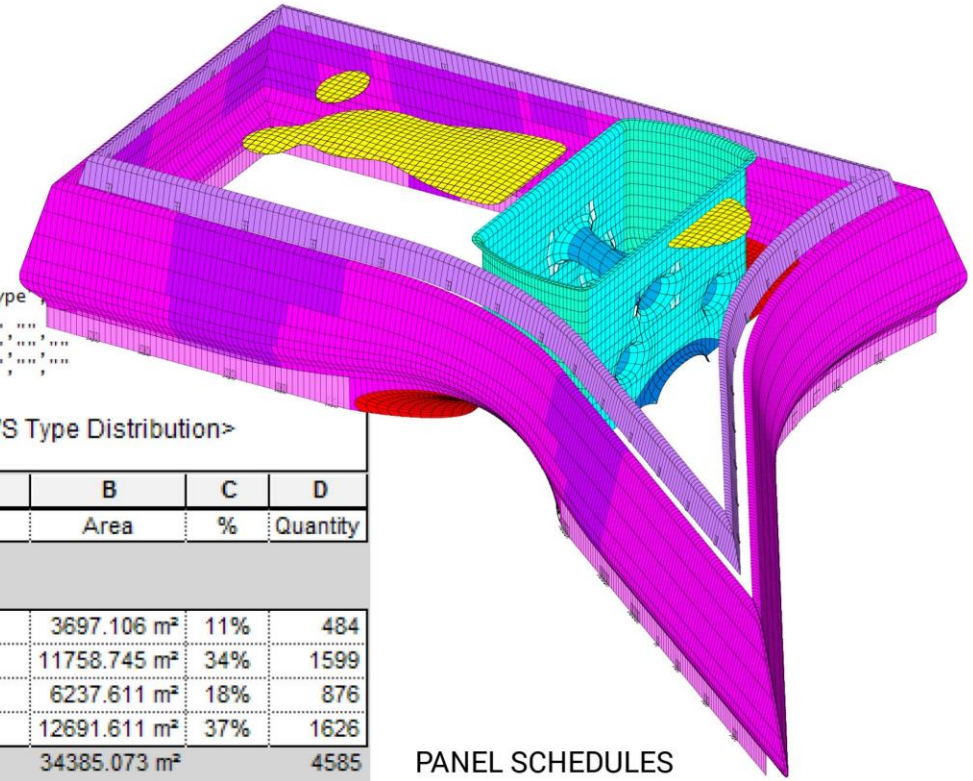

<EWS Type Distribution>

A	B	C	D
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EWS 15			
East	1098.766 m²	13%	114

PANEL SCHEDULES

<Geometry Type by Orientation>

A	B	C	D
Geometry Type	Area	%	Quantity
Bridges			
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Single Curved	1326.086 m²	36%	108
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East			
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Flat	7364.211 m²	64%	726
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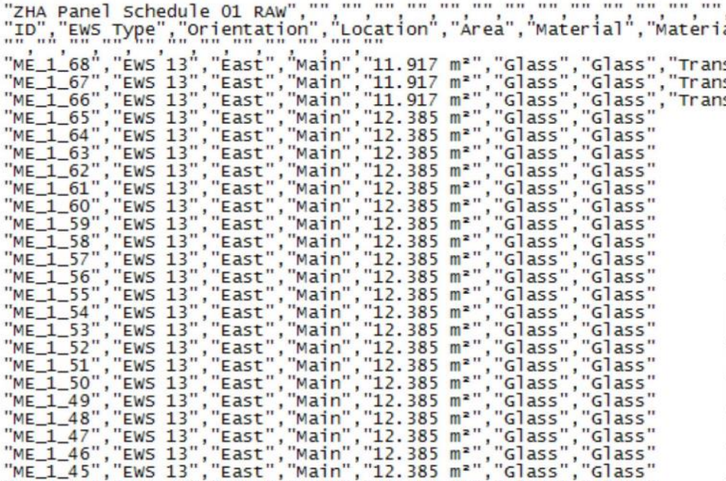
FACADE . SCHEDULING



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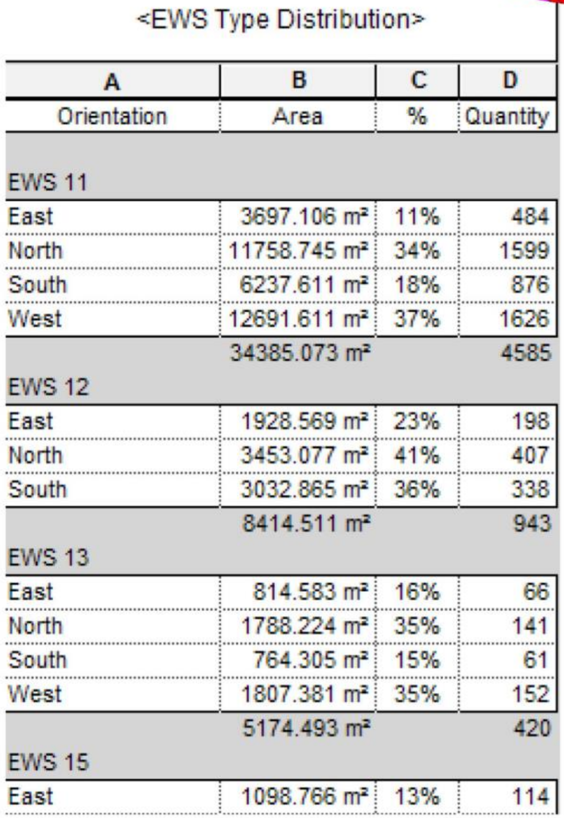

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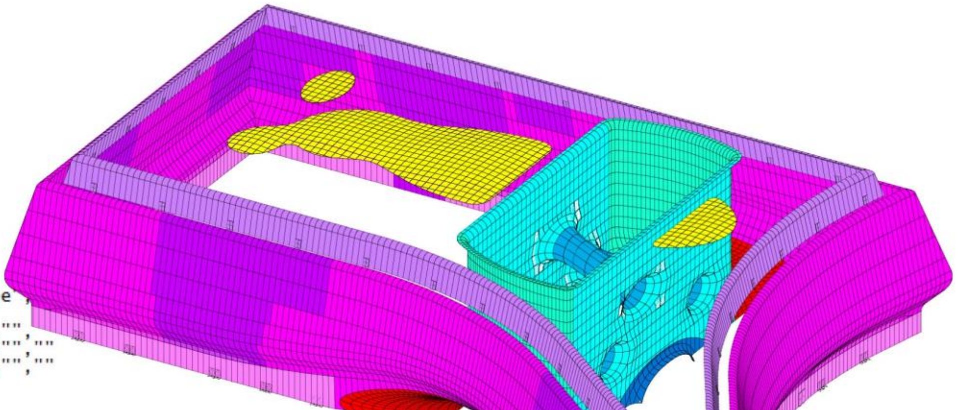
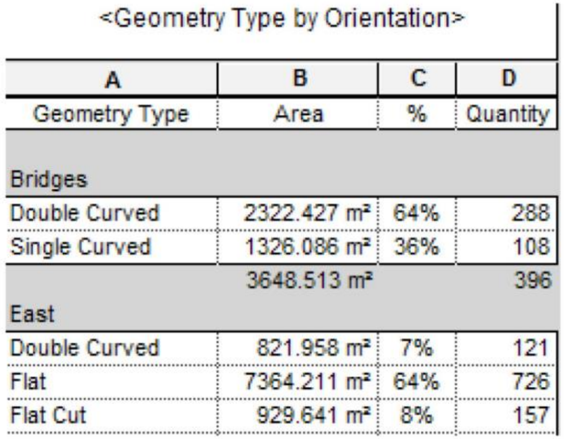


PANEL SCHEDULES



<Geometry Type by Orientation>

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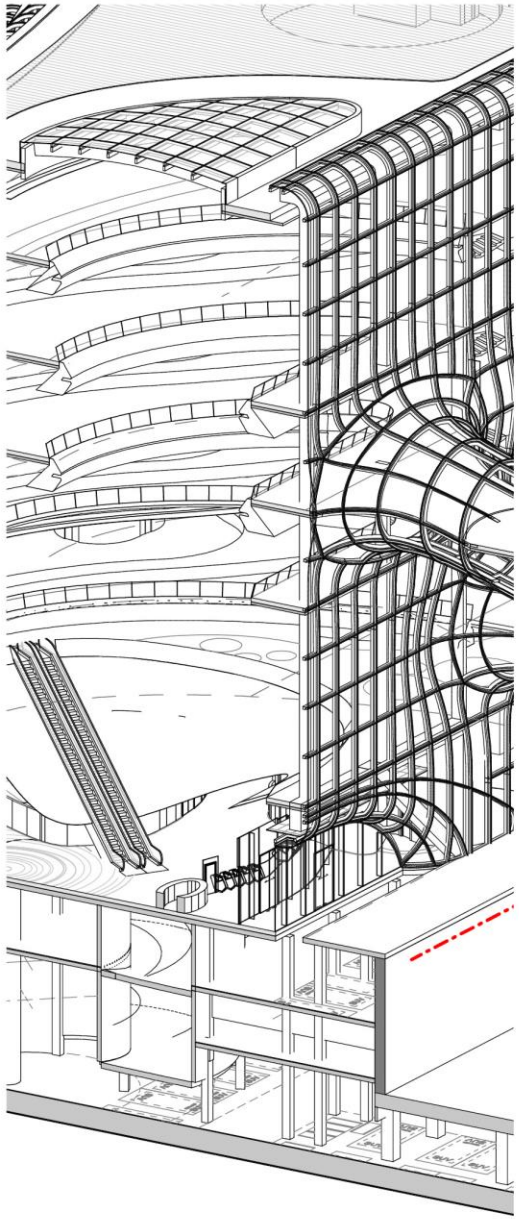
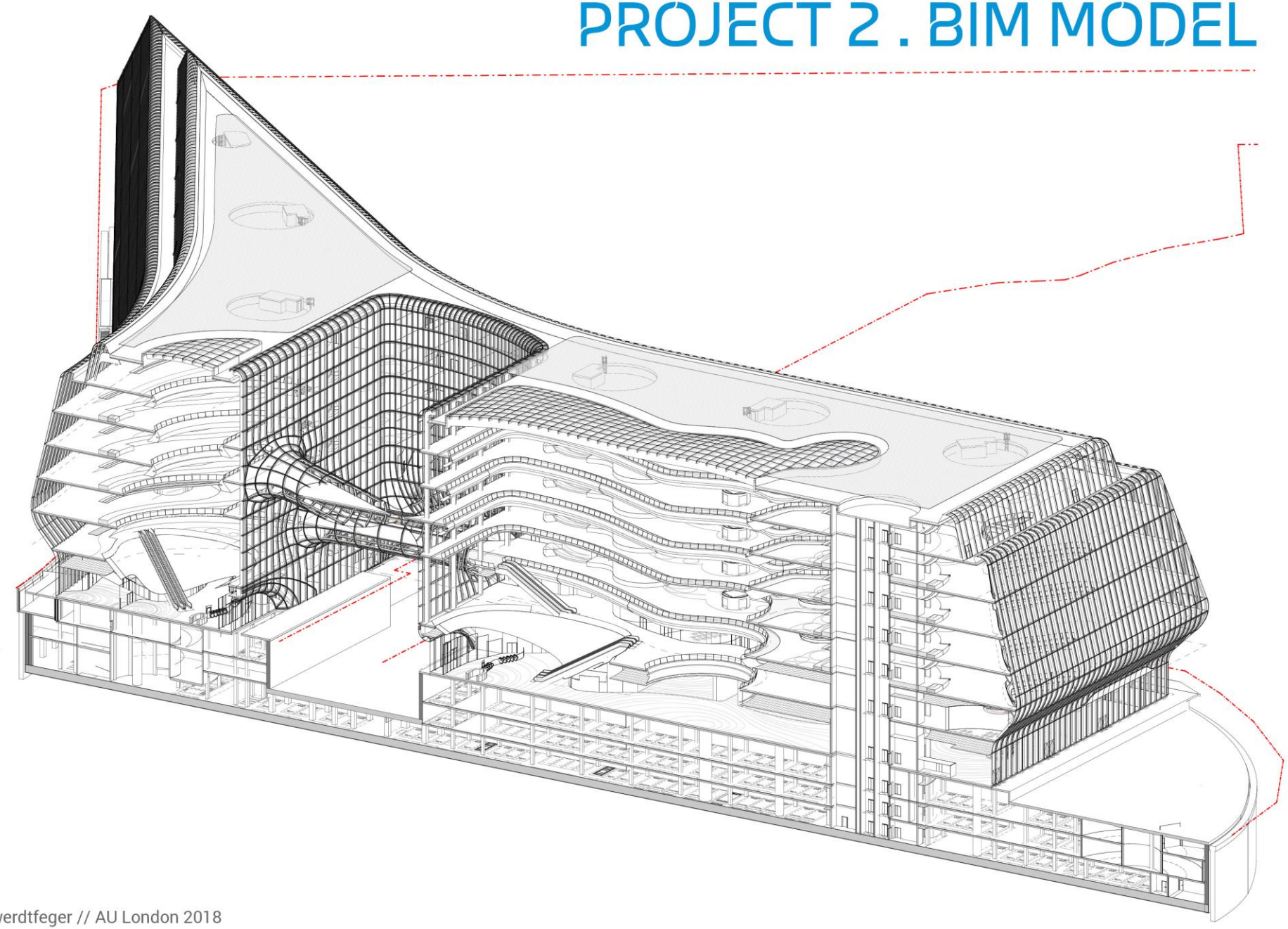
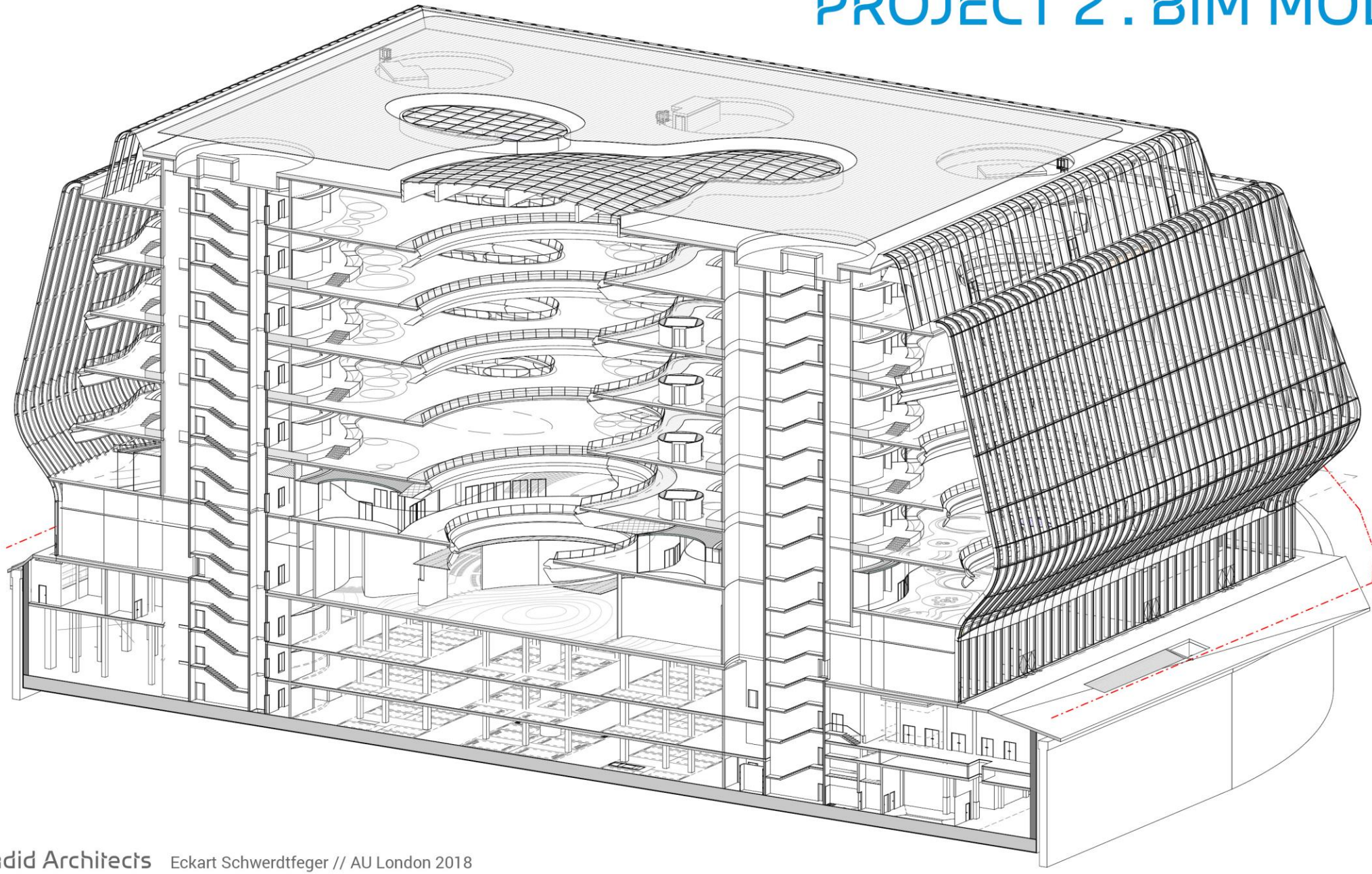
PROJECT 2 . BIM MODEL





PROJECT 2 . BIM MODEL



Zaha Hadid Architects Eckart Schwerdtfeger // AU London 2018

ZAHA HADID ARCHITECTS

Studio London
10 Bowling Green Lane
London EC1R 0BQ
T +44 20 7253 5147
F +44 20 7251 8322

mail@zaha-hadid.com
www.zaha-hadid.com

www.zaha-hadid.com
www.twitter.com/ZHA_News
www.linkedin.com/company/zaha-hadid-architects/

Eckart Schwerdtfeger
BIM Lead

Eckart.Schwerdtfeger@zaha-hadid.com

www.twitter.com/Eckart_S
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