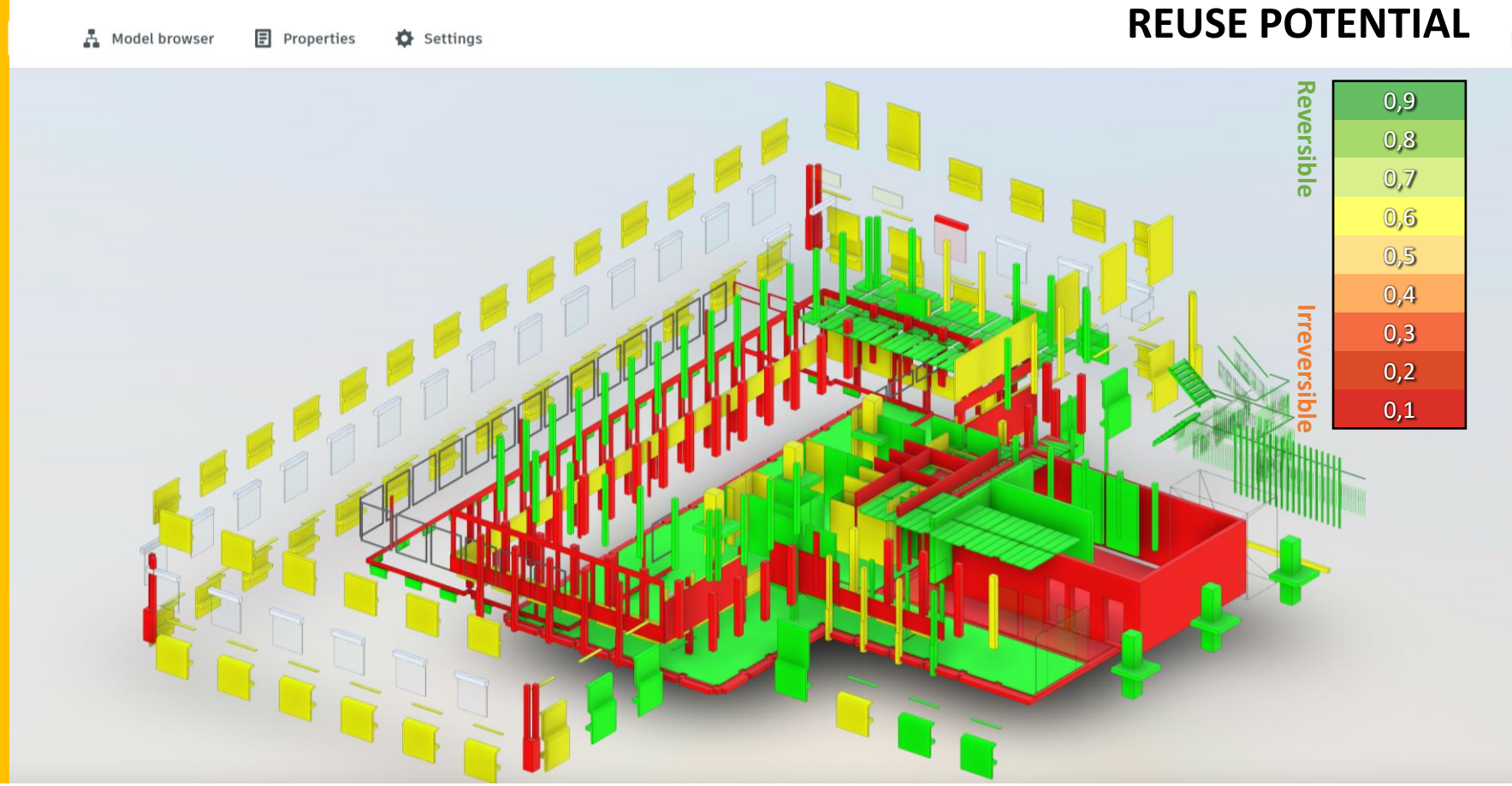
Reversible BIM

©Model E.Durmisevic 2015

Digital Reversibility/ Reuse Potential Assessment



4D architects

EUROPEAN UNION

Interreg North-West Europe

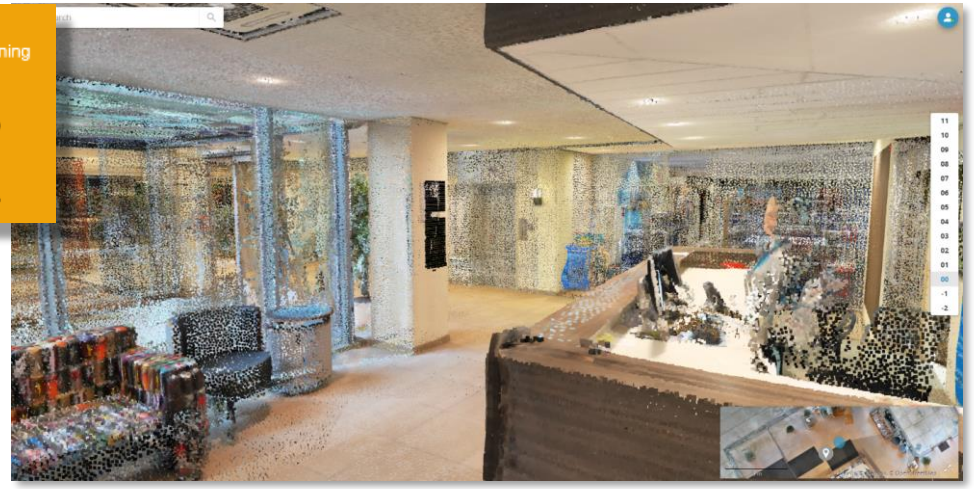
Digital Deconstruction

European Regional Development Fund

EUROPEAN UNION

gtb lab

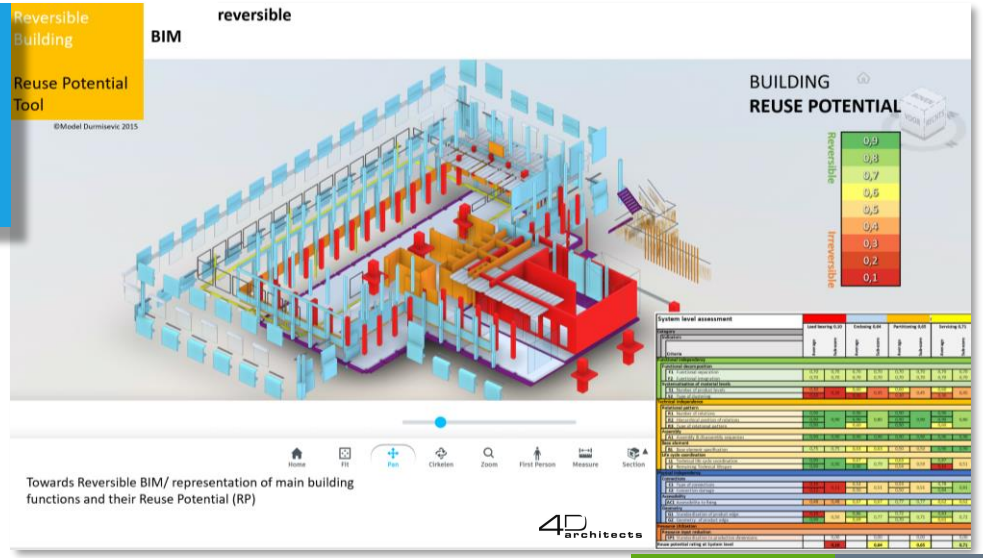
3D scan & screening



Reversible BIM

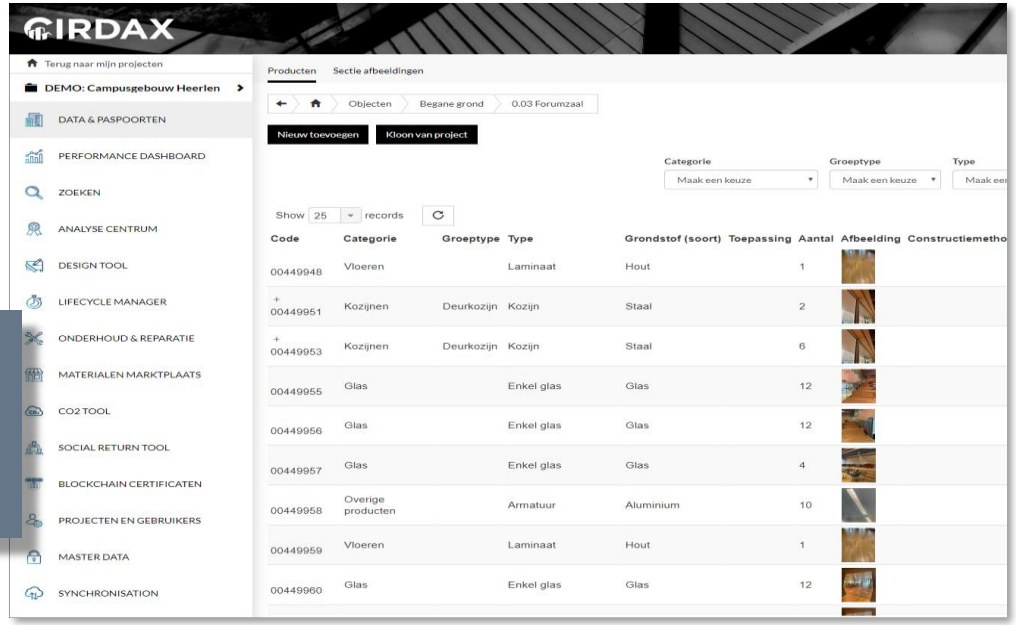
Reversible Building

Reuse Potential Tool



Digital materials & buildings database

Blockchain

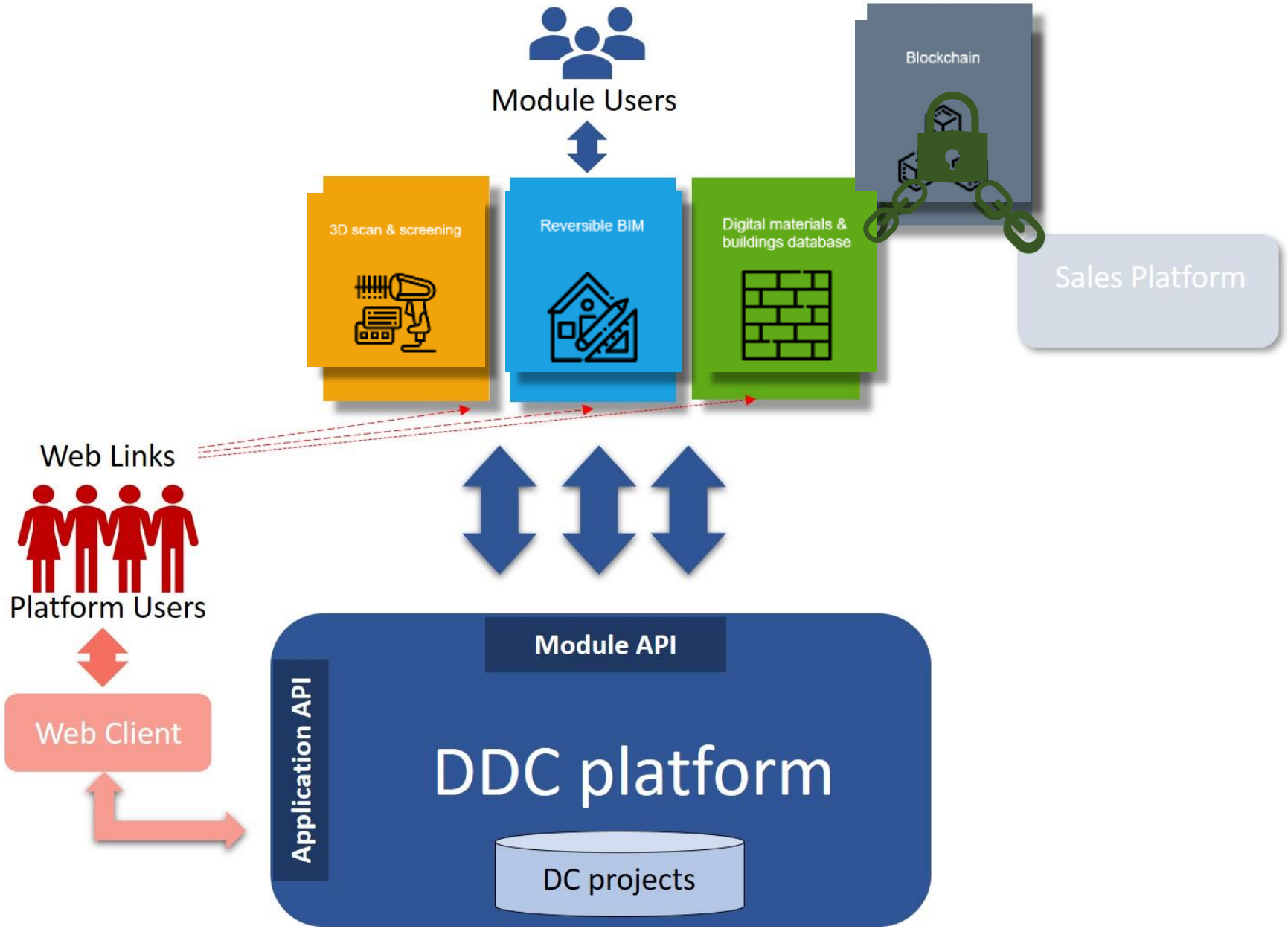


Interreg
North-West Europe
Digital Deconstruction
European Regional Development Fund

DDC – WPT2 Innovation Hub Kick off

Dr. Elma Durmisevic

25/02/2021



Reversible Building

Reuse Potential Tool

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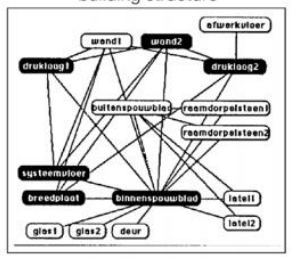
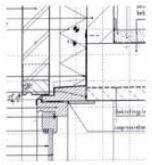
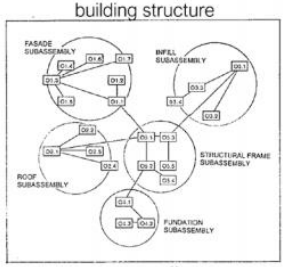
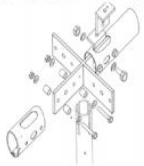
Pattern representing irreversible building structure

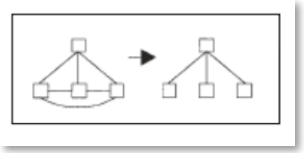


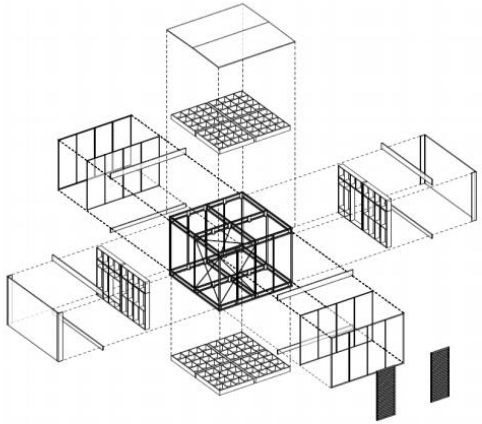


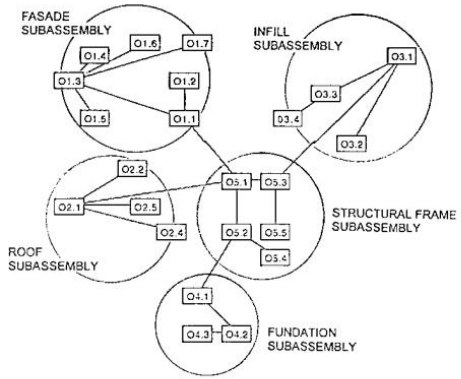
Pattern representing reversible building structure

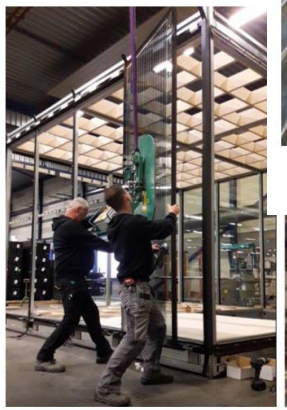












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Reversible Building

Reuse Potential Tool

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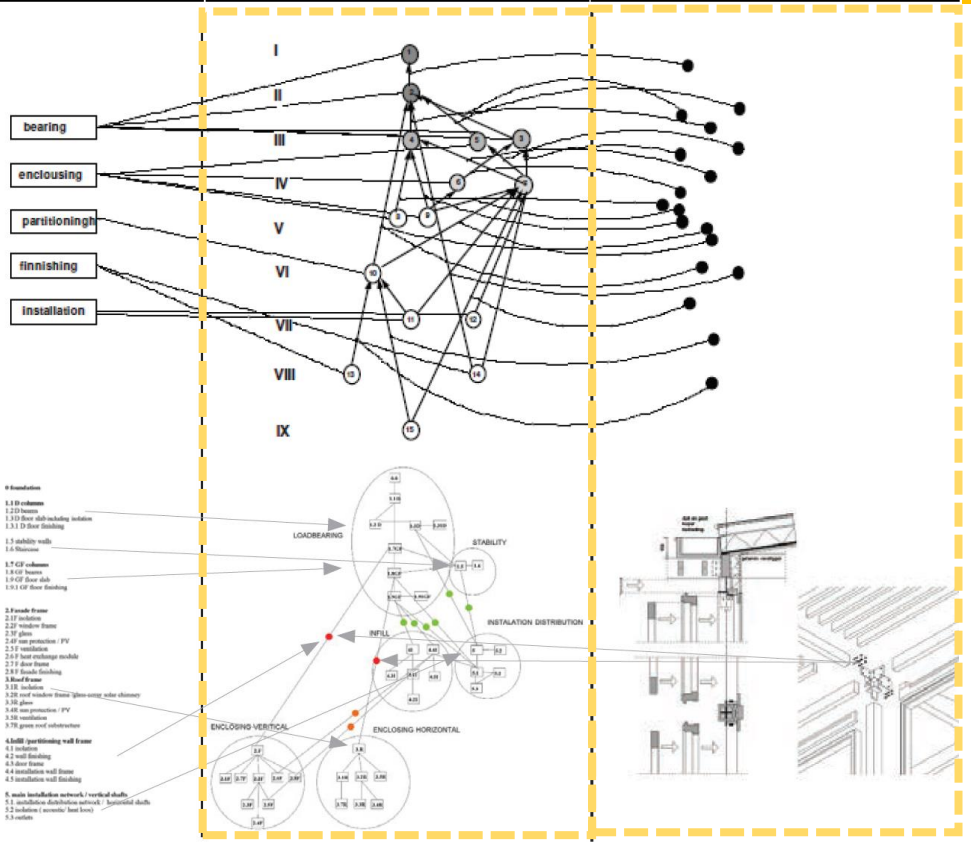
Technical Reversibility

Functional dependence	Technical dependence	Physical dependence



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Reversible Building

Reuse Potential Tool

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INDICATORS/ Technical Reversibility

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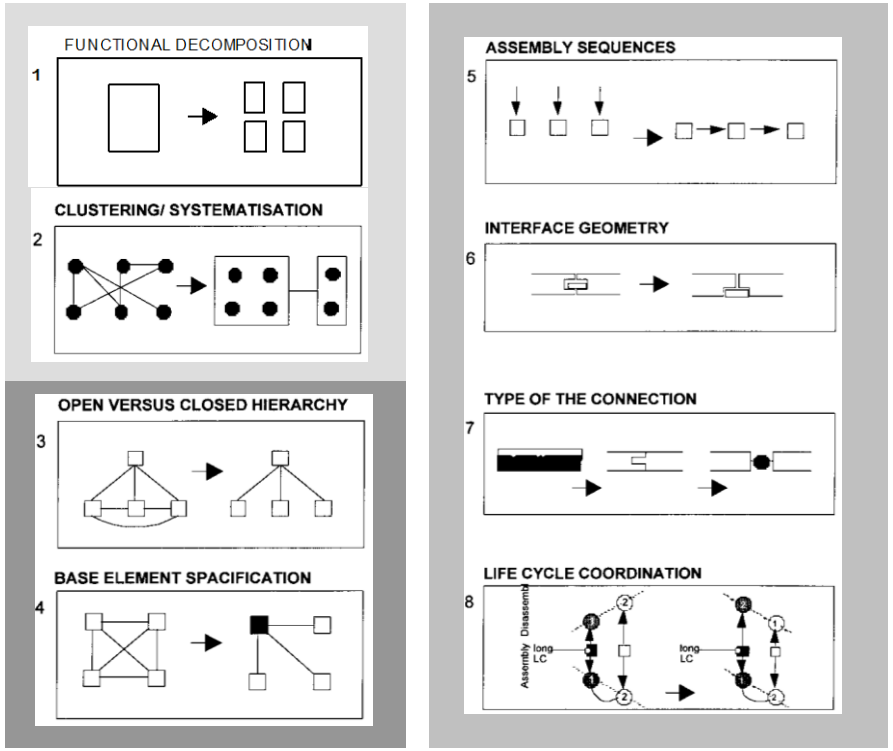
8 ASPECTS OF REVERSIBLE BUILDING STRUTURE

FUNCTIONAL decomposition

TECHNICAL dependences

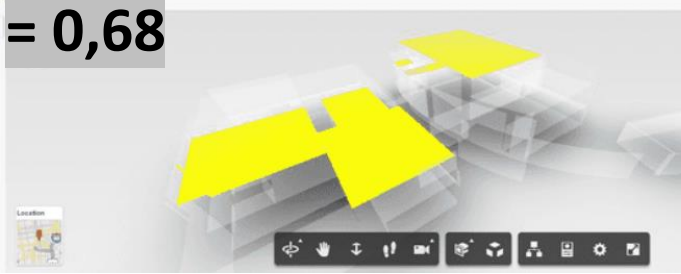


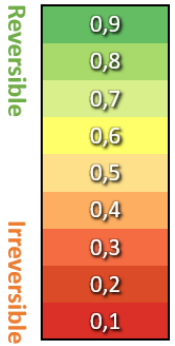
PHYSICAL dependences

© E.Durmisevic 2006

Reuse potential

= 0,68





Reuse options:

- **RP > 0,7** = Direct reuse by minor repair or reconfiguration, upgrading
- **RP >0,4 and RP < 0,6** = Reuse by major repair Re-manufacture
- **RP > 0,3** = Recycle

Reversible BIM Module

Reuse Potential (RP)Tool

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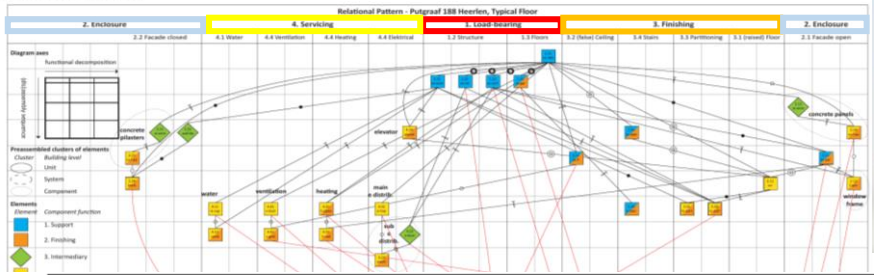
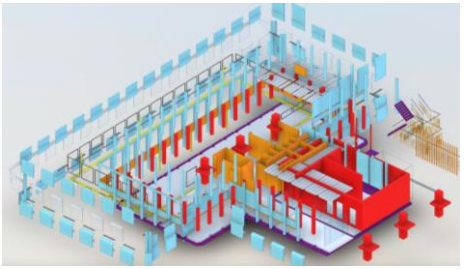
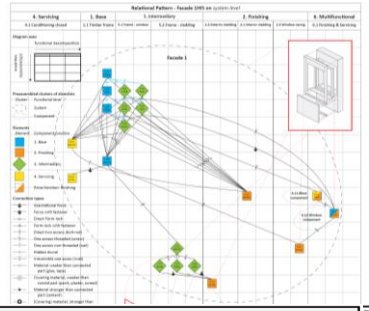
Relational pattern



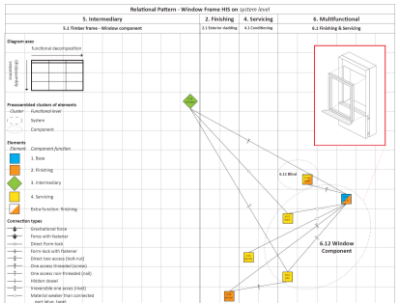
RP BUILDING level



SYSTEM level



PART level



System level assessment	System level							
	Load bearing 0,10		Enclosing 0,64		Partitioning 0,65		Servicing 0,71	
Category / Indicators / Criteria	Average	Sub-score	Average	Sub-score	Average	Sub-score	Average	Sub-score
Functional independency								
Functional decomposition								
F1 Functional separation	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,70
F2 Functional integration	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,70
Systematisation of material levels								
S1 Number of product levels	0,30	0,20	0,60	0,35	0,60	0,45	0,60	0,45
S2 Type of clustering	0,10		0,10		0,30		0,30	
Technical independence								
Relational pattern								
R1 Number of relations	0,90	0,90	0,90	0,80	0,90	0,90	0,90	0,80
R2 Hierarchical position of relations	0,90		0,90		0,90		0,90	
R3 Type of relational pattern	0,90		0,60		0,90		0,60	
Assembly								
A1 Assembly & disassembly sequences	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90
Base element								
B1 Base element specification	0,75	0,75	0,63	0,63	0,50	0,50	0,90	0,90
Life cycle coordination								
L1 Technical life cycle coordination	0,90	0,90	0,67	0,79	0,63	0,59	0,87	0,51
L2 Remaining Technical lifespan	0,90		0,90		0,54		0,16	
Physical independency								
Connections								
C1 Type of connections	0,10	0,11	0,52	0,51	0,53	0,51	0,78	0,81
C2 Connection damage	0,12		0,50		0,50		0,84	
Accessibility								
AC1 Accessibility to fixing	0,48	0,48	0,67	0,67	0,77	0,77	0,62	0,62
Geometry								
G1 Standardisation of product edge	0,10	0,50	0,86	0,77	0,72	0,71	0,83	0,72
G2 Geometry of product edge	0,90		0,69		0,70		0,61	
Resource Utilization								
Resource input reduction								
SP1 Standardisation to production dimensions		0,00		0,00		0,00		0,00
Reuse potential rating at System level		0,10		0,64		0,65		0,71

ystem level assessment	Sub-system		Enclosing				
	2.1 Facade open0,67		.2 Facade closed 10,6		.3 Facade closed 20,6		
ors / eria	Average	Sub-score	Average	Sub-score	Average	Sub-score	Factors
al independency							
onal decomposition							
Functional separation	0,70	0,70	0,70	0,70	0,70	0,70	1
Functional integration	0,70	0,70	0,70	0,70	0,70	0,70	1
natisation of material levels							
Number of product levels	0,90	0,90	0,30	0,20	0,30	0,20	2
Type of clustering	0,90		0,10		0,10		
Independence							
onal pattern							
Number of relations	0,90	0,63	0,90	0,80	0,90	0,80	2
Hierarchical position of relations	0,90		0,90		0,90		
Type of relational pattern	0,10		0,60		0,60		
bly							
Assembly & disassembly sequences	0,90	0,90	0,90	0,90	0,90	0,90	1
lement							
Base element specification	0,10	0,10	0,90	0,90	0,90	0,90	1
cle coordination							
Technical life cycle coordination	0,90	0,90	0,90	0,90	0,37	0,63	1
Remaining Technical lifespan	0,90		0,90		0,90		
independency							
ctions							
Type of connections	0,53	0,42	0,51	0,56	0,52	0,48	3
Connection damage	0,30		0,60		0,45		
ibility							
Accessibility to fixing	0,90	0,90	0,60	0,60	0,68	0,68	1
etry							
Standardisation of product edge	0,90	0,85	0,85	0,76	0,85	0,76	1
Geometry of product edge	0,80		0,68		0,68		
Utilization							
rce input reduction							
Standardisation to production dimensions		0,00		0,00		0,00	1
Reuse potential rating at Sub-System level		0,67		0,65		0,62	

Part level assessment	2.21 co fa		2.22 br par		2.23 st pin		2.24 st ang		2.31 co pil	
Category / Indicators / Criteria	Average	Sub-score	Average	Sub-score	Average	Sub-score	Average	Sub-score	Average	Sub-score
Functional independency										
Functional decomposition										
F1 Functional separation	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,70
F2 Functional integration										
Systematisation of material levels										
S1 Number of product levels	0,30	0,20	0,30	0,20	0,30	0,20	0,30	0,20	0,30	0,20
S2 Type of clustering	0,10		0,10		0,10		0,10		0,10	
Technical independence										
Relational pattern										
R1 Number of relations	0,90	0,80	0,90	0,80	0,90	0,90	0,90	0,90	0,90	0,70
R2 Hierarchical position of relations	0,90		0,90		0,90		0,90		0,90	
R3 Type of relational pattern	0,60		0,60		0,90		0,90		0,30	
Assembly										
A1 Assembly & disassembly sequences	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90
Base element										
B1 Base element specification	0,10	0,10	0,10	0,10	0,90	0,90	0,90	0,90	0,10	0,10
Life cycle coordination										
L1 Technical life cycle coordination	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90
L2 Remaining Technical lifespan	0,90		0,90		0,90		0,90		0,90	
Physical independency										
Connections										
C1 Type of connections	0,40	0,35	0,30	0,30	0,90	0,90	0,90	0,90	0,40	0,35
C2 Connection damage	0,30		0,30		0,90		0,90		0,30	
Accessibility										
AC1 Accessibility to fixing	0,90	0,90	0,90	0,90	0,30	0,30	0,30	0,30	0,90	0,90
Geometry										
G1 Standardisation of product edge	0,90	0,85	0,70	0,80	0,90	0,70	0,90	0,70	0,90	0,85
G2 Geometry of product edge	0,80		0,90		0,50		0,50		0,80	
Resource Utilization										
Resource input reduction										
SP1 Standardisation to production dimensions		0,00		0,00		0,00		0,00		0,00
Reuse potential rating at Sub-System level		0,57		0,55		0,72		0,72		0,55

Reversible Building

I M P A C T S

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3 CATEGORIES OF MATERIAL STREAMS

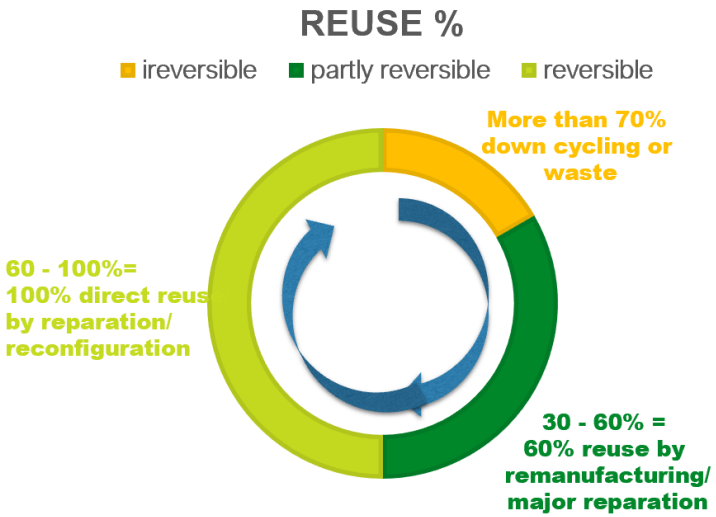
in relation to the RP score

IRREVERSIBLE
if RP indicates that a system has **RP < than 0,3** these systems will be characterised as irreversible and **the end of life options** = **RECYCLING/DOWN CYCLING**.

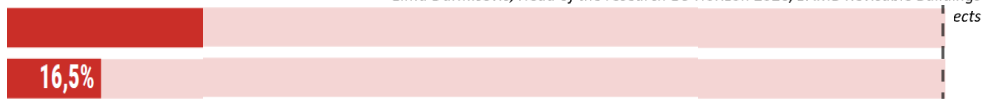
PARTLY REVERSIBLE
If system has **RP> 0,3 and RP < 0,6 end of life options** =**REMANUFACTURE/ MAJOR REPAIR,**

REVERSIBLE
If system has **RP > 0,6** this would mean that besides **DIRECT REUSE AND MINOR REPAIR** of its parts the system can be **RECONFIGURED AND UPGRADED** and its **dimensions adjustable to fit new require**

Technical reversibility presented through RP and related indicators



Embodied Environmental Impact
Embodied Value (EV)



Elma Durmisevic, Head of the research EU Horizon 2020/BAMB Revisable Buildings ects

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4D architects

Reversible BIM

Reuse Potential Tool

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1

DATA GATHERING

Drawings
point cloud
site visit

2

DATA PROCESSING

Product coding for assessment & BIM template

3

BIM PLUGINS

Reversibility assessment Dynamo Autodesk

4

REIVIT2 EXCL2REVIT

Full Reuse Potential Calculation

5

REVERSIBLE BIM

Digital reversible 3D twin
3D viewer

6

REPORTING REVERSIBILITY

Reuse options
Deconstruction staps
& embodied value

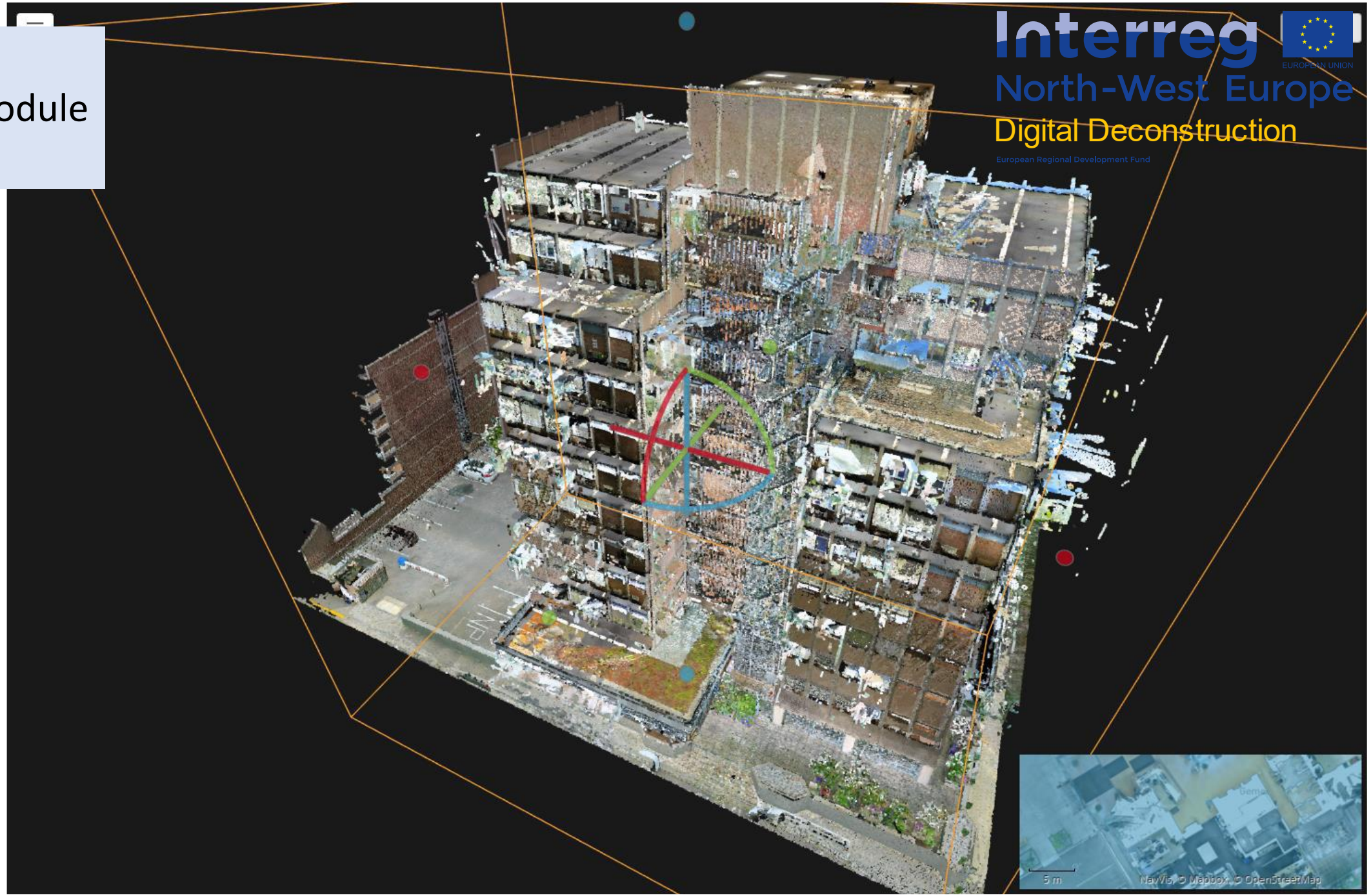
7

BIM OBJECTS LIBRARY

BIM based catalogues of reusable elements

3/

WPT1 modules
3D Scanning Module
BIM_Y



Reversible BIM Module

Reuse Potential (RP)Tool

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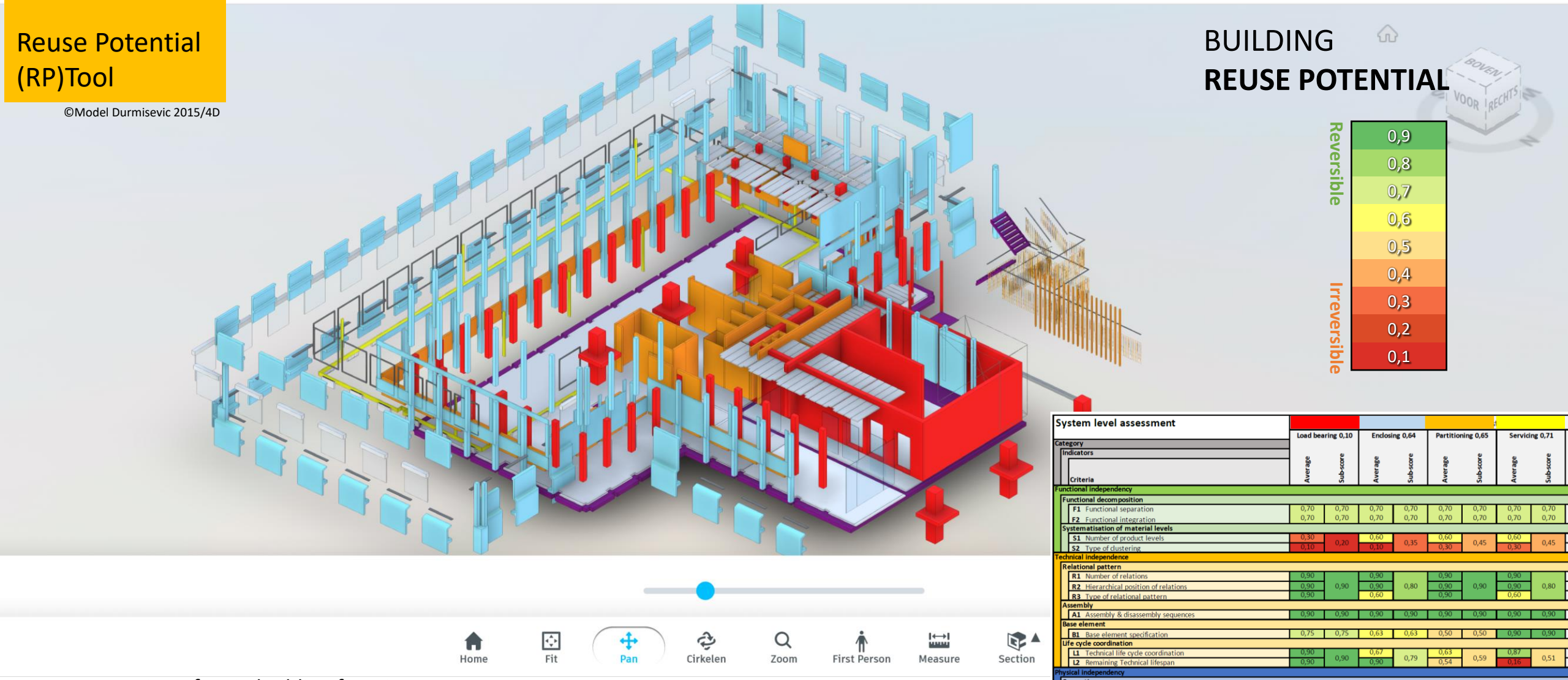

System level assessment	Load bearing 0,10		Enclosing 0,64		Partitioning 0,65		Servicing 0,71	
Category / Indicators / Criteria	Average	Sub-score	Average	Sub-score	Average	Sub-score	Average	Sub-score
Functional independency								
Functional decomposition								
F1 Functional separation	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,70
F2 Functional integration	0,70	0,70	0,70	0,70	0,70	0,70	0,70	0,70
Systematisation of material levels								
S1 Number of product levels	0,30	0,20	0,60	0,35	0,60	0,45	0,60	0,45
S2 Type of clustering	0,10		0,10		0,30		0,30	
Technical independence								
Relational pattern								
R1 Number of relations	0,90	0,90	0,90	0,80	0,90	0,90	0,90	0,80
R2 Hierarchical position of relations	0,90		0,90		0,90		0,90	
R3 Type of relational pattern	0,90		0,60		0,90		0,60	
Assembly								
A1 Assembly & disassembly sequences	0,90	0,90	0,90	0,90	0,90	0,90	0,90	0,90
Base element								
B1 Base element specification	0,75	0,75	0,63	0,63	0,50	0,50	0,90	0,90
Life cycle coordination								
L1 Technical life cycle coordination	0,90	0,90	0,67	0,79	0,63	0,59	0,87	0,51
L2 Remaining Technical lifespan	0,90		0,90		0,54		0,16	
Physical independency								
Connections								
C1 Type of connections	0,10	0,11	0,52	0,51	0,53	0,51	0,78	0,81
C2 Connection damage	0,12		0,50		0,50		0,84	
Accessibility								
AC1 Accessibility to fixing	0,48	0,48	0,67	0,67	0,77	0,77	0,62	0,62
Geometry								
G1 Standardisation of product edge	0,10	0,50	0,86	0,77	0,72	0,71	0,83	0,72
G2 Geometry of product edge	0,90		0,69		0,70		0,61	
Resource Utilization								
Resource input reduction								
SP1 Standardisation to production dimensions		0,00		0,00		0,00		0,00
Reuse potential rating at System level		**0,10**		**0,64**		**0,65**		**0,71**

representation of main building functions

Reversible BIM

Reuse Potential Tool

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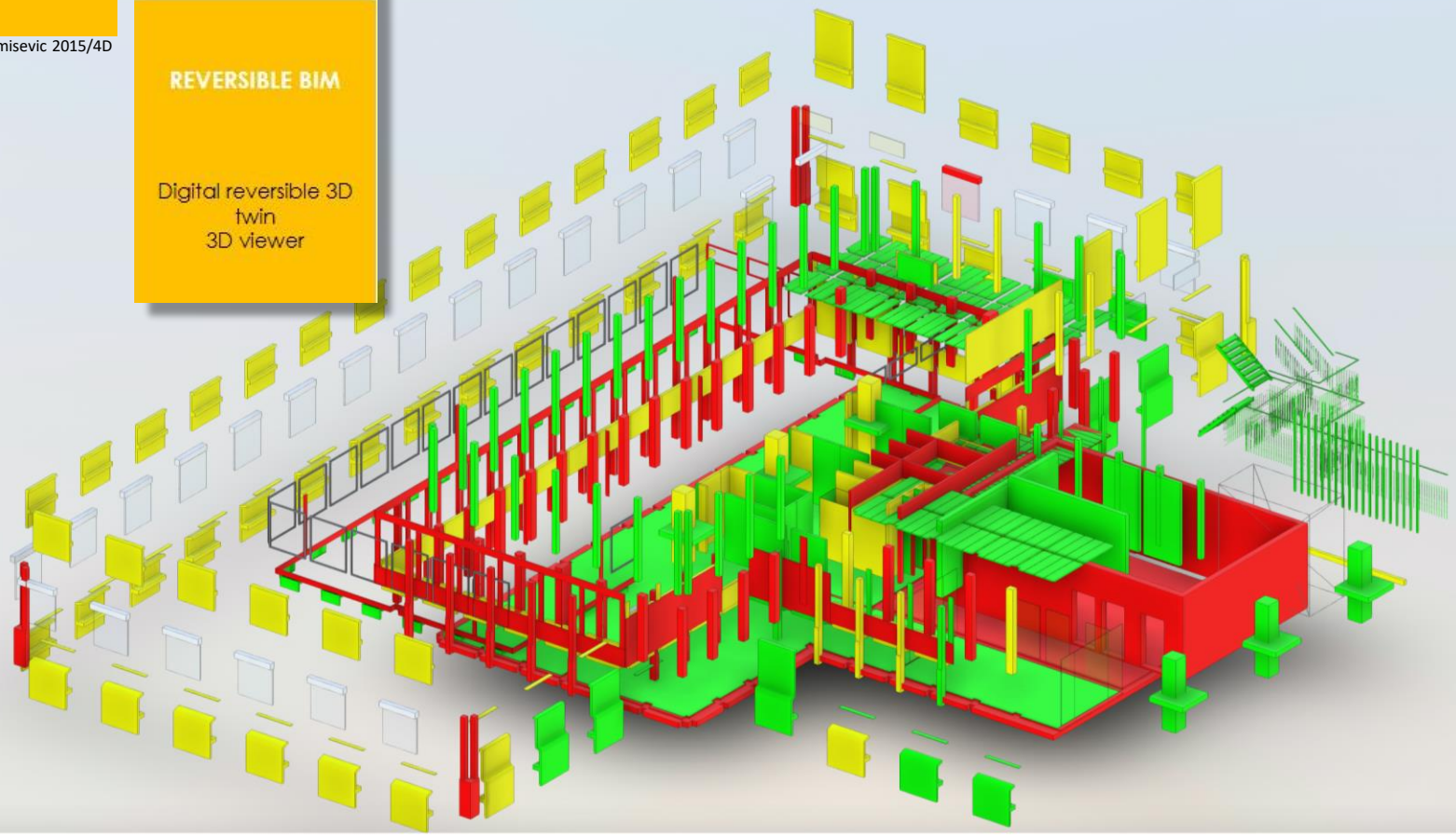
gtb lab

REVERSIBLE BIM

Digital reversible 3D twin
3D viewer



BUILDING
REUSE POTENTIAL

Reversible	0,9
	0,8
	0,7
	0,6
	0,5
	0,4
	0,3
	0,2
Irreversible	0,1

Home | Fit | Pan | Cirkelen | Zoom | First Person | Measure | Section | Explode

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Reversible BIM

Reuse Potential Tool

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5

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REVERSIBLE BIM

Digital reversible 3D twin
3D viewer

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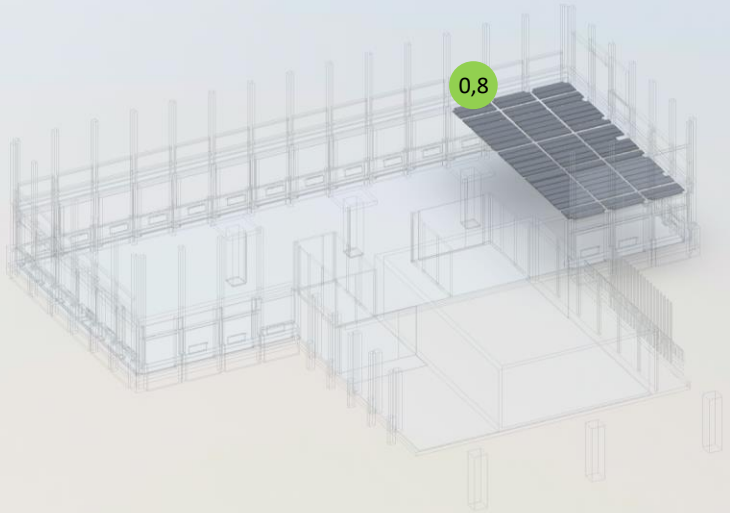
Views | Model browser | Properties | Comments | Print | Export | Share

- Walls
- Generic Models
- Ceilings
- Windows
- Plumbing Fixtures
- Electrical Equipment
- Railings
- Top Rails



BUILDING
REUSE POTENTIAL

0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1

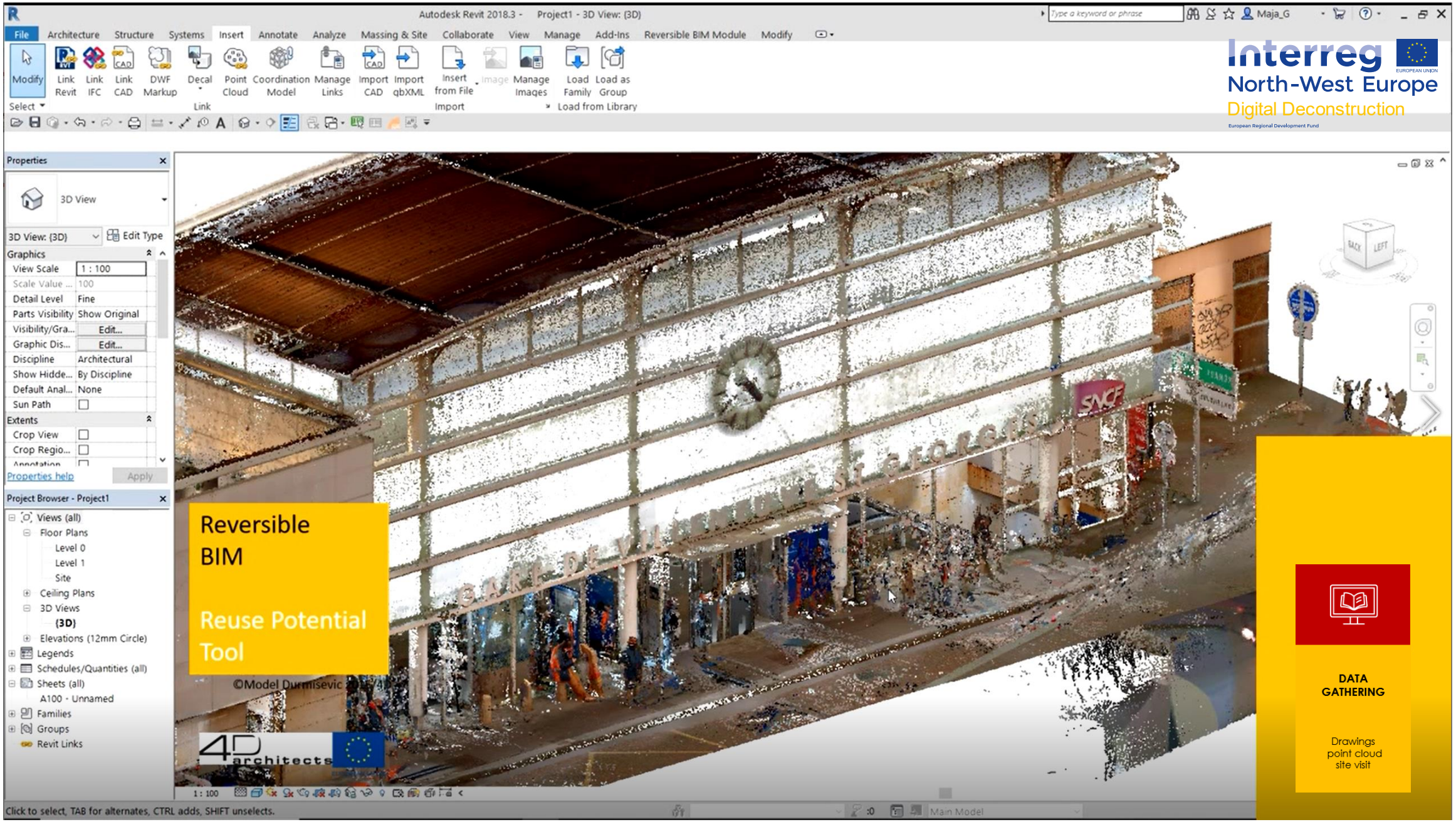
Ceilings

Name	Ceilings	0,8

Home | Fit | Cirkelen | Pan | Zoom | First Person | Measure | Section | Explode

4D architects

EUROPEAN UNION


Autodesk Revit 2018.3 - Project1 - 3D View: {3D}
File
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Reversible BIM Module
Modify
Properties
3D View
3D View: {3D}
Edit Type
Graphics
View Scale 1 : 100
Scale Value ... 100
Detail Level Fine
Parts Visibility Show Original
Visibility/Gra... Edit...
Graphic Dis... Edit...
Discipline Architectural
Show Hidde... By Discipline
Default Anal... None
Sun Path
Extents
Crop View
Crop Regio...
Properties help
Apply
Project Browser - Project1
Views (all)
Floor Plans
Level 0
Level 1
Site
Ceiling Plans
3D Views
{3D}
Elevations (12mm Circle)
Legends
Schedules/Quantities (all)
Sheets (all)
A100 - Unnamed
Families
Groups
Revit Links
Reversible BIM
Reuse Potential Tool
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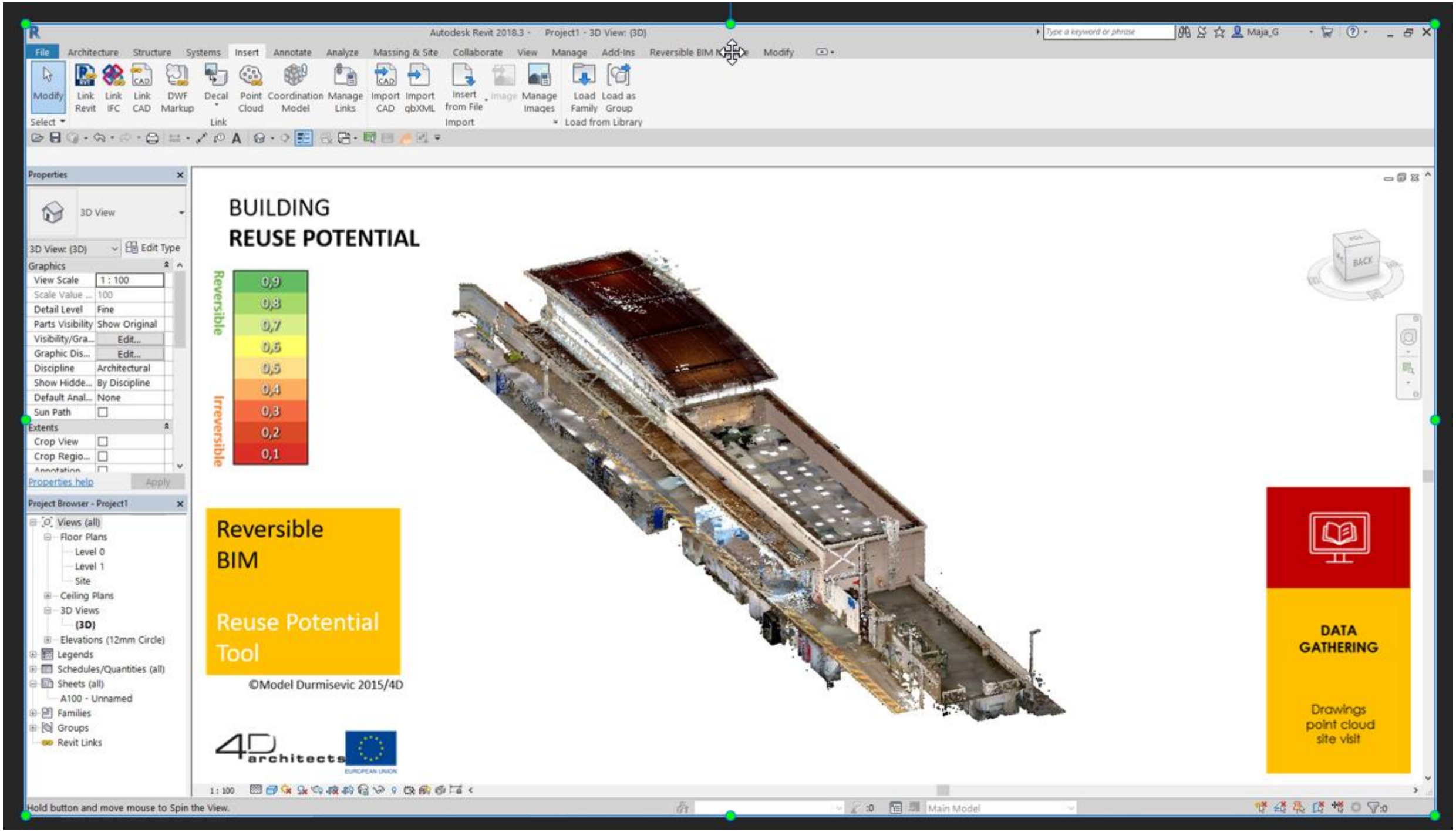
4D architects
Interreg
North-West Europe
Digital Deconstruction
European Regional Development Fund
DATA GATHERING
Drawings
point cloud
site visit
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.


Autodesk Revit 2018.3 - Project1 - 3D View: (3D)
File
Architecture
Structure
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Reversible BIM
Modify
Link Revit
Link IFC
Link CAD
DWF Markup
Decal
Point Cloud
Coordination Model
Manage Links
Import CAD
Import qbXML
Insert from File
Manage Images
Load Family
Load as Group
Properties
3D View
3D View: (3D)
Edit Type
Graphics
View Scale 1 : 100
Scale Value ... 100
Detail Level Fine
Parts Visibility Show Original
Visibility/Gra... Edit...
Graphic Dis... Edit...
Discipline Architectural
Show Hidde... By Discipline
Default Anal... None
Sun Path
Extents
Crop View
Crop Regio...
Properties help
Apply
Project Browser - Project1
Views (all)
Floor Plans
Level 0
Level 1
Site
Ceiling Plans
3D Views
(3D)
Elevations (12mm Circle)
Legends
Schedules/Quantities (all)
Sheets (all)
A100 - Unnamed
Families
Groups
Revit Links
BUILDING
REUSE POTENTIAL
Reversible
Irreversible
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
Reversible BIM
Reuse Potential Tool
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4D architects
EUROPEAN UNION
DATA GATHERING
Drawings point cloud site visit
Hold button and move mouse to Spin the View.
Main Model

Reversible BIM

Reuse Potential Tool

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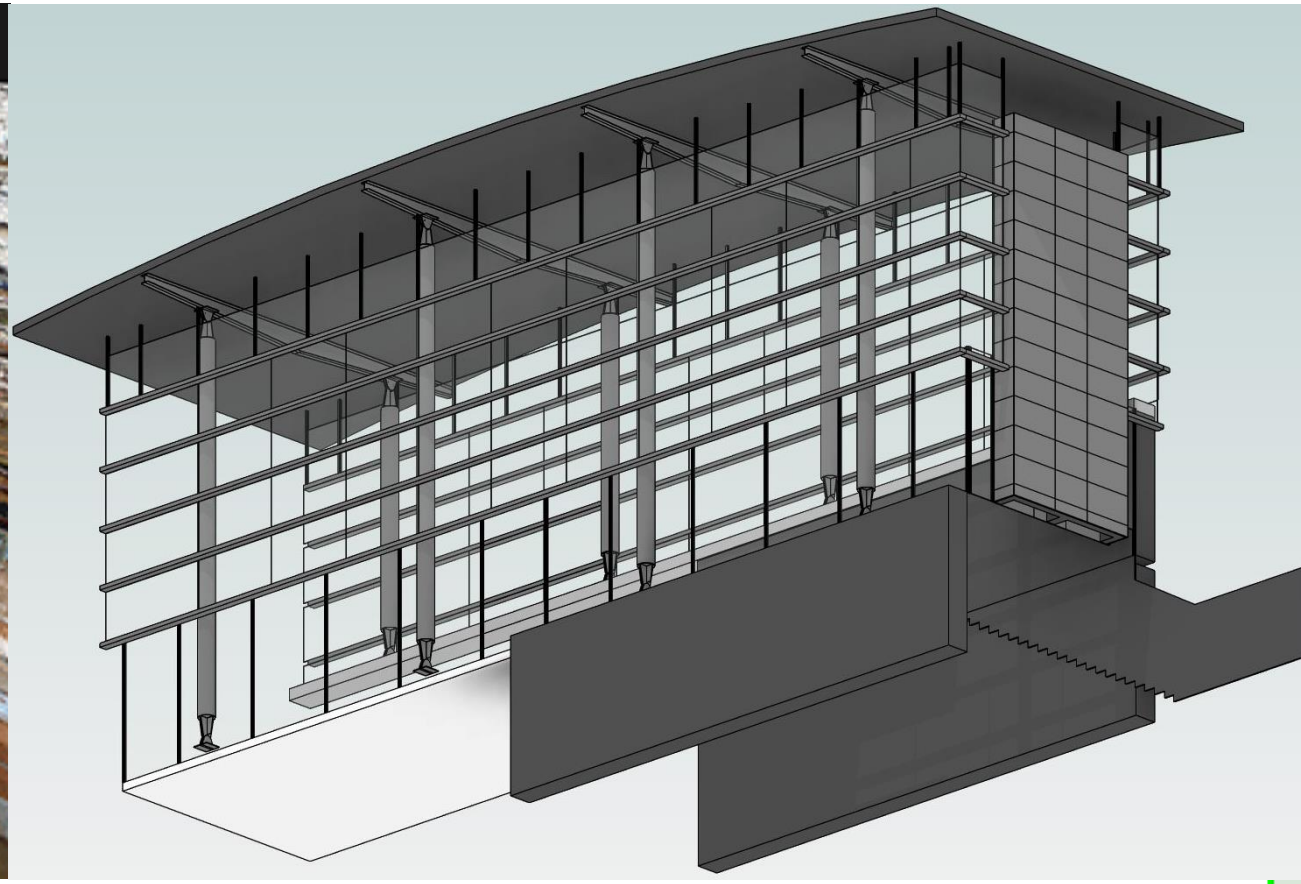
DATA GATHERING

Drawings
point cloud
site visit



- Gap between existing Revit model and RBIM
- Gap 3D scanning and drawings / Revit model

Reversible BIM

Reuse Potential Tool

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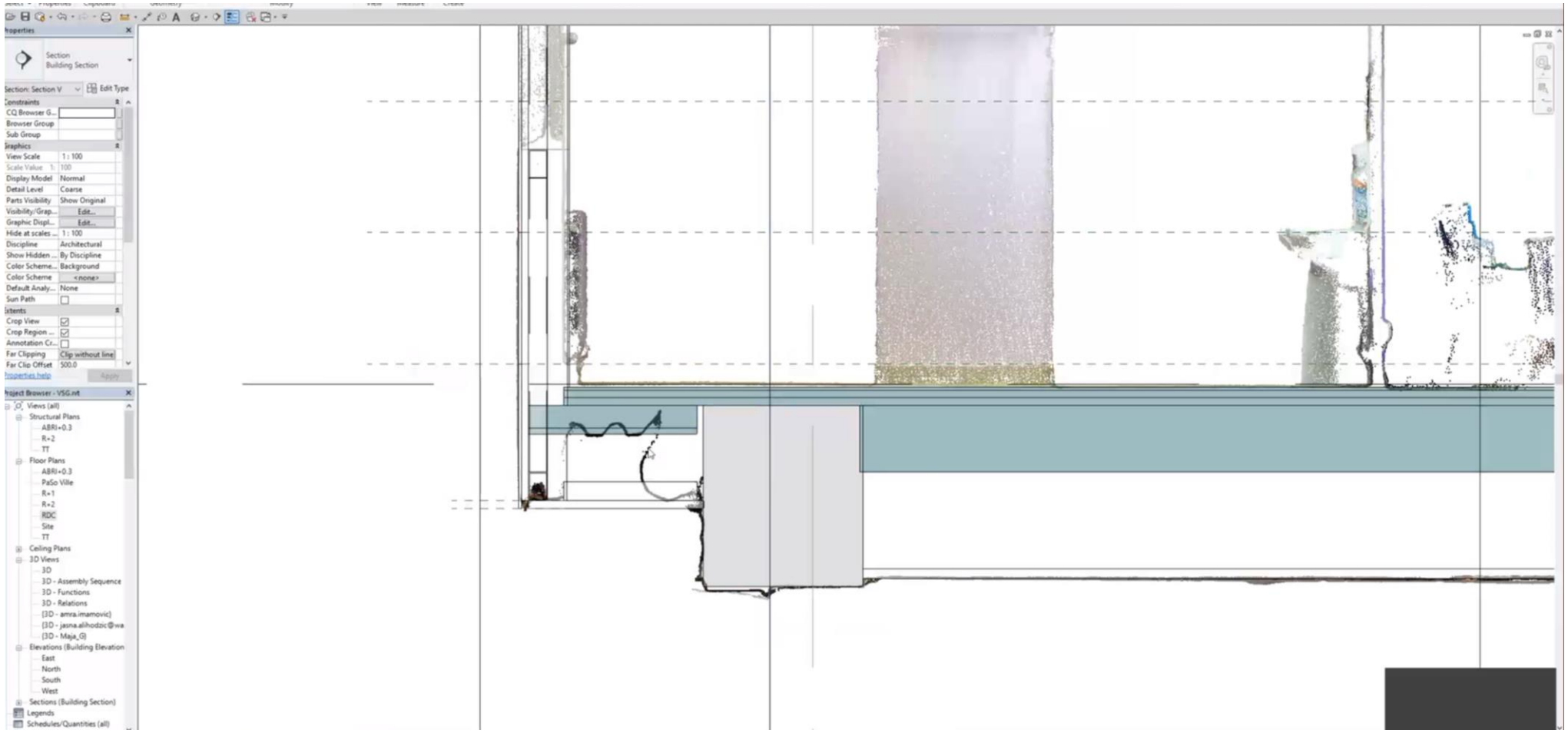
DATA GATHERING

Drawings
point cloud
site visit



Reversible BIM

Reuse Potential Tool

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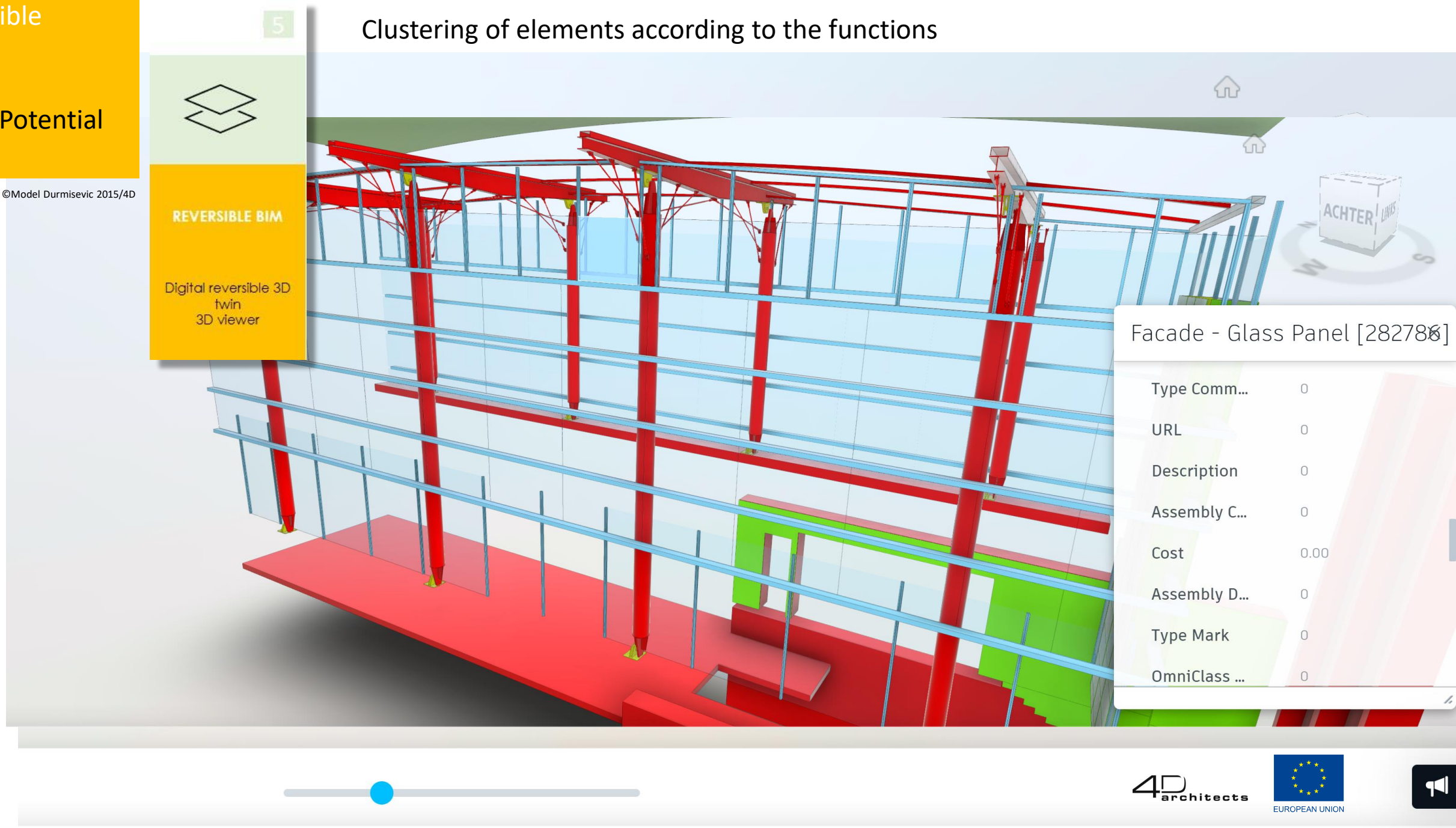
Clustering of elements according to the functions



Reversible BIM

Reuse Potential Tool

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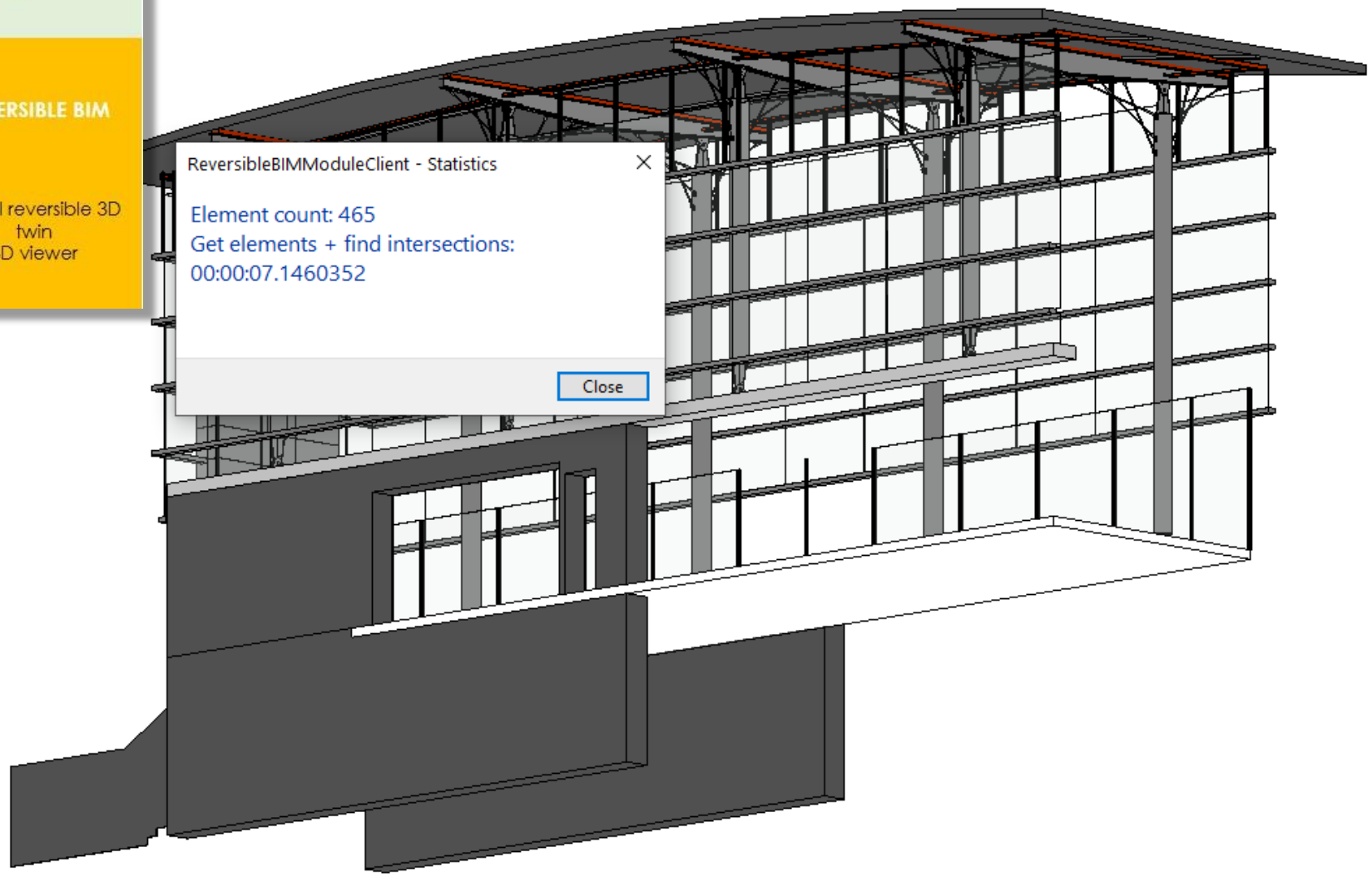
5

REVERSIBLE BIM

Digital reversible 3D twin
3D viewer

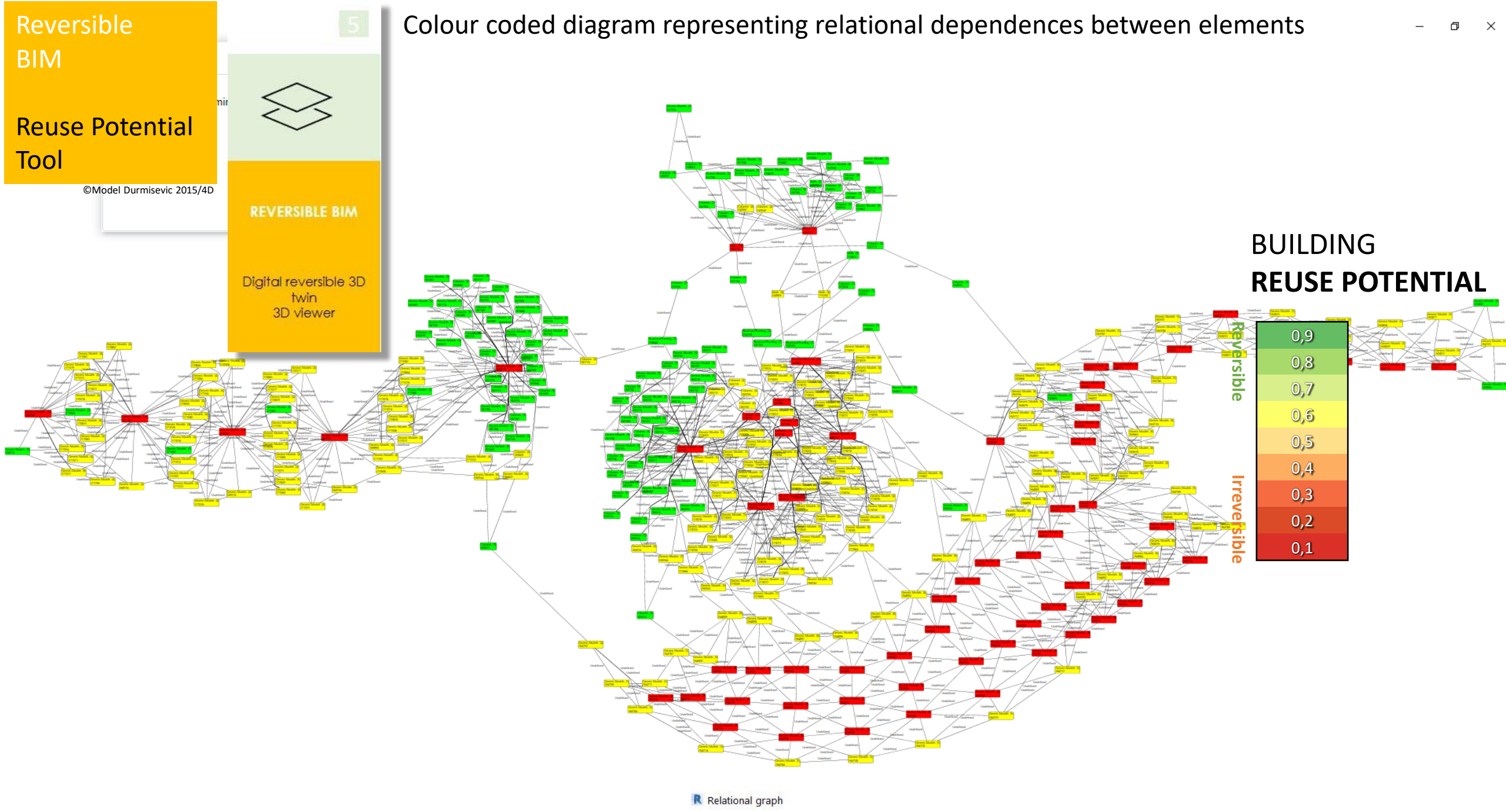


Reversible BIM

Reuse Potential Tool

©Model Durmisevic 2015/4D

Colour coded diagram representing relational dependences between elements



Reversible BIM

Reuse Potential Tool

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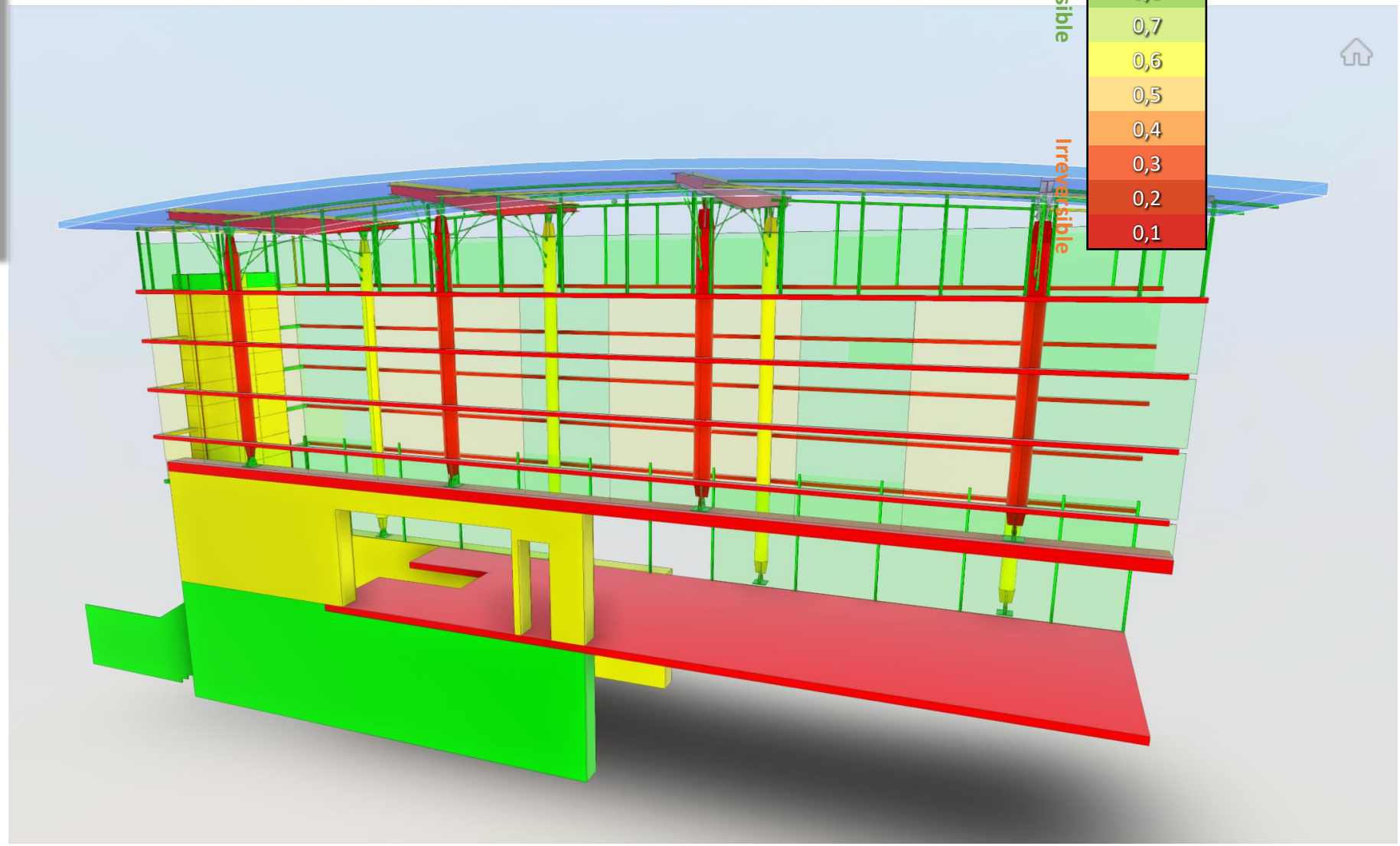
REVERSIBLE BIM

Digital reversible 3D twin
3D viewer

BUILDING
REUSE POTENTIAL



4D architects

EUROPEAN UNION

Reversible BIM

Reuse Potential Tool

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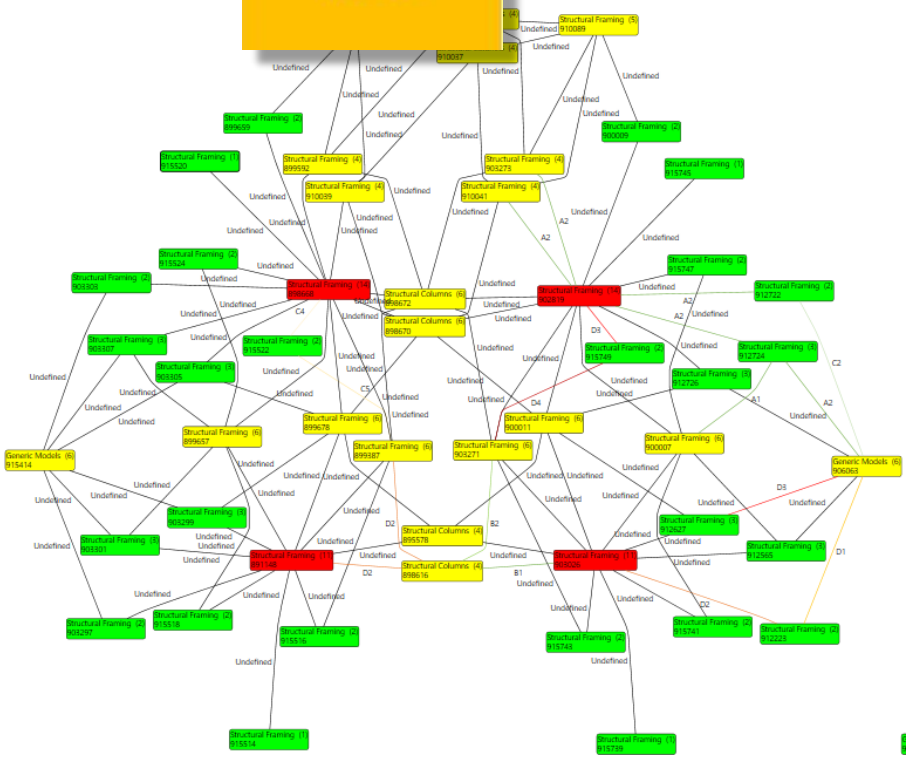
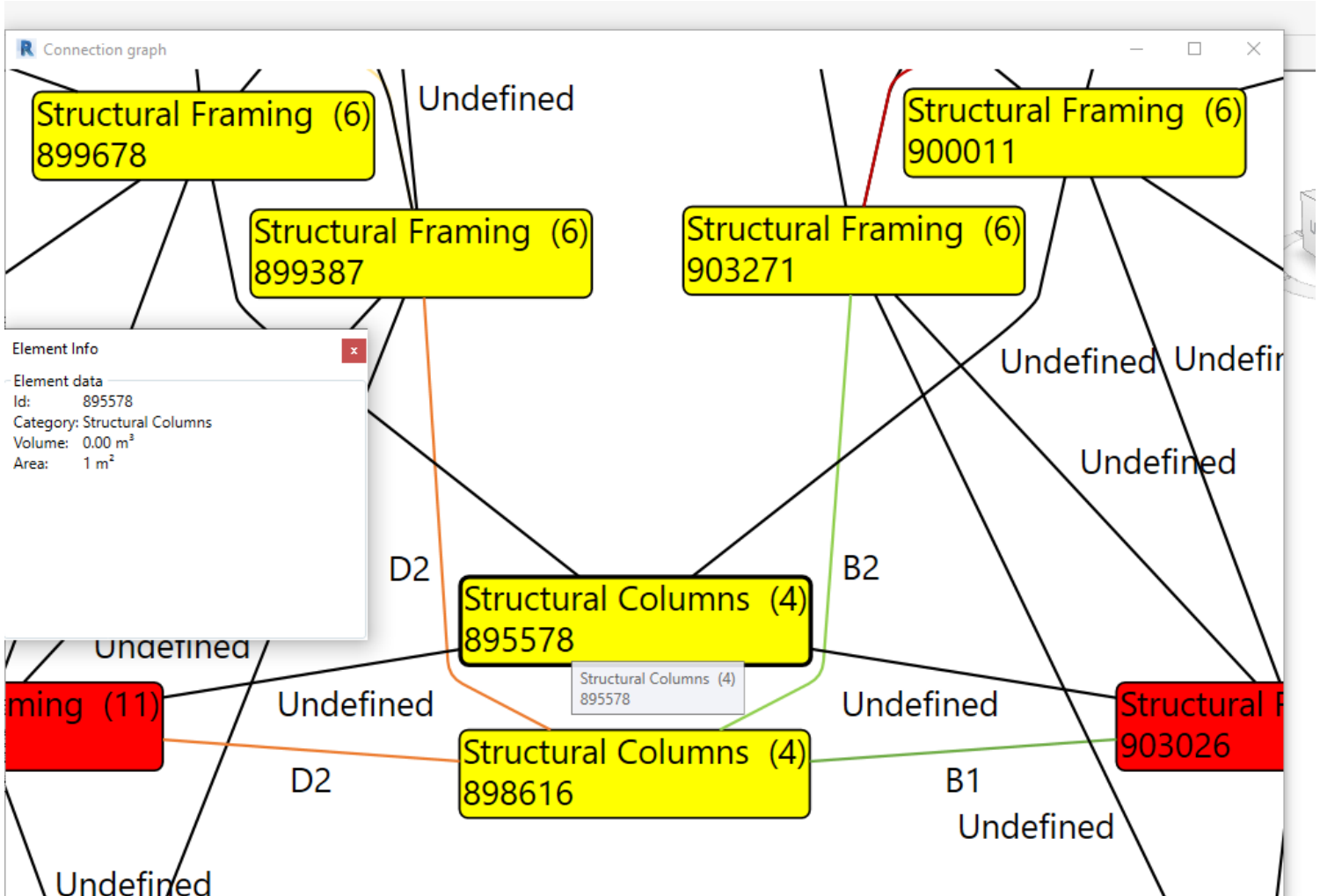
REVERSIBLE BIM

Digital reversible 3D twin
3D viewer

Colour coded diagram representing relational dependences between elements





Reversible BIM Module

Reuse Potential (RP)Tool

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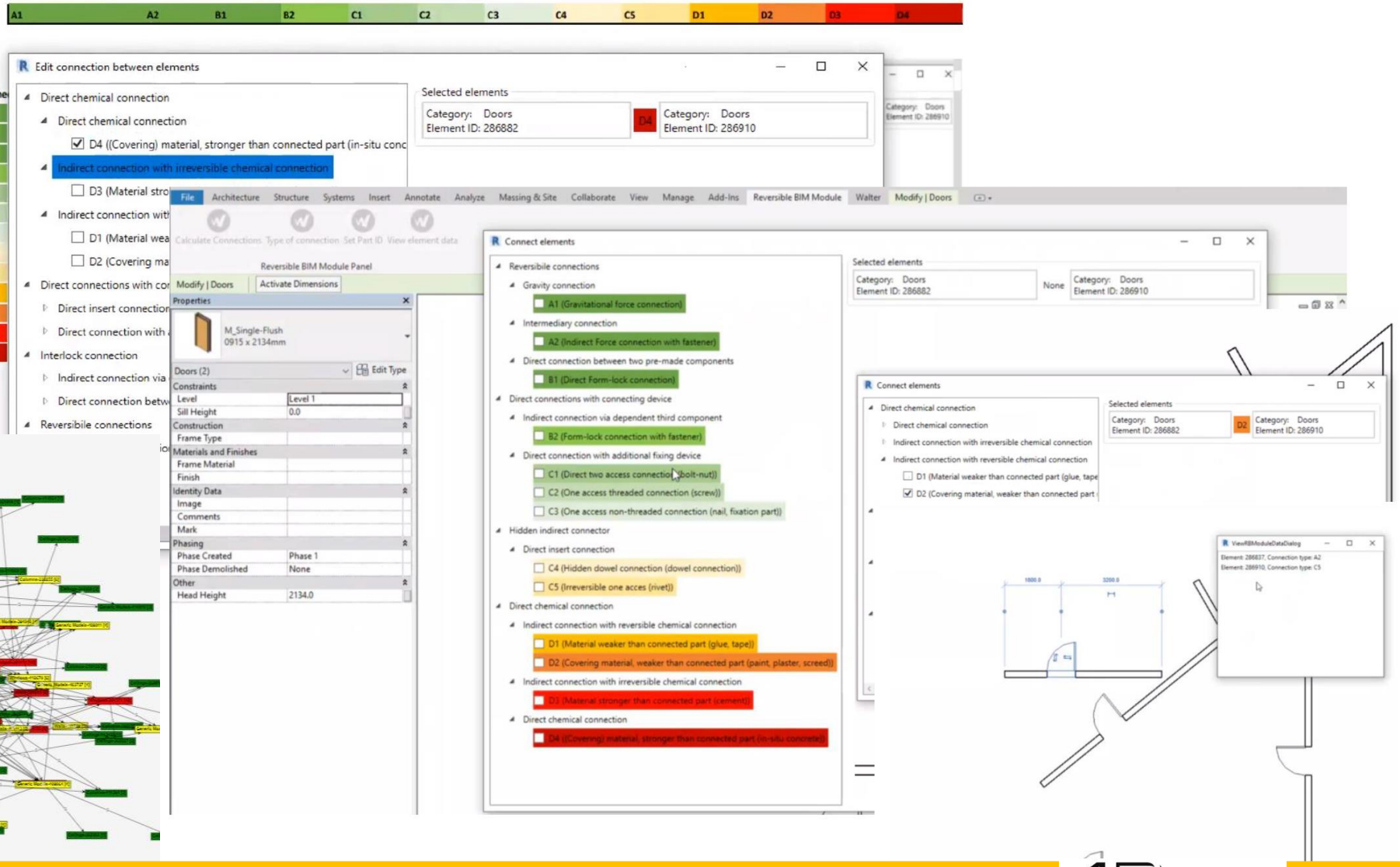
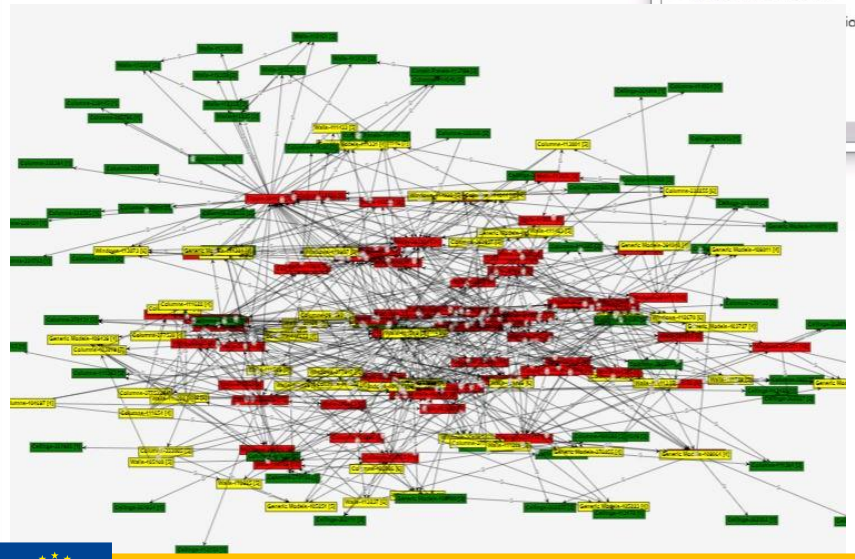
Type of Connections

Reversible connections	A1	Gravity connection	A1
	A2	Intermediary connection	A2
	B1	Direct connection between two pre-ma	B1
	B2	Indirect connection via dependent third	B2
Direct connections with connecting device	C1	Direct connection with additional fixing	C1
	C2		C2
	C3		C3
Hidden indirect connector	C4	Direct insert connection	C4
	C5		C5
Material connections	D1	Indirect connection with reversible che	D1
	D2		D2
	D3	Indirect connection with irreversible ch	D3
	D4	Direct chemical connection	D4





Reversible BIM

Reuse Potential Tool

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REVERSIBLE BIM

Digital reversible 3D twin
3D viewer

Order elements

Selection | Assembly Sequence

Copy element id
Select all instances
Highlight selected
Add highlighted

			Family and Type Name	Current Sequence Nr	New Sequence Nr
			houten element gevel standaard 3_	1	1
			L-Angles: H300/90/10	4	2
			L-Angles: H300/90/10	4	3
☑	☑	903303	L-Angles: H300/90/10	4	4
☑	☑	903305	L-Angles: H300/90/10	4	5
☑	☑	903307	L-Angles: H300/90/10	4	6
☑	☑	912223	L-Angles: H300/90/10	4	7
☑	☑	912627	L-Angles: H300/90/10	4	8
☑	☑	912722	L-Angles: H300/90/10	4	9
☑	☑	912724	L-Angles: H300/90/10	4	10
☑	☑	912726	L-Angles: H300/90/10	4	11
☑	☑	915524	L-Angles: H300/90/10	4	12
☑	☑	915747	L-Angles: H300/90/10	4	13
☑	☐	899659	ligger 80x340: ligger horizontaal	10	14
☑	☐	899678	ligger 80x340: ligger horizontaal	11	15
☑	☑	900009	ligger 80x340: ligger horizontaal	13	16
☑	☑	900011	ligger 80x340: ligger horizontaal	13	17
☑	☑	910035	ligger 80x340: ligger horizontaal	13	18
☑	☑	910039	ligger 80x340: ligger horizontaal	13	19
☑	☑	910041	ligger 80x340: ligger horizontaal	13	20
☑	☐	910089	ligger 80x340: ligger horizontaal	14	21
☑	☐	895578	staander 80x80: 80x80SHS	15	22
☑	☐	898670	staander 80x80: 80x80SHS	17	23
☑	☐	898765	staander 80x80: 80x80SHS	19	24
☑	☐	910037	staander 80x80: 80x80SHS	20	25

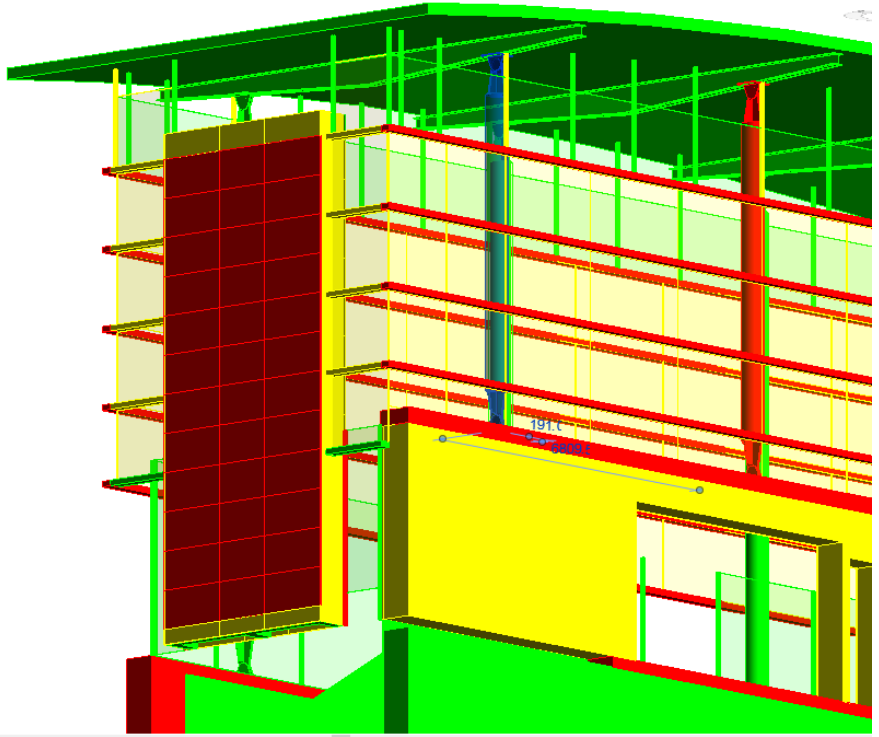
Get selection | Update

Element connections

Element data
Id: 898616
Category: Columns
Volume: 0.71 m³
Area: 5 m²
Connections: 4

Element connections

Element ID	Connection type
891148	D2
899387	D2
903026	B1
903271	B2



Reversible BIM

Reuse Potential Tool

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Elements in assembly sequence

Id	Category	Family and Type Name	Assembly Sequence Nr	Number of connections
245275	Walls	Basic Wall: Structure - Wall YV 600	1	10
280579	Floors	Floor: Structure - Floor Slab 200 mm	2	21
260398	Walls	Facade - Shaft Wall: Facade - Shaft Wall	3	3
244905	Walls	Basic Wall: Structure - Wall IV 600	3	5
388651	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	4	2
386510	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	4	2
388845	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	4	1
243485	Structural Framing	Structure - Beam Concrete - Cast-in-Place Rectangular: 680x280	4	19
388888	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	4	1
203304	Structural Columns	Structure - Main Column 1: Structure - Main Column 1	5	8
203327	Structural Columns	Structure - Main Column 1: Structure - Main Column 1	5	8
203265	Structural Columns	Structure - Main Column 1: Structure - Main Column 1	5	8
201756	Structural Columns	Structure - Main Column 1: Structure - Main Column 1	5	9
385427	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	6	2
385418	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	6	2
385409	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	6	2
385224	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	6	2
203356	Structural Columns	Structure - Main Column 2: Structure - Main Column 2	7	11
231268	Structural Columns	Structure - Main Column 2: Structure - Main Column 2	7	11
231298	Structural Columns	Structure - Main Column 2: Structure - Main Column 2	7	11
231284	Structural Columns	Structure - Main Column 2: Structure - Main Column 2	7	11
247155	Structural Framing	Structure - Roof Beam: Structure - Roof Beam	8	23
258596	Structural Framing	Structure - Roof Beam: Structure - Roof Beam	8	23
258159	Structural Framing	Structure - Roof Beam: Structure - Roof Beam	8	24
259848	Structural Framing	Structure - Roof Beam: Structure - Roof Beam	8	21
383560	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	9	2
385407	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	9	2
388763	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	9	2
388750	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	9	2
386793	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	9	2
388774	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	9	2
385426	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	9	2
385417	Structural Framing	Intermediary - Column Joint: Intermediary - Column Joint	9	2
463267	Structural Framing	Structure - Brace 6: Structure - Brace 6	10	2
463210	Structural Framing	Structure - Brace 6: Structure - Brace 6	10	2
467939	Structural Framing	Structure - Brace 3: Structure - Brace 3	10	2
463304	Structural Framing	Structure - Brace 6: Structure - Brace 6	10	2
467275	Structural Framing	Structure - Brace 3: Structure - Brace 3	10	2
467277	Structural Framing	Structure - Brace 3: Structure - Brace 3	10	2
467207	Structural Framing	Structure - Brace 3: Structure - Brace 3	10	2
463334	Structural Framing	Structure - Brace 6: Structure - Brace 6	10	2
464118	Structural Framing	Structure - Brace 3: Structure - Brace 3	10	2
333406	Structural Framing	Structure - Brace 1: Structure - Brace 1	10	2
333431	Structural Framing	Structure - Brace 1: Structure - Brace 1	10	3
350695	Structural Framing	Structure - Brace 1: Structure - Brace 1	10	2
323324	Structural Framing	Structure - Brace 1: Structure - Brace 1	10	2

Elements in assembly sequence

Id	Category	Family and Type Name	Assembly Sequence Nr	Number of connections
323324	Structural Framing	Structure - Brace 1: Structure - Brace 1	10	2
378691	Generic Models	Structure - Brace 5: Structure - Brace 5	10	3
462766	Structural Framing	Structure - Brace 6: Structure - Brace 6	10	1
462846	Structural Framing	Structure - Brace 6: Structure - Brace 6	10	1
449113	Structural Framing	Structure - Brace 6: Structure - Brace 6	10	1
462711	Structural Framing	Structure - Brace 6: Structure - Brace 6	10	1
467941	Structural Framing	Structure - Brace 3: Structure - Brace 3	10	2
480792	Structural Framing	Structure - Brace 2: Structure - Brace 2	10	2
483577	Structural Framing	Structure - Brace 2: Structure - Brace 2	10	2
483579	Structural Framing	Structure - Brace 2: Structure - Brace 2	10	2
477818	Structural Framing	Structure - Brace 2: Structure - Brace 2	10	2
333572	Structural Framing	Structure - Brace 1: Structure - Brace 1	10	3
475638	Structural Framing	Structure - Brace 4: Structure - Brace 4	10	2
476573	Structural Framing	Structure - Brace 1: Structure - Brace 1	10	2
333450	Structural Framing	Structure - Brace 1: Structure - Brace 1	10	2
333553	Structural Framing	Structure - Brace 1: Structure - Brace 1	10	2
483621	Structural Framing	Structure - Brace 2: Structure - Brace 2	10	2
483619	Structural Framing	Structure - Brace 2: Structure - Brace 2	10	2
483598	Structural Framing	Structure - Brace 2: Structure - Brace 2	10	2
483600	Structural Framing	Structure - Brace 2: Structure - Brace 2	10	2
360072	Generic Models	Structure - Brace 5: Structure - Brace 5	10	2
475637	Structural Framing	Structure - Brace 4: Structure - Brace 4	10	2
468258	Structural Framing	Structure - Brace 4: Structure - Brace 4	10	2
468004	Structural Framing	Structure - Brace 3: Structure - Brace 3	10	2
360087	Generic Models	Structure - Brace 5: Structure - Brace 5	10	2
378644	Generic Models	Structure - Brace 5: Structure - Brace 5	10	2
360804	Generic Models	Structure - Brace 5: Structure - Brace 5	10	3
378621	Generic Models	Structure - Brace 5: Structure - Brace 5	10	2
468002	Structural Framing	Structure - Brace 3: Structure - Brace 3	10	2
360102	Generic Models	Structure - Brace 5: Structure - Brace 5	10	2
475628	Structural Framing	Structure - Brace 4: Structure - Brace 4	10	2
475629	Structural Framing	Structure - Brace 4: Structure - Brace 4	10	2
475521	Structural Framing	Structure - Brace 4: Structure - Brace 4	10	2
475616	Structural Framing	Structure - Brace 4: Structure - Brace 4	10	2
475615	Structural Framing	Structure - Brace 4: Structure - Brace 4	10	2
378663	Generic Models	Structure - Brace 5: Structure - Brace 5	10	3
493336	Structural Framing	Structure - Beam 5: Structure - Beam 5	11	3
380443	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 100x220x5	11	6
380486	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 100x220x5	11	6
380350	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 100x220x5	11	6
380091	Structural Framing	Structure - Beam VKR: Structure - Beam 120x220x5	11	6
381628	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 150x100x5	11	8
491597	Structural Framing	Structure - Beam 4: Structure - Beam 4	11	3
491448	Structural Framing	Structure - Beam 3: Structure - Beam 3	11	3
493229	Structural Framing	Structure - Beam 5: Structure - Beam 5	11	3
490599	Structural Framing	Structure - Beam 2: Structure - Beam 2	11	3

Elements in assembly sequence

Id	Category	Family and Type Name	Assembly Sequence Nr	Number of connections
490599	Structural Framing	Structure - Beam 2: Structure - Beam 2	11	3
493332	Structural Framing	Structure - Beam 1: Structure - Beam 1	11	4
488159	Structural Framing	Structure - Beam 1: Structure - Beam 1	11	4
493334	Structural Framing	Structure - Beam 3: Structure - Beam 3	11	3
493333	Structural Framing	Structure - Beam 2: Structure - Beam 2	11	3
493335	Structural Framing	Structure - Beam 4: Structure - Beam 4	11	3
283306	Roofs	Basic Roof: Enclosure - Roof - 200mm	12	26
262310	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	27
262324	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	54
269264	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	5
262048	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	14
262283	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	27
262291	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	27
269263	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	5
265780	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	58
268579	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	3
269116	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	5
265777	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	31
265778	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	31
265779	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	31
269260	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	1
269261	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	5
269262	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	5
269124	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	5
269136	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	5
269144	Generic Models	Facade-Horizontal Mullion: Facade-Horizontal Mullion	13	6
401813	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x120x5	14	6
401811	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x120x5	14	8
402000	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x80x5	14	4
402422	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x120x5	14	7
402205	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x80x5	14	4
401302	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x120x5	14	9
399702	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x120x5	14	8
401452	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x80x5	14	4
381405	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x120x5	14	10
382172	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 150x100x5	14	6
403047	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x80x5	14	4
401611	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x80x5	14	4
403097	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x120x5	14	7
403045	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x120x5	14	9
402820	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x120x5	14	6
402985	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x120x5	14	9
402987	Structural Framing	Structure - Beam VKR: Structure - Beam VKR 50x80x5	14	4
282772	Generic Models	Facade-Vertical Mullion: Facade-Vertical Mullion	15	4
282777	Generic Models	Facade-Vertical Mullion: Facade-Vertical Mullion	15	4
282773	Generic Models	Facade-Vertical Mullion: Facade-Vertical Mullion	15	4

Id	A1	A2	B1	B2	C1	C2	C3	C4	C5	D1	D2	D3	D4	Sum
898616	0	0	1	1	0	0	0	0	0	0	2	0	0	4
902819	0	2	0	0	0	0	0	0	0	0	0	1	0	3
903026	0	0	0	0	0	0	0	0	0	0	1	0	0	1
903271	0	0	0	0	0	0	0	0	0	0	0	0	1	1
898668	0	0	0	0	0	0	0	1	0	0	0	0	0	1
900007	1	0	0	0	0	0	0	0	0	0	0	0	0	1
899387	0	0	0	0	0	0	0	0	1	0	0	0	0	1
912627	0	0	0	0	0	0	0	0	0	0	0	1	0	1
912223	0	0	0	0	0	0	0	0	0	1	0	0	0	1
912724	0	1	0	0	0	0	0	0	0	0	0	0	0	1
912722	0	0	0	0	0	1	0	0	0	0	0	0	0	1
899659	0	0	0	0	0	0	0	0	0	0	0	0	0	0
898672	0	0	0	0	0	0	0	0	0	0	0	0	0	0
900009	0	0	0	0	0	0	0	0	0	0	0	0	0	0
899678	0	0	0	0	0	0	0	0	0	0	0	0	0	0
899592	0	0	0	0	0	0	0	0	0	0	0	0	0	0
898765	0	0	0	0	0	0	0	0	0	0	0	0	0	0
910037	0	0	0	0	0	0	0	0	0	0	0	0	0	0

From

Id	A1	A2	B1	B2	C1	C2	C3	C4	C5	D1	D2	D3	D4	Sum
906063	0	1	0	0	0	1	0	0	0	1	0	1	0	4
912724	1	1	0	0	0	0	0	0	0	0	0	0	0	2
915749	0	0	0	0	0	0	0	0	0	0	0	1	1	2
915522	0	0	0	0	0	0	0	1	1	0	0	0	0	2
903271	0	0	0	1	0	0	0	0	0	0	0	0	0	1
903026	0	0	1	0	0	0	0	0	0	0	0	0	0	1
891148	0	0	0	0	0	0	0	0	0	0	1	0	0	1
899387	0	0	0	0	0	0	0	0	0	0	1	0	0	1
912223	0	0	0	0	0	0	0	0	0	0	1	0	0	1
912722	0	1	0	0	0	0	0	0	0	0	0	0	0	1
900009	0	0	0	0	0	0	0	0	0	0	0	0	0	0
900007	0	0	0	0	0	0	0	0	0	0	0	0	0	0
900011	0	0	0	0	0	0	0	0	0	0	0	0	0	0
899592	0	0	0	0	0	0	0	0	0	0	0	0	0	0
910037	0	0	0	0	0	0	0	0	0	0	0	0	0	0
899657	0	0	0	0	0	0	0	0	0	0	0	0	0	0
899678	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Dependences in assembly
(before and after assembly of element)

BUILDING
REUSE POTENTIAL

Reversible

0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1

Irreversible

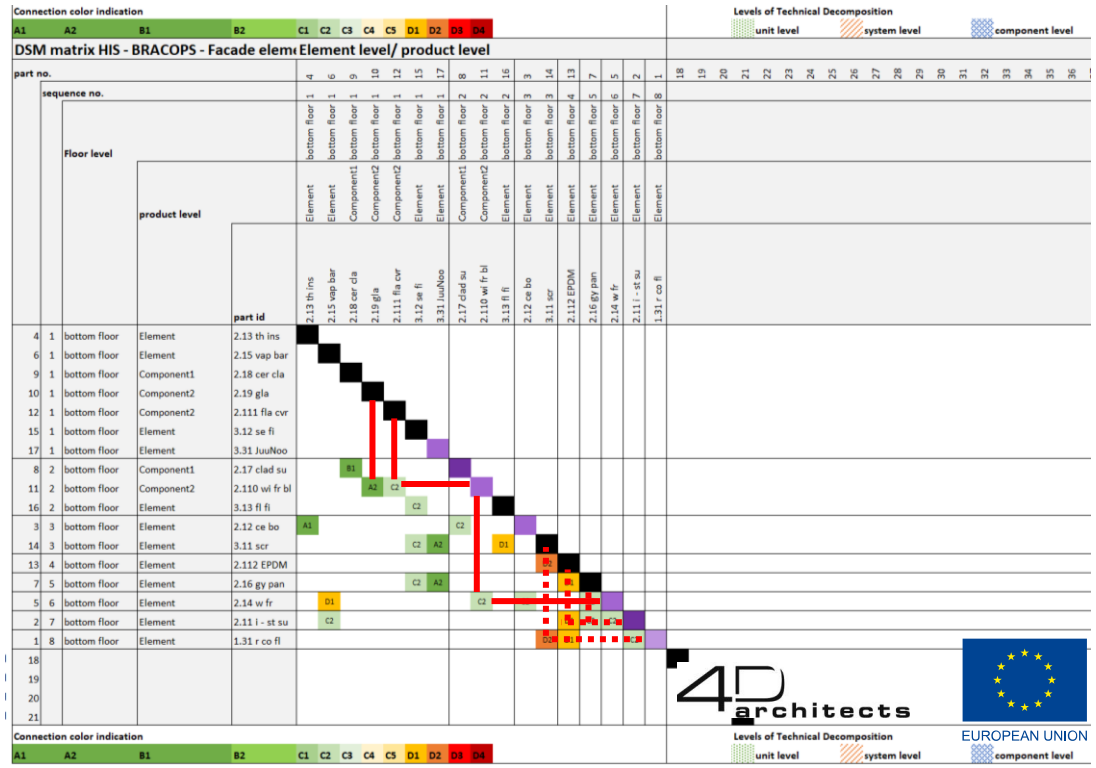
6

REPORTING REVERSIBILITY

Reuse options
Deconstruction
staps & embodied
value

Connect elements

- Reversibile connections
  - Gravity connection
    - A1 (Gravitational force connection)
  - Intermediary connection
    - A2 (Indirect Force connection with fastener)
  - Direct connection between two pre-made components
    - B1 (Direct Form-lock connection)
- Direct connections with connecting device
  - Indirect connection via dependent third component
    - B2 (Form-lock connection with fastener)
  - Direct connection with additional fixing device
    - C1 (Direct two access connection (bolt-nut))
    - C2 (One access threaded connection (screw))
    - C3 (One access non-threaded connection (nail, fixation part))
- Hidden indirect connector
  - Direct insert connection
    - C4 (Hidden dowel connection (dowel connection))
    - C5 (Irreversible one acces (rivet))
- Direct chemical connection
  - Indirect connection with reversible chemical connection
    - D1 (Material weaker than connected part (glue, tape))
    - D2 (Covering material, weaker than connected part (paint, plaster, screed))
  - Indirect connection with irreversible chemical connection
    - D3 (Material stronger than connected part (cement))
  - Direct chemical connection
    - D4 ((Covering) material, stronger than connected part (in-situ concrete))



Reversible BIM

Reuse Potential Tool

©Model Durmisevic 2015/4D

5

REVERSIBLE BIM

Digital reversible 3D twin
3D viewer

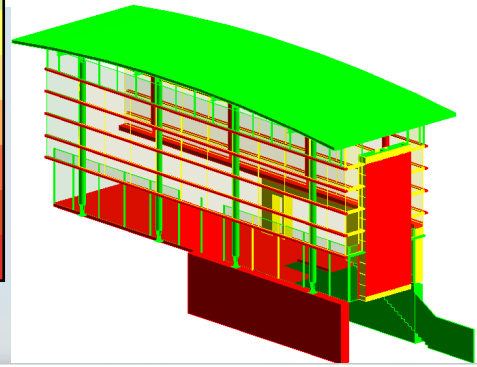
BUILDING
REUSE POTENTIAL

Reversible

0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1

Irreversible

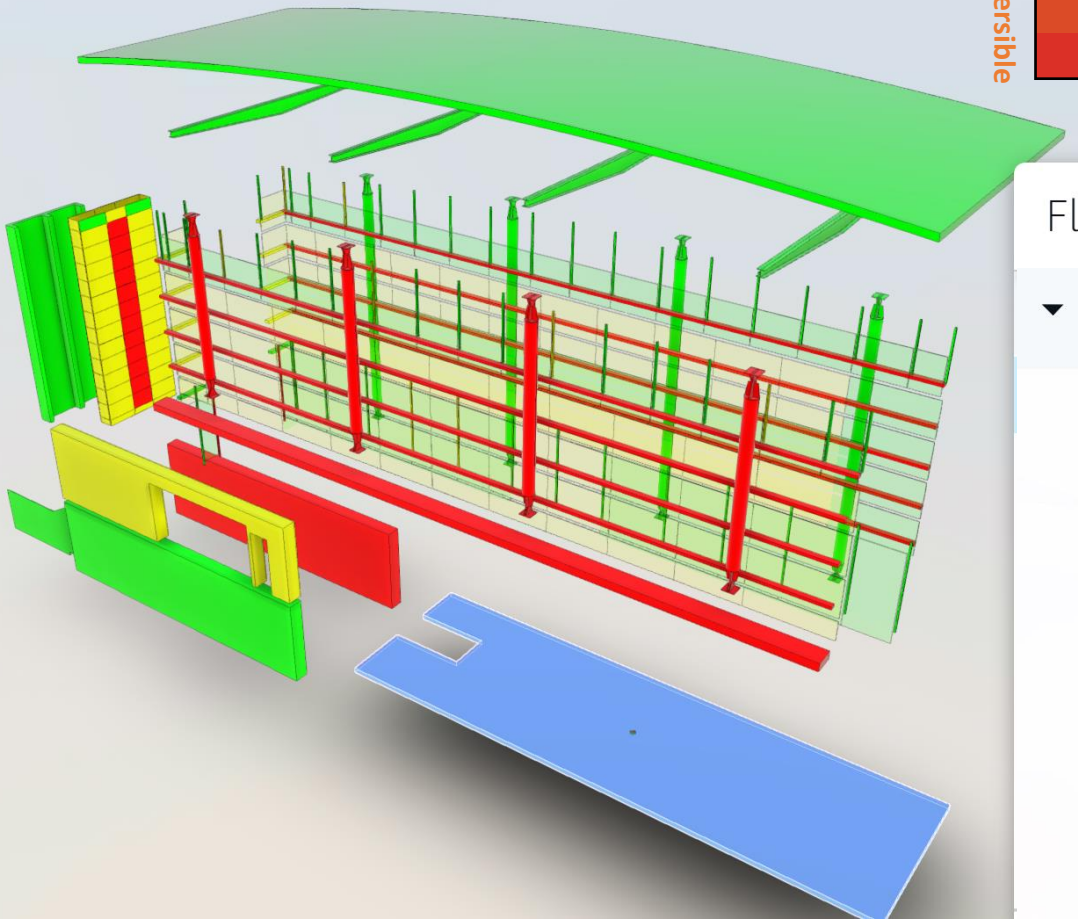
- Formatting outputs



Model

Zoeken

- Glass Facade
- Glass Facade [28564...
- Glass Facade [28581...
- Glass Facade [28667...
- Profile Facade
- Panel Vent.Facade
- Floors
  - Floor
    - Floor Slab 200 mm
      - Floor [280579]
- Roofs



Floor [280579]

Dimensions

Slope	0.00 degree
Perimeter	59220.1 mm
Area	120.2 m^2
Volume	24.04 m^3
Elevation at...	-1181.1 mm
Elevation at...	-1381.1 mm
Thickness	200.0 mm

4D architects

EUROPEAN UNION

Reversible BIM

Reuse Potential Tool

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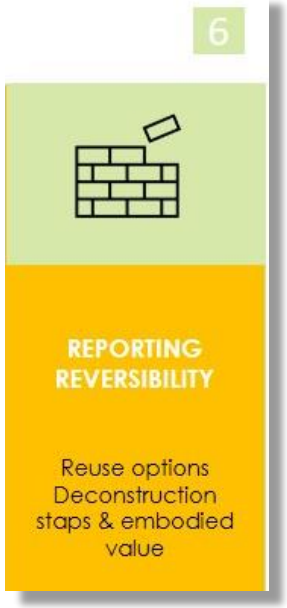
Formatting outputs



Sequence no.	ID	Type	Material name	Volume	Area	Number of connections
1	245275	Structure - Wall YV 600	Concrete	31.01 mÂ³	52 mÂ²	10
2	280579	Structure - Floor Slab 200 mm	Concrete	24.04 mÂ³	120 mÂ²	21
3	260398	Facade - Shaft Wall	Concrete	8.94 mÂ³	1 mÂ²	3
3	244905	Structure - Wall IV 600	Concrete	17.26 mÂ³	29 mÂ²	5
4	388651	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2
4	386510	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2
4	388845	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	1
4	243485	680x280	Concrete	4.97 mÂ³	25 mÂ²	19
4	388888	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	1
5	203304	Structure - Main Column 1	Steel	1.24 mÂ³	7 mÂ²	8
5	203327	Structure - Main Column 1	Steel	1.19 mÂ³	7 mÂ²	8
5	203265	Structure - Main Column 1	Steel	1.19 mÂ³	7 mÂ²	8
5	201756	Structure - Main Column 1	Steel	1.24 mÂ³	7 mÂ²	9
6	385427	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2
6	385418	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2
6	385409	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2
6	385224	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2
7	203356	Structure - Main Column 2	Steel	0.70 mÂ³	5 mÂ²	11
7	231268	Structure - Main Column 2	Steel	0.75 mÂ³	5 mÂ²	11
7	231298	Structure - Main Column 2	Steel	0.70 mÂ³	5 mÂ²	11
7	231284	Structure - Main Column 2	Steel	0.75 mÂ³	5 mÂ²	11
8	247155	Structure - Roof Beam	Steel	0.08 mÂ³	8 mÂ²	23
8	258596	Structure - Roof Beam	Steel	0.08 mÂ³	8 mÂ²	23
8	258159	Structure - Roof Beam	Steel	0.08 mÂ³	8 mÂ²	24
8	259848	Structure - Roof Beam	Steel	0.08 mÂ³	8 mÂ²	21
9	383560	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2
9	385407	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2
9	388763	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2
9	388750	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2
9	386793	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2
9	388774	Intermediary - Column Joint	Steel	0.01 mÂ³	0 mÂ²	2

4D architects

EUROPEAN UNION

RP INDICATOR 1

RP(r1) number of relations

RP INDICATOR 2

RP(r2) relations based on hierarchical position/dependency in assembly

INDICATOR 3

RP(a1) disassembly sequences

INDICATOR 4

RP(c1) type of connection

INDICATOR 5

RP(c2) damage by disassembly

4

REIVIT2 EXCL2REVIT

Full Reuse Potential Calculation

6

REPORTING REVERSIBILITY

Reuse options Deconstruction staps & embodied value

typePerElement.csv | Preview 'typePerElement.csv'

Sequence no.	ID	Type	Material name	Volume	Area	Number of con
1	934028	2400x48(Steel		0.67 m³	20 m²	76
2	940005	4800x24(Steel		0.48 m³	13 m²	42
3	1045845	Z-connec Steel		0.00 m³	0 m²	2
3	1045833	Z-connec Steel		0.00 m³	0 m²	2
3	1045937	Z-connec Steel		0.00 m³	0 m²	2
3	1045807	Z-connection2	Steel	0.00 m³	0 m²	2
3	1050083	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045798	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045938	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045947	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045948	Z-connection2	Steel	0.00 m³	0 m²	3
3	1045949	Z-connection2	Steel	0.00 m³	0 m²	3
3	1045939	Z-connection2	Steel	0.00 m³	0 m²	3
3	1045940	Z-connection2	Steel	0.00 m³	0 m²	3
3	1045946	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045563	Z-connection2	Steel	0.00 m³	0 m²	3
3	1045579	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045591	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045525	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045538	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045550	Z-connection2	Steel	0.00 m³	0 m²	3
3	1045607	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045757	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045772	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045789	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045620	Z-connection2	Steel	0.00 m³	0 m²	2
3	1045639	Z-connection2	Steel	0.00 m³	0 m²	3
3	1045652	Z-connection2	Steel	0.00 m³	0 m²	3
3	1046284	Z-connection2	Steel	0.00 m³	0 m²	2
3	1047231	Z-connection2	Steel	0.00 m³	0 m²	2
3	1047264	Z-connection2	Steel	0.00 m³	0 m²	2
3	1047298	Z-connection2	Steel	0.00 m³	0 m²	2
3	1047116	Z-connection2			0 m²	2
3	1047200	Z-connection2			0 m²	2

Skype

Preview 'indicators.csv'

ID	Type	RP(r1)	RP(r2)	RP(a1)	RP(c1)	RP(c2)	RP
934028	2400x4800x3625	0.1	0	0	0.72	0.6	0.39
940005	4800x2400x3625	0.1	0	0	0.72	0.6	0.39
1045845	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045833	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045937	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045807	Z-connection2	0.9	0	0	0.7	0.6	0.5
1050083	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045798	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045938	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045947	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045948	Z-connection2	0.9	0	0	0.78	0.6	0.52
1045949	Z-connection2	0.9	0	0	0.78	0.6	0.52
1045939	Z-connection2	0.9	0	0	0.78	0.6	0.52
1045940	Z-connection2	0.9	0	0	0.78	0.6	0.52
1045946	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045563	Z-connection2	0.9	0	0	0.78	0.6	0.52
1045579	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045591	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045525	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045538	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045550	Z-connection2	0.9	0	0	0.78	0.6	0.52
1045607	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045757	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045772	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045789	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045620	Z-connection2	0.9	0	0	0.7	0.6	0.5
1045639	Z-connection2	0.9	0	0	0.78	0.6	0.52
1045652	Z-connection2	0.9	0	0	0.78	0.6	0.52
1046284	Z-connection2	0.9	0	0	0.7	0.6	0.5
1047231	Z-connection2	0.9	0	0	0.7	0.6	0.5
1047264	Z-connection2	0.9	0	0	0.7	0.6	0.5
1047298	Z-connection2	0.9	0	0	0.7	0.6	0.5
1047116	Z-connection2	0.9	0	0	0.7	0.6	0.5
1047200	Z-connection2	0.9	0	0	0.7	0.6	0.5

Reversible BIM

Reuse Potential Tool

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4D architects

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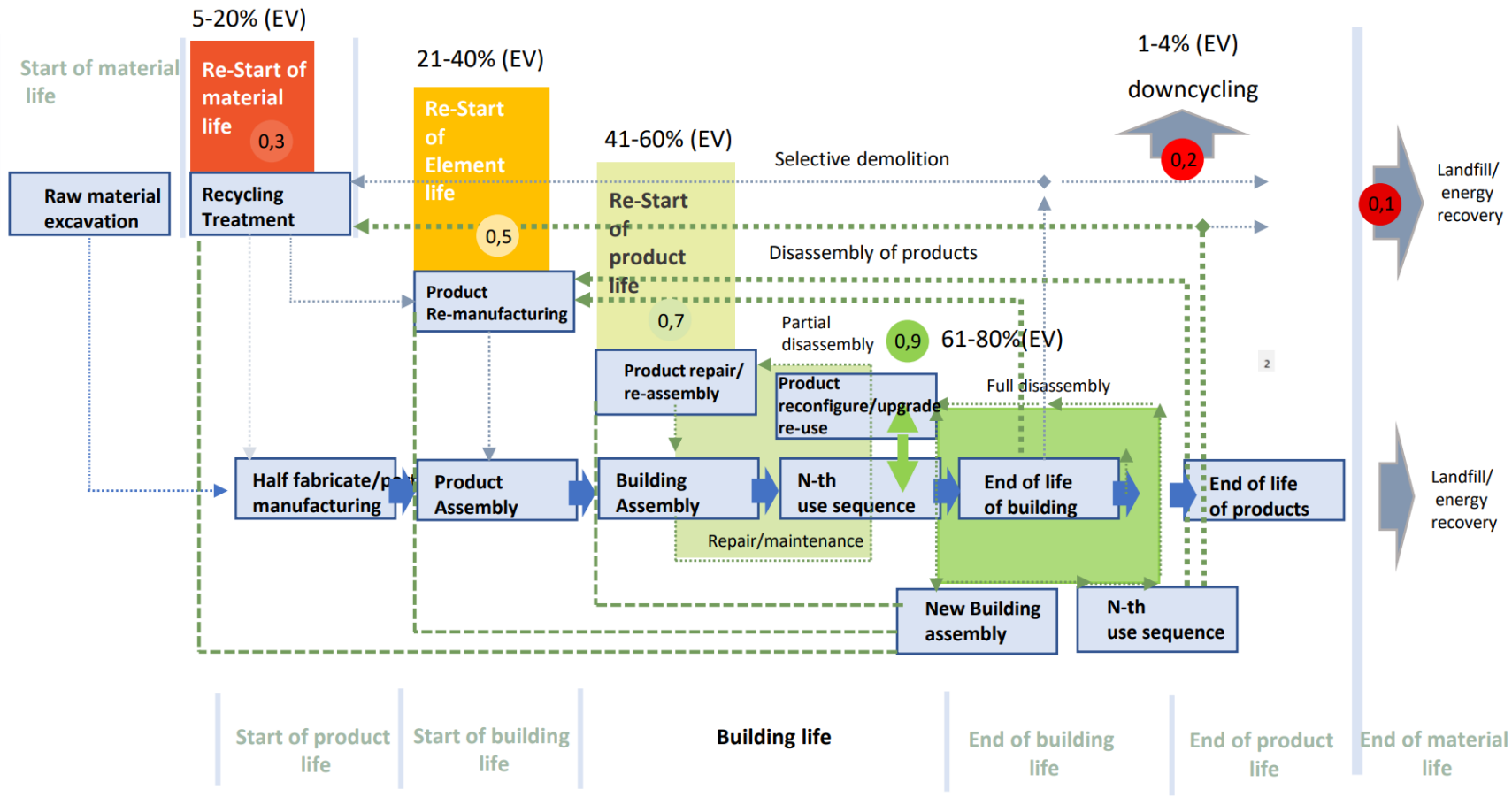
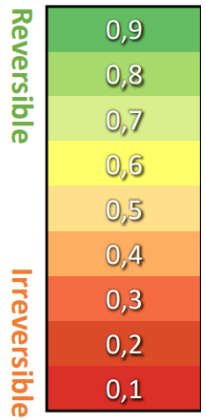
BUILDING REUSE POTENTIAL

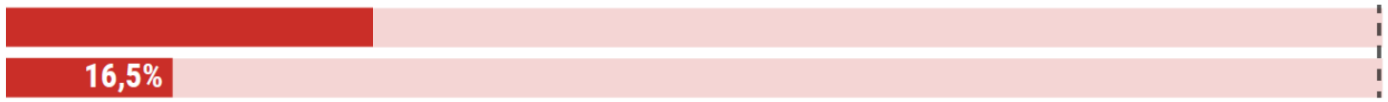
REUS OPTIONS AND STRATEGIES





Embodied Value (EV)

Embodied Environmental impact



4D architects

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Reversible BIM

Reuse Potential Tool

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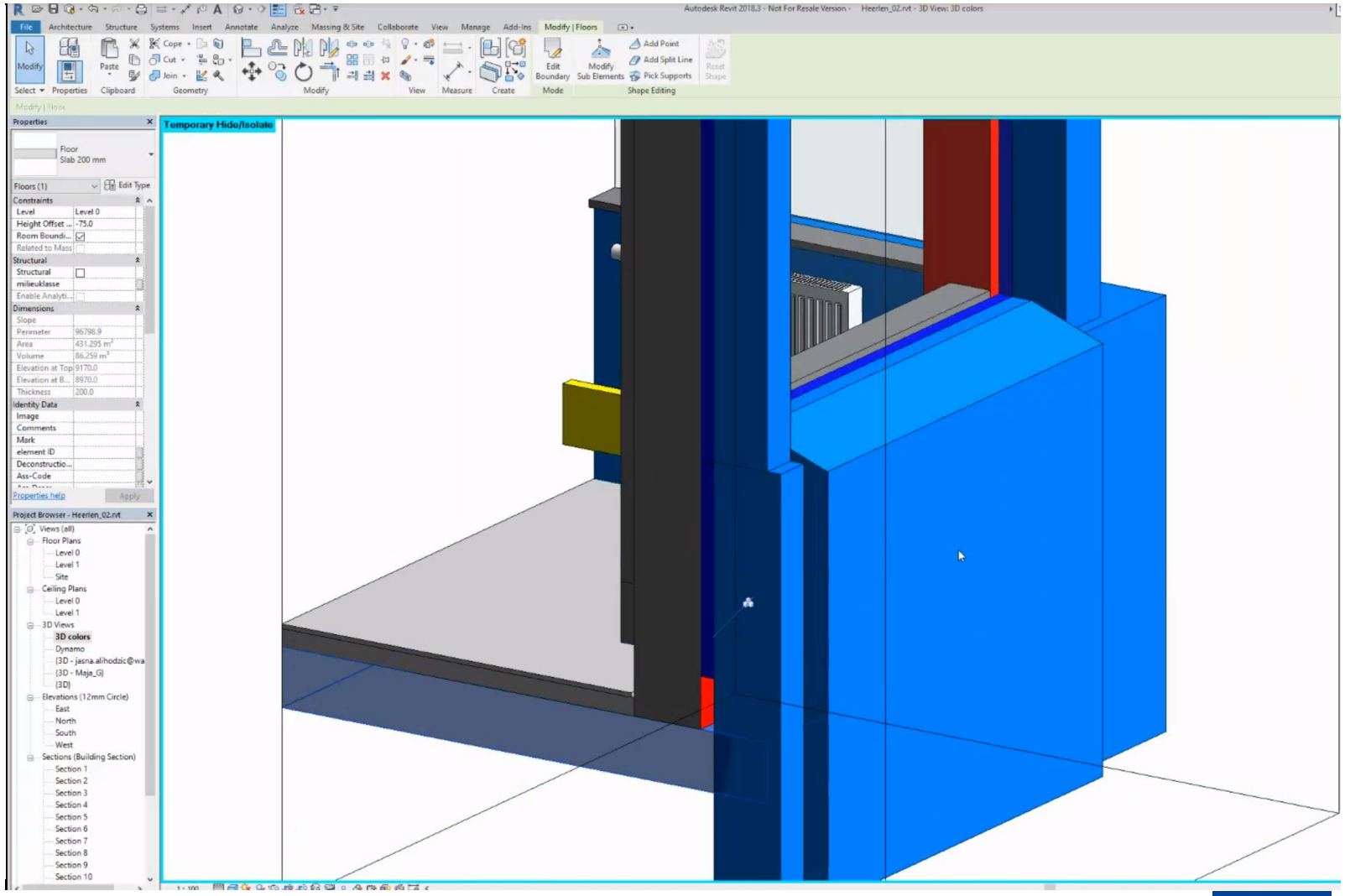
BIM objects
3D library of reusable elements

No.	Part id	Rating
1	1.21 re core	0,10
2	1.22 re col	0,30
3	1.23 re col fa	0,10
4	1.24 co core	0,90
5	1.25 co col	0,90
6	1.26 co col fa	0,90
7	1.31 re slab	0,10
8	1.32 co slab	0,10
9	1.33 co gal	0,90
10	2.11 win	0,90
11	2.21 co fa	0,90
12	2.22 br par	0,90
13	2.23 st pin	0,30
14	2.24 st ang	0,30
15	2.31 co pil	0,90
16	2.32 br fa	0,90
17	2.33 st anch	0,30
18	2.34 wall tie	0,60
19	3.11 fl fi	0,30
20	3.21 ceil	0,90
21	3.22 ceil br	0,60
22	3.31 br pa	0,90
23	3.32 win fr	0,90
24	3.33 met st	0,90
25	3.34 met st u	0,60
26	3.41 stair	0,90
27	3.42 em st	0,90
28	4.11 wa sup	0,60
29	4.12 sanit	0,90
30	4.13 wa br	0,30
31	4.21 e cab	0,60
32	4.22 elev	0,90
33	4.23 e tray	0,60
34	4.24 e duct	0,90
35	4.25 e tr br	0,30
36	4.31 rad br	0,60
37	4.32 h br	0,60
38	4.33 heat	0,60
39	4.41 v duct	0,60
40	4.42 v grid	0,90
		0,30



BIM OBJECTS LIBRARY

BIM based catalogues of reusable elements

4D architects

EUROPEAN UNION

1

‘Architecture / Design’ and ‘Consultancy firm / Demolition expert’

2

Construction phase: ‘Construction contractor’, ‘Demolition contractor’ and ‘Material producer’

3

Clients: ‘Private client’ and ‘Public client’

Interreg North-West Europe
Digital Deconstruction
European Regional Development Fund

1b ARCHITECTURE / DESIGN' AND 'CONSULTANCY FIRM / DEMOLITION EXPERT'

End user needs:

A. BIM-based assessment tool for reusability of building elements

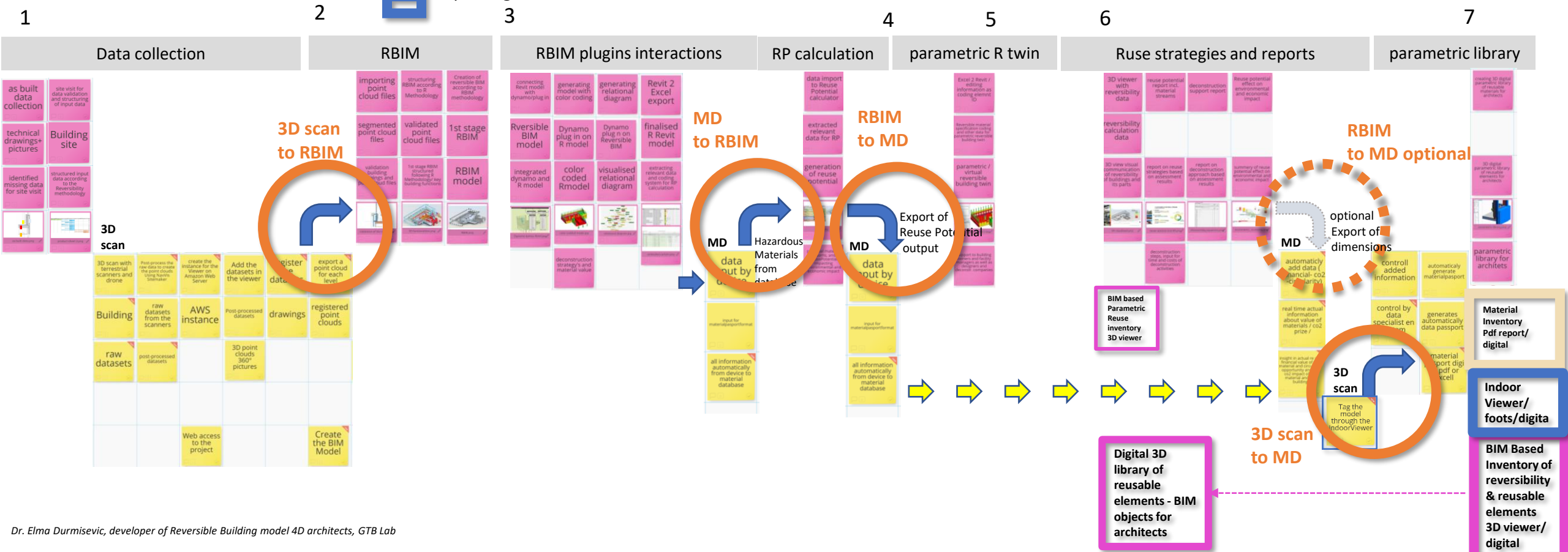
B. A tool to make materials inventory

C. A calculation tool assessing different scenarios and options for waste management

D. Identifying reusable building elements and assessing reusability of building materials (demountability, value, technical quality)

Connection points beween DDC modules

Outputs for the end user
Suporting end user needs



Dr. Elma Durmisevic, developer of Reversible Building model 4D architects, GTB Lab

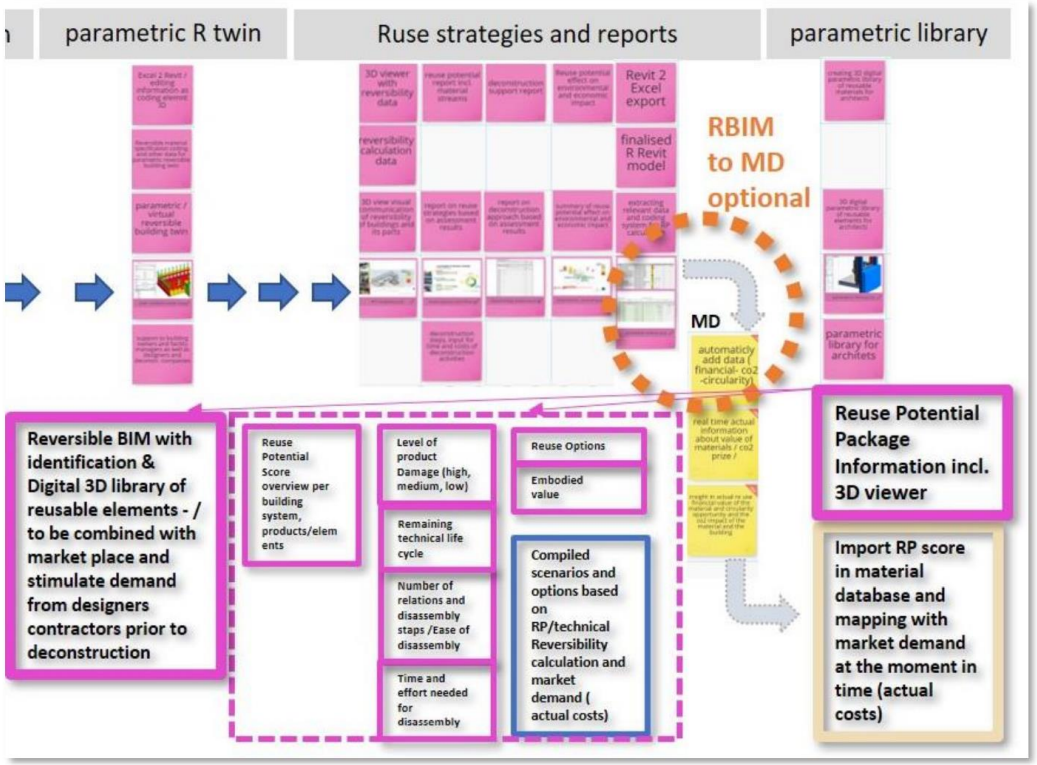
User groups:

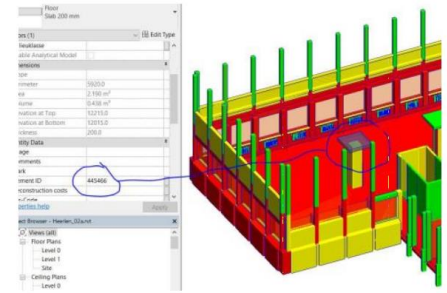
- ARCHITECTURE / DESIGN' AND 'CONSULTANCY FIRM / DEMOLITION EXPERT'
- CONSTRUTION
- OWNERS

End user need:

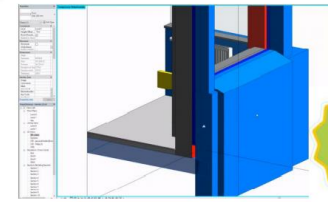
D. Identifying reusable building elements and assessing reusability of building materials (demountability, value, technical quality)

DDC Platform Outputs





Relational pattern



Reversible BIM

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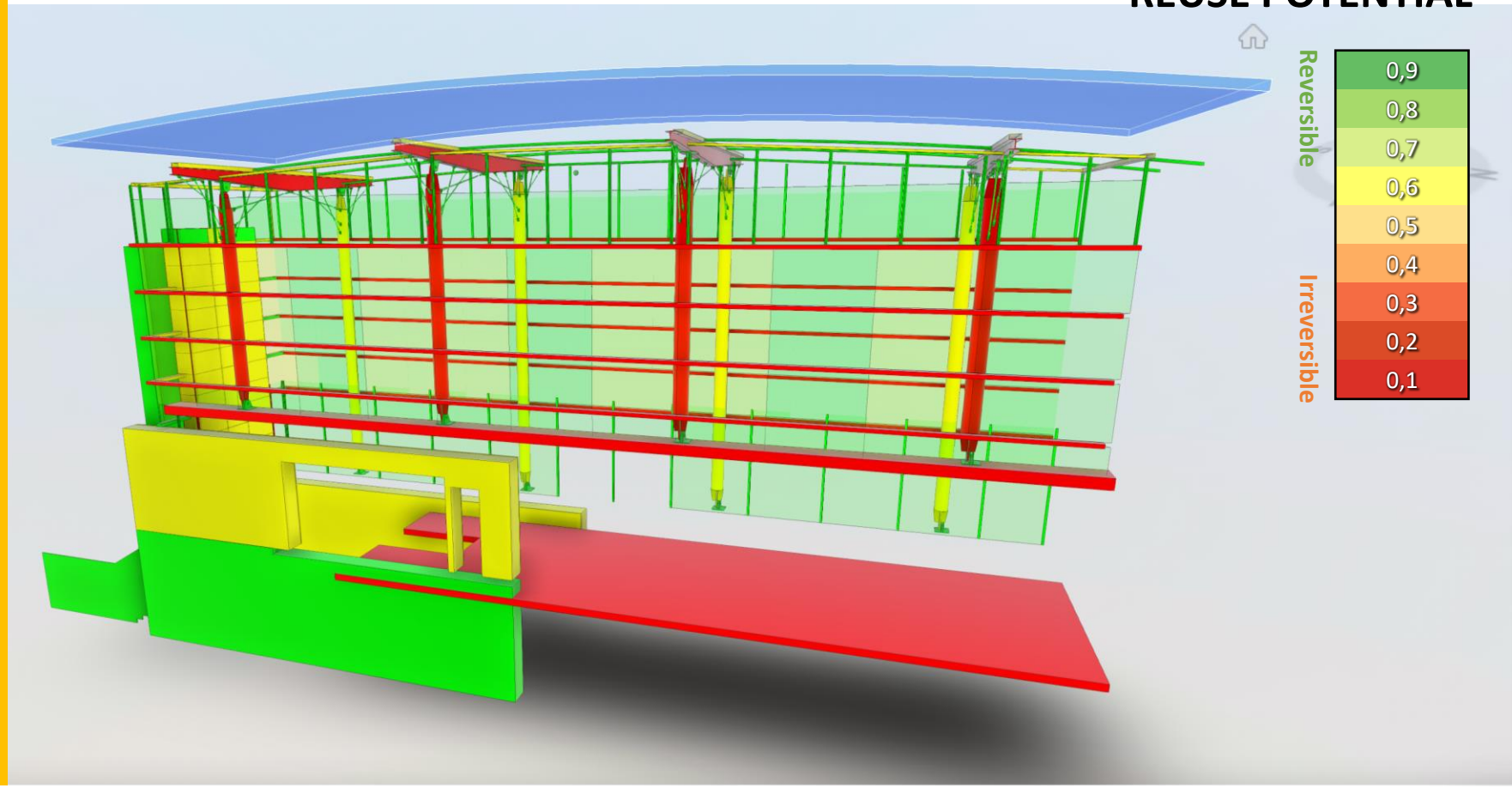
Digital Reversibility/ Reuse Potential Assessment

Interreg North-West Europe
Digital Deconstruction
European Regional Development Fund

gtb lab



4D architects

EUROPEAN UNION