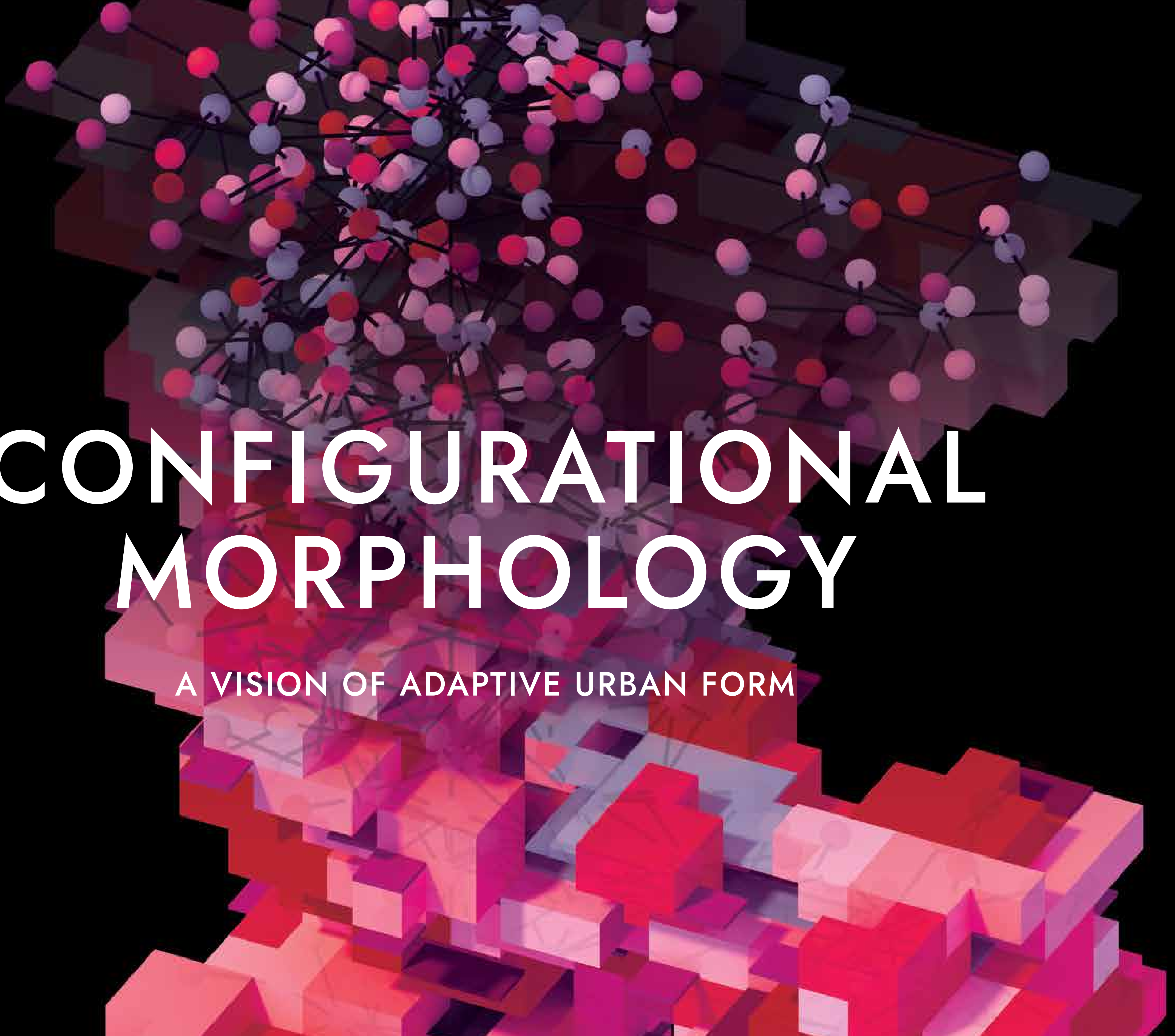
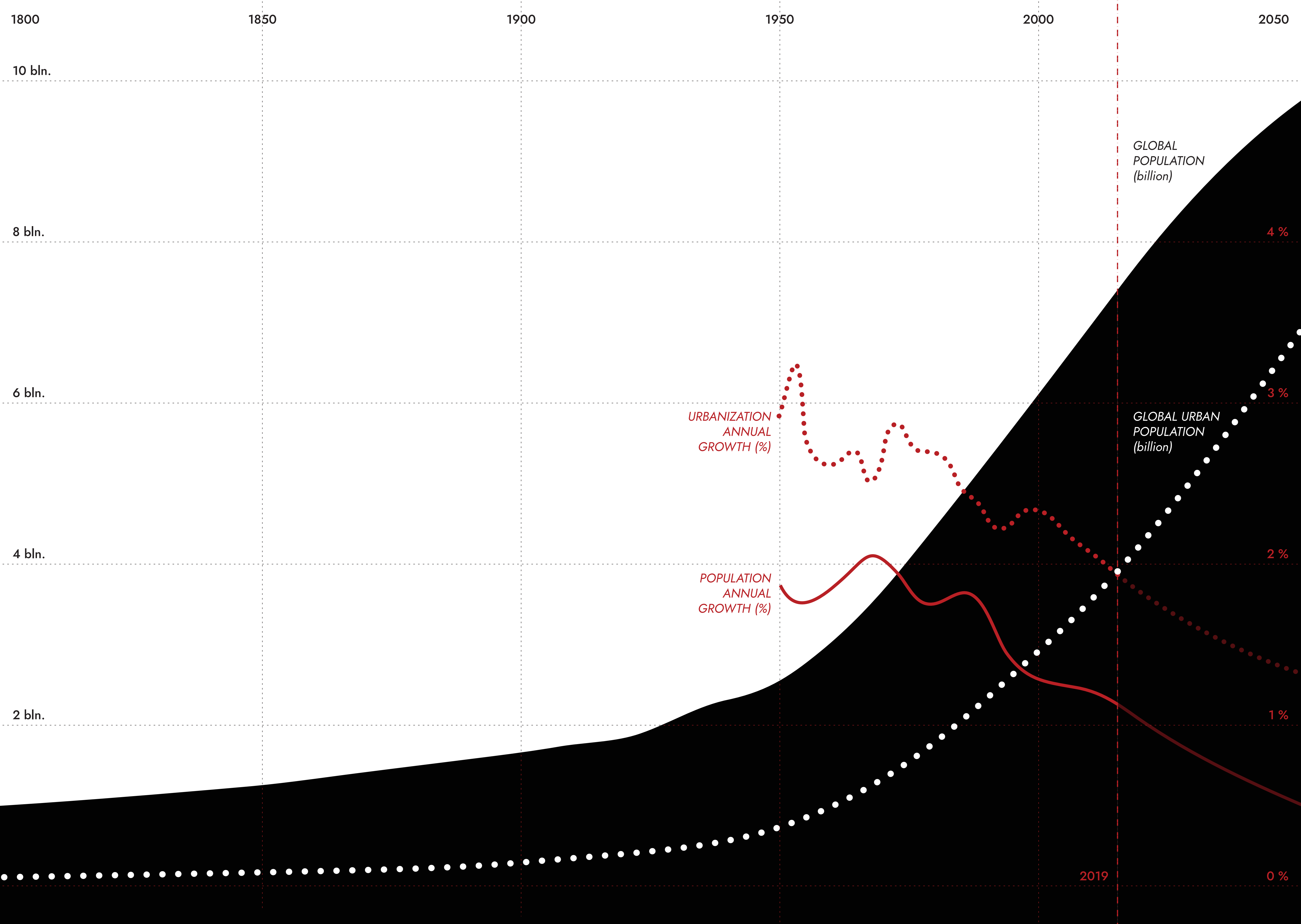


CONFIGURATIONAL MORPHOLOGY

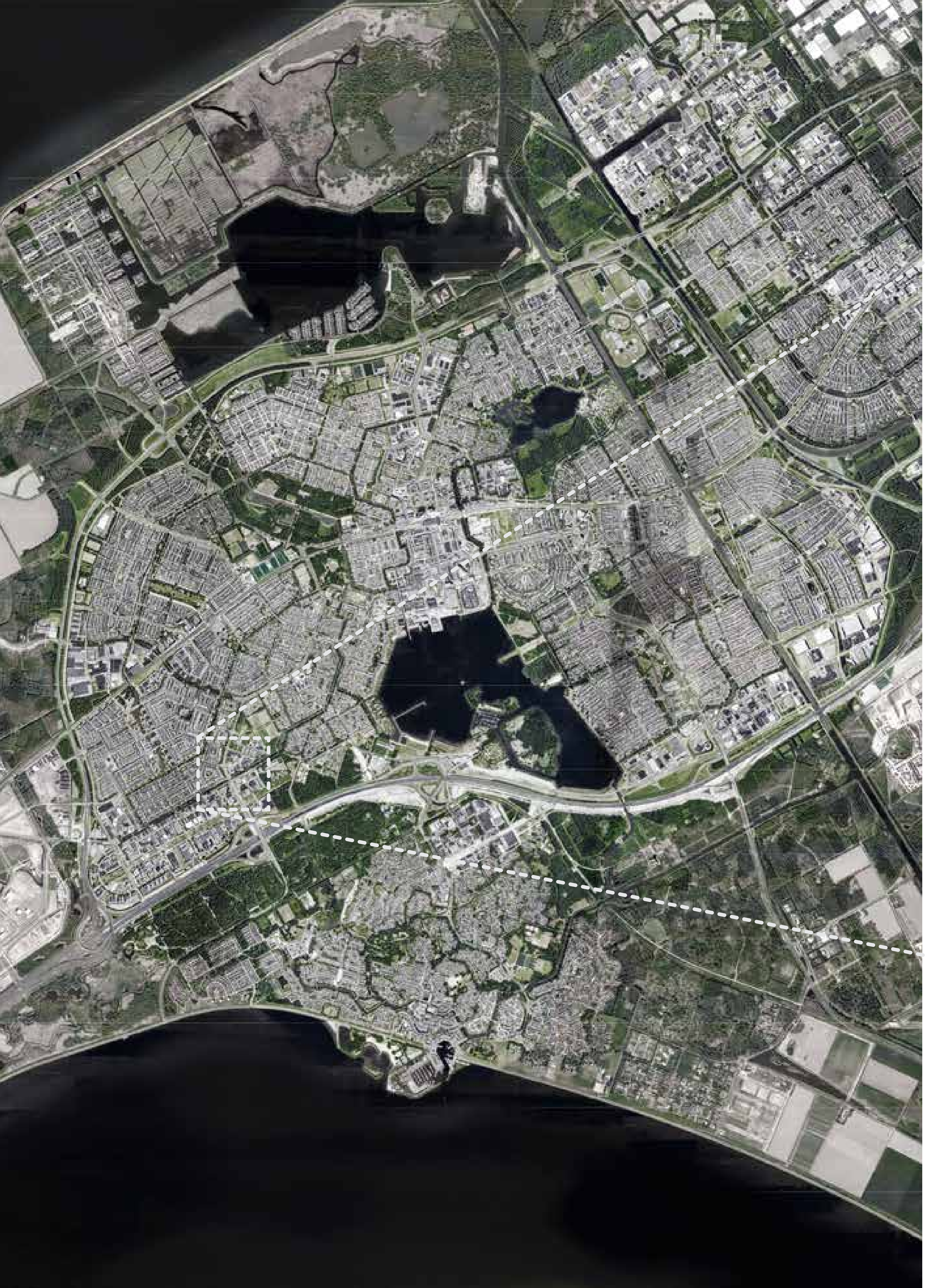
A VISION OF ADAPTIVE URBAN FORM

INTRODUCTION

Tokyo, the largest metro area in the world with 38.140.000 inhabitants



1800
1850
1900
1950
2000
2050
10 bln.
8 bln.
6 bln.
4 bln.
2 bln.
GLOBAL
POPULATION
(billion)
4 %
3 %
2 %
1 %
0 %
URBANIZATION
ANNUAL
GROWTH (%)
GLOBAL URBAN
POPULATION
(billion)
POPULATION
ANNUAL
GROWTH (%)
2019

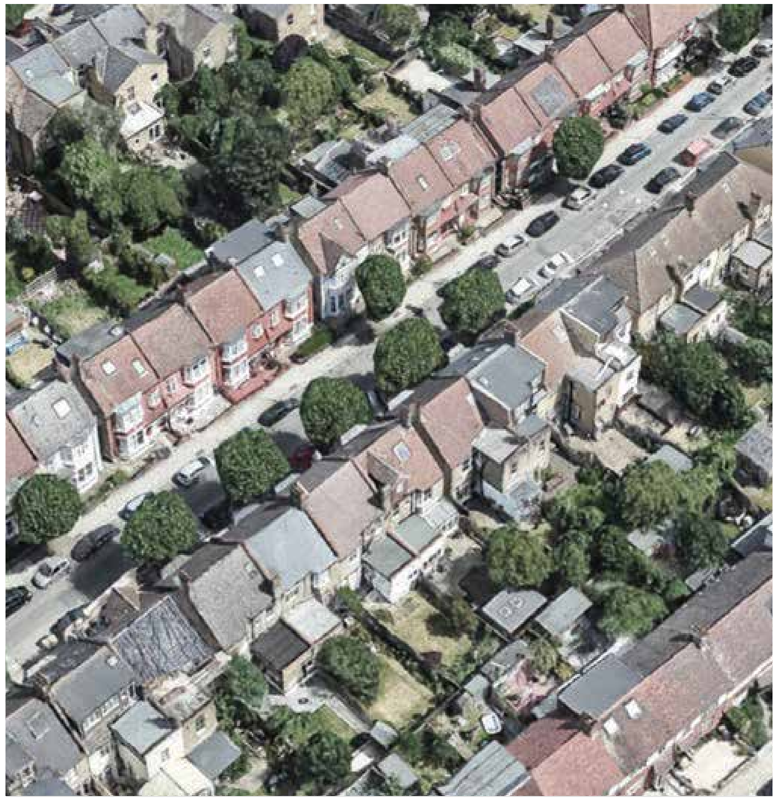


Urban form

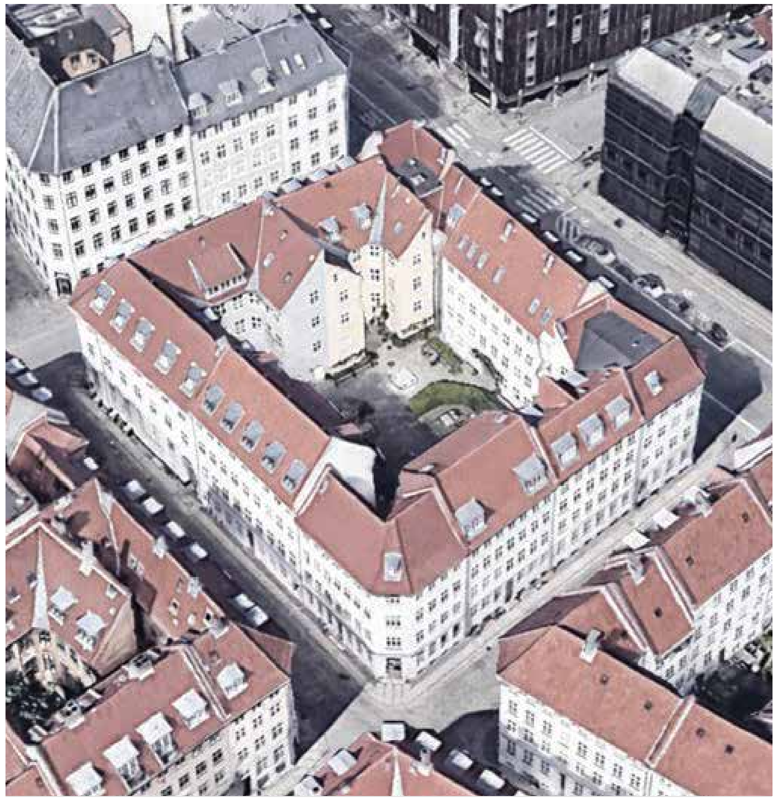
Detached house; Los Angeles

Row house; Rotterdam

Slab; Moscow

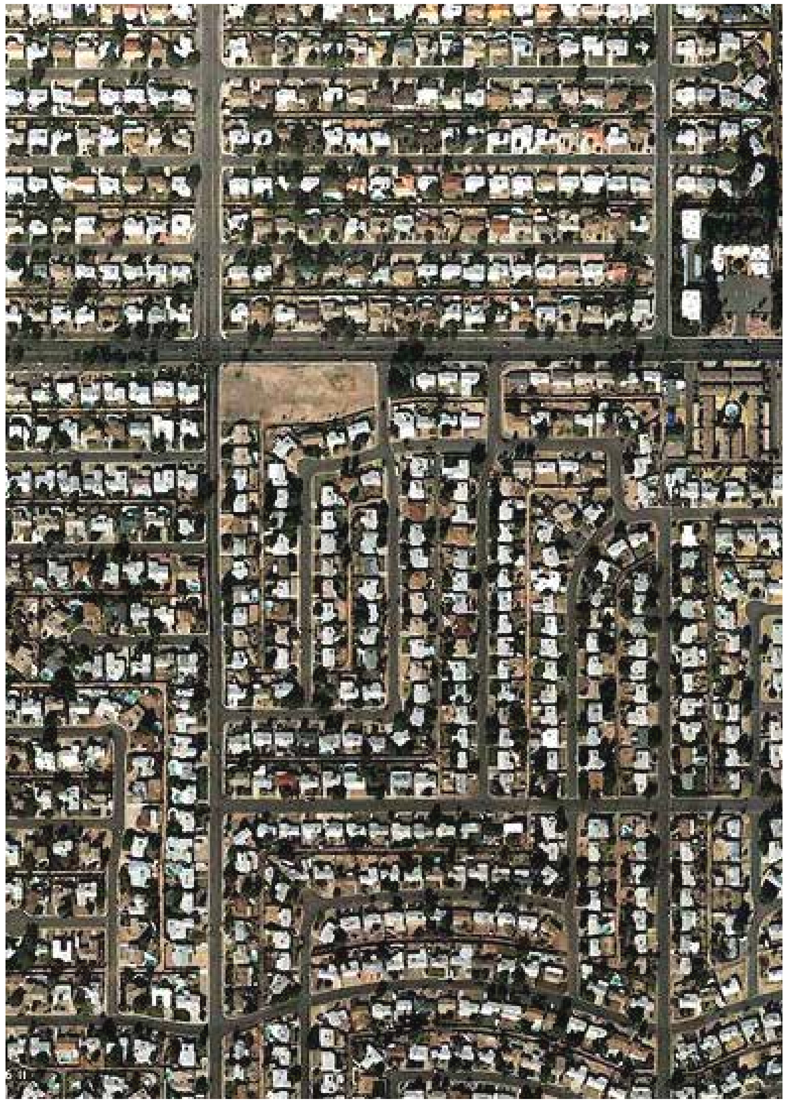


Semi-detached house; London



Courtyard townhouse; Copenhagen

Tower; Rotterdam



Detached house
=
Urban sprawl

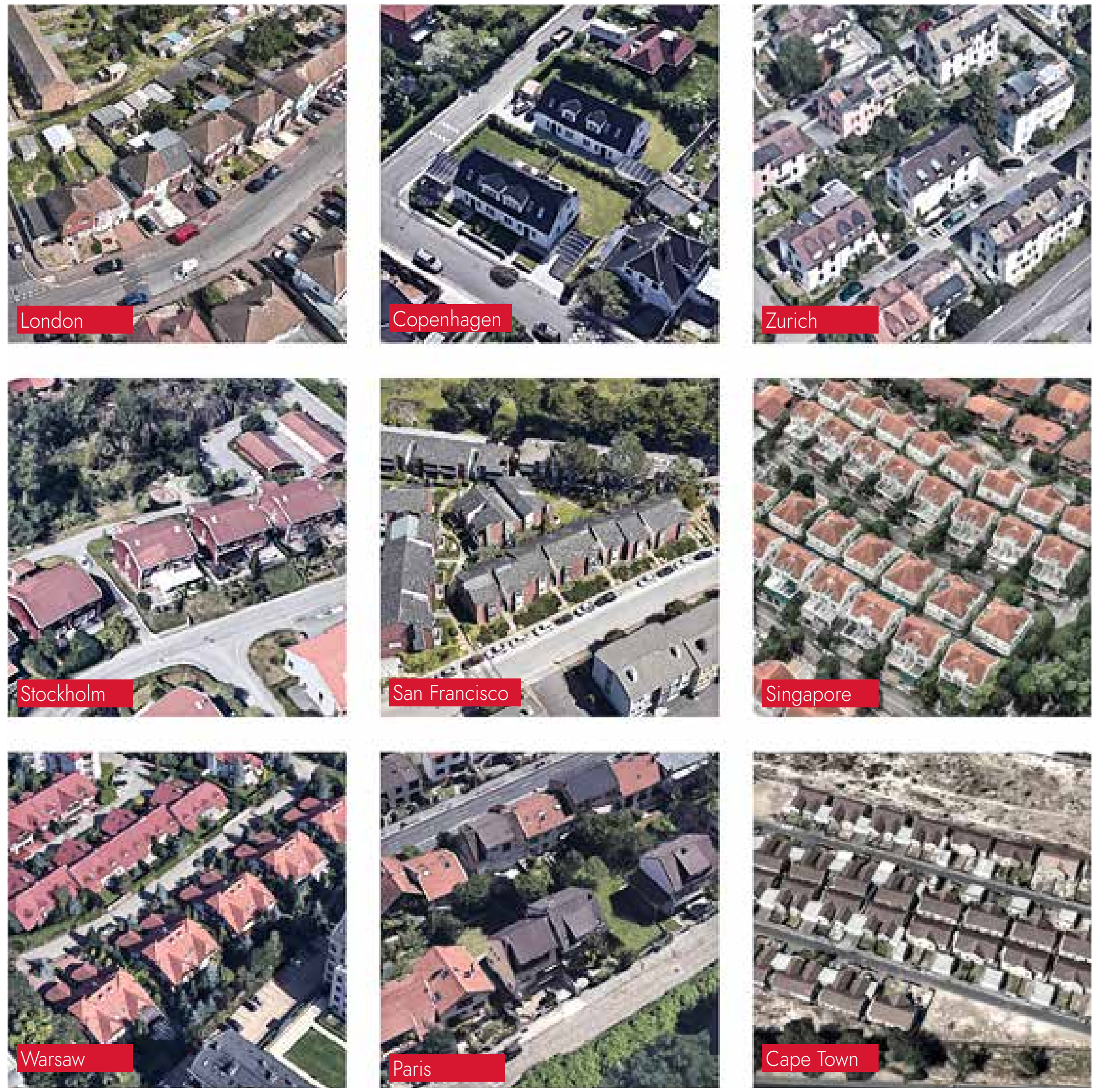
Row house
=
Low density

High-rise
=
Social isolation

THE GENERIC CITY

Overview of the expansive global spread of the generic city through the basic urban types constituting it.

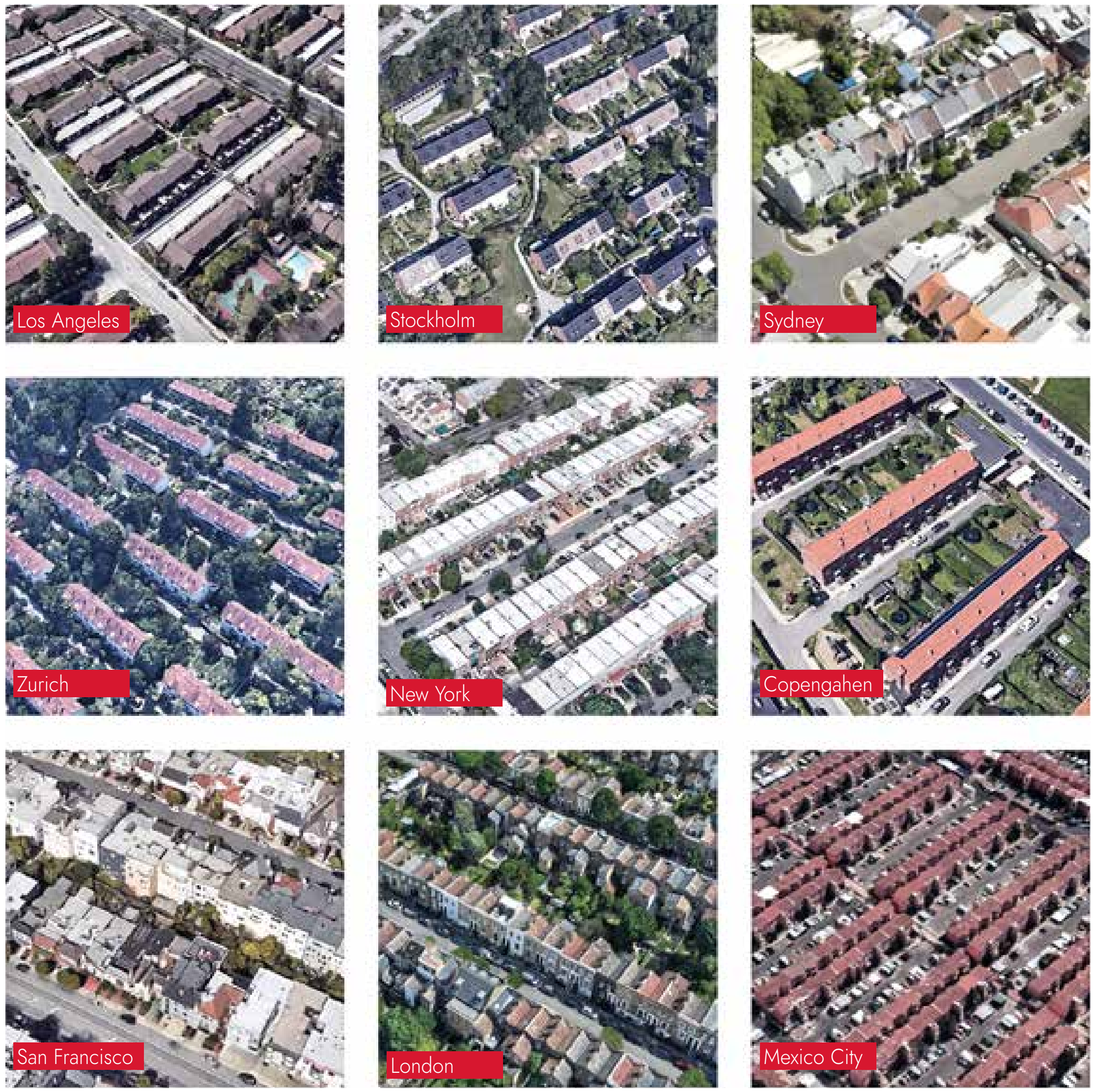
Detached house



Semi-detached house

THE GENERIC CITY

Overview of the expansive global spread of the generic city through the basic urban types constituting it.



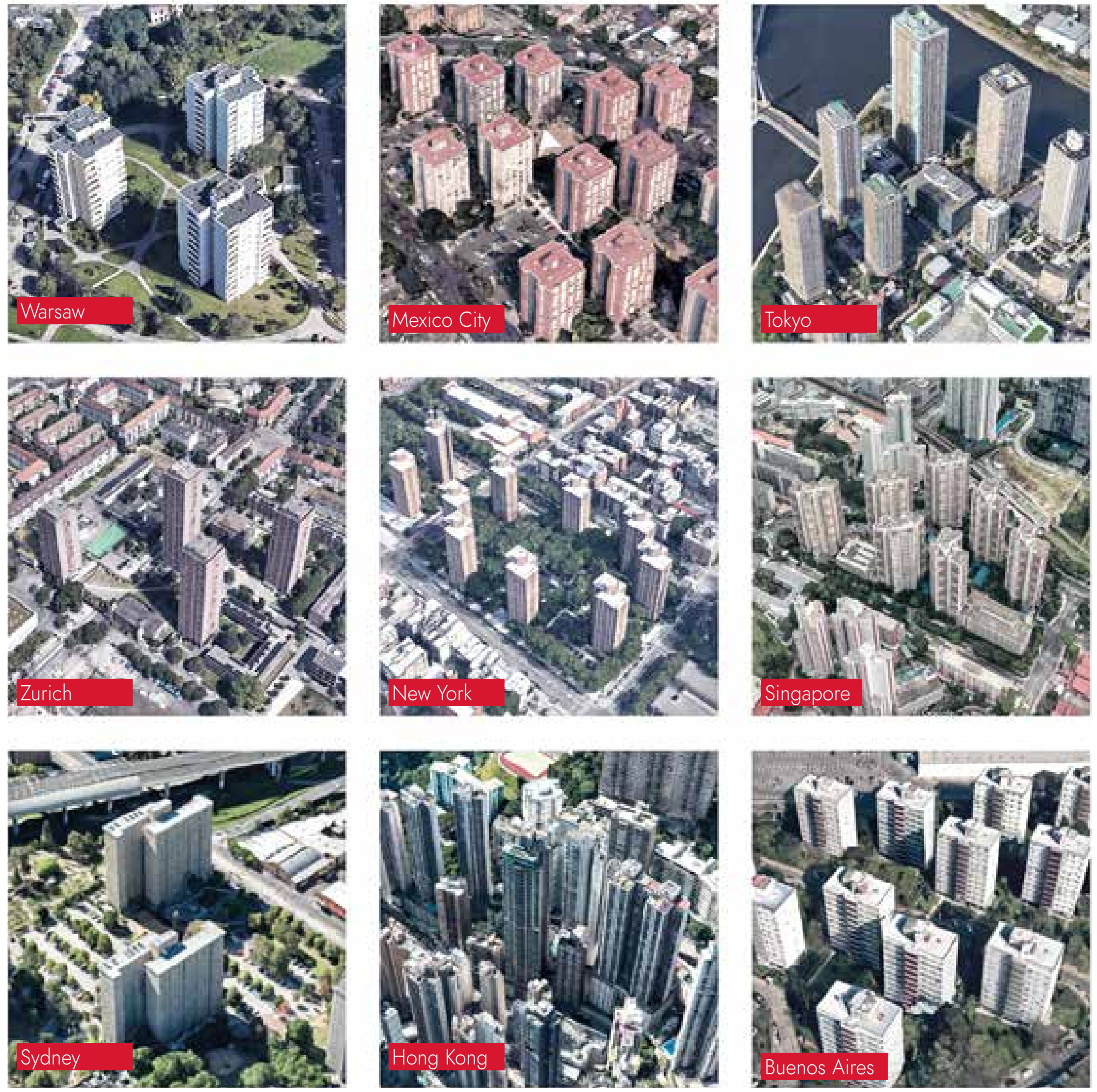
Row house

Courtyard townhouse

THE GENERIC CITY

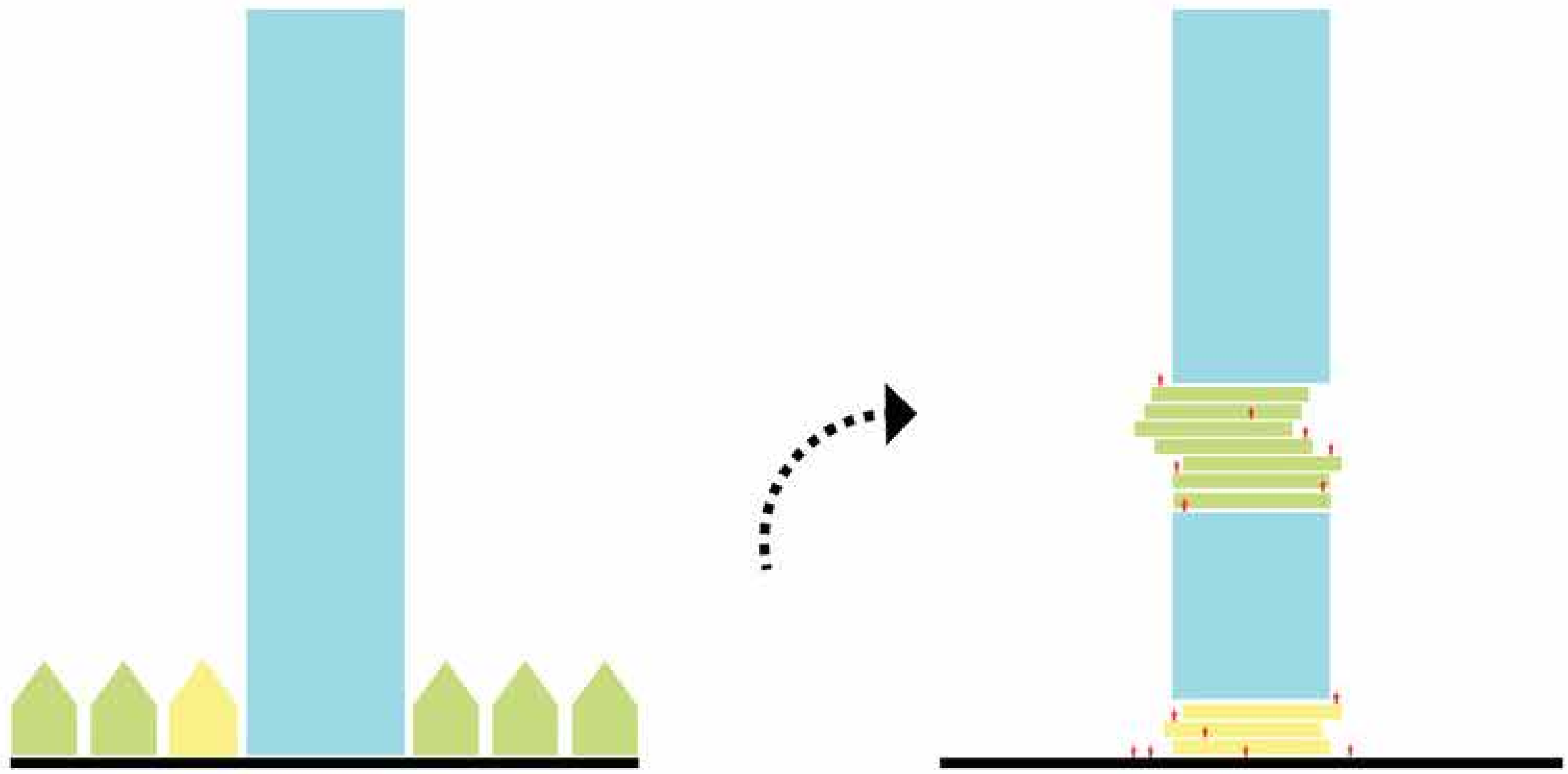
Overview of the expansive global spread of the generic city through the basic urban types constituting it.

Slab

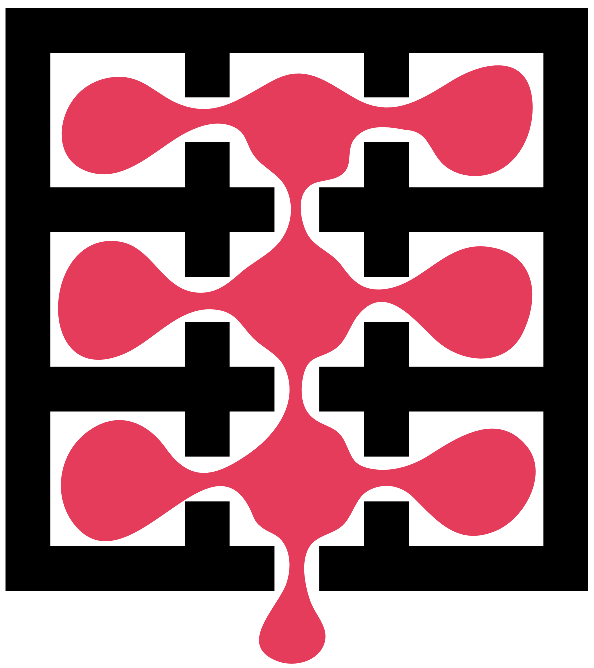


Tower

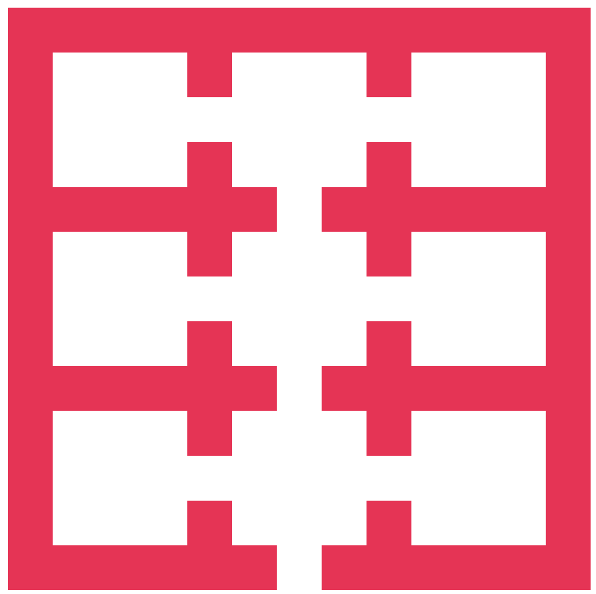
How can we design urban form adapted to the environmental, social and economic context in which it is placed?



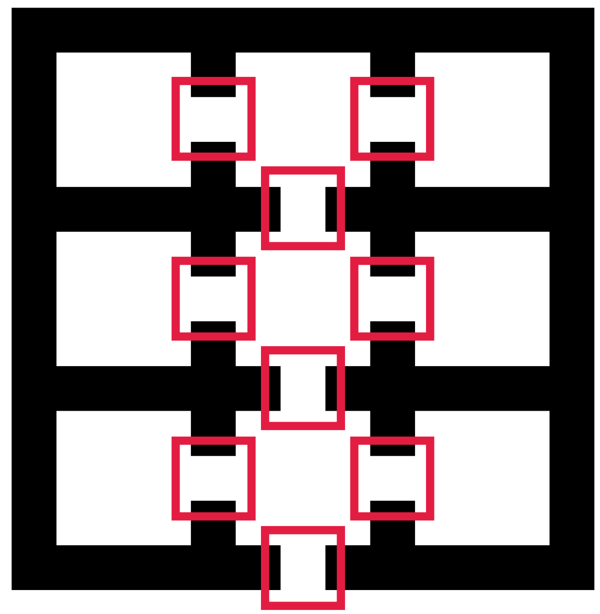
Urban type => Formal bias => Genericness



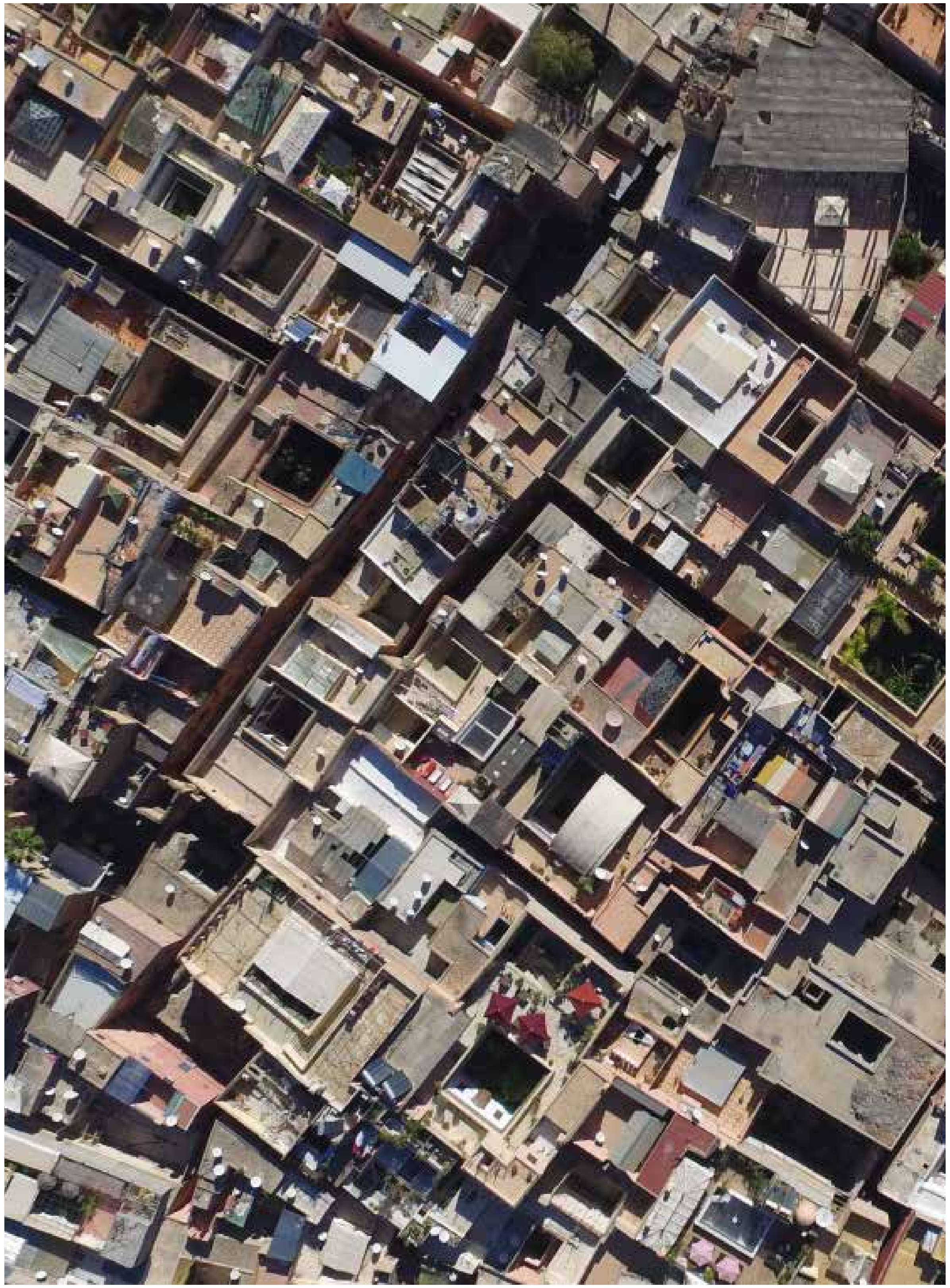
1. spatial organization = configuration

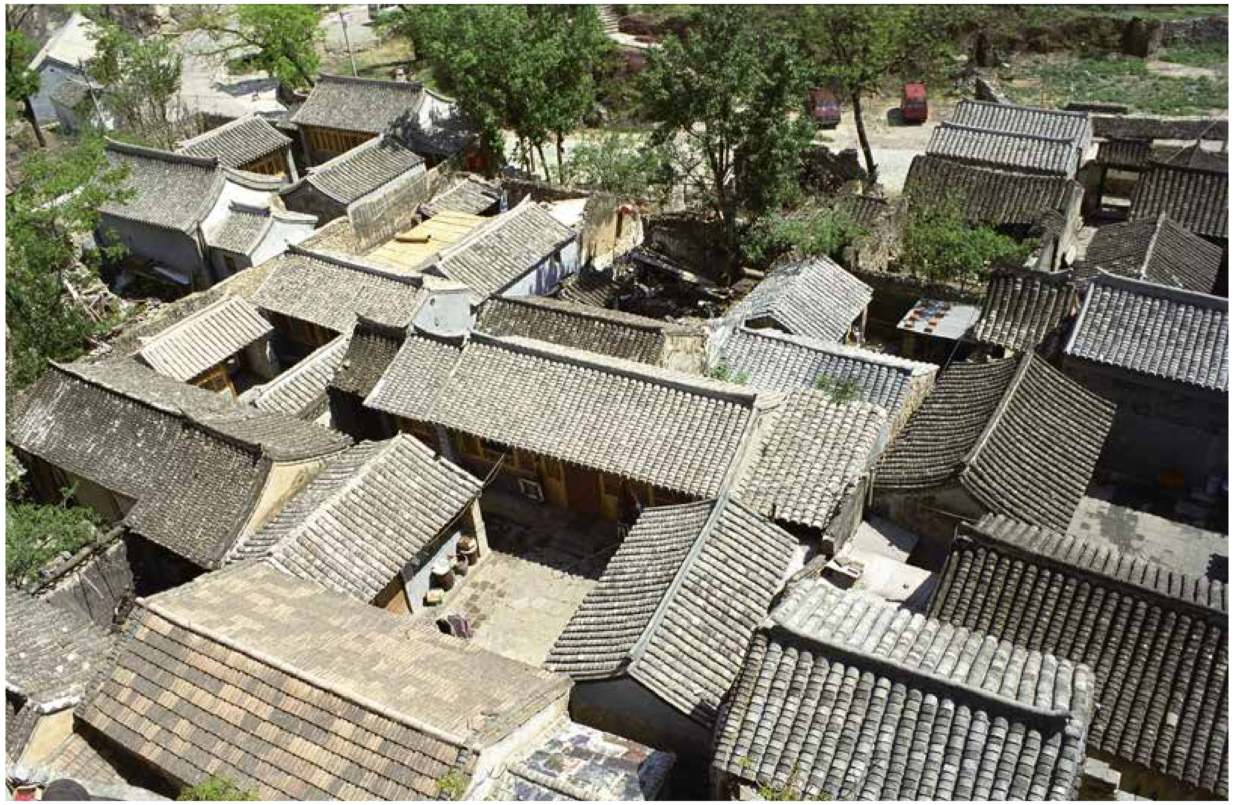


2. physical structure = built form



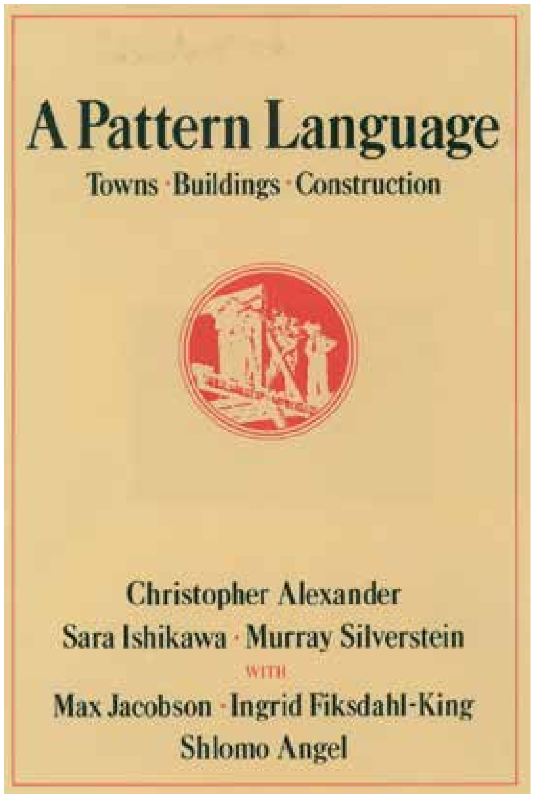
3. stylistic system = detail

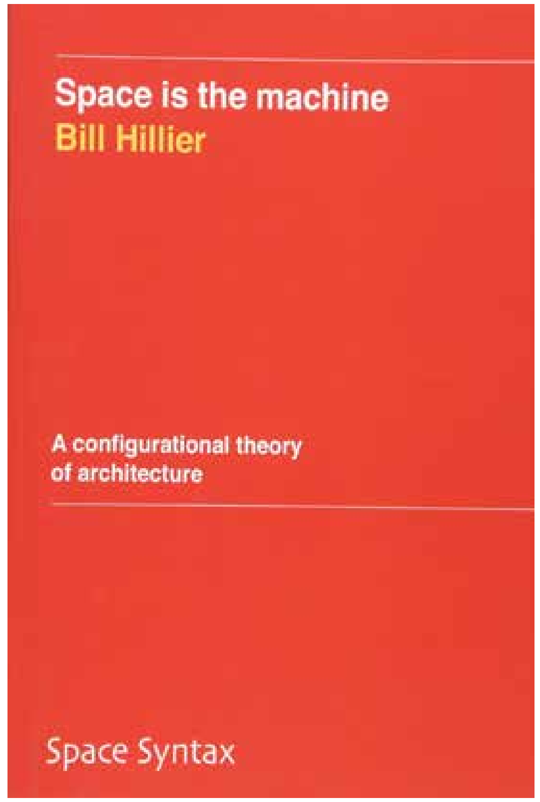


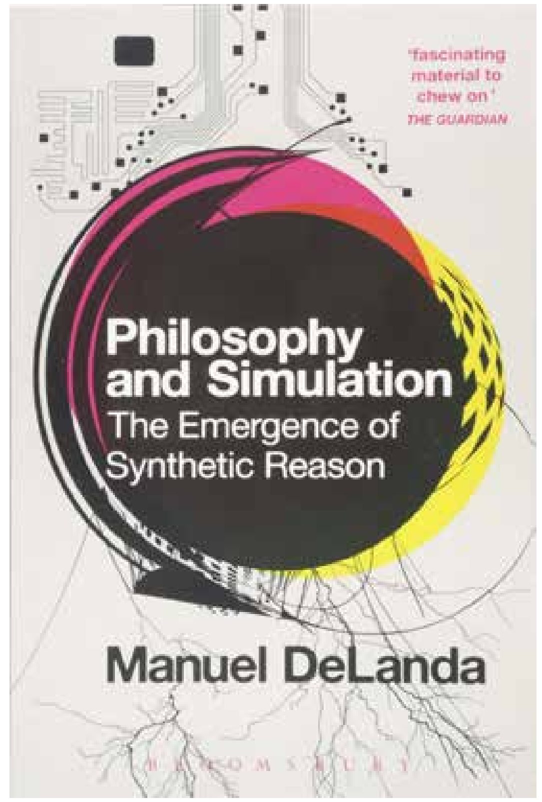


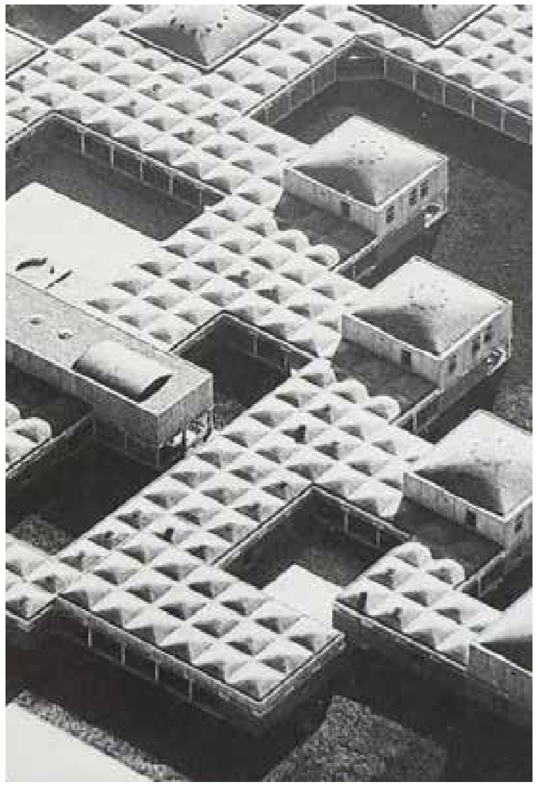
Examples of vernacular architecture; Left: Marrakech Medina, Top right: village in Japan, Bottom right: village in Andalucia, Spain

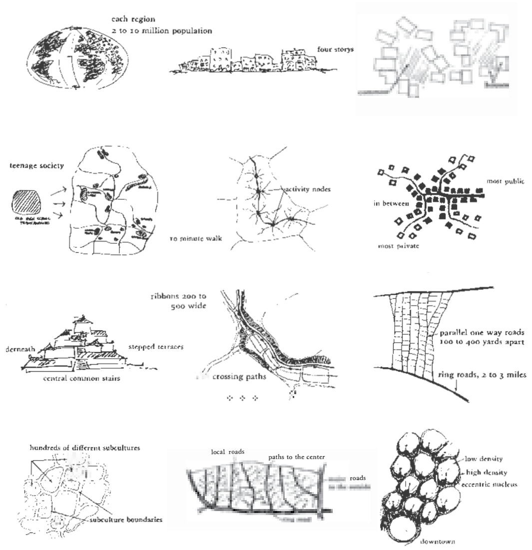

FORUM
4 1960/61

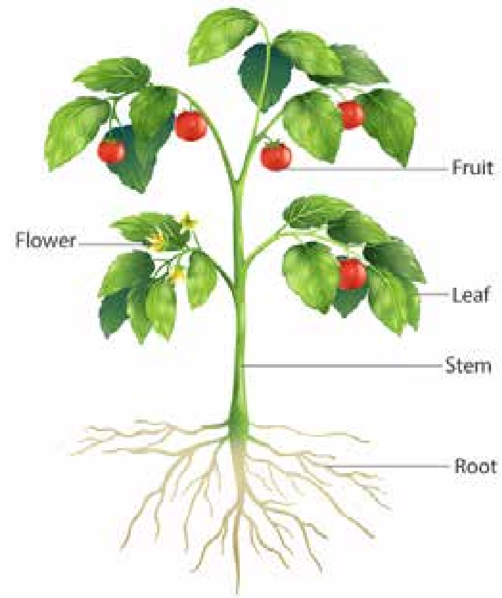

A Pattern Language
Towns · Buildings · Construction
Christopher Alexander
Sara Ishikawa · Murray Silverstein
WITH
Max Jacobson · Ingrid Fiksdahl-King
Shlomo Angel


Space is the machine
Bill Hillier
A configurational theory
of architecture
Space Syntax


'fascinating
material to
chew on'
THE GUARDIAN
Philosophy
and Simulation
The Emergence of
Synthetic Reason
Manuel DeLanda

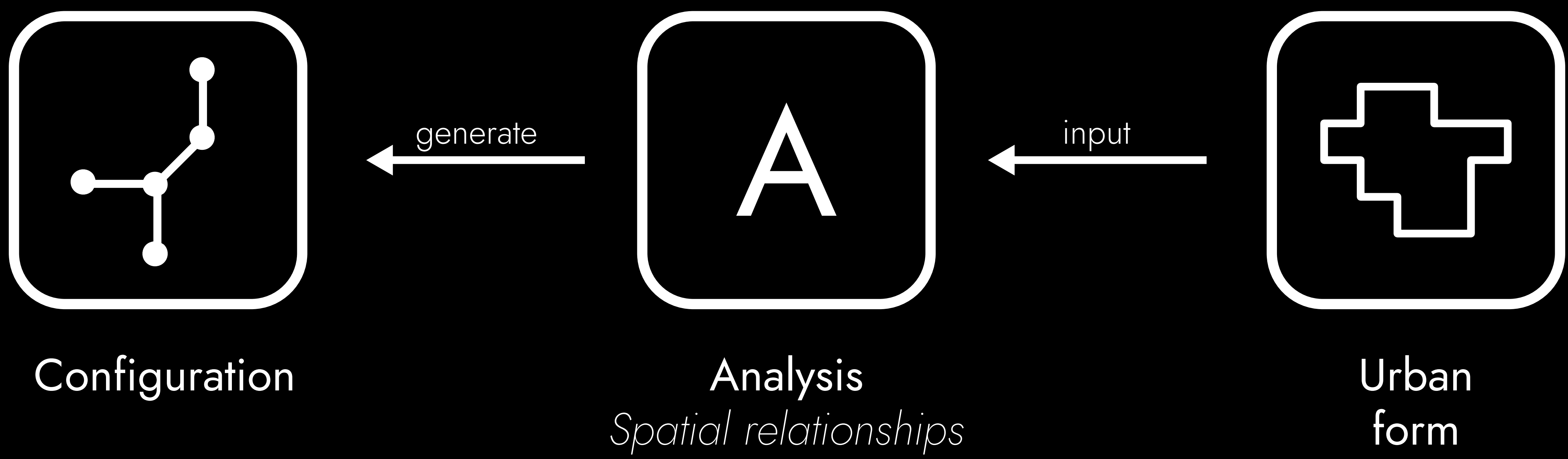




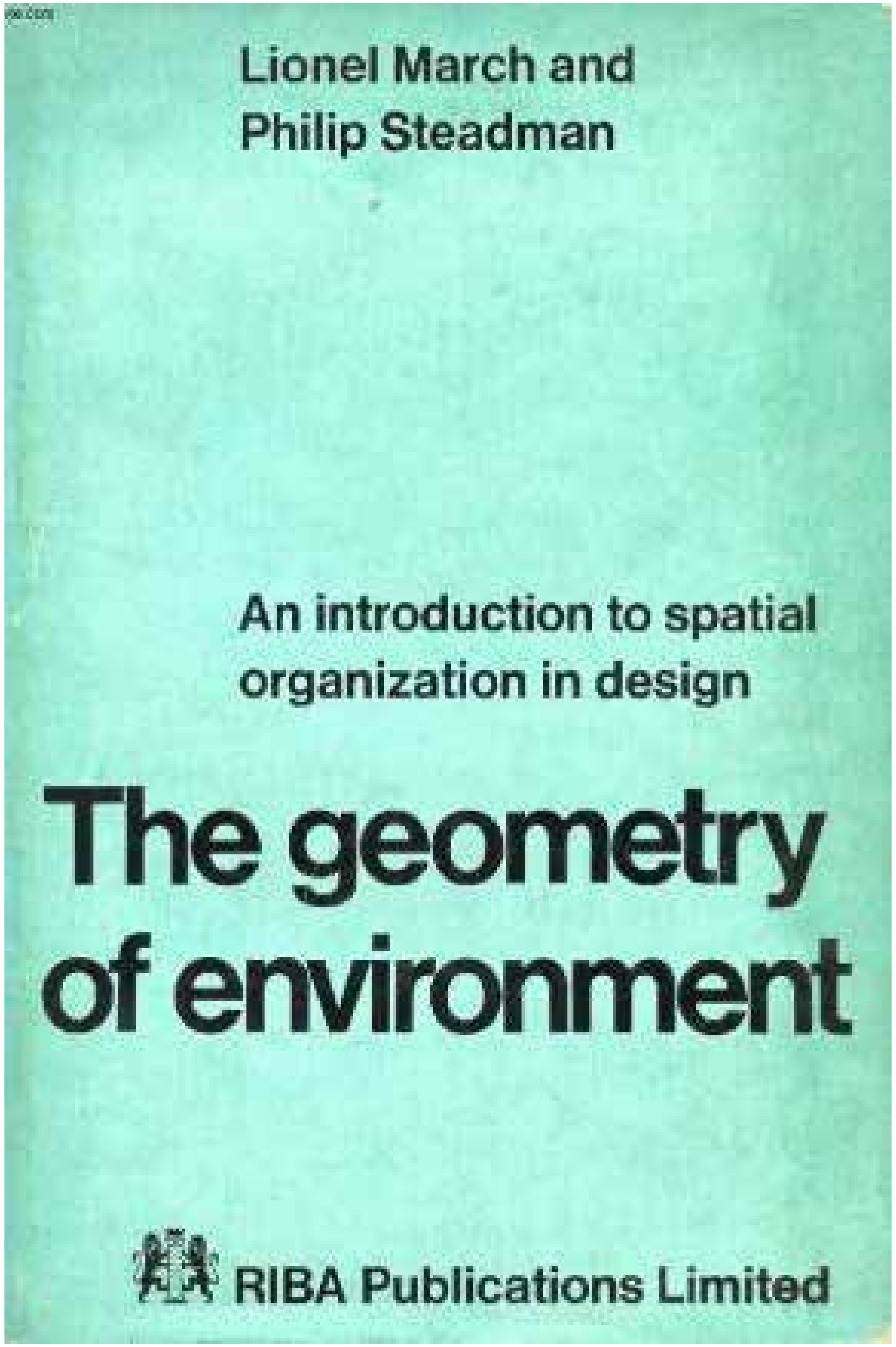

Fruit
Flower
Leaf
Stem
Root

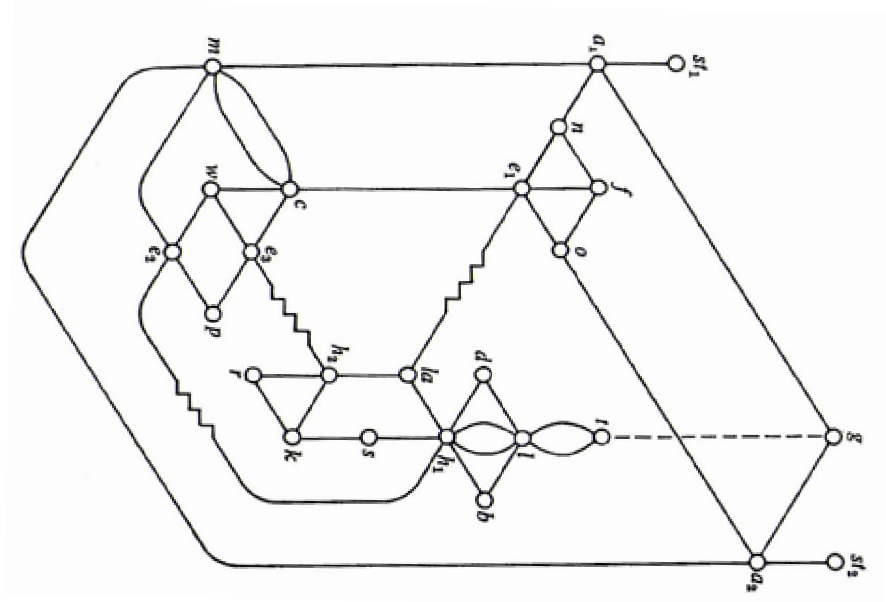
What are the potentials and limitations of a configurational approach for the design of adaptive urban form?

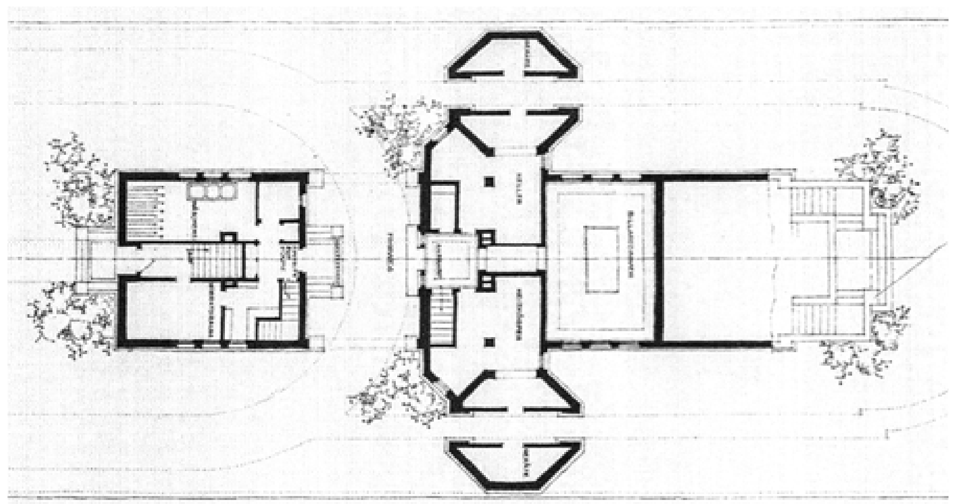
ANALYSIS


generate
input
A
Configuration
Analysis
Spatial relationships
Urban
form

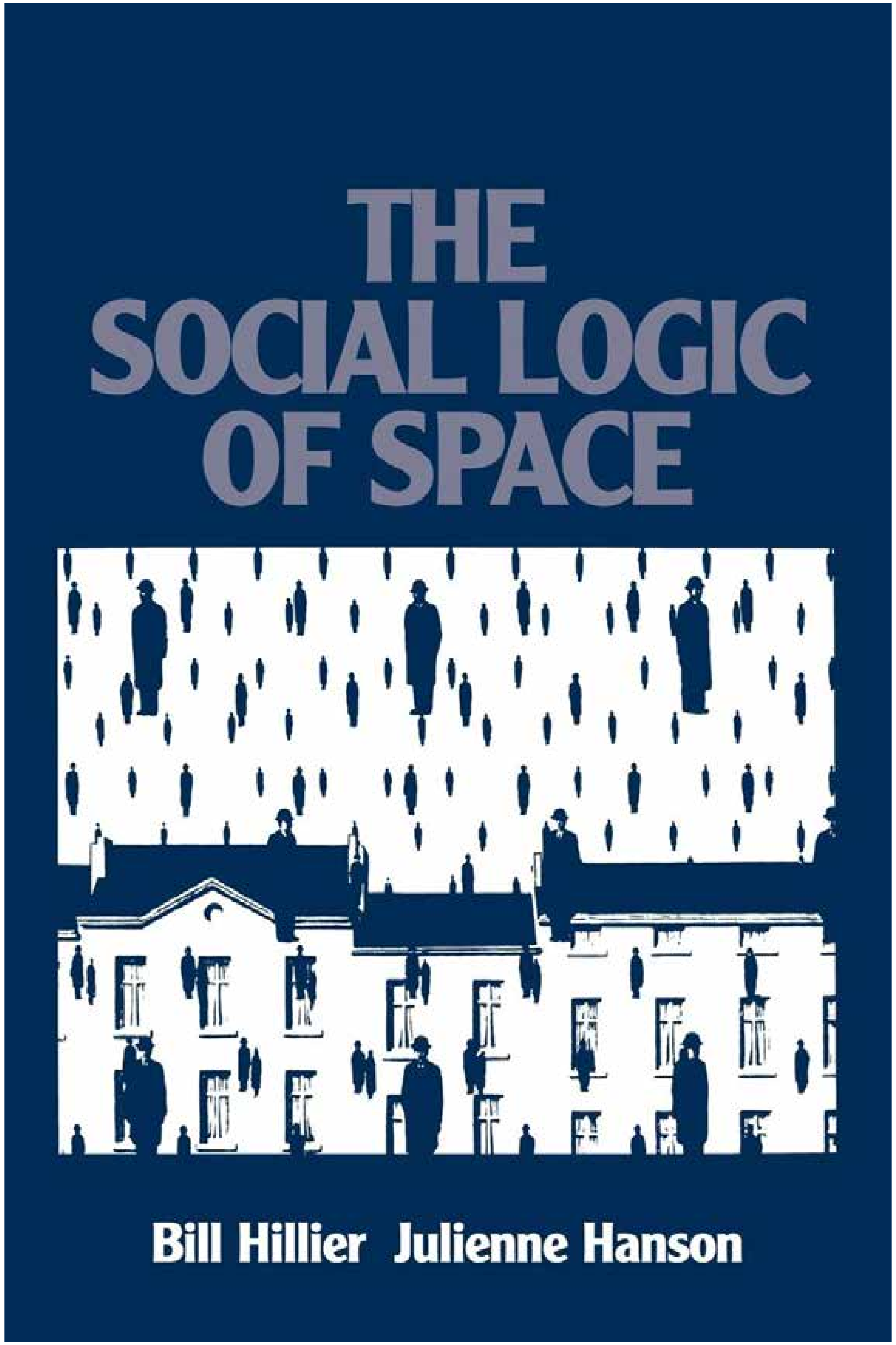
Opposite: Geometry of Environment by March & Steadman; Below: excerpt from the book abstracting Wright's Devin house plan to topological graph.

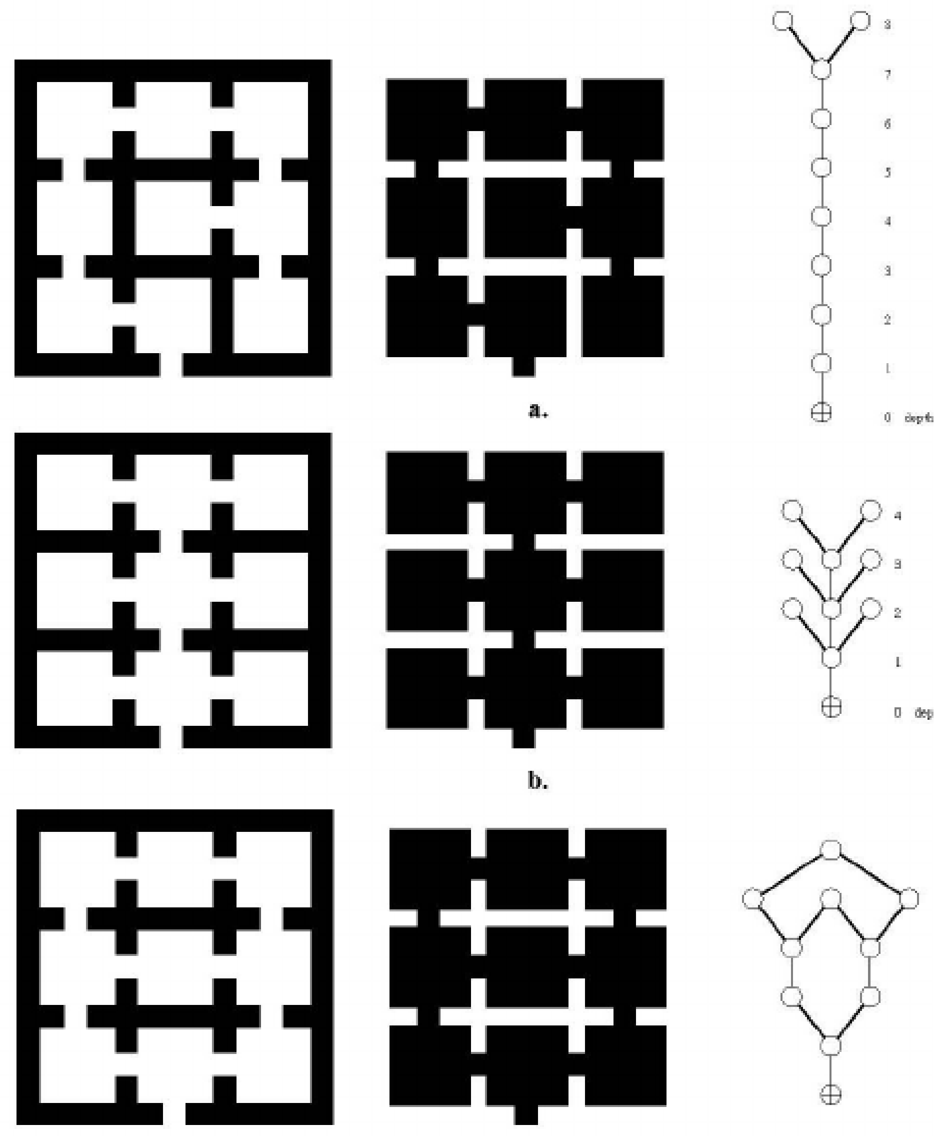






Opposite: The Social Logic of Space, 1984 by Hillier & Hanson; Below: a diagram explaining systematic abstraction of space to topology.

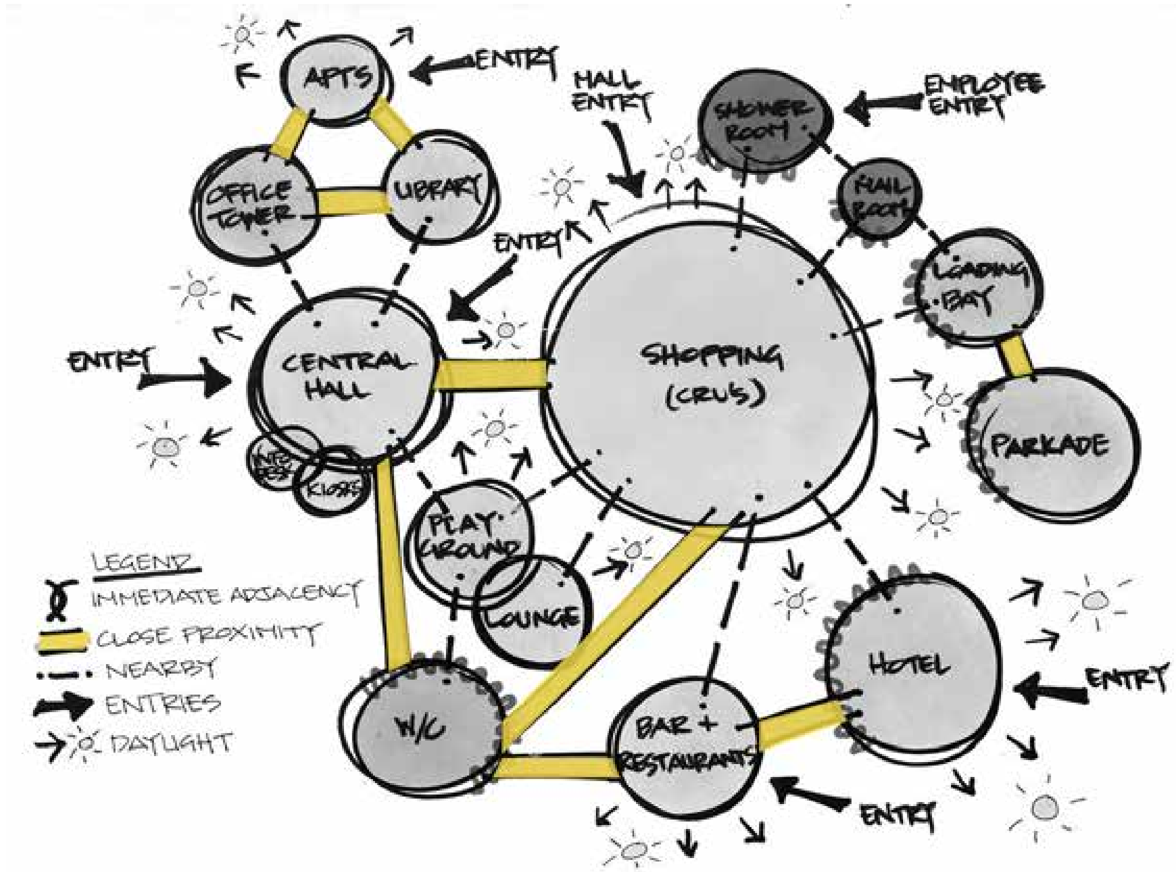




Topological graph

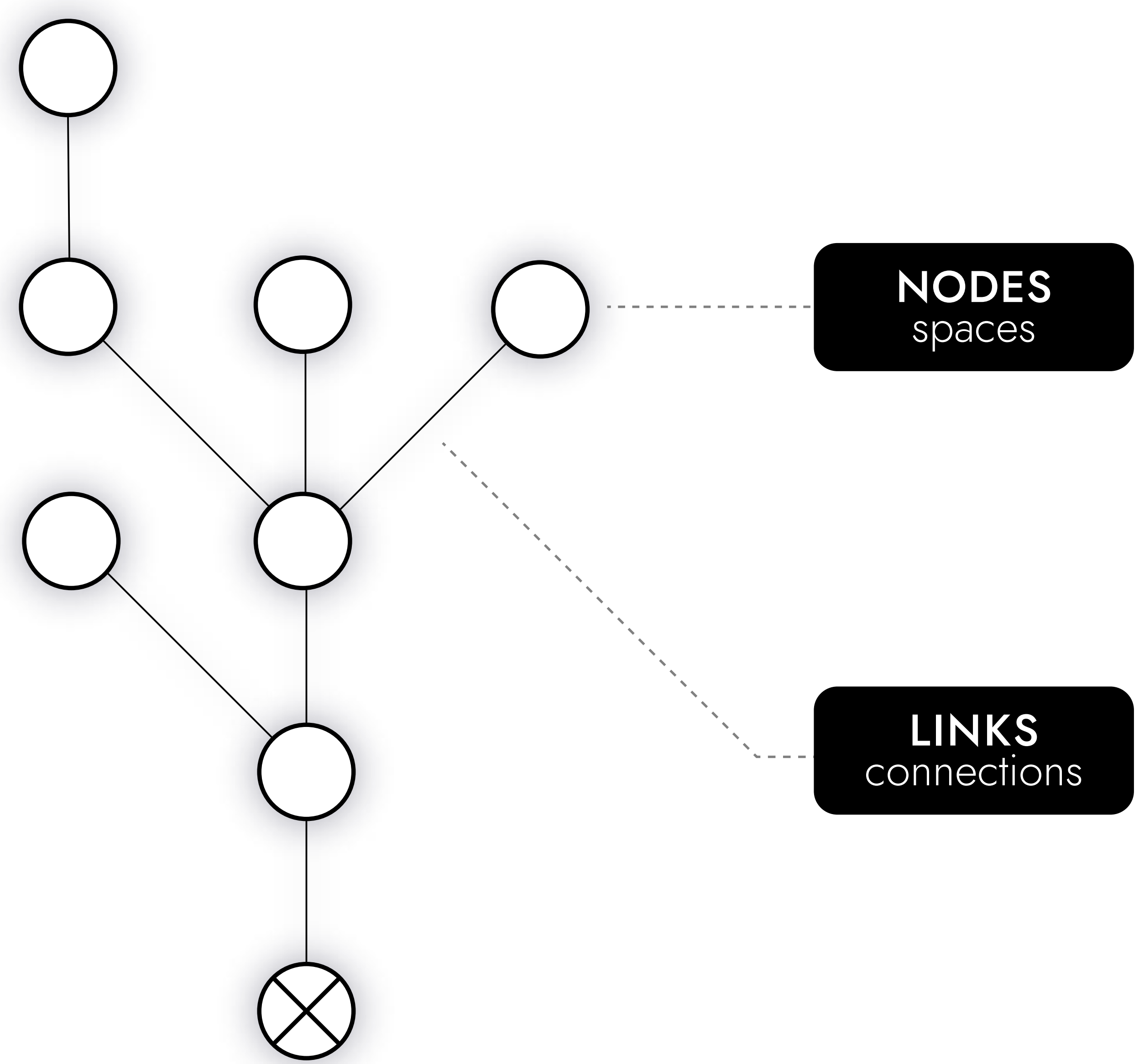
BUBBLE DIAGRAM

Opposite: Satellite photo of central Copenhagen; Below: Archtiectural bubble diagram depicting programme, its parameters and connectivity.

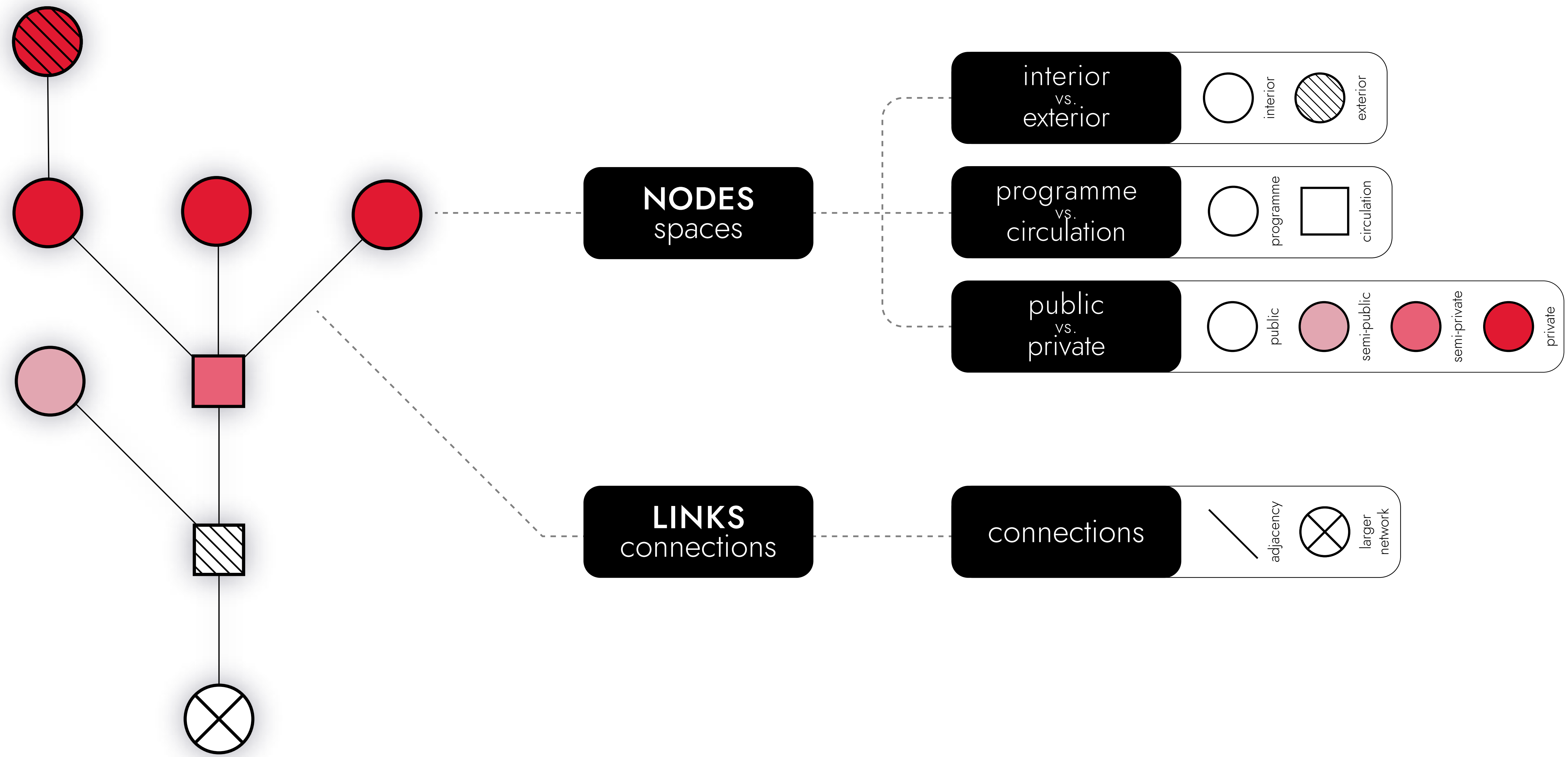


Bubble diagram

TOPOLOGICAL GRAPH

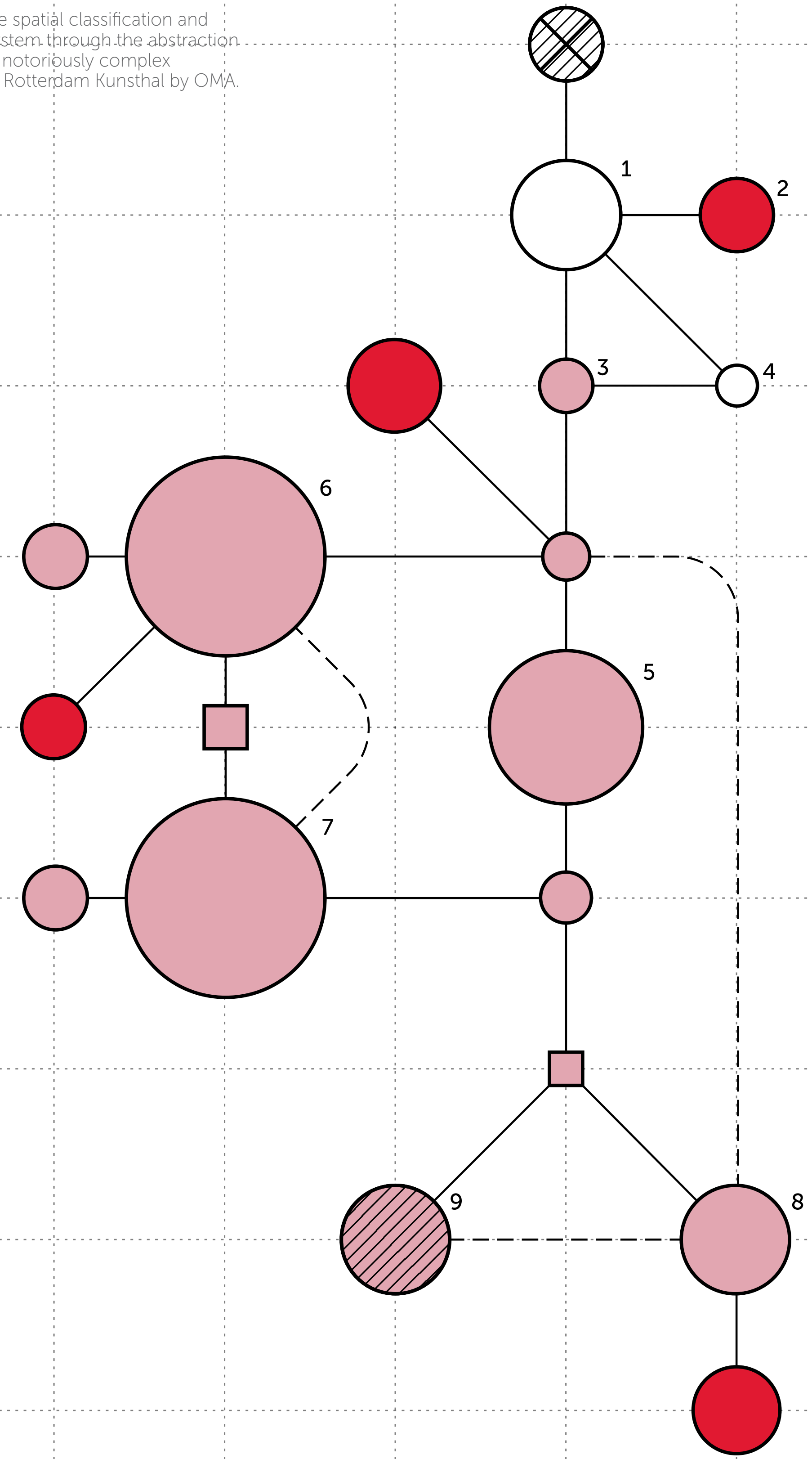


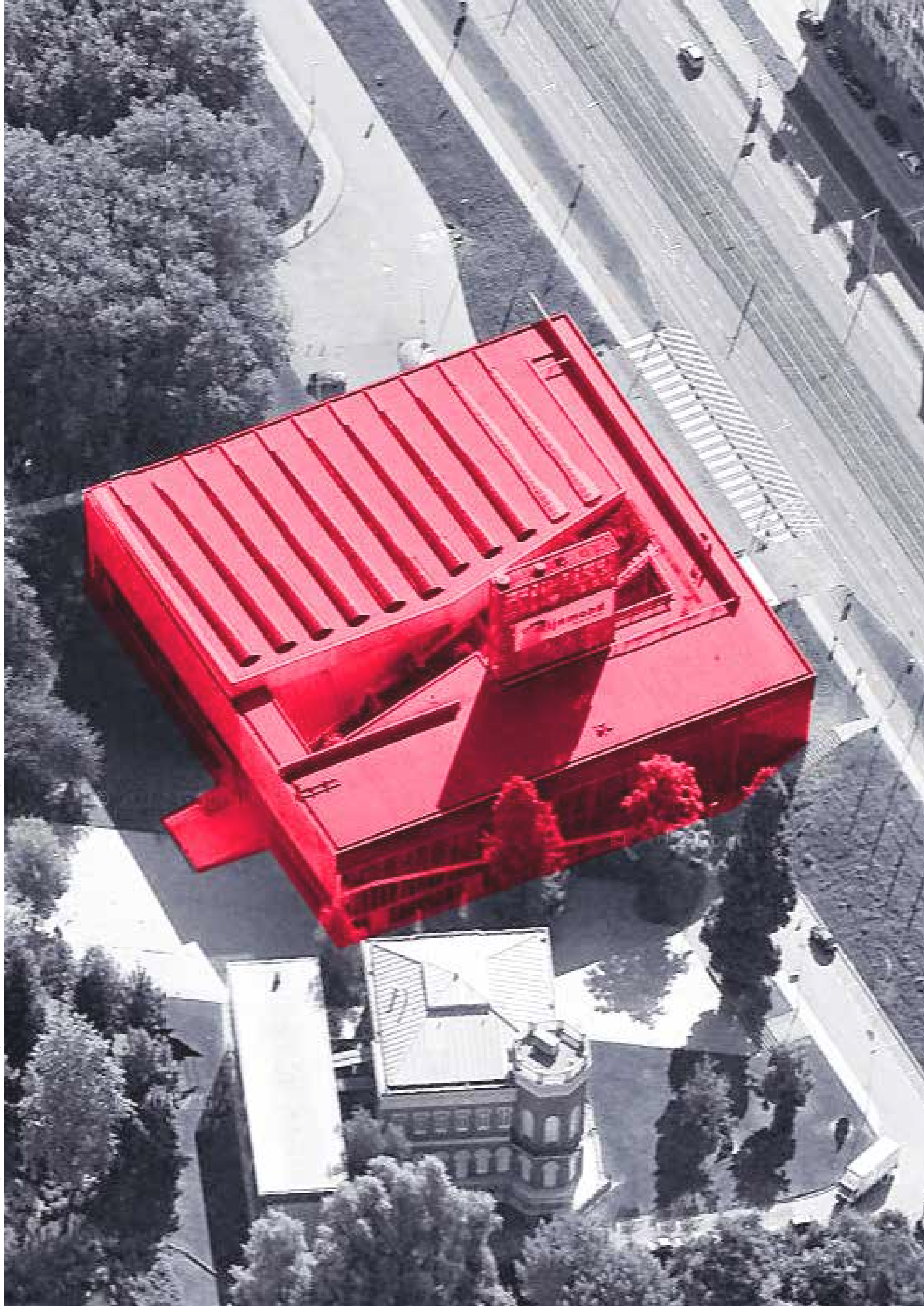
SPATIAL NETWORK



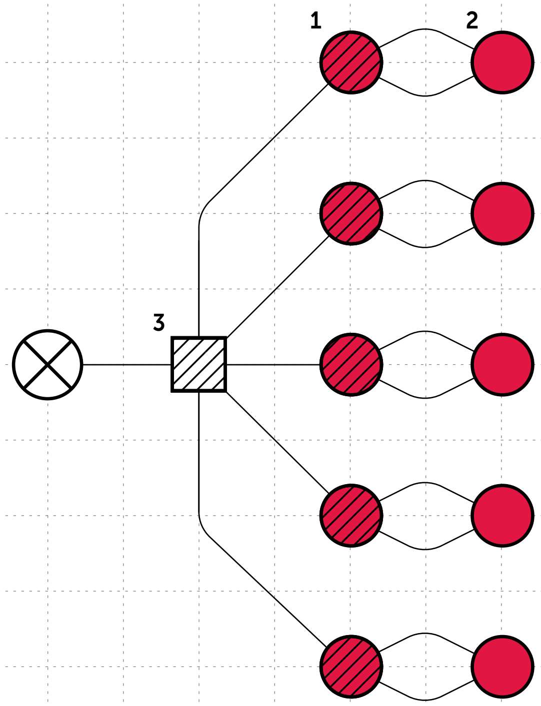
KUNSTHAL SPATIAL NETWORK

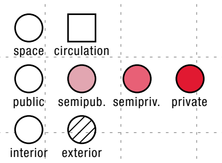
Testing of the spatial classification and notational system through the abstraction of a spatially notoriously complex building; the Rotterdam Kunsthal by OMA.

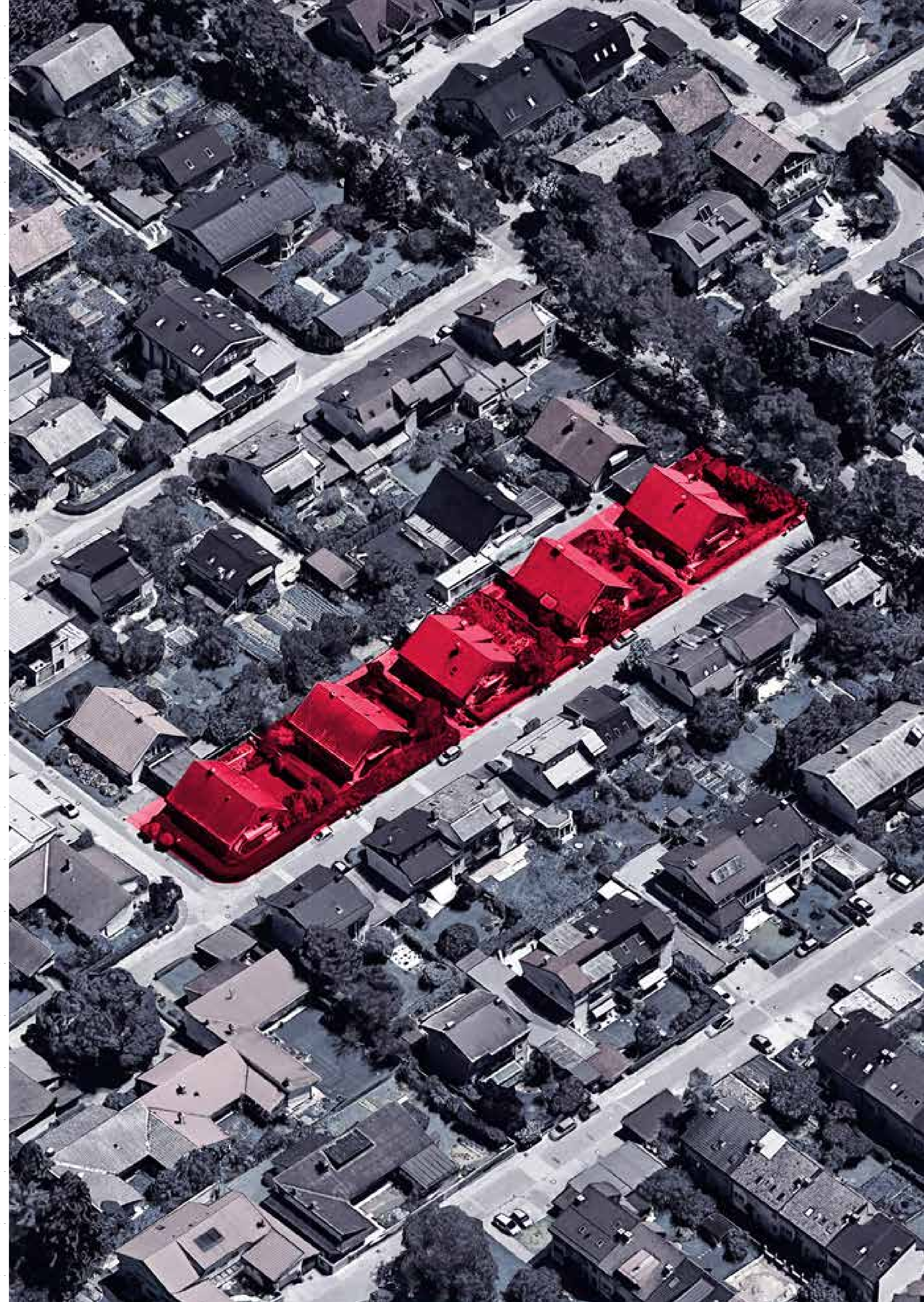




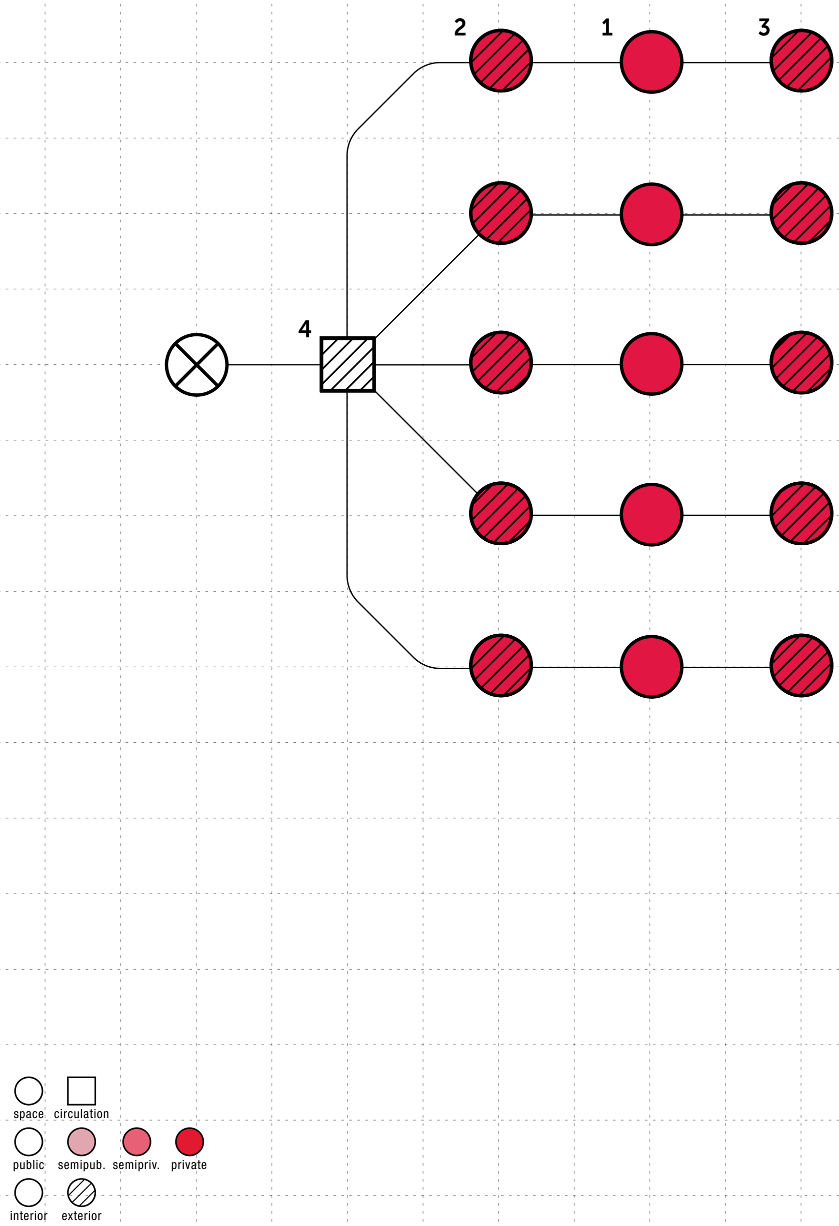
DETACHED HOUSE





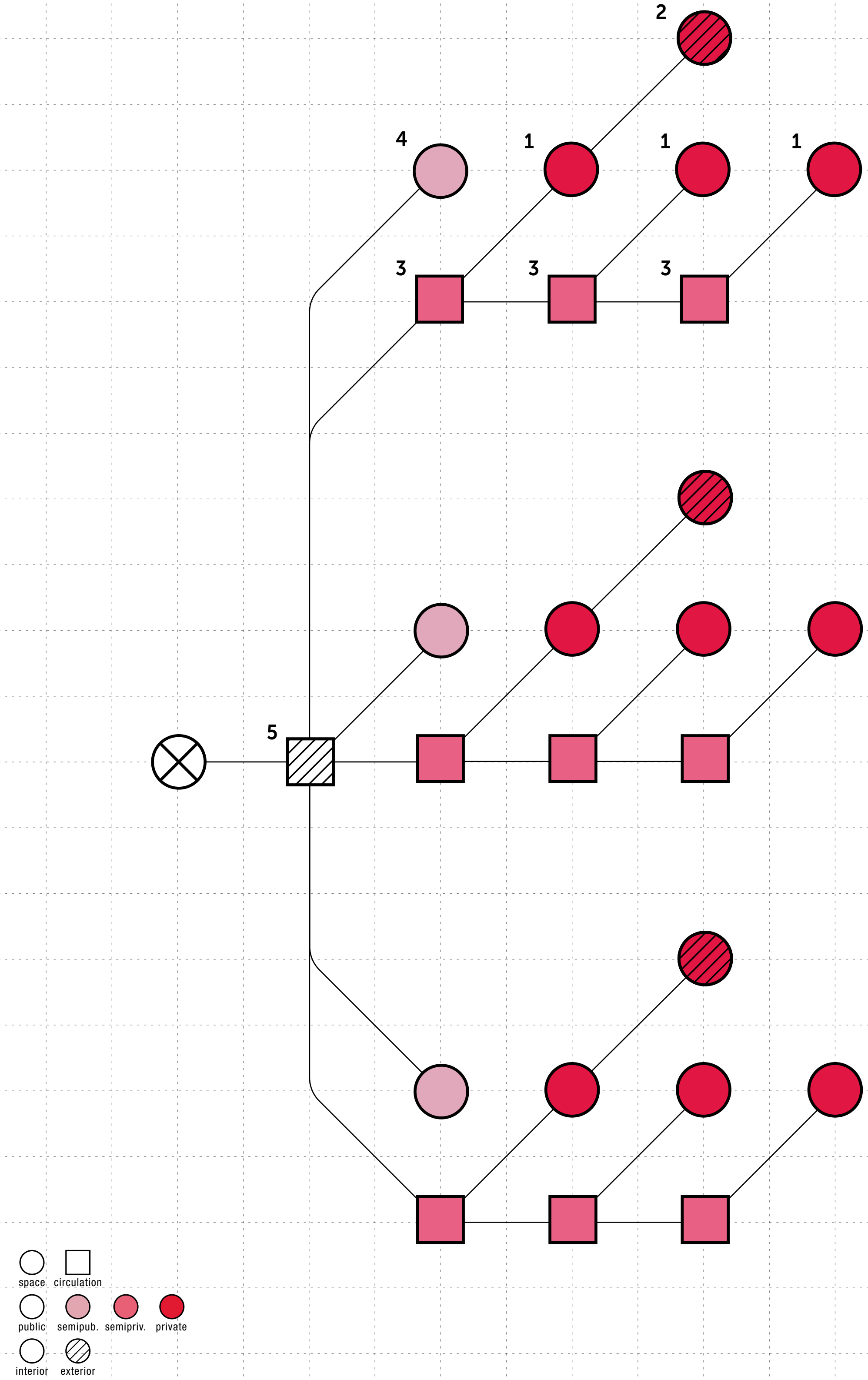


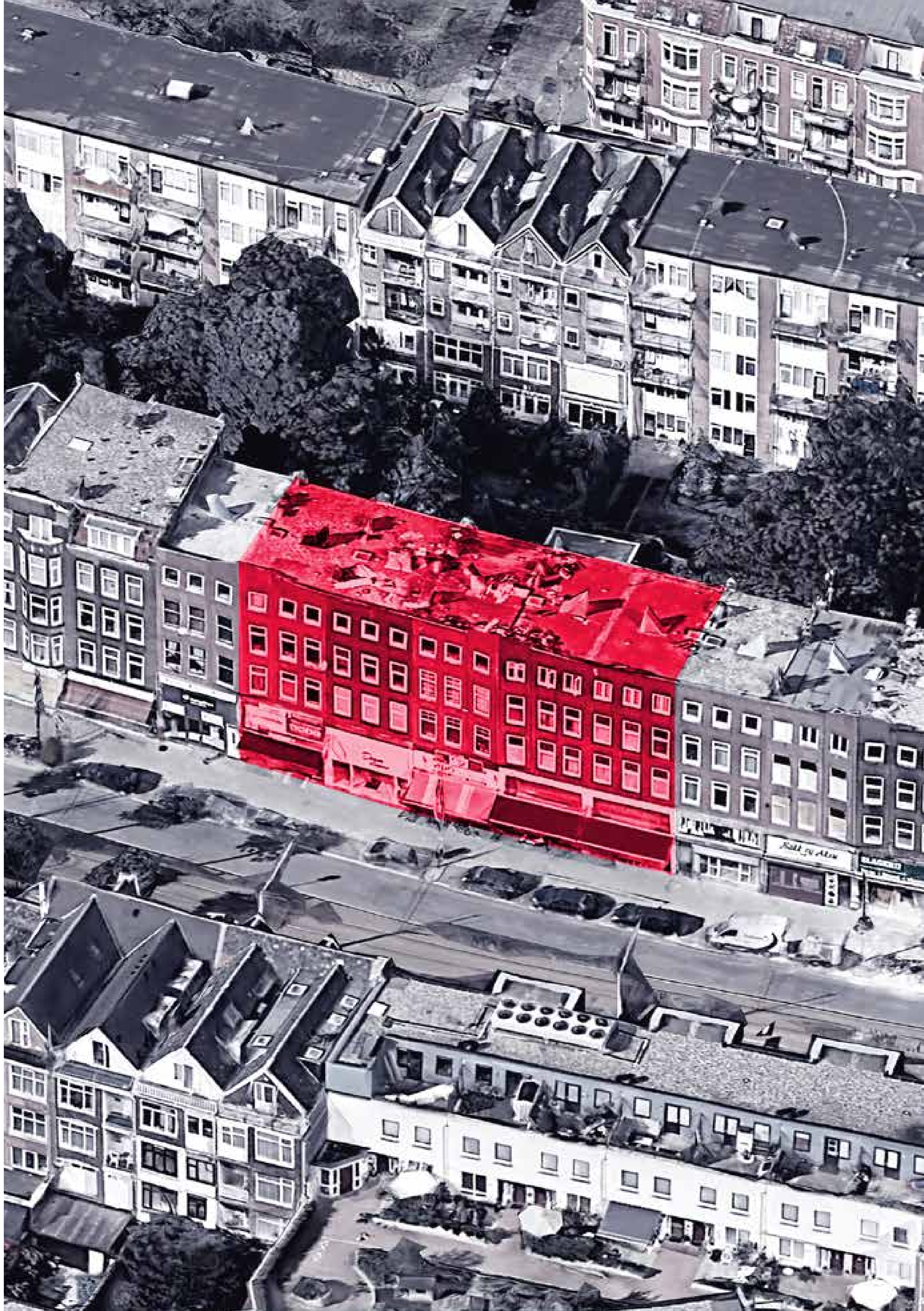
ROWHOUSE



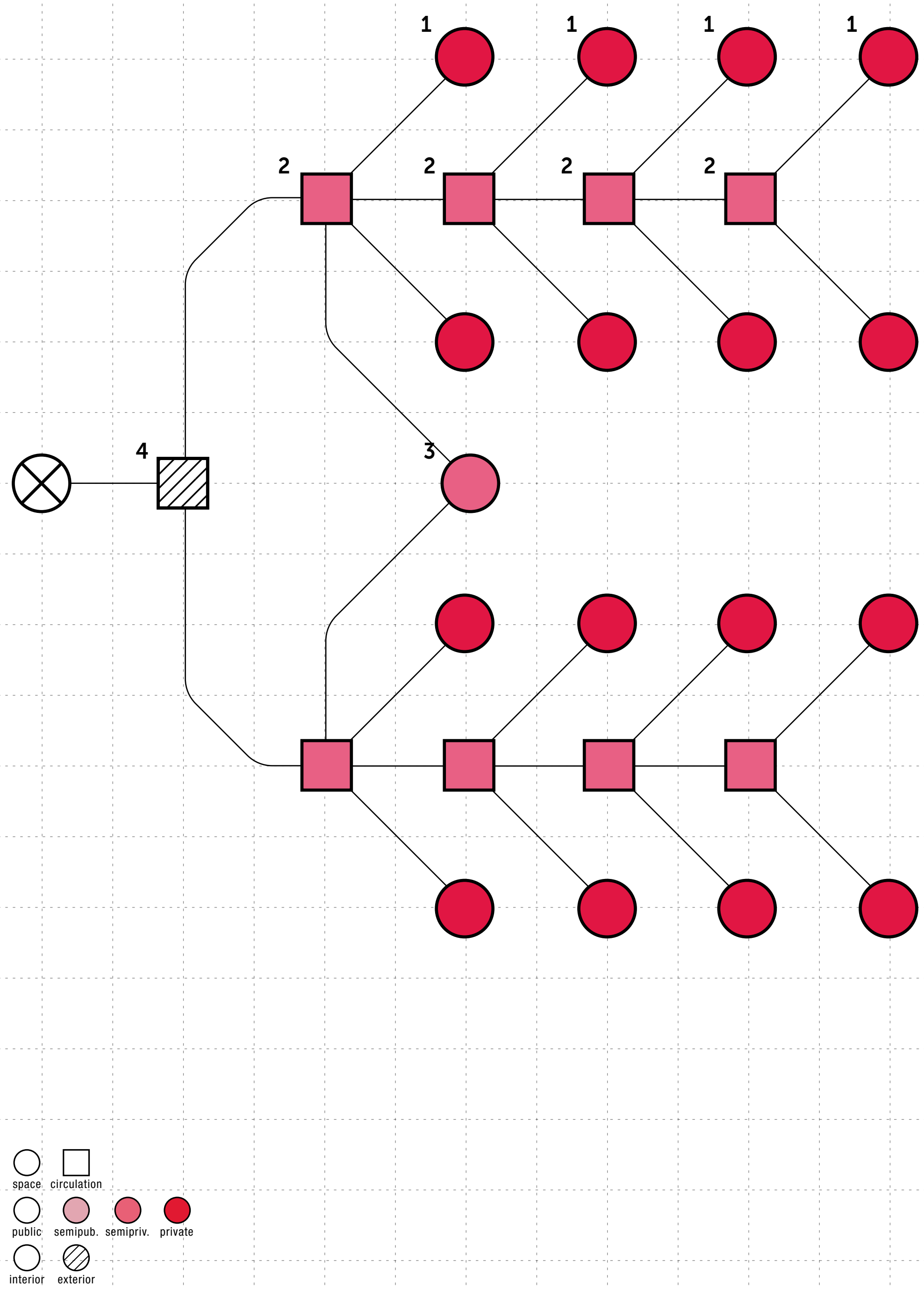
2
1
3
4
space
circulation
public
semipub.
semipriv.
private
interior
exterior

TOWNHOUSE SHOPHOUSE HYBRID

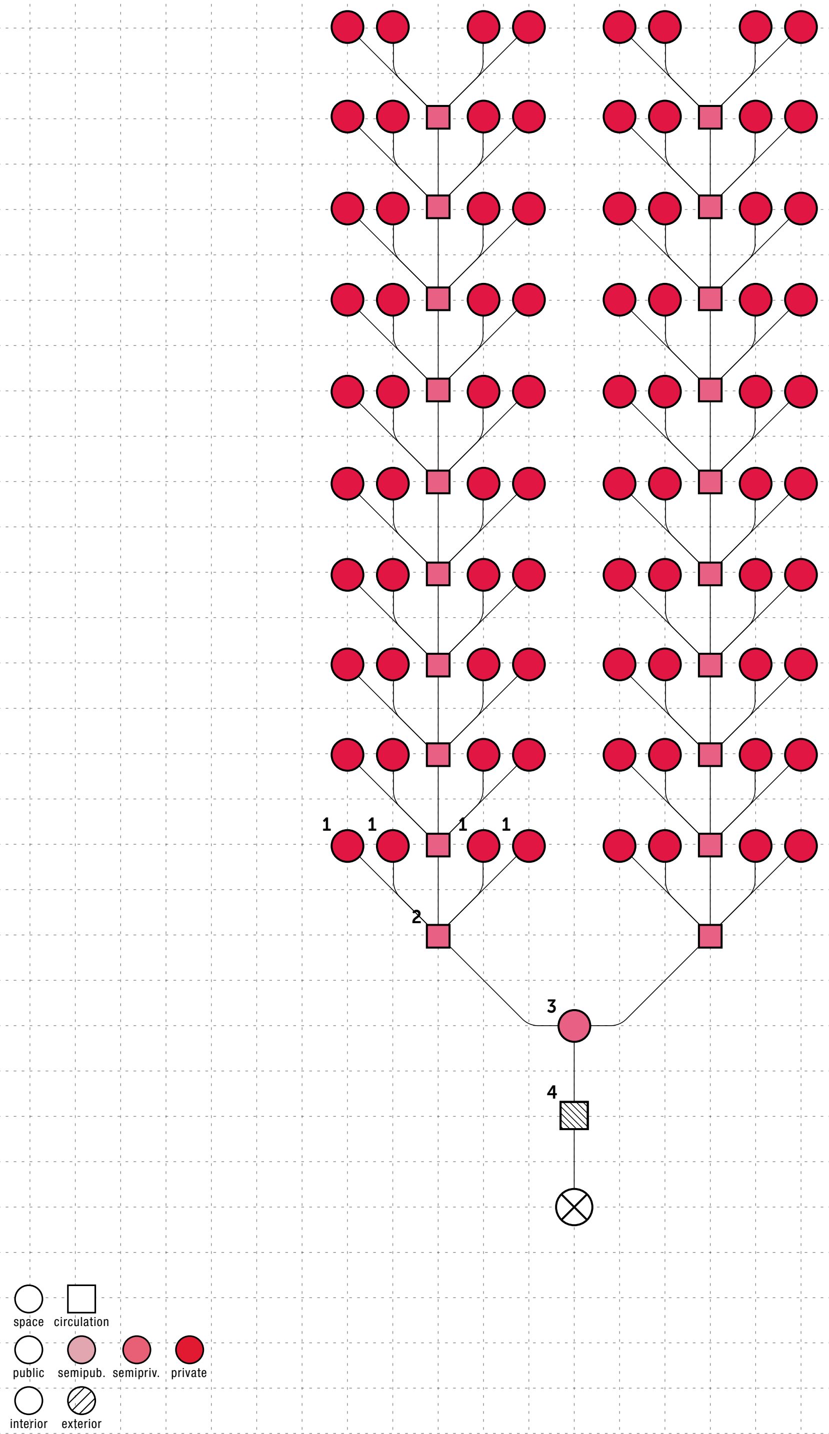


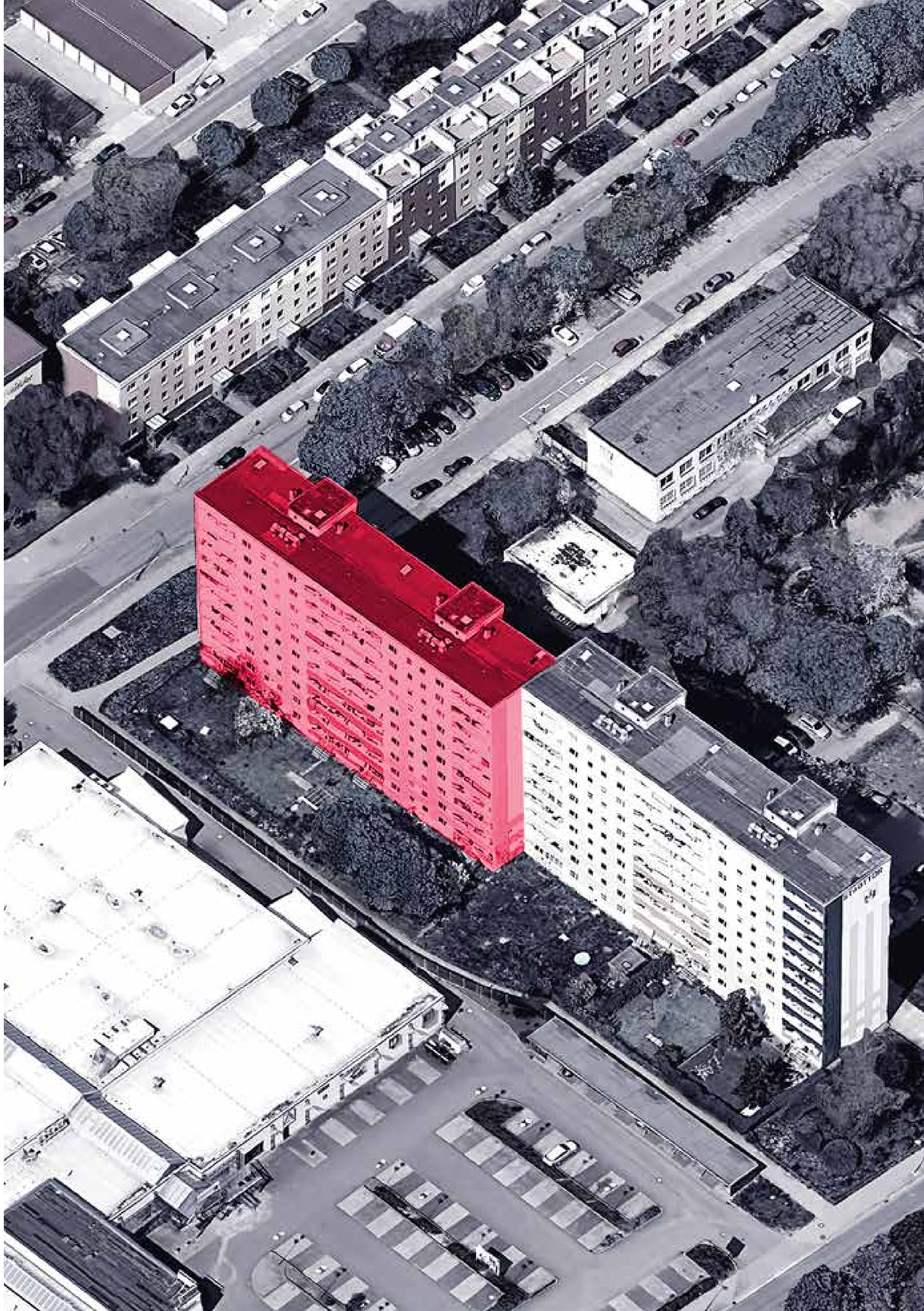


TOWNHOUSE COURTYARD

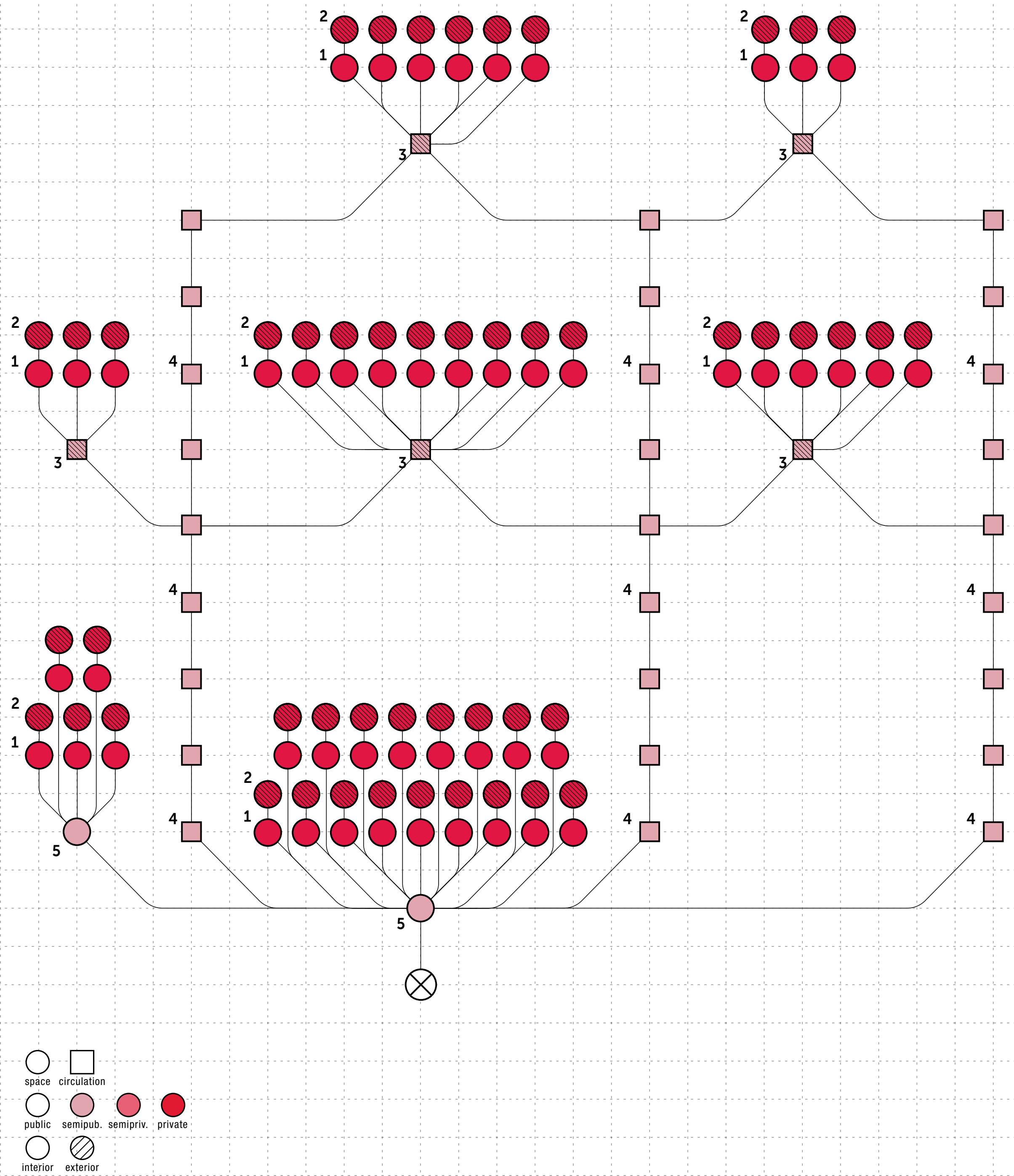


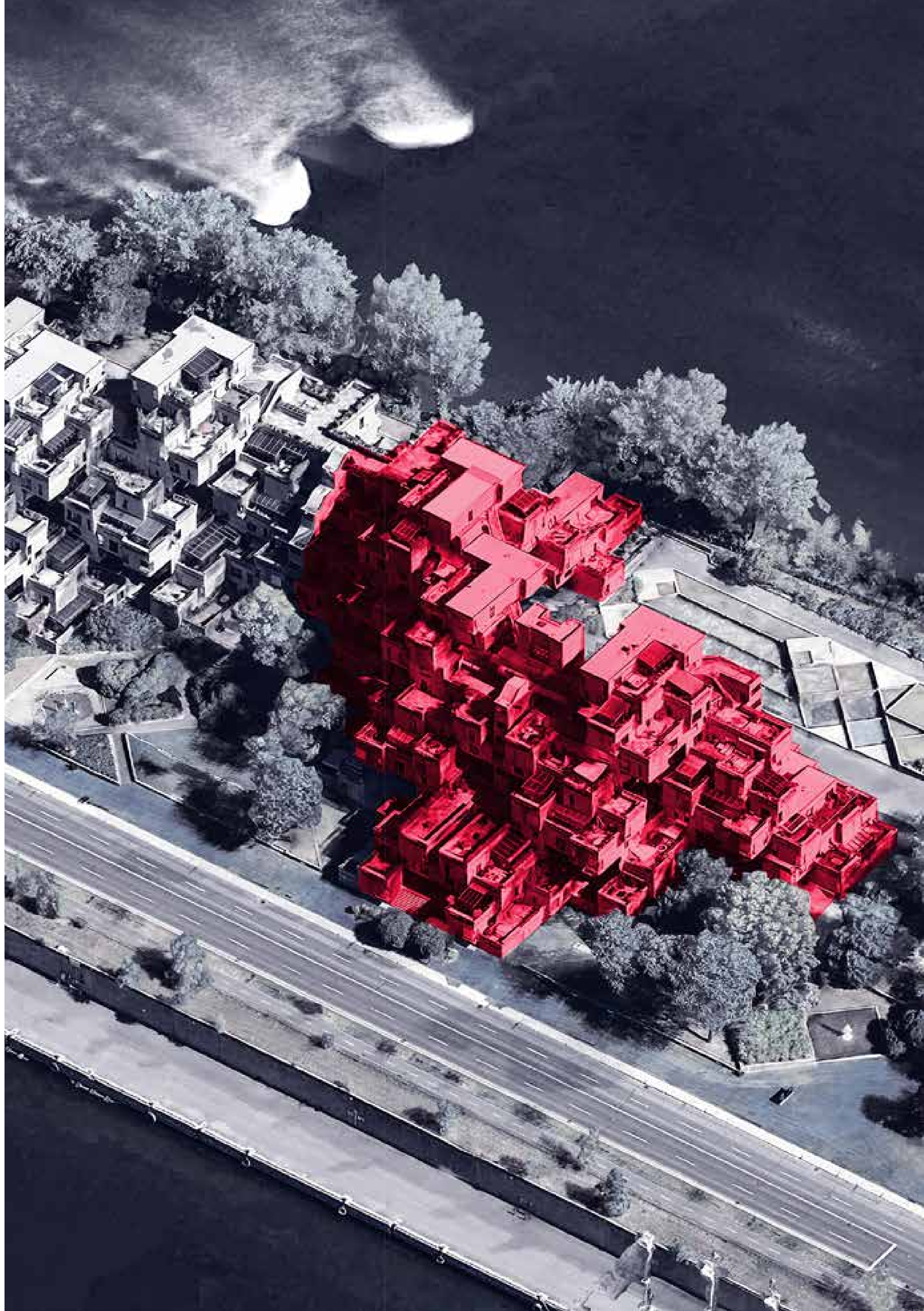
CENTRAL CORE SLAB

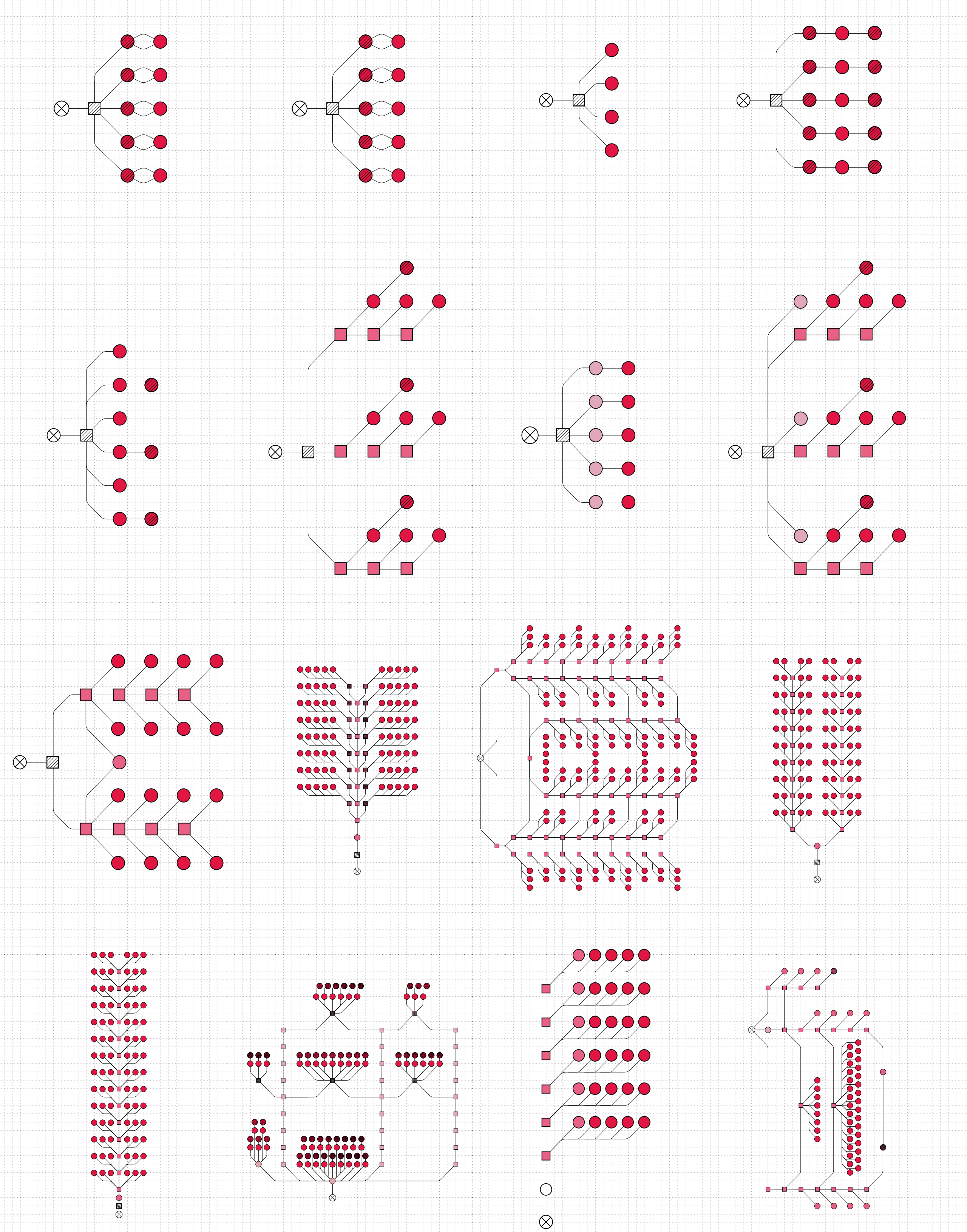




HABITAT 67


space
circulation
public
semipub.
semipriv.
private
interior
exterior

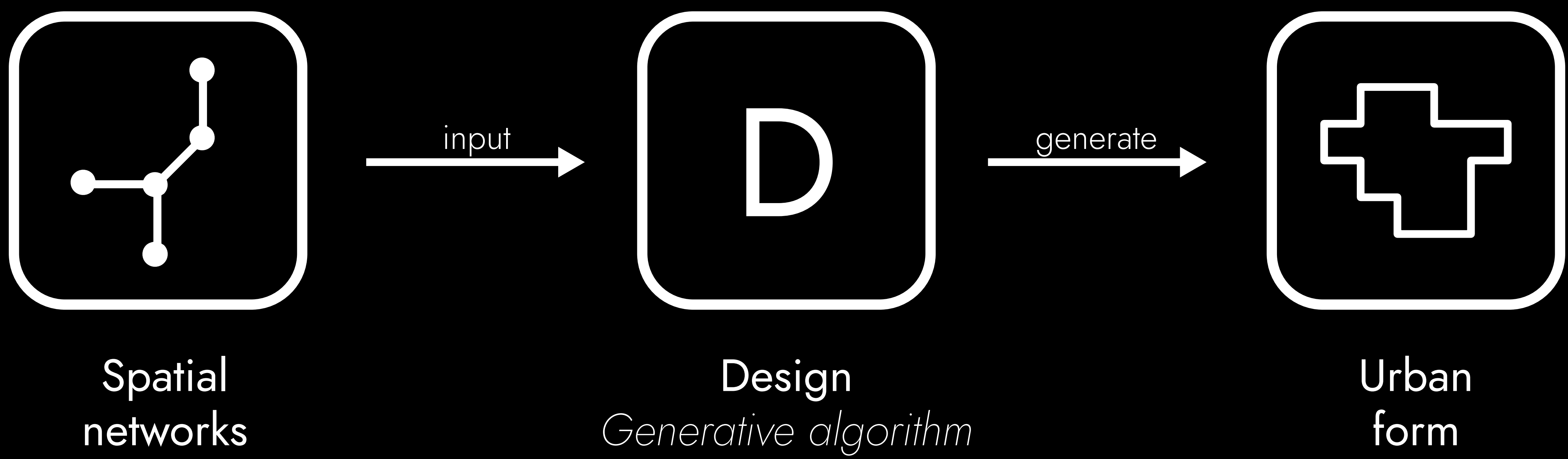


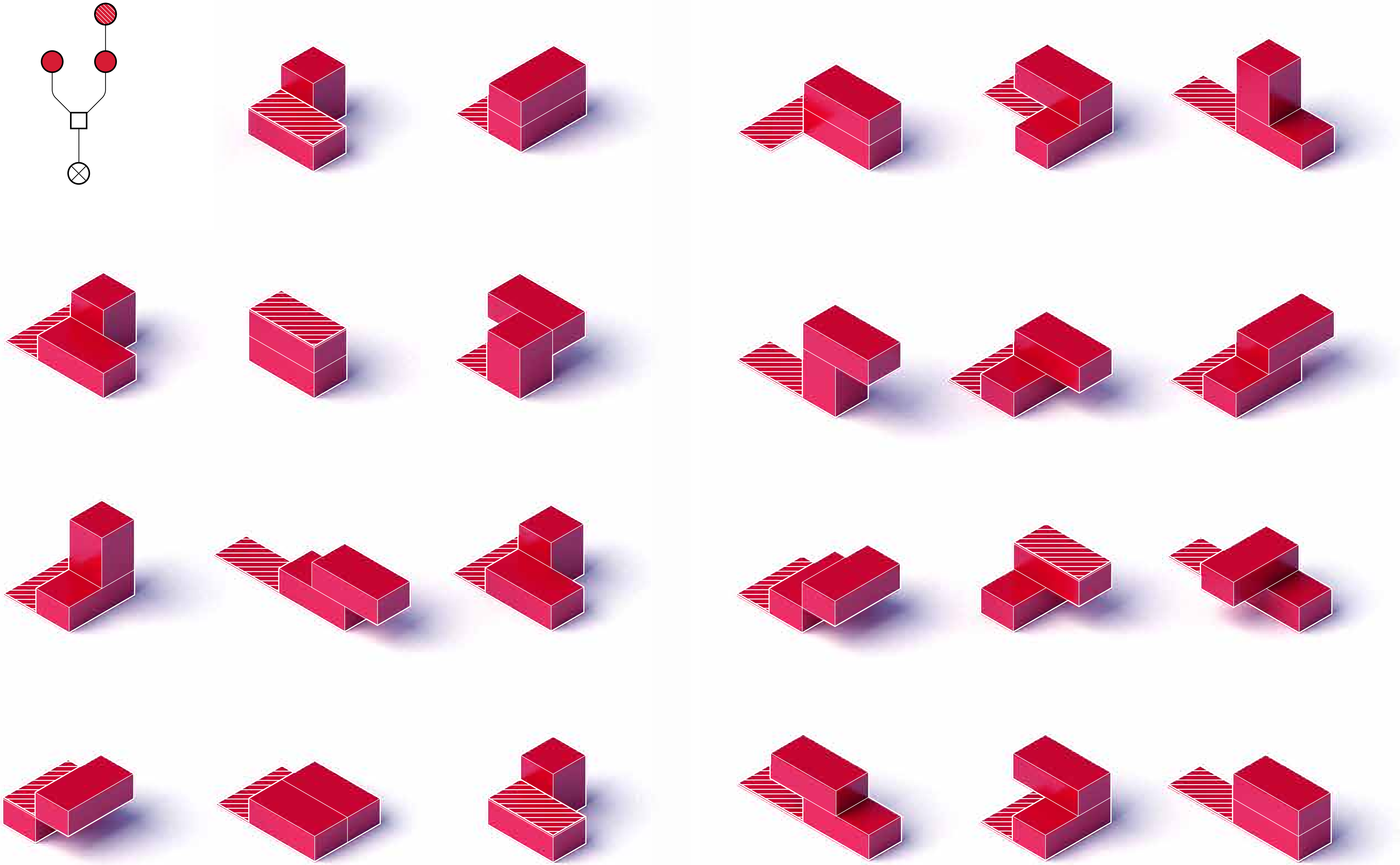


Theoretical and computational innovations should allow type to become a dynamic set of relationships that can vary with pressure, situation, actor and time.

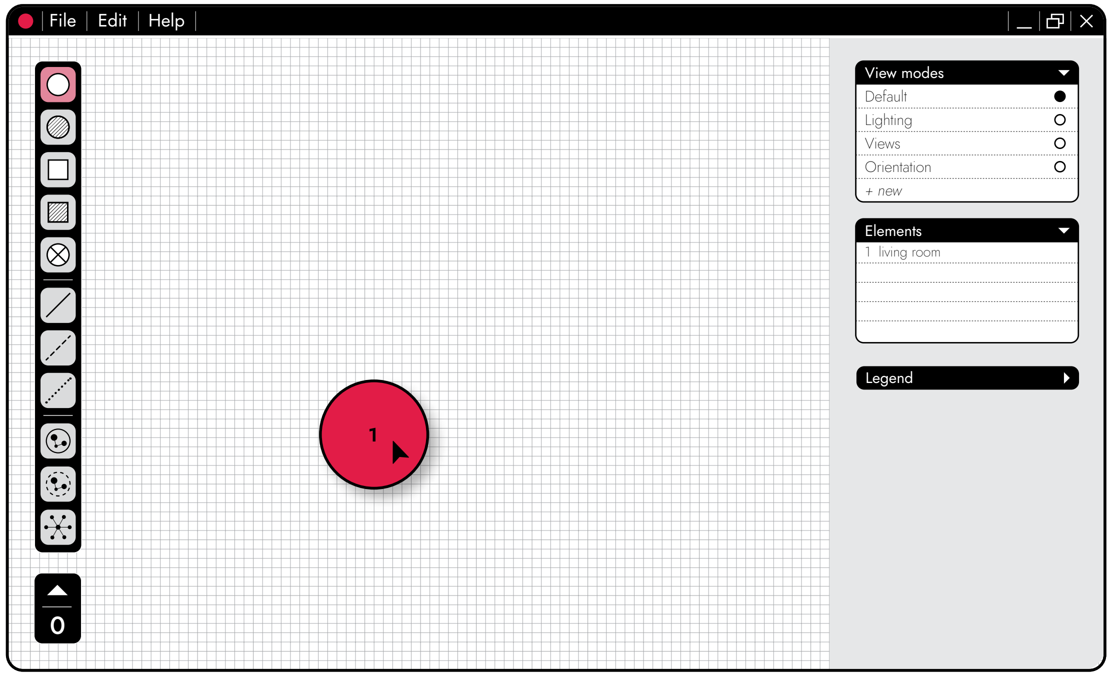
- David Grahame Shane, Transcending type, 2011

D E S I G N

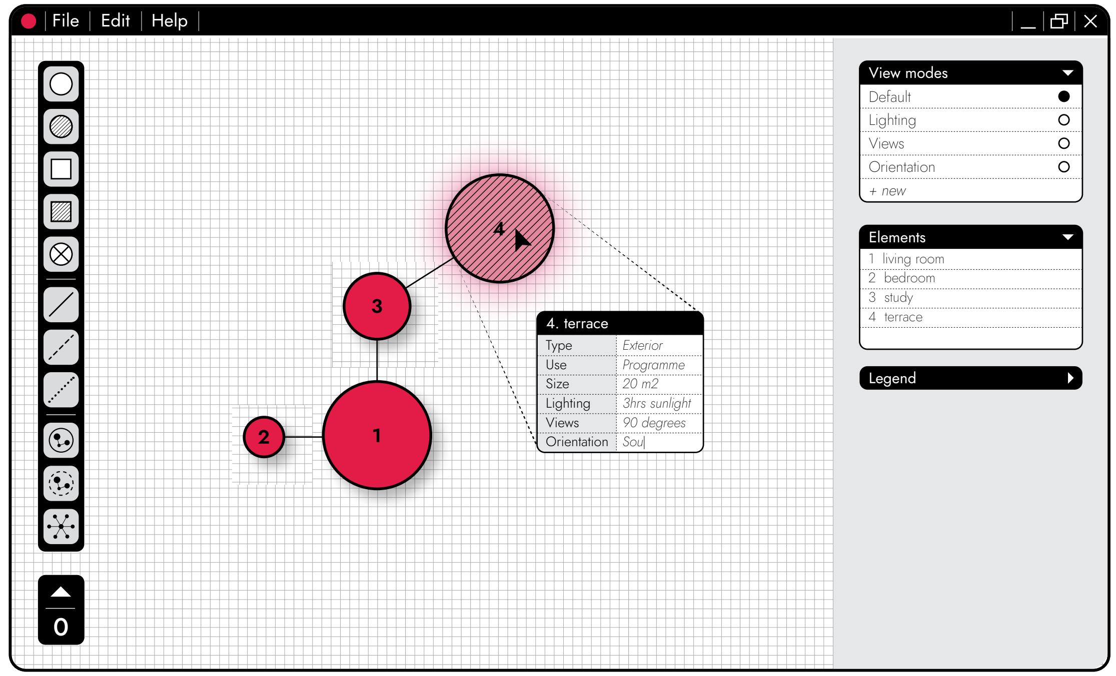

input
D
generate
Spatial networks
Design
Generative algorithm
Urban form



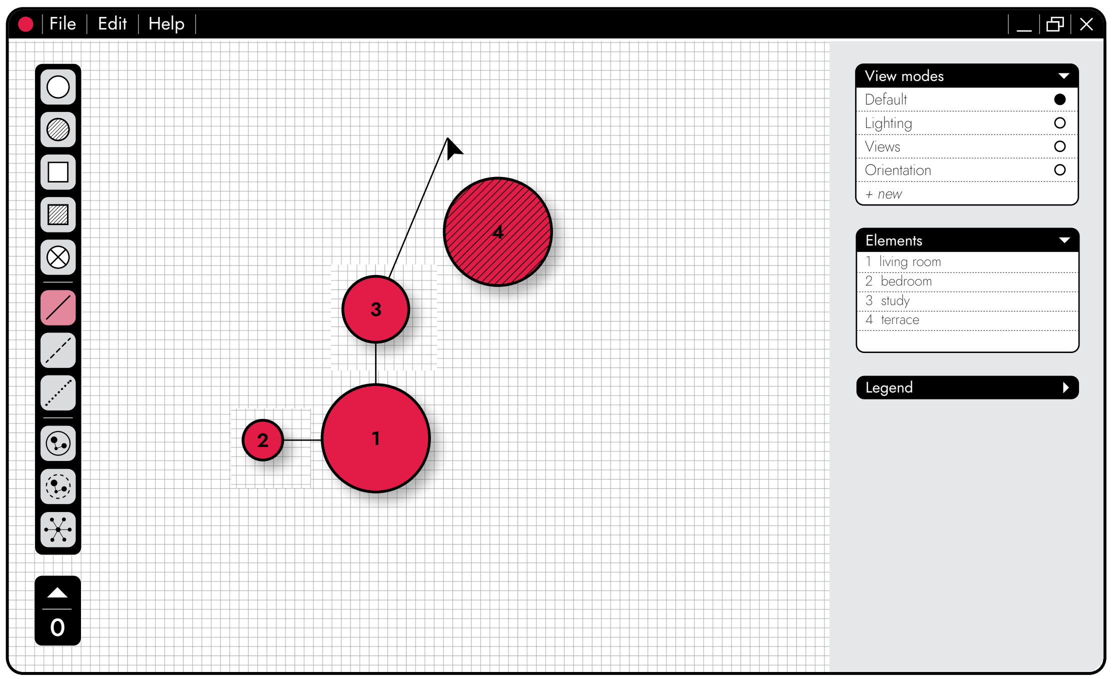
DESIGN INTERFACE



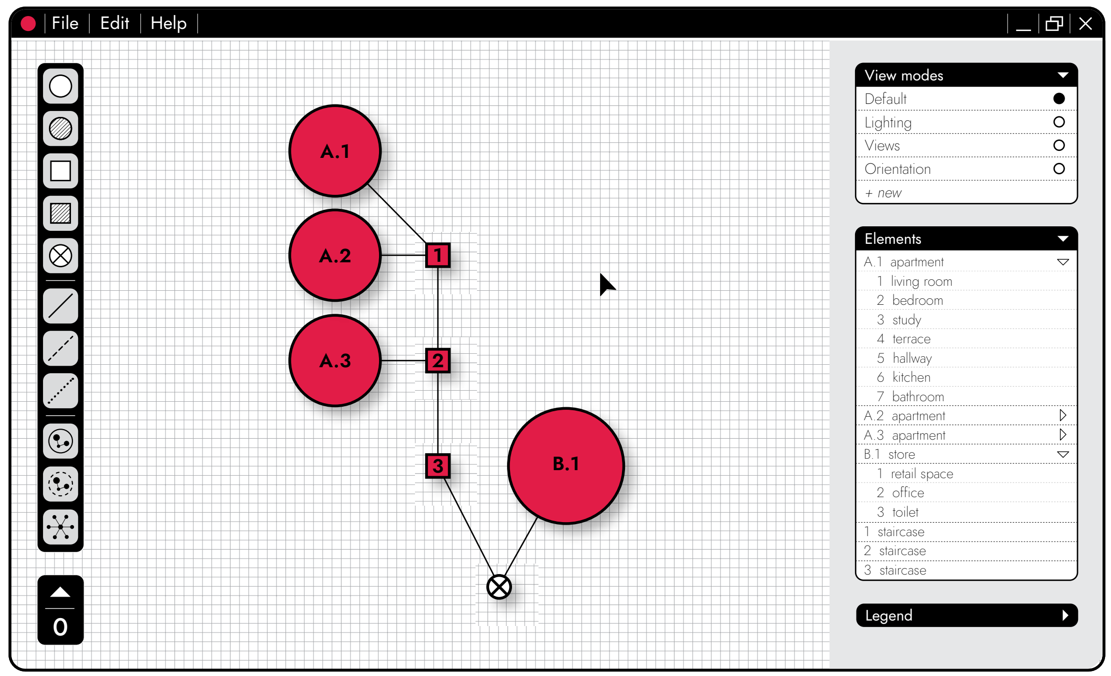
Dropping nodes representing spaces with the click of a mouse



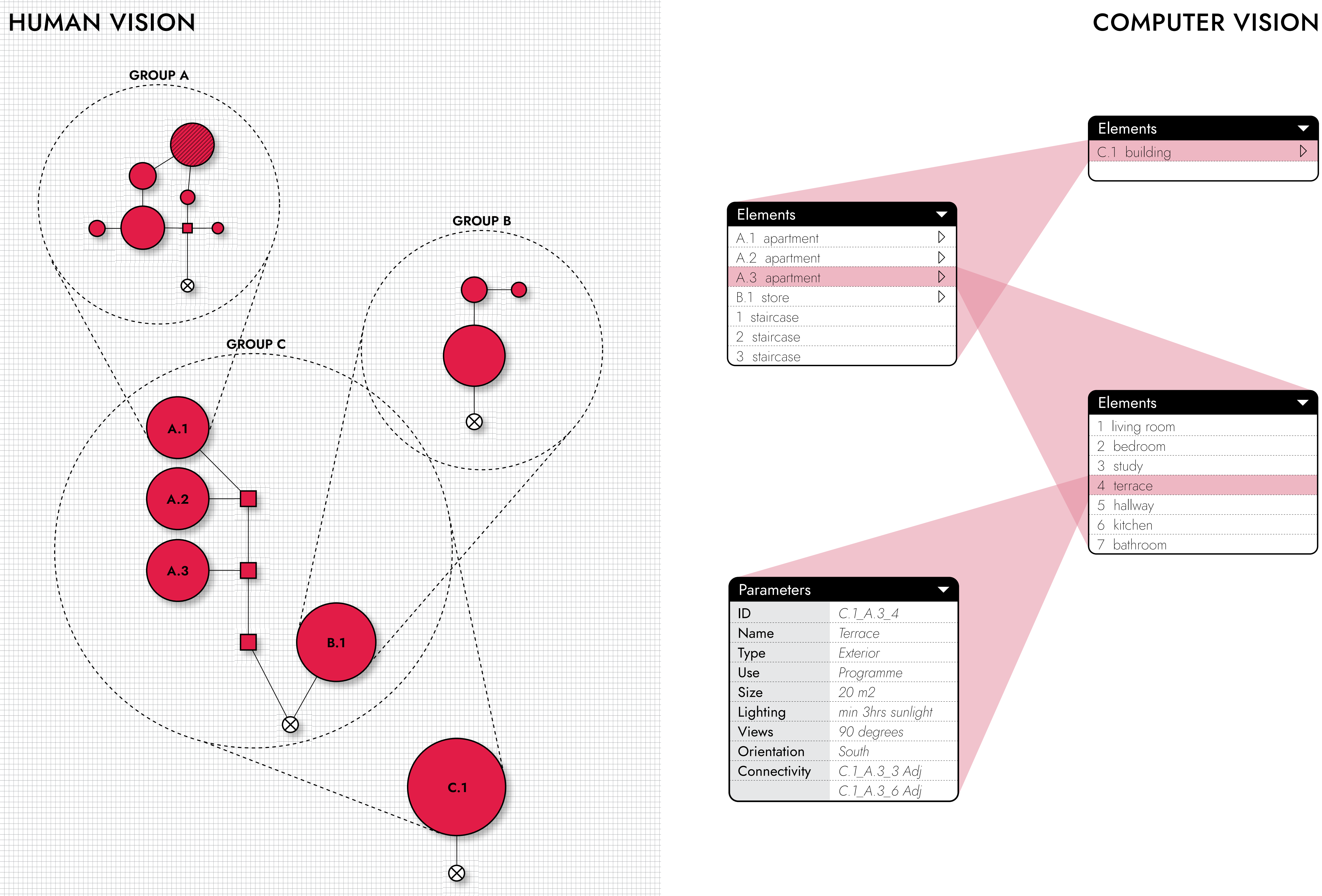
Each node can have a number of user-defined spatial requirements assigned

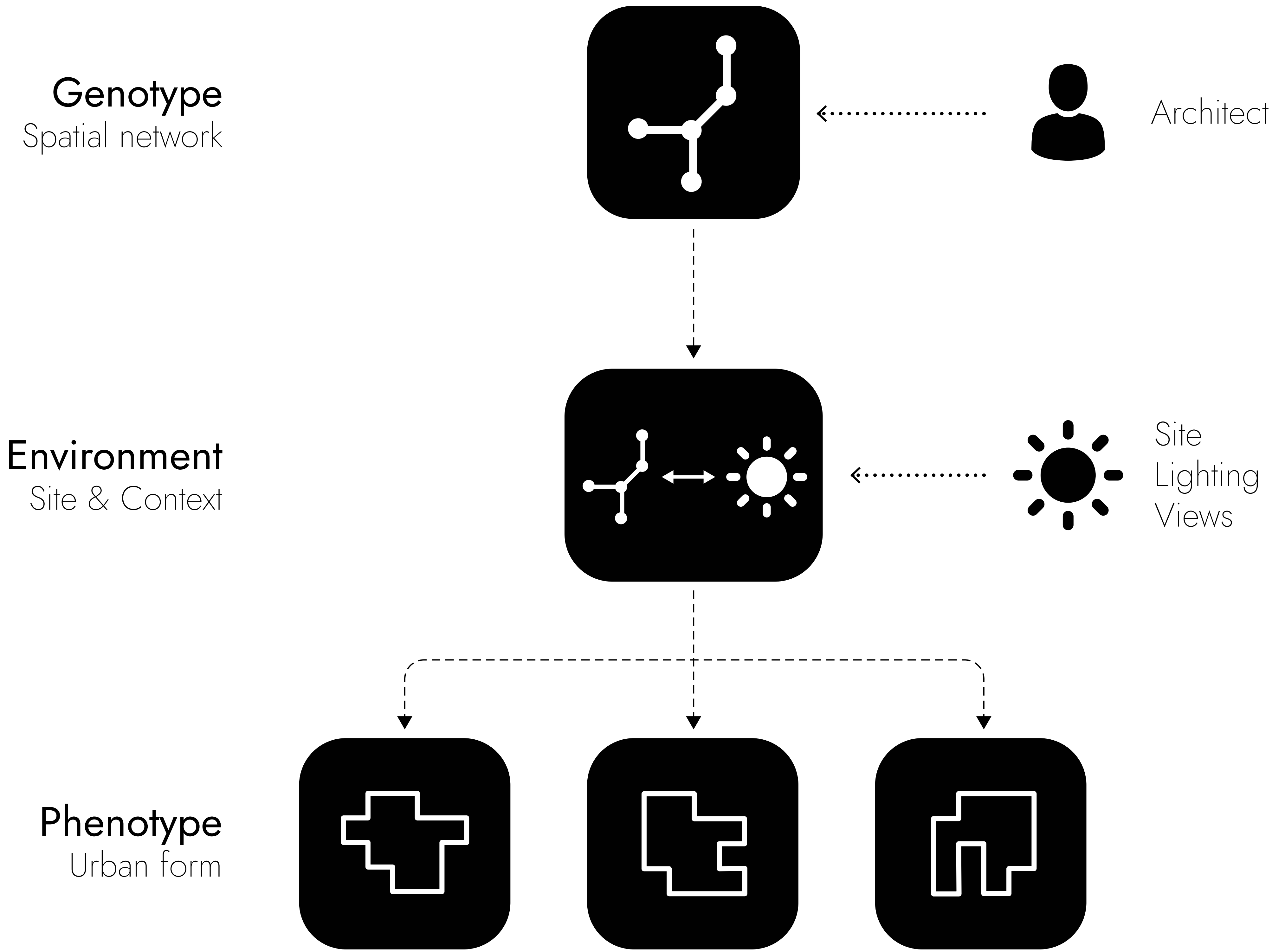


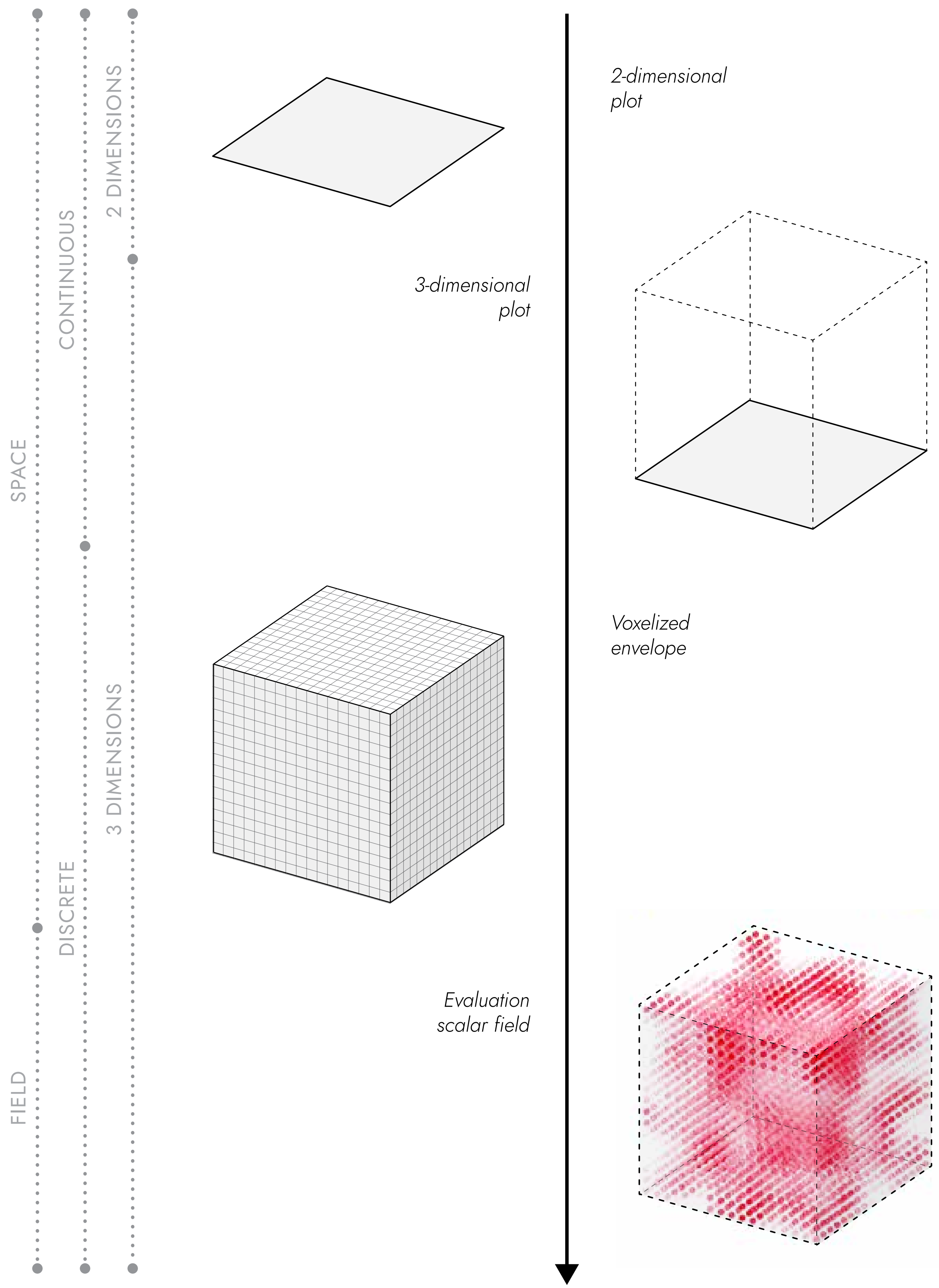
Connections between nodes automatically snap into place

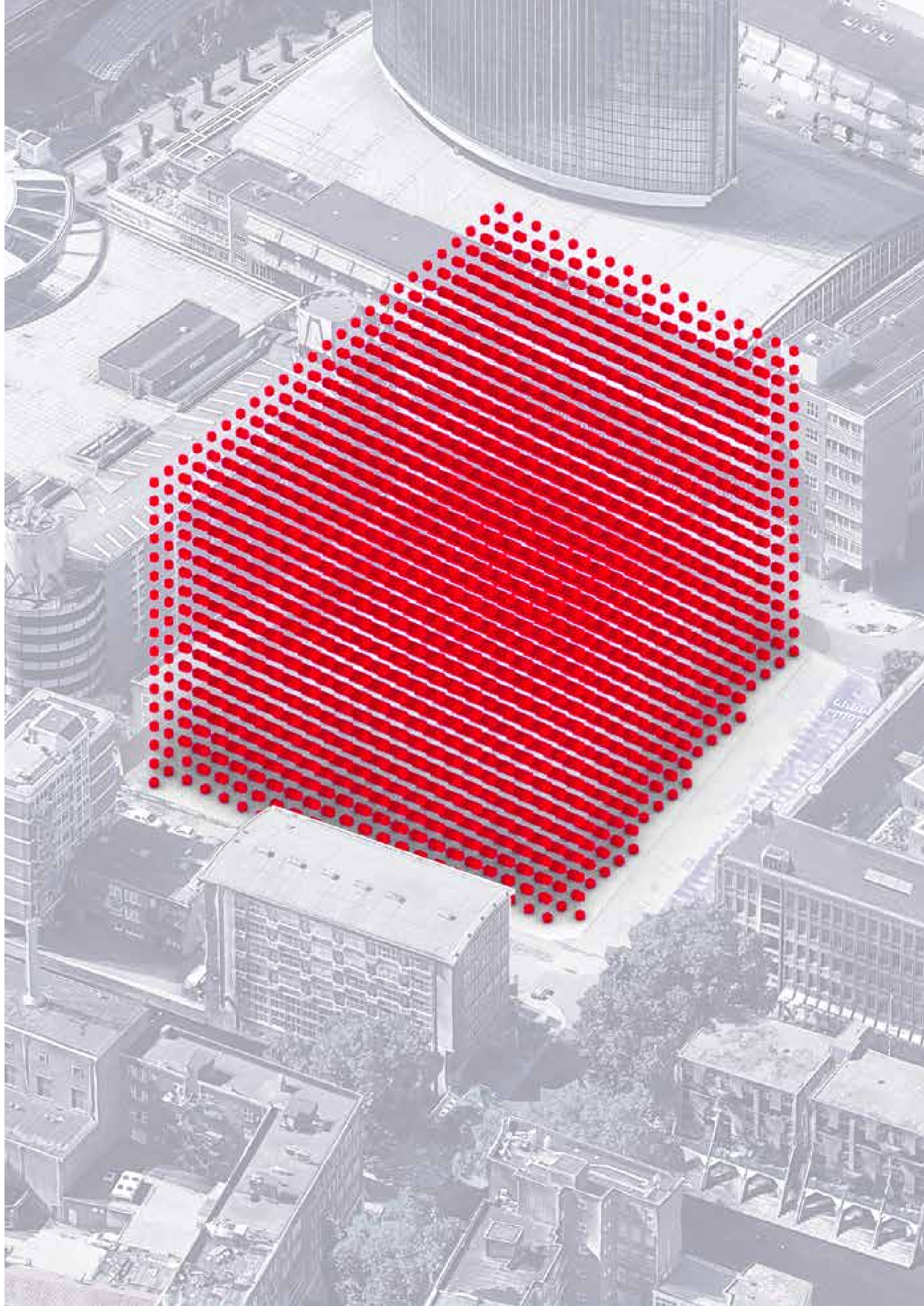


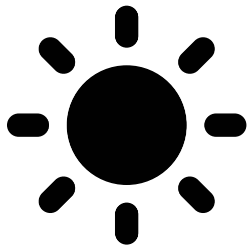
Efficient preview toggling diplaying node colours by parameter values

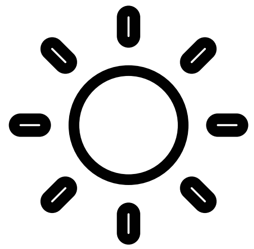

HUMAN VISION
GROUP A
GROUP B
GROUP C
A.1
A.2
A.3
B.1
C.1
COMPUTER VISION
Elements
C.1 building
Elements
A.1 apartment
A.2 apartment
A.3 apartment
B.1 store
1 staircase
2 staircase
3 staircase
Elements
1 living room
2 bedroom
3 study
4 terrace
5 hallway
6 kitchen
7 bathroom
Parameters
ID C.1_A.3_4
Name Terrace
Type Exterior
Use Programme
Size 20 m2
Lighting min 3hrs sunlight
Views 90 degrees
Orientation South
Connectivity C.1_A.3_3 Adj
C.1_A.3_6 Adj

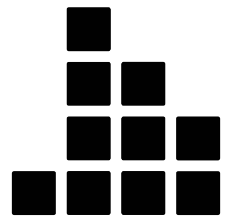

Genotype
Spatial network
Architect
Environment
Site & Context
Site
Lighting
Views
Phenotype
Urban form

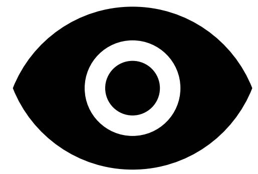

SPACE
FIELD
CONTINUOUS
DISCRETE
2 DIMENSIONS
3 DIMENSIONS
2-dimensional plot
3-dimensional plot
Voxelized envelope
Evaluation scalar field

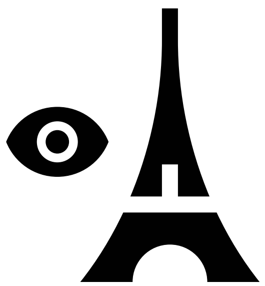


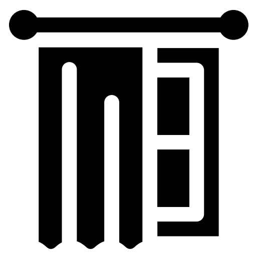

sunlight

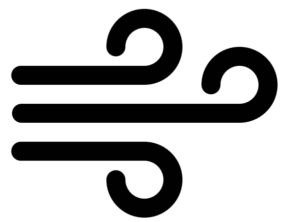

daylight

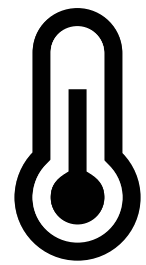

structure

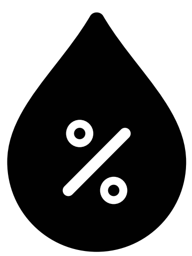

views

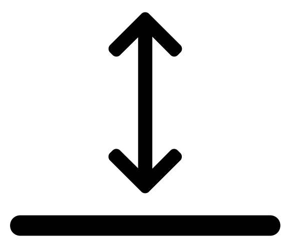

point of interest view


visual privacy


wind speed

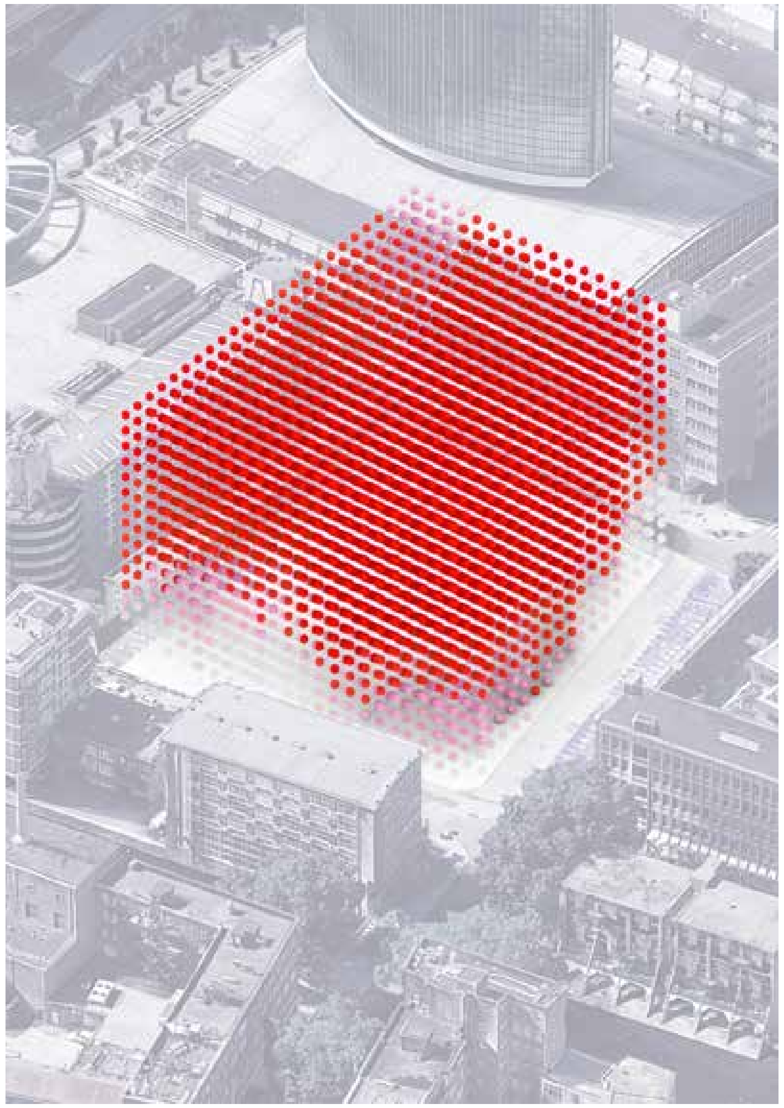

temperature


humidity

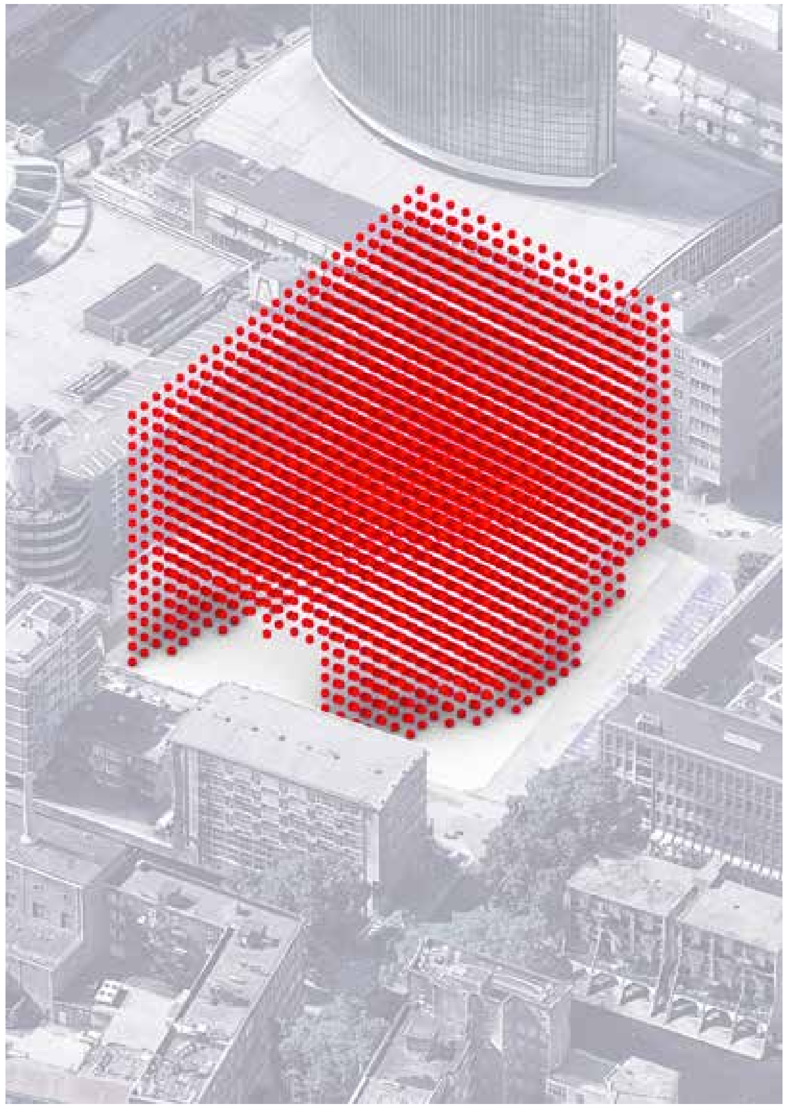

height


rain

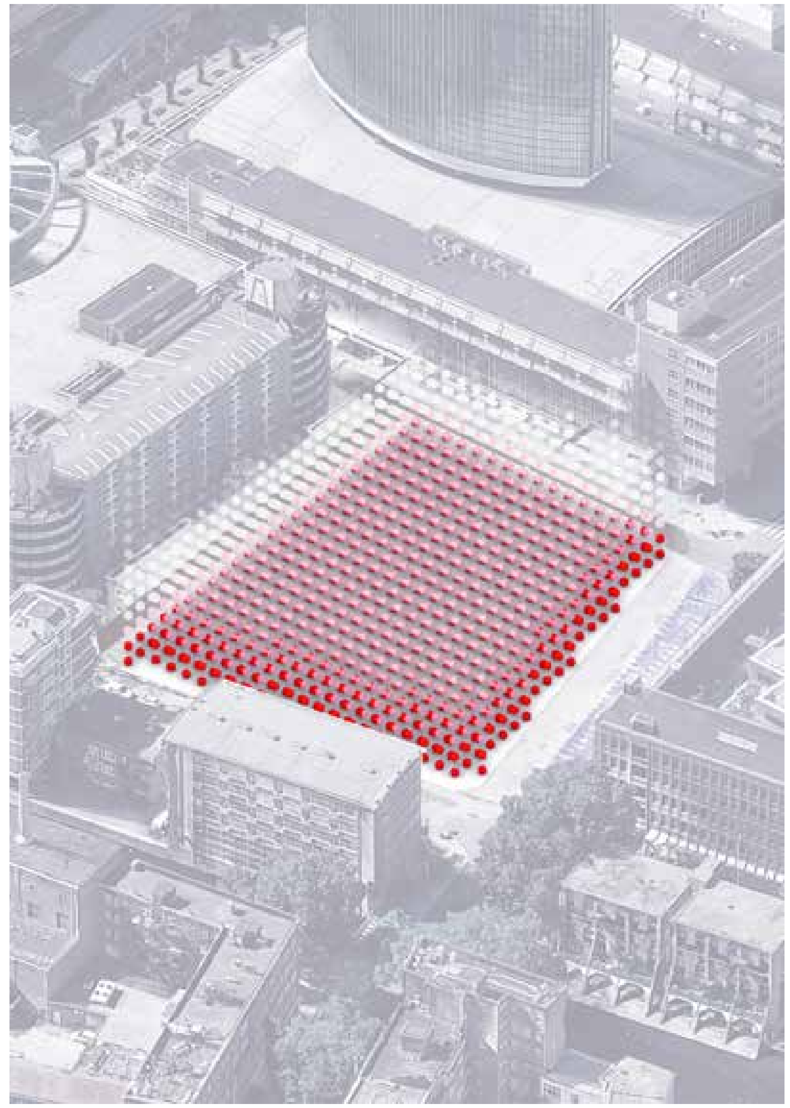

more?



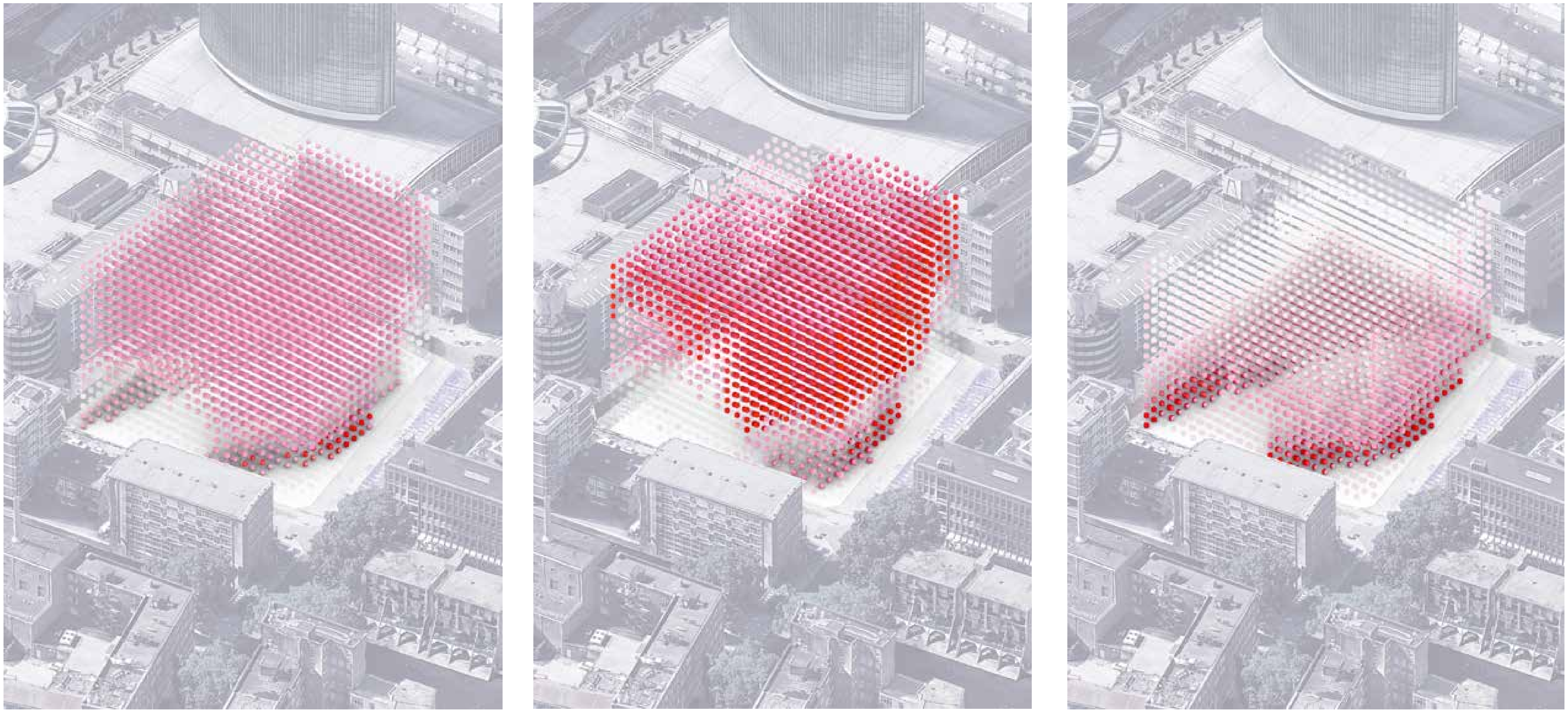
Sunlight



View



Structure



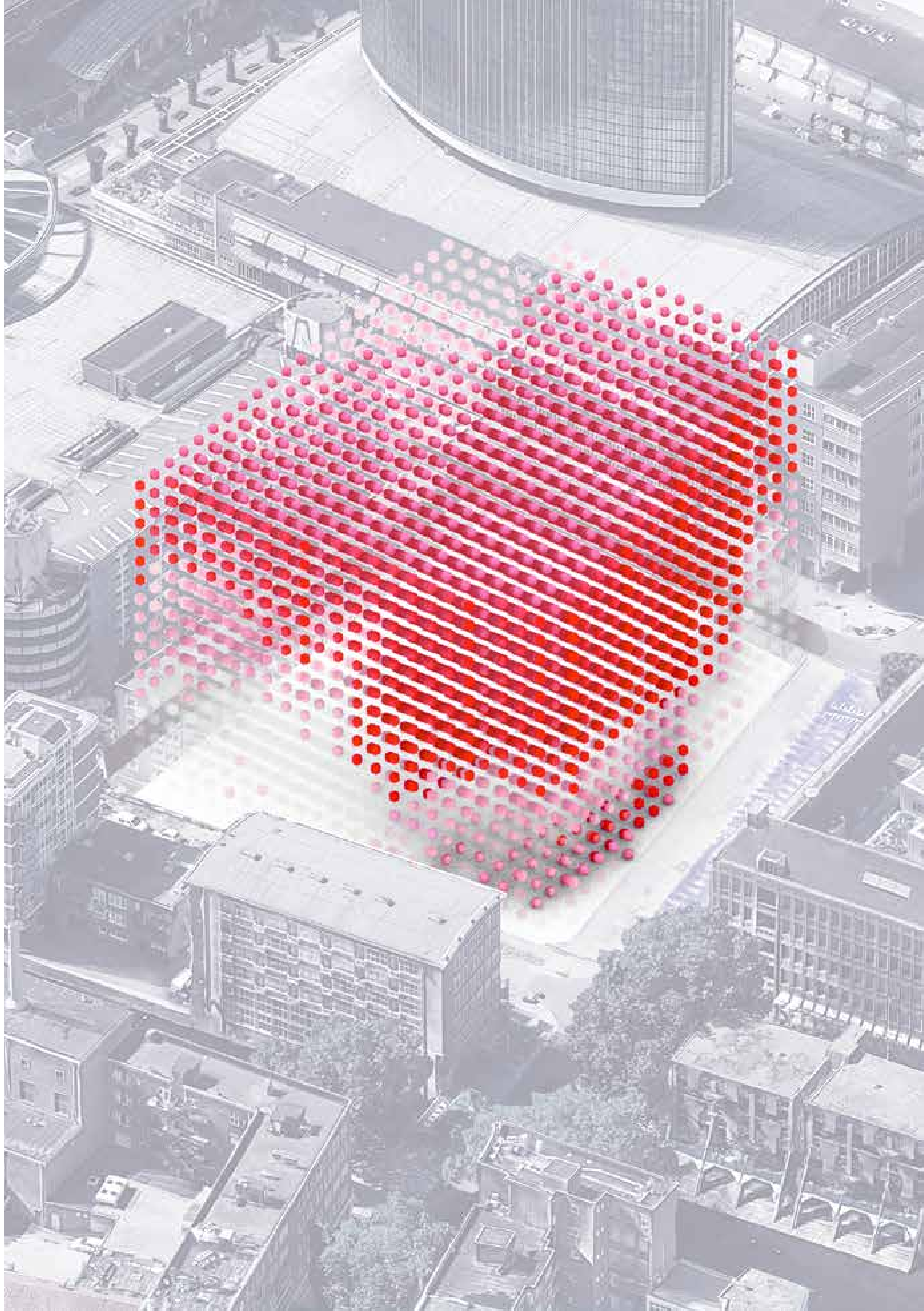
Sun, View and Structure fields merged with different weighting factors

”

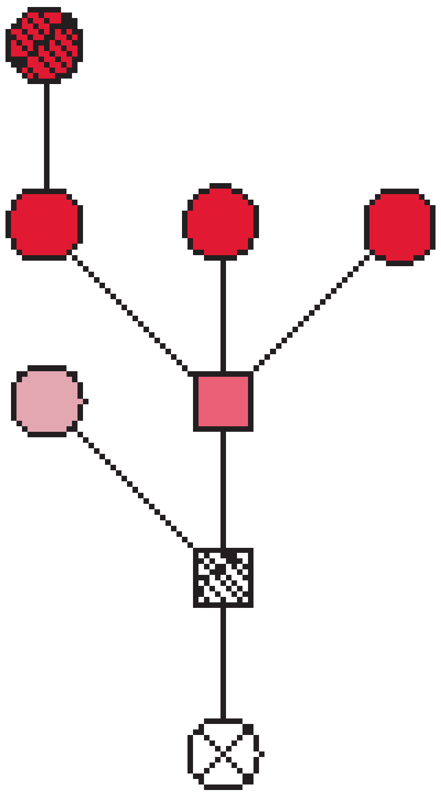
Field conditons treat constraints as opportunity... Working with and not against the site, something new is produced by registering the complexity of the given.

- Stan Allen, From Object to Field, 1997

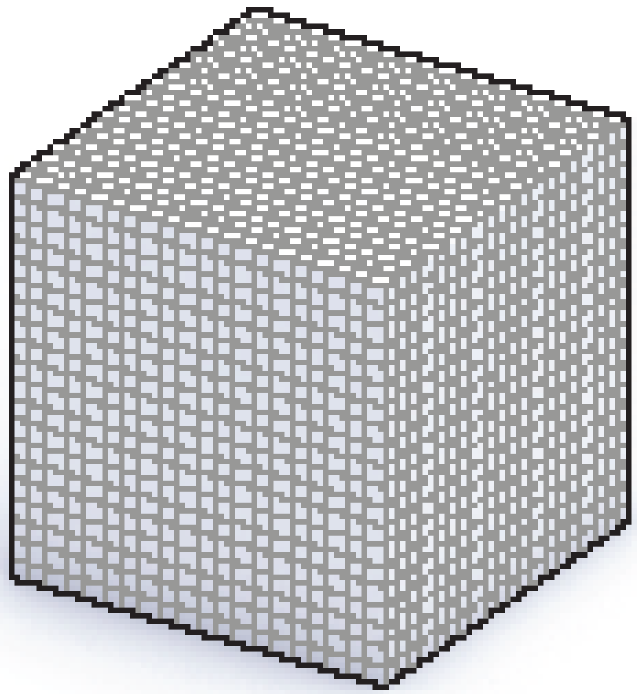
”



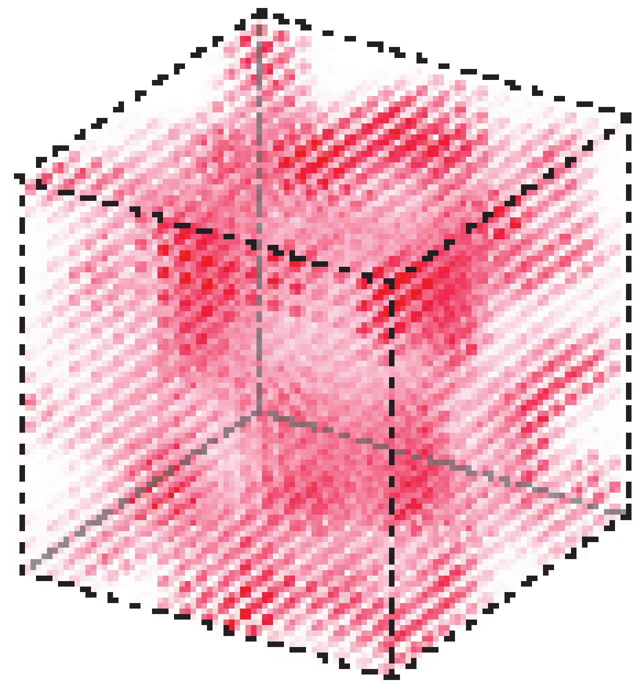
ALGORITHM COMPONENTS



Spatial network



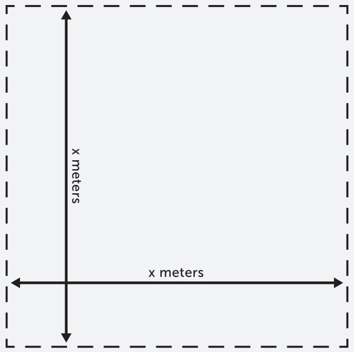
Voxelized Envelope



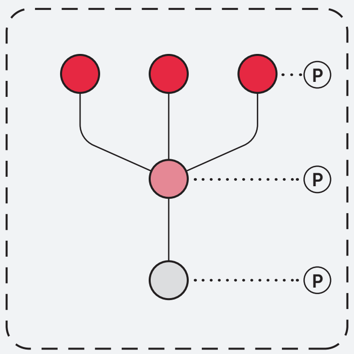
Environment Field

CONFIGURATIONAL ALGORITHM

INPUT

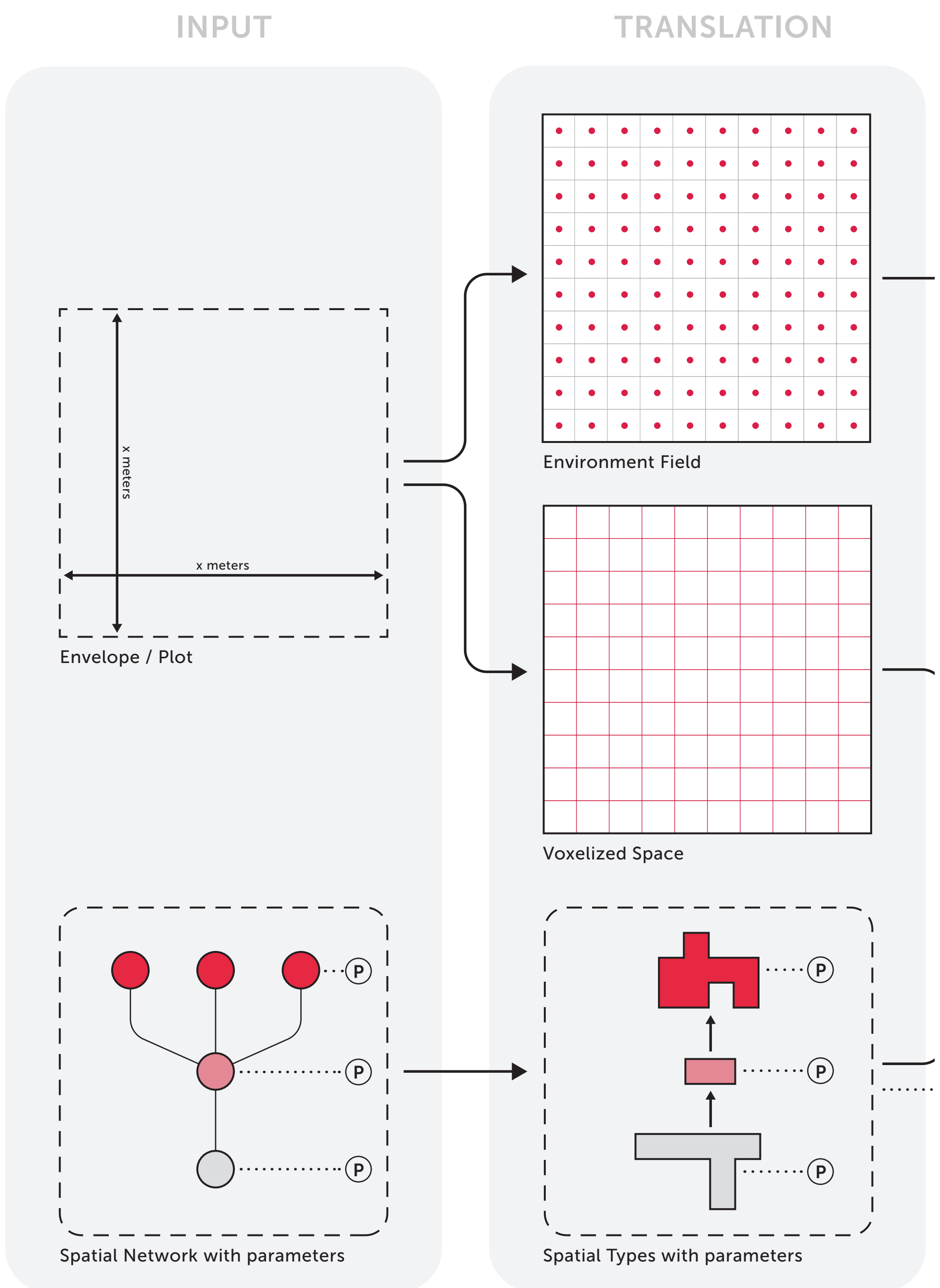


Envelope / Plot

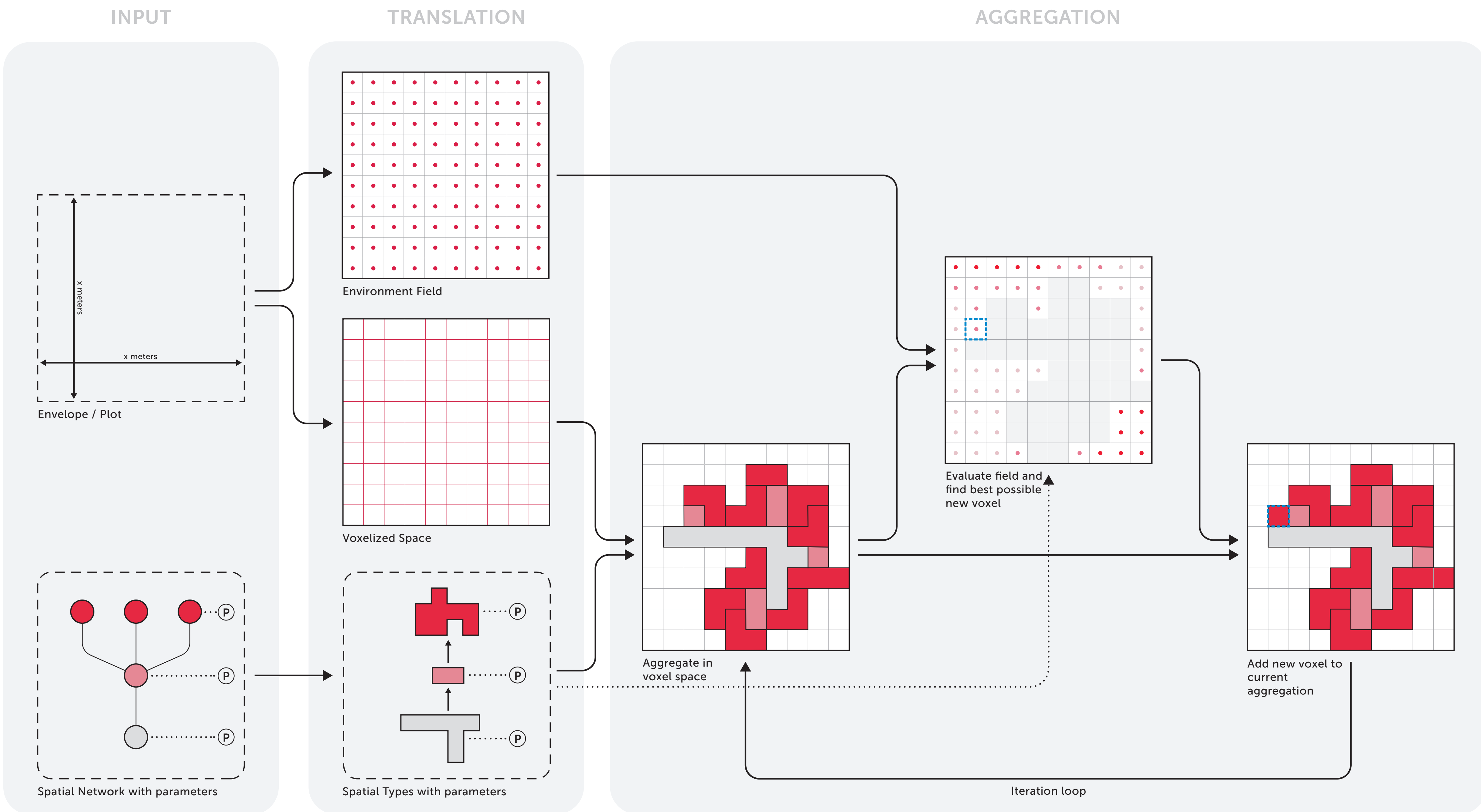


Spatial Network with parameters

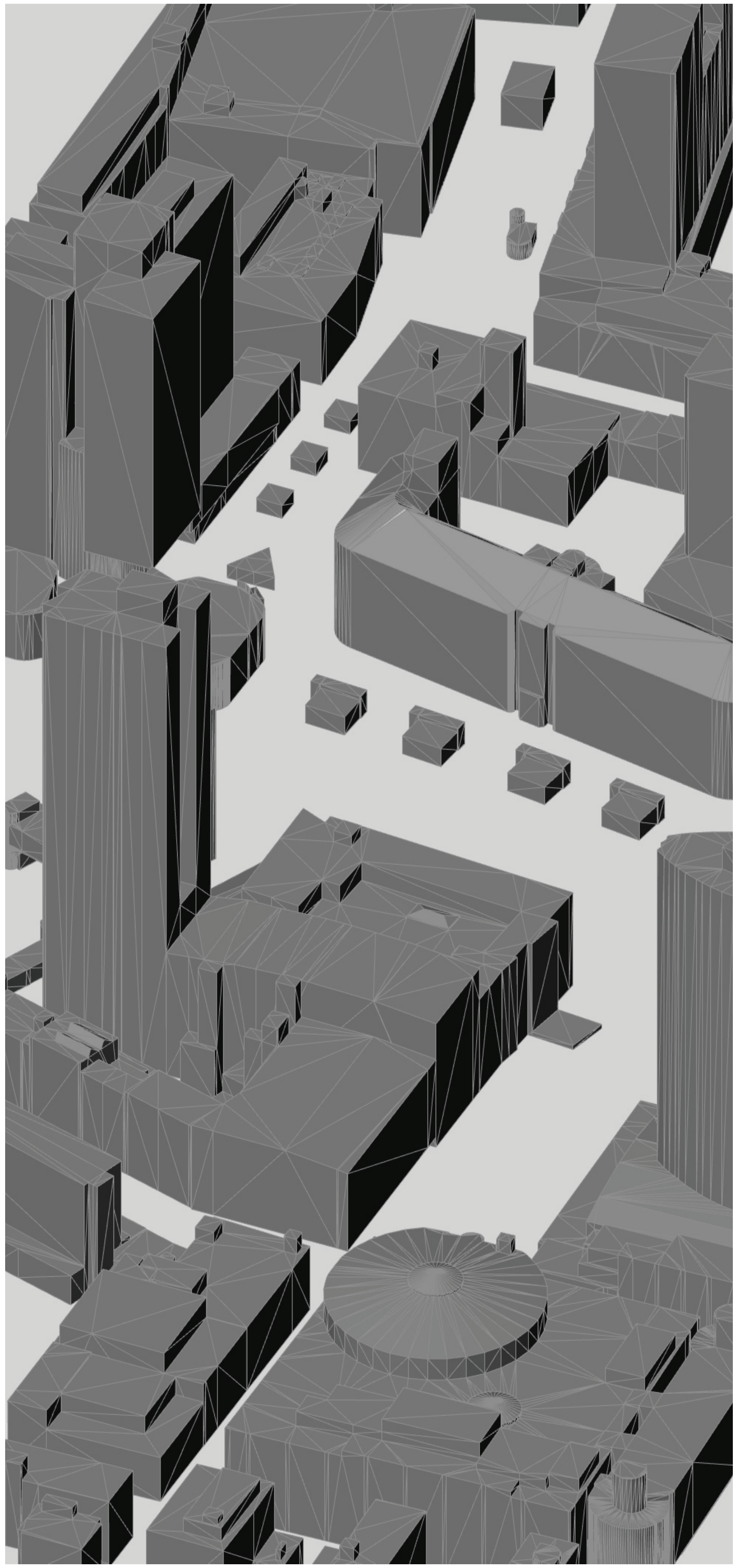
CONFIGURATIONAL ALGORITHM



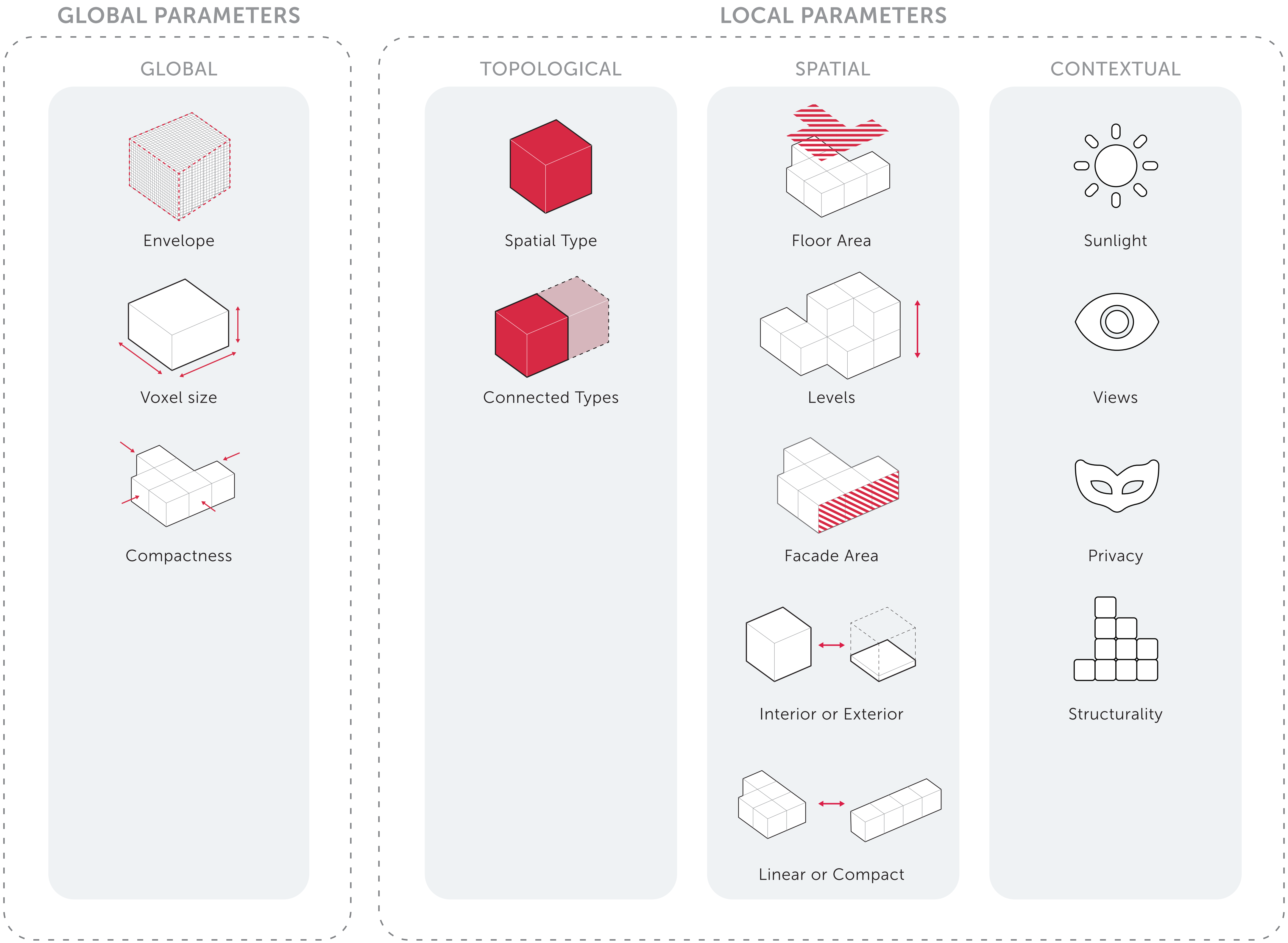
CONFIGURATIONAL ALGORITHM



PARAMETERS - SPATIAL BEHAVIOU					
SEARCH		SIZE			SHA
behaviour	distance	m2 / unit	min size %	total vol. %	type
type of searching behaviour 0 = local 1 = global	distance offset for primary circulation in number of voxels horiz - vert	desired size in square meters of each unit of this type; 0 = unlimited	minimum allowed size before die off in percentage	desired total volume percentage of this type in final building	shape aggregation behaviour 0 = random 1 = compact 2 = linear
1	9-1	30	0,00	0	2
1	4-1	40	0,00	0	2
0	0	30	0,80	14	1
0	0	50	0,80	23	1
0	0	70	0,80	19	1
0	0	90	0,80	18	1
0	0	110	0,80	11	1
0	0	10	0,80	7	1
0	0	20	0,45	3	1
0	0	70	0,60	5	1

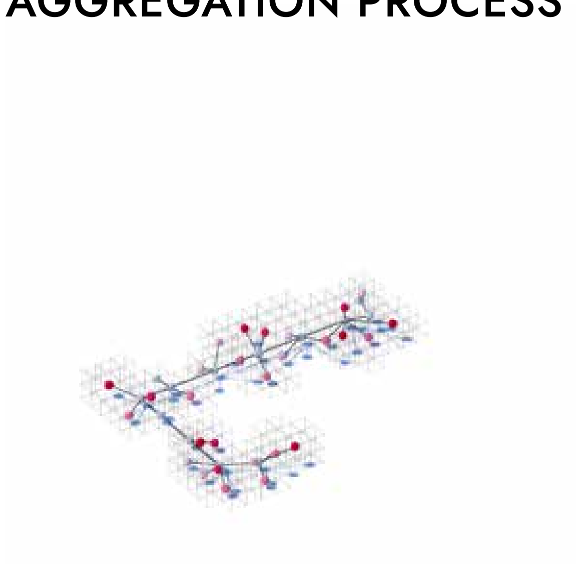


```
            fieldValue *= circulationEmptyInd[fieldPoint];
        }
        tempFieldArray[j] = fieldValue;
        });

    //diffuse field
    double[] diffusedFieldArray = DiffuseField(tempFieldArray, globalGridNeighb, di

    //copy to list
    List<double> tempField = new List<double>();
    for (int j = 0; j < diffusedFieldArray.Length; j++) {
        tempField.Add(diffusedFieldArray[j]);
    }

    //add to field data tree
    globalGridTypeFields.AddRange(tempField, new GH_Path(listindex));
    globalGridTestField.RemovePath(new GH_Path(listindex));
    globalGridTestField.AddRange(tempField, new GH_Path(listindex));

    //calculate max value
    double maxValue = 0;
    if (tempField.Count > 0) {maxValue = System.Linq.Enumerable.Max(tempField);}
    globalGridTypeFieldsMaxValues.Add(maxValue);
}

//check max field values for requirements
for (int i = 0; i < globalGridTypeFieldsMaxValues.Count; i++) { //for each max valu
    int listindex = typesThatNeedAField[i];
    if (listindex > 0 && globalGridTypeFieldsMaxValues[i] < minimumGlobalFieldValue
        int circulationType = listindex - 1;
        fullPrimaryCirculations.Add(circulationType);
        //delete all points of this type from current selection
        for (int j = (potentialPoints.Count - 1); j >= 0; j--) {
            if (potentialPointTypes[j] == circulationType) {
                potentialPoints.RemoveAt(j);
                potentialPointClusters.RemoveAt(j);
                potentialPointTypes.RemoveAt(j);
                potentialPointGrowthTypes.RemoveAt(j);
                potentialPointsSearchBehaviour.RemoveAt(j);
            }
        }
    }
}

//evaluate each point according to local field
List<double> potentialPointShapeValue = new List<double>();
List<double> potentialPointsField = new List<double>();
List<int> potentialPointsToEval = new List<int>(potentialPoints);
double[] tempGlobalFieldValues = new double[globalGridIndices.Count];
List<int> potentialPointsIndexMap = new List<int>();

//double maxLevelGlobal = (double) occupiedInd.Max() / (arrayCellCount[0] * arrayCe
//maxLevelGlobal = Math.Ceiling(maxLevelGlobal) - 1;

int coreMaxMax = 0;
int coreMaxMin = 0;
int coreMaxLevelDiff = 0;
if (coreVoxelsHeight.Count > 1) {
    coreMaxMax = coreVoxelsHeight.Max();
    coreMaxMin = coreVoxelsHeight.Min();
    coreMaxLevelDiff = coreMaxMax - coreMaxMin;
}

timer.Stop();
times.Add(Convert.ToInt32(timer.ElapsedMilliseconds), new GH_Path(102));
timer.Reset();

timer.Start();


for (int fieldEvalIter = 0; fieldEvalIter < potentialPointsToEval.Count; fieldEvalI

    int testPointIndex = potentialPointsToEval[fieldEvalIter];
    int testPointCluster = potentialPointClusters[fieldEvalIter];
    int testPointClusterType = currentAggregationOperable[testPointCluster].GetClus
```

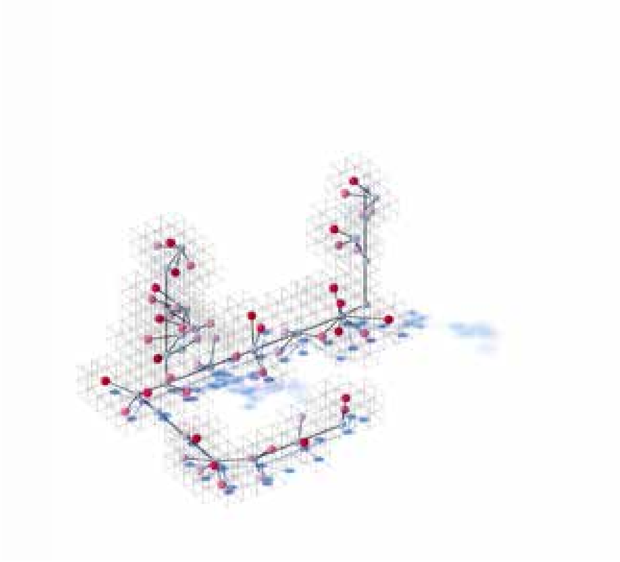


GLOBAL PARAMETERS
LOCAL PARAMETERS
GLOBAL
Envelope
Voxel size
Compactness
TOPOLOGICAL
Spatial Type
Connected Types
SPATIAL
Floor Area
Levels
Facade Area
Interior or Exterior
Linear or Compact
CONTEXTUAL
Sunlight
Views
Privacy
Structurality

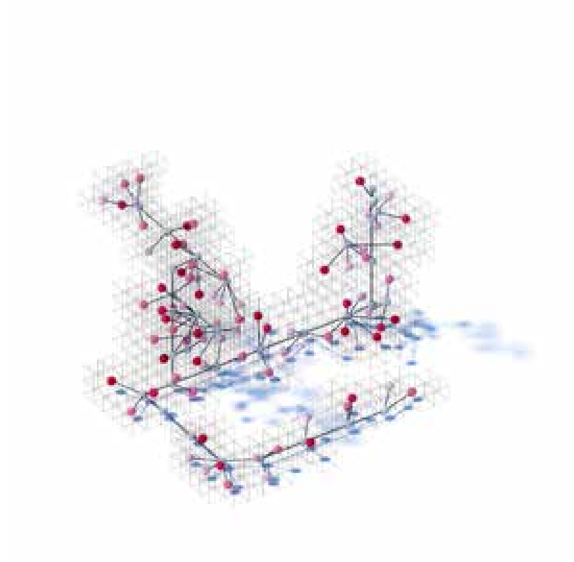
AGGREGATION PROCESS



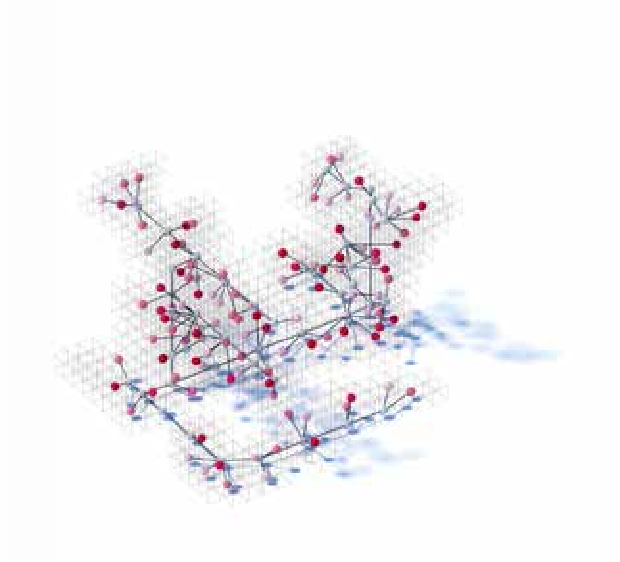
iteration # 500 | topology



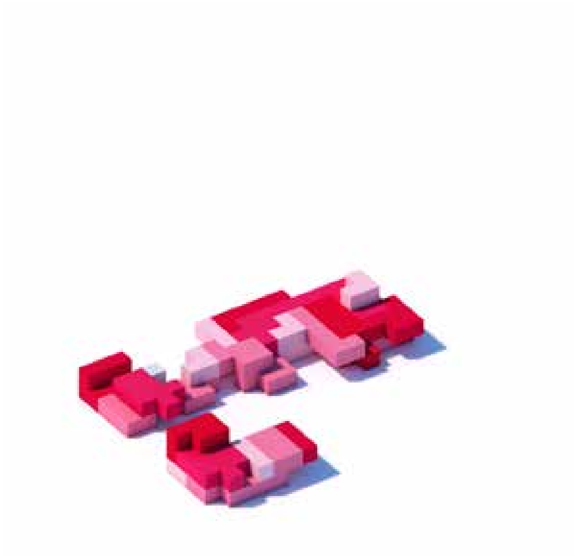
iteration # 1000 | topology



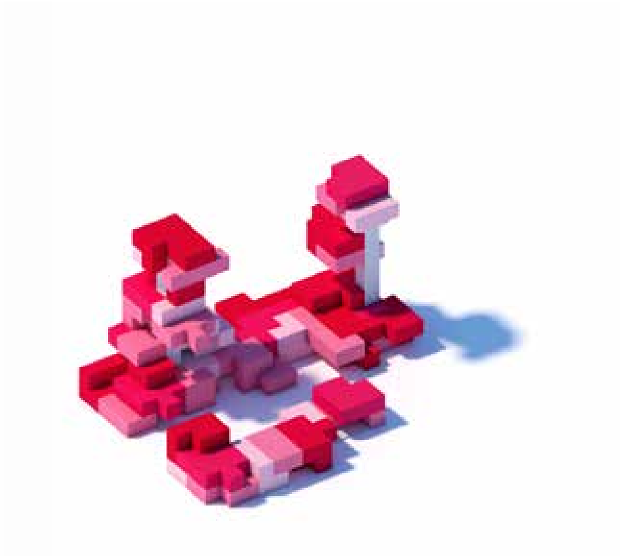
iteration # 1500 | topology



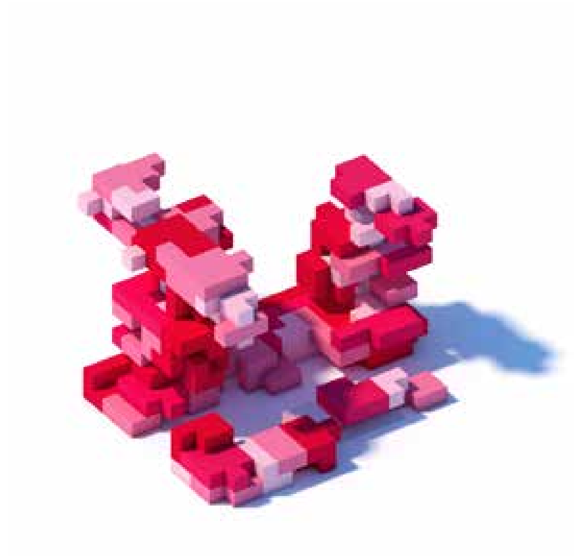
iteration # 2000 | topology



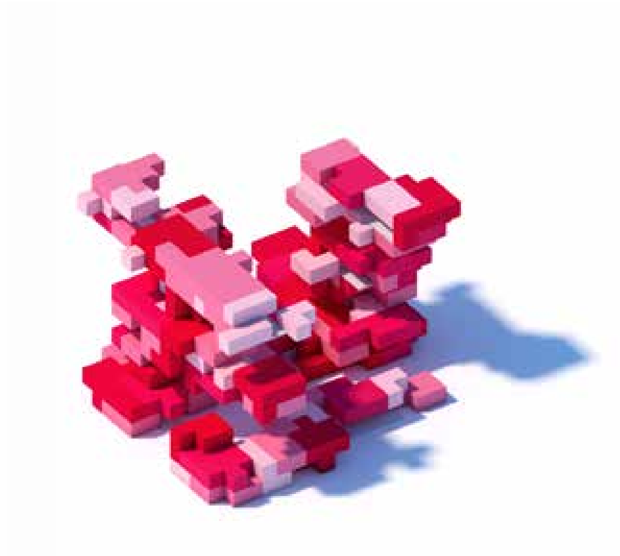
iteration # 500 | volume



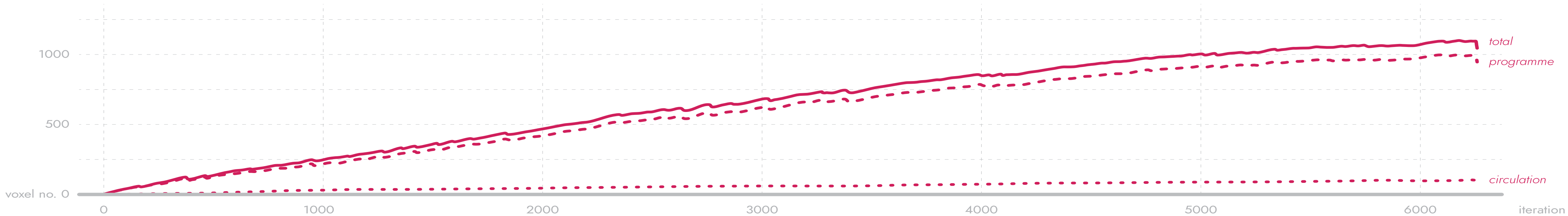
iteration # 1000 | volume



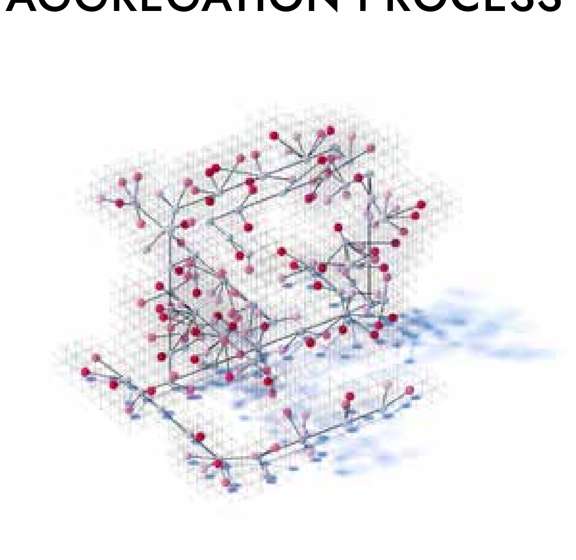
iteration # 1500 | volume



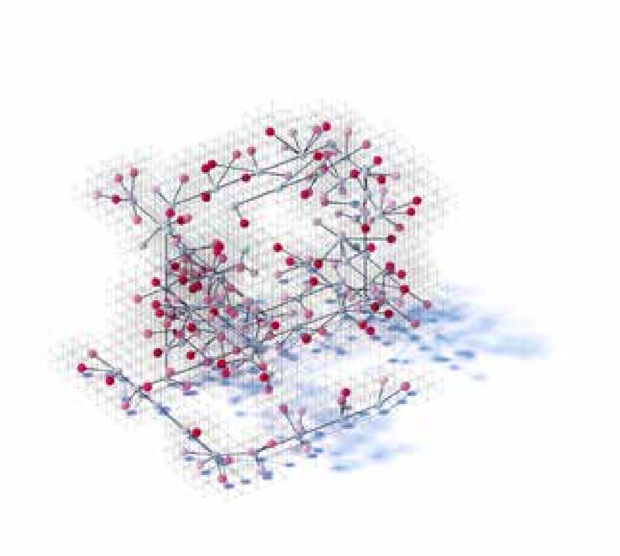
iteration # 2000 | volume



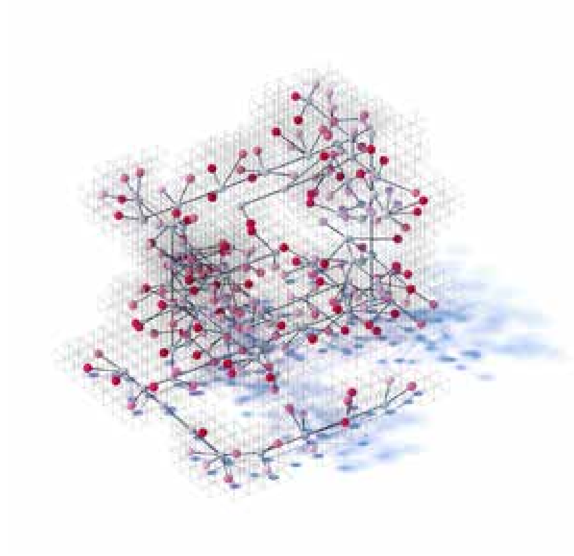
AGGREGATION PROCESS



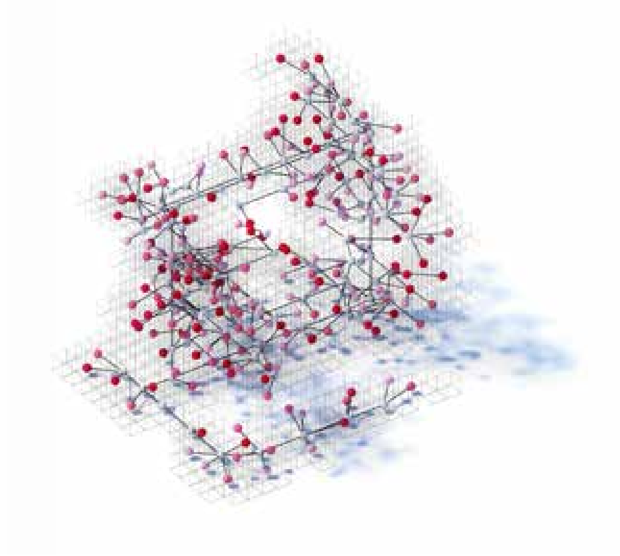
iteration # 3000 | topology



iteration # 4000 | topology

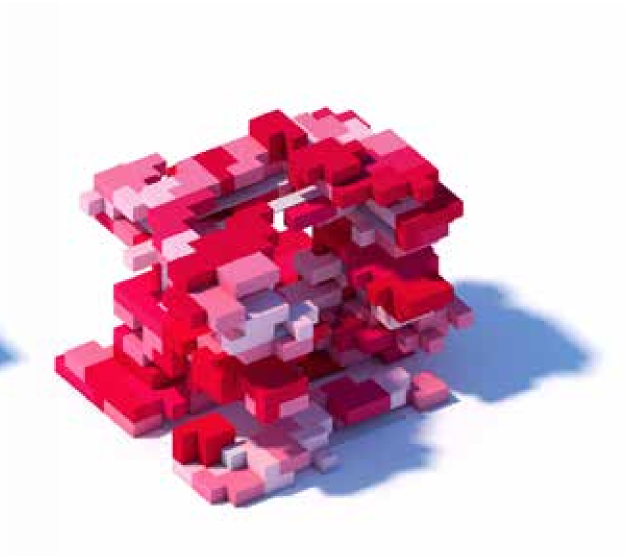


iteration # 5000 | topology

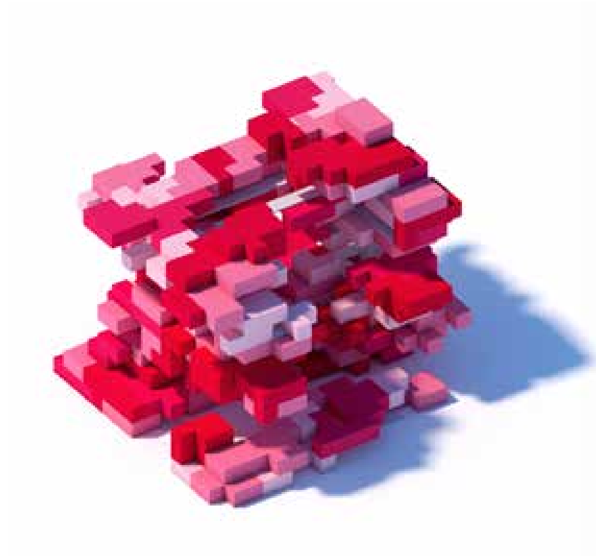


iteration # 6000 | topology

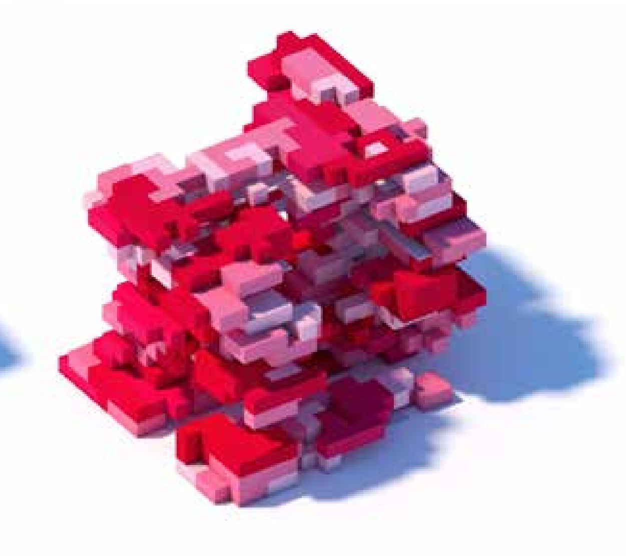
iteration # 3000 | volume



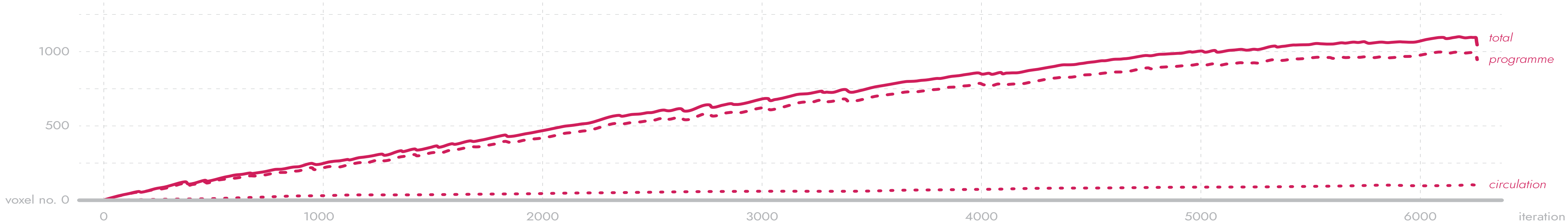
iteration # 4000 | volume



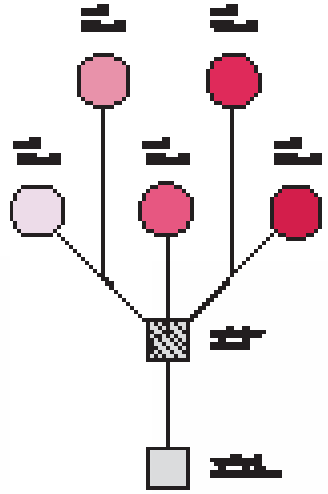
iteration # 5000 | volume

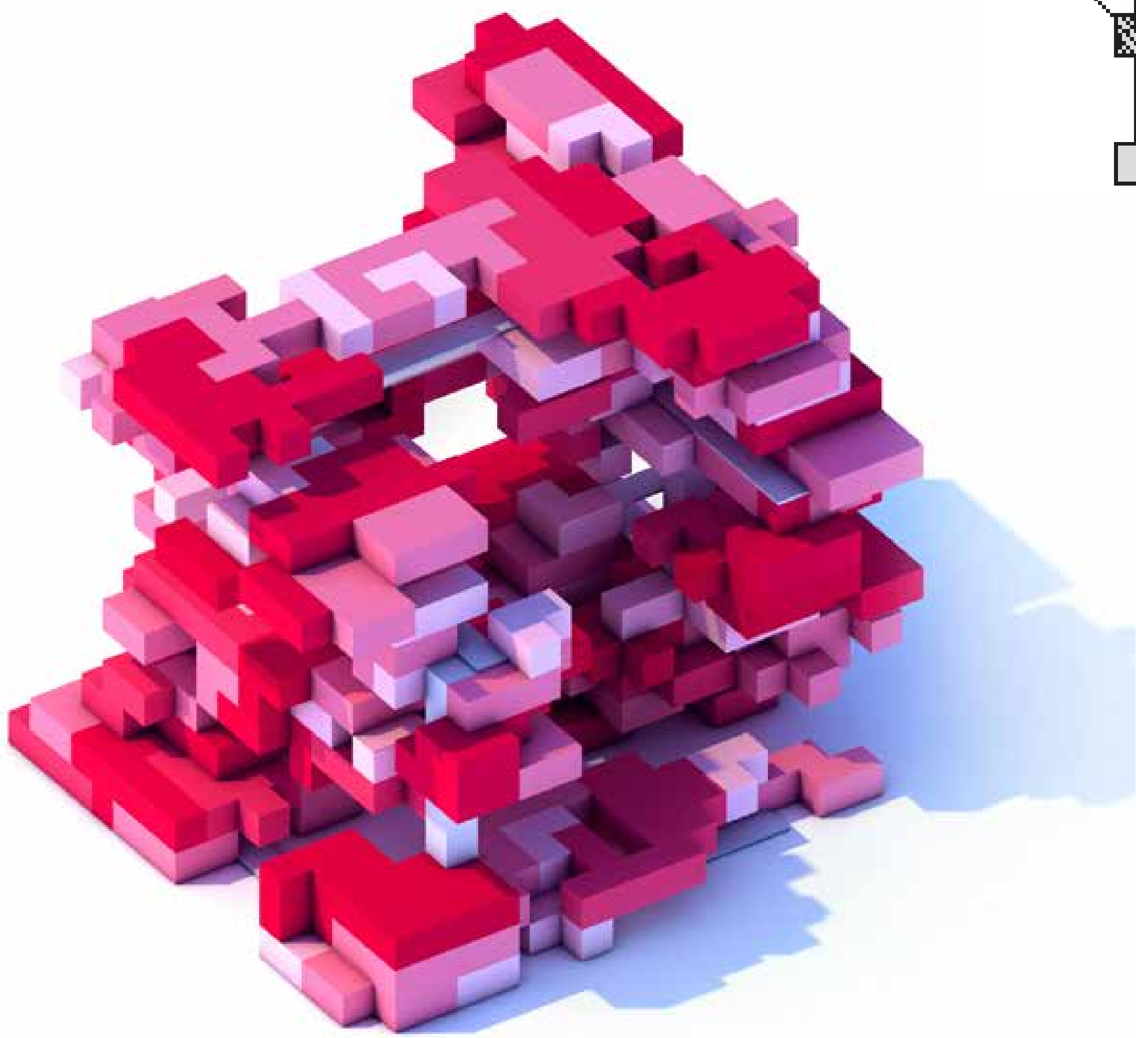


iteration # 6000 | volume

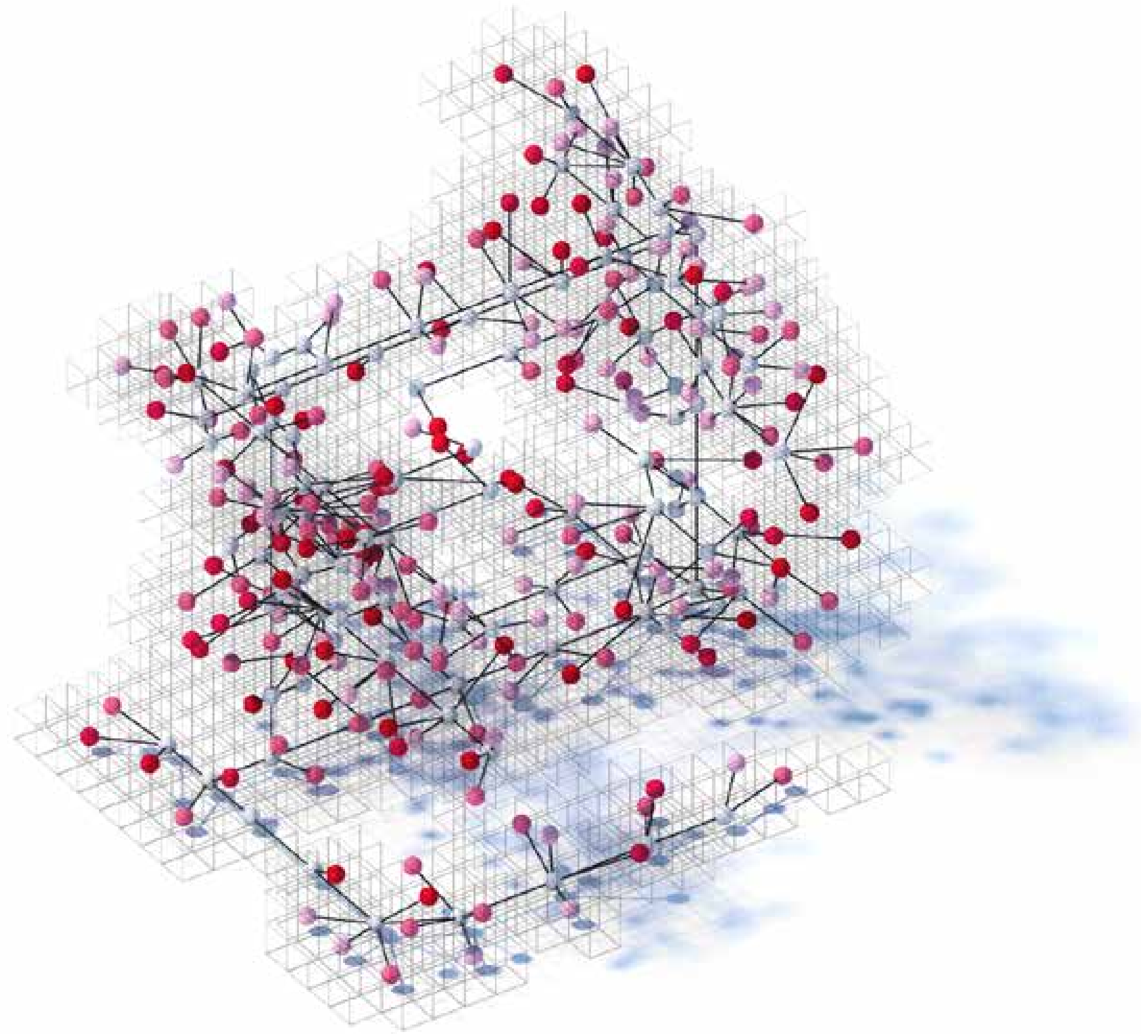


SIMULATION OUTPUT



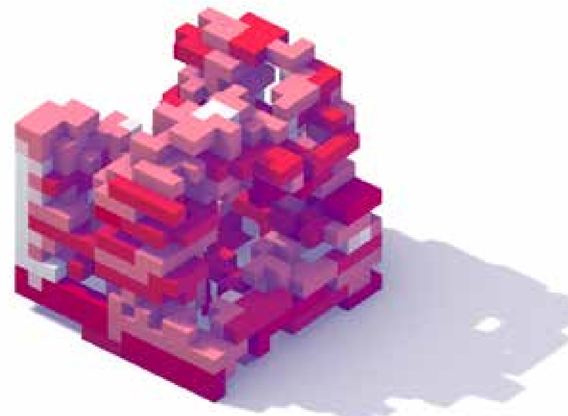


Spatial composition

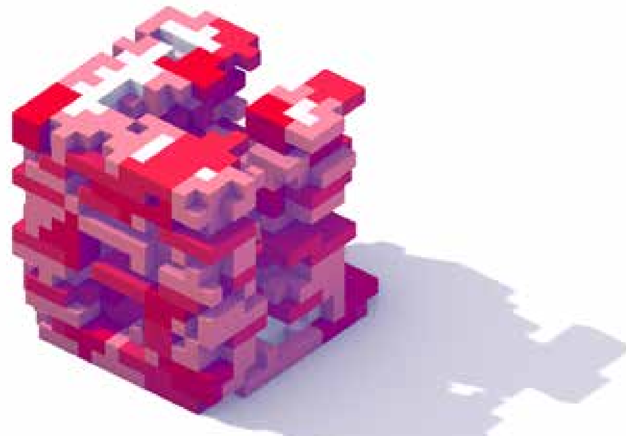


Spatial network

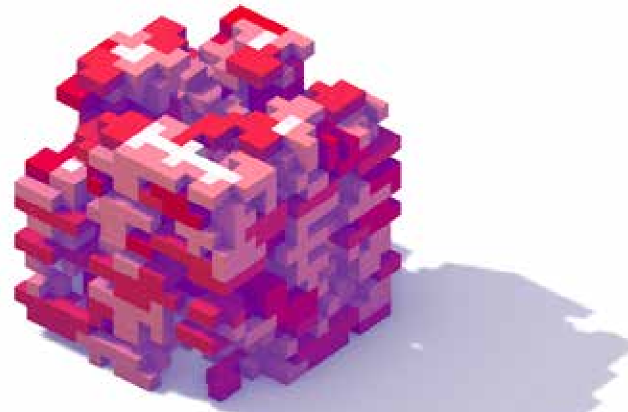
ENVIRONMENT ADAPTIVITY



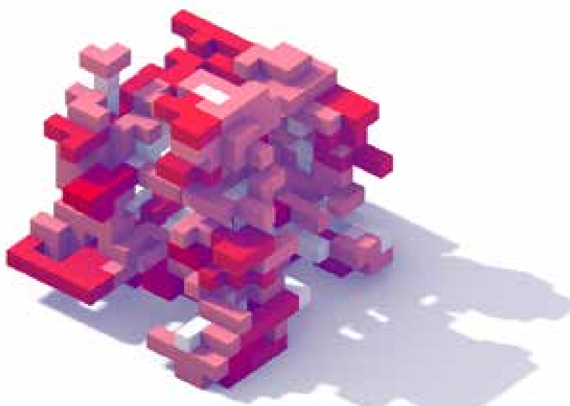
3 hrs | SE



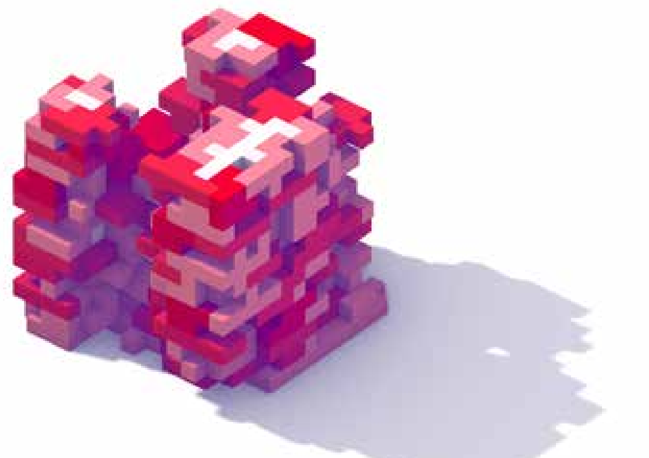
45 deg | 100m | SE



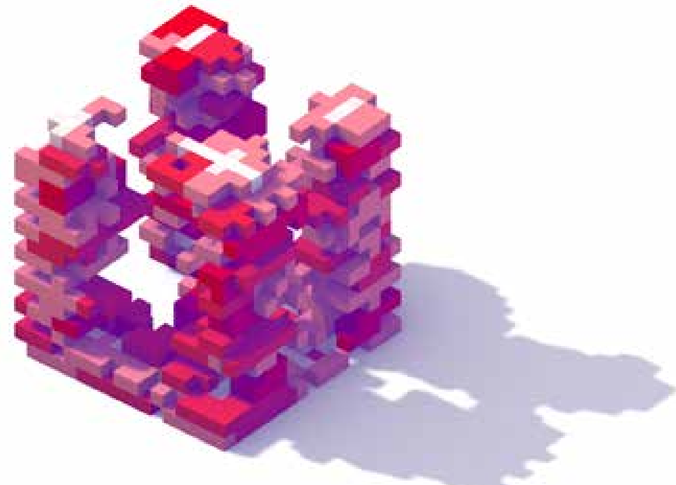
10m | 75% | SE



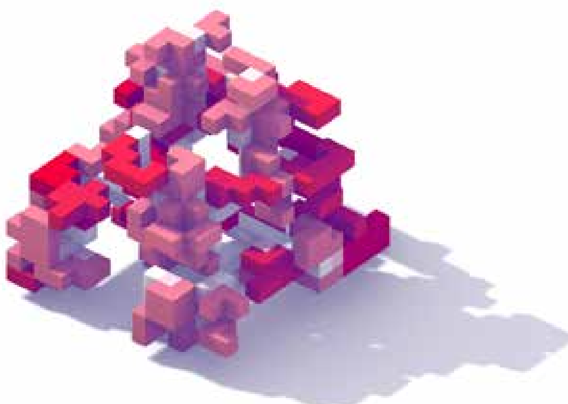
5 hrs | SE



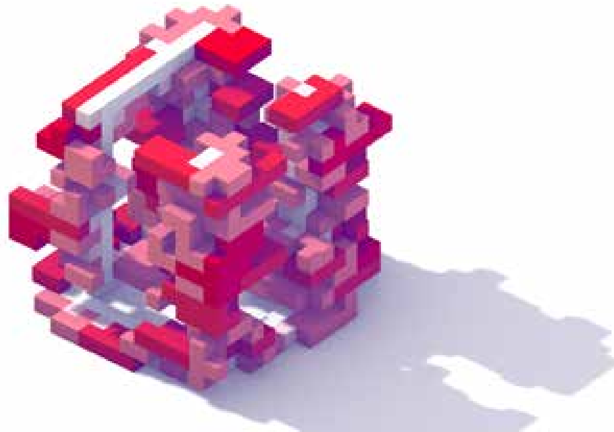
90 deg | 100m | SE



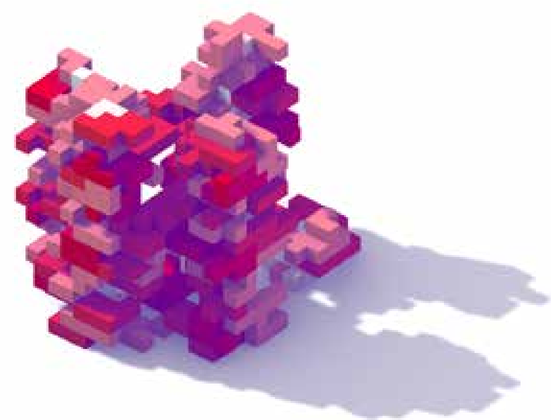
25m | 75% | SE



7 hrs | SE

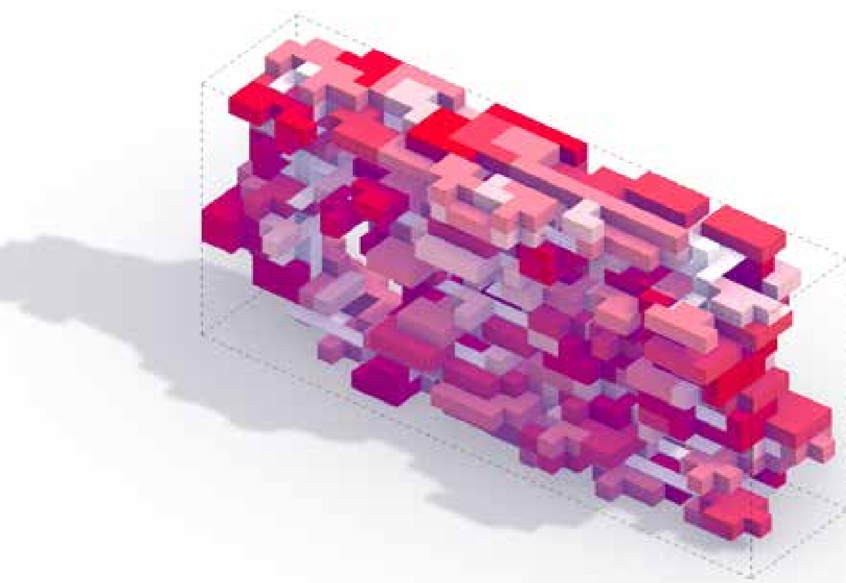


180 deg | 100m | SE

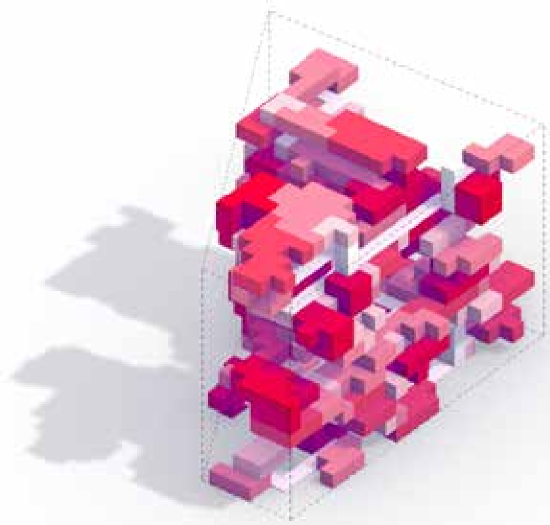


50m | 75% | SE

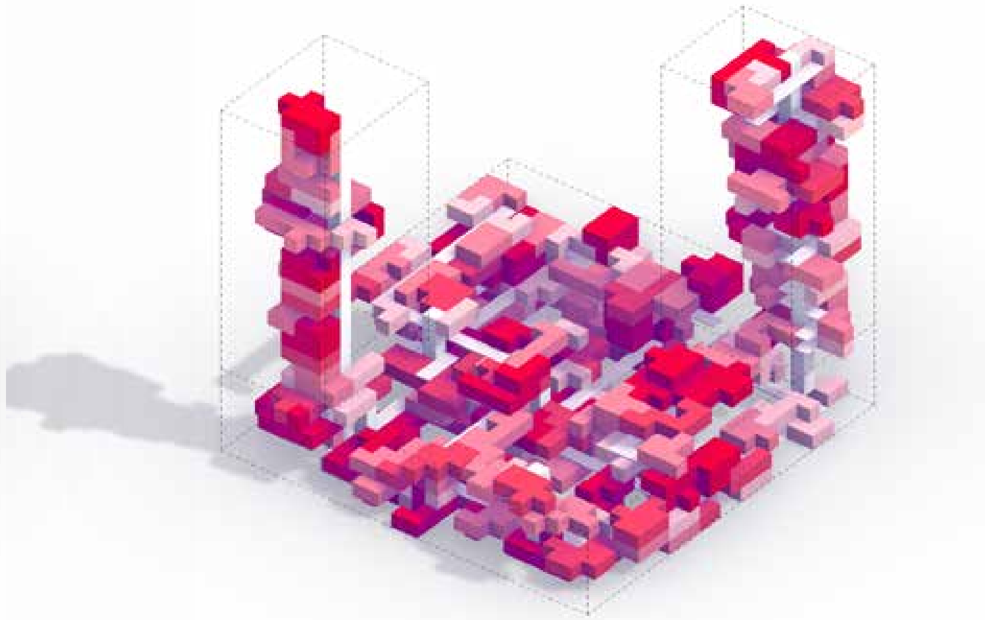
ENVELOPE ADAPTIVITY



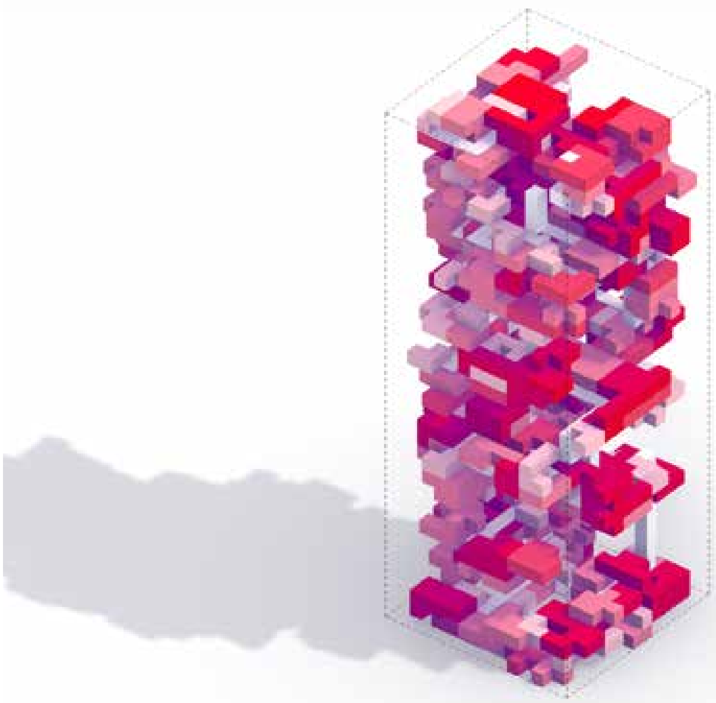
SLAB ENVELOPE



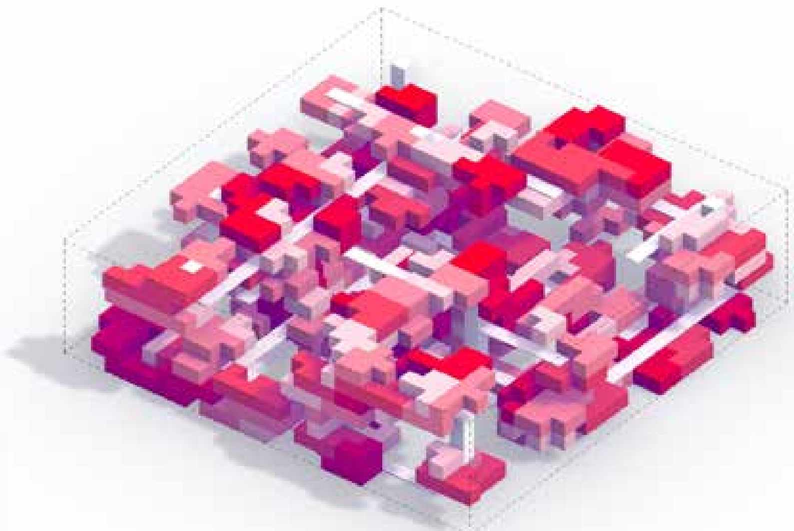
TRIANGULAR ENVELOPE



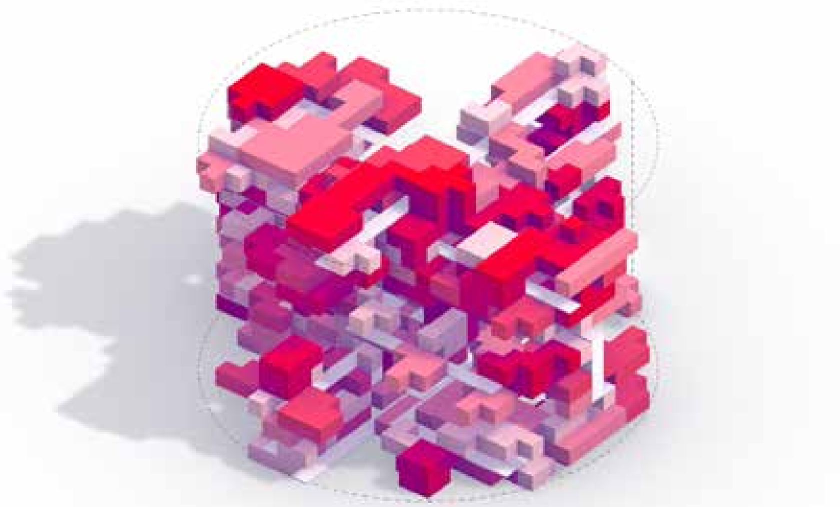
PODIUM WITH TOWERS ENVELOPE



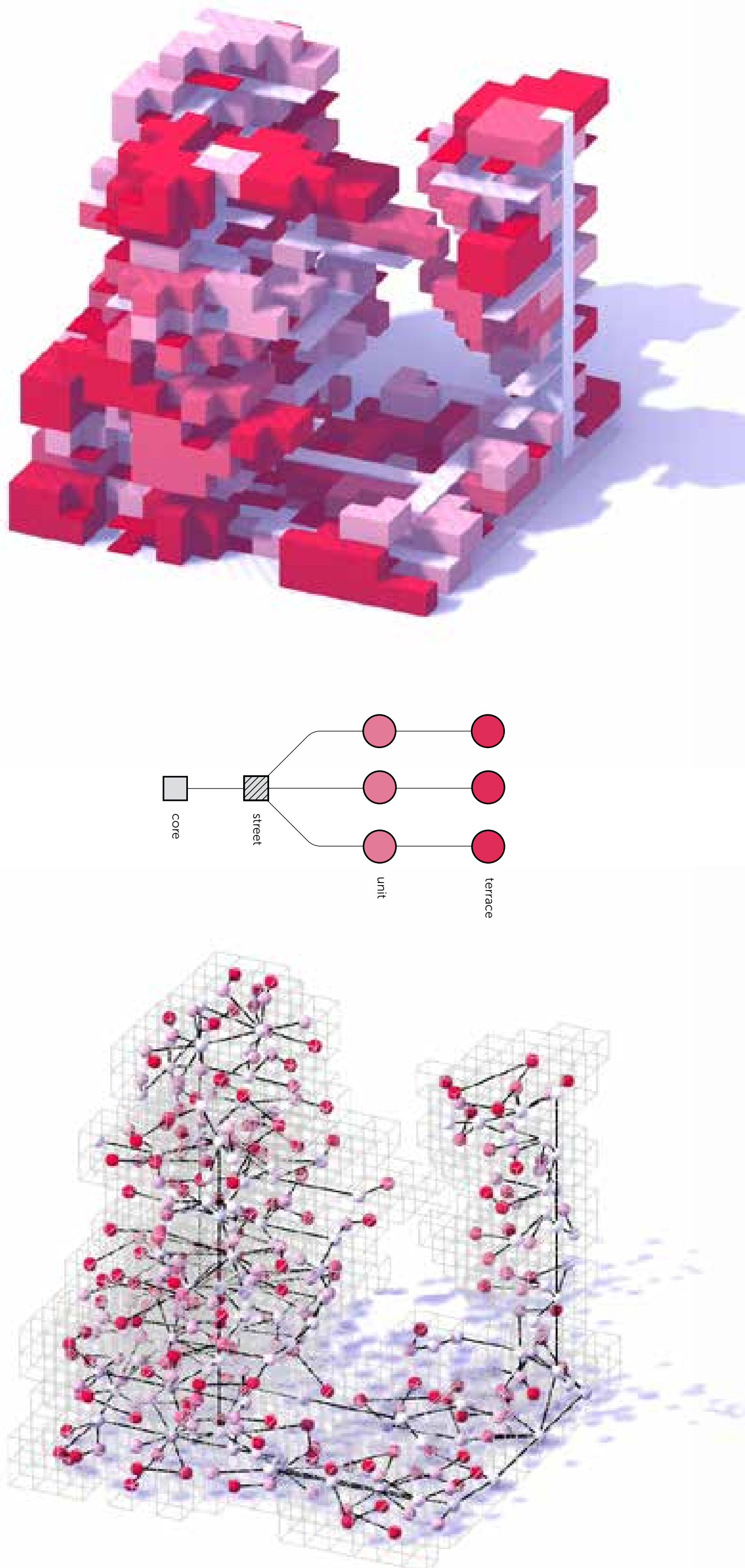
TOWER ENVELOPE



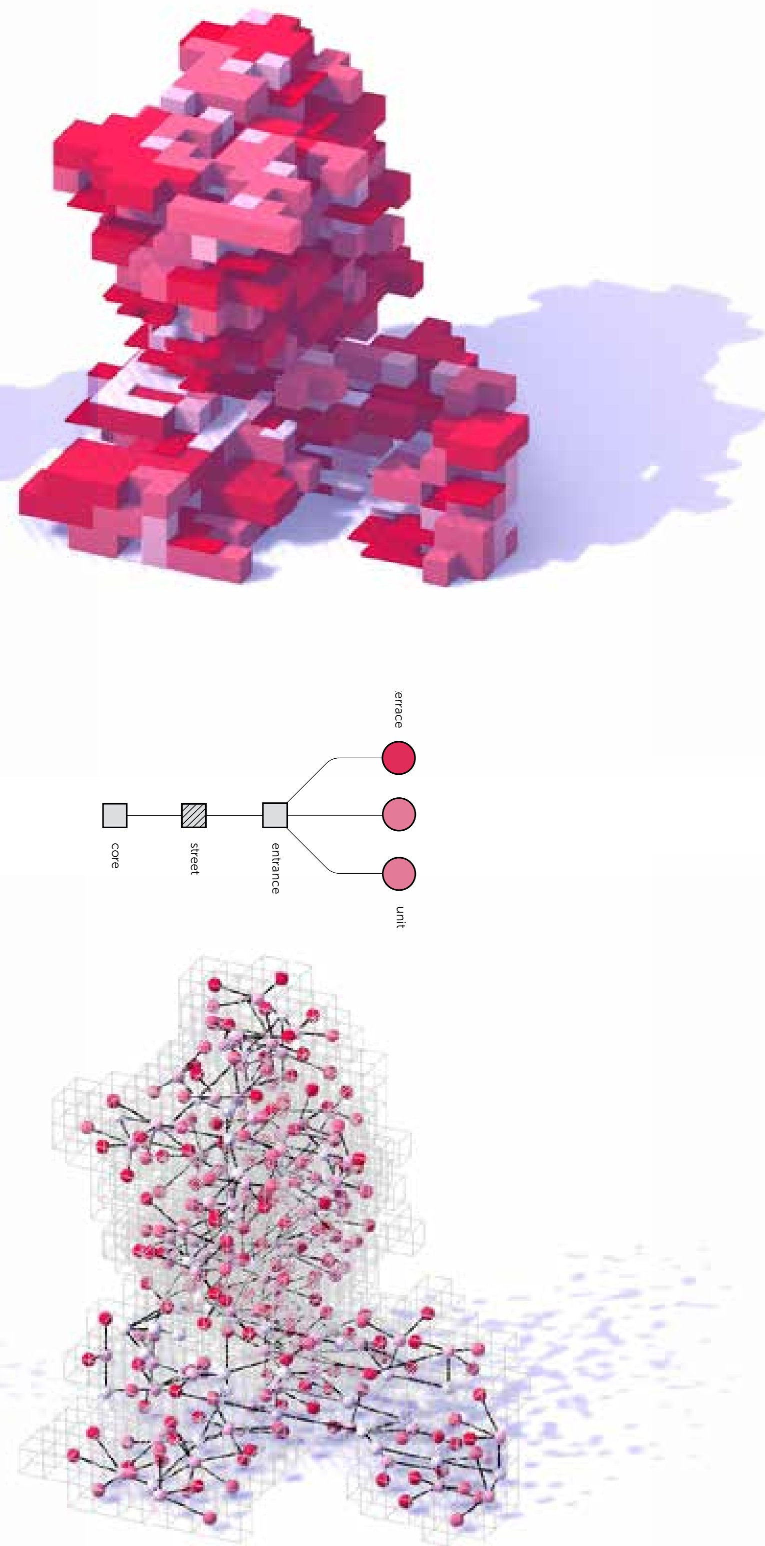
PODIUM ENVELOPE



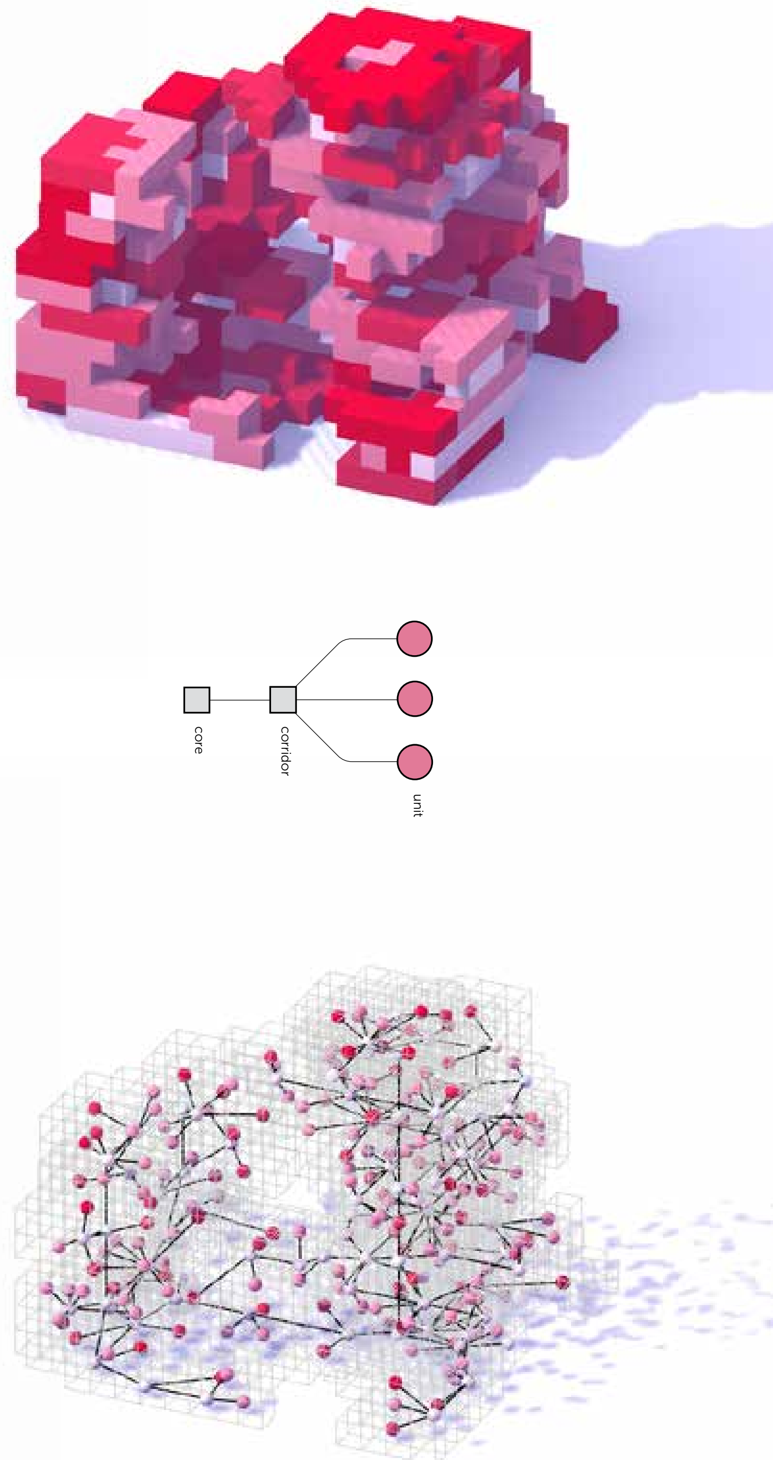
CUBE ENVELOPE



ROWHOUSE TOPOLOGY

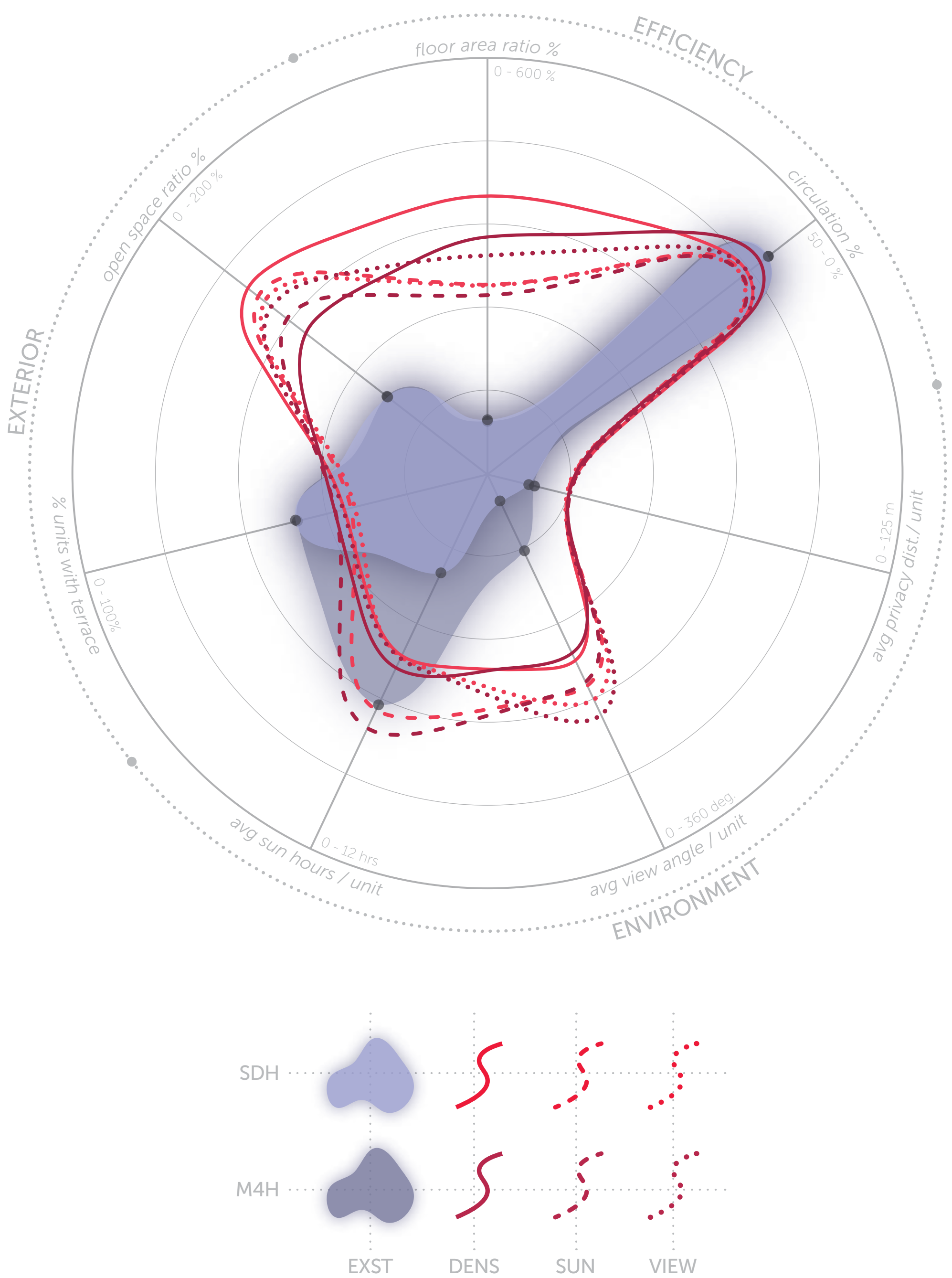


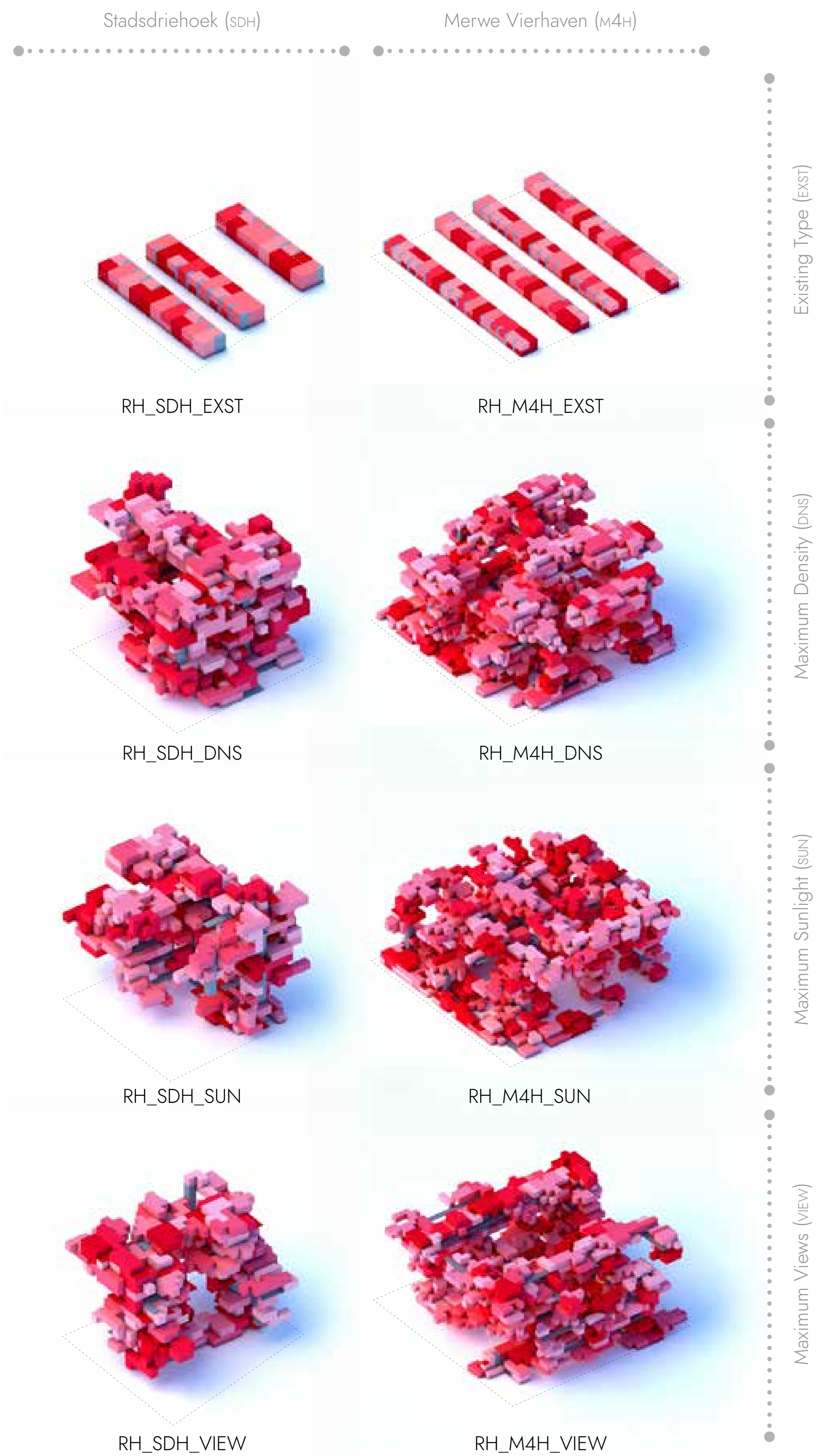
COURTYARD TOPOLOGY

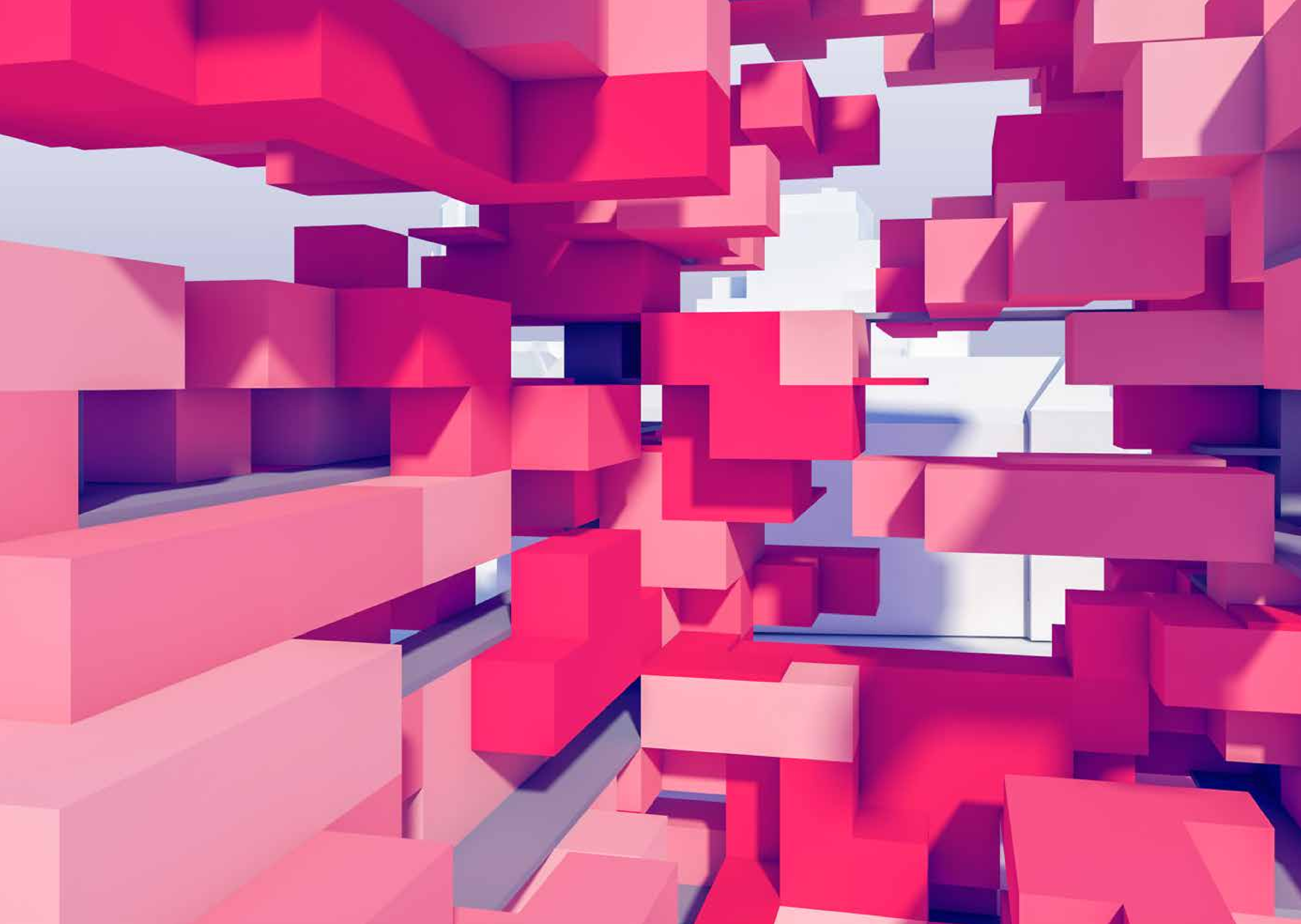


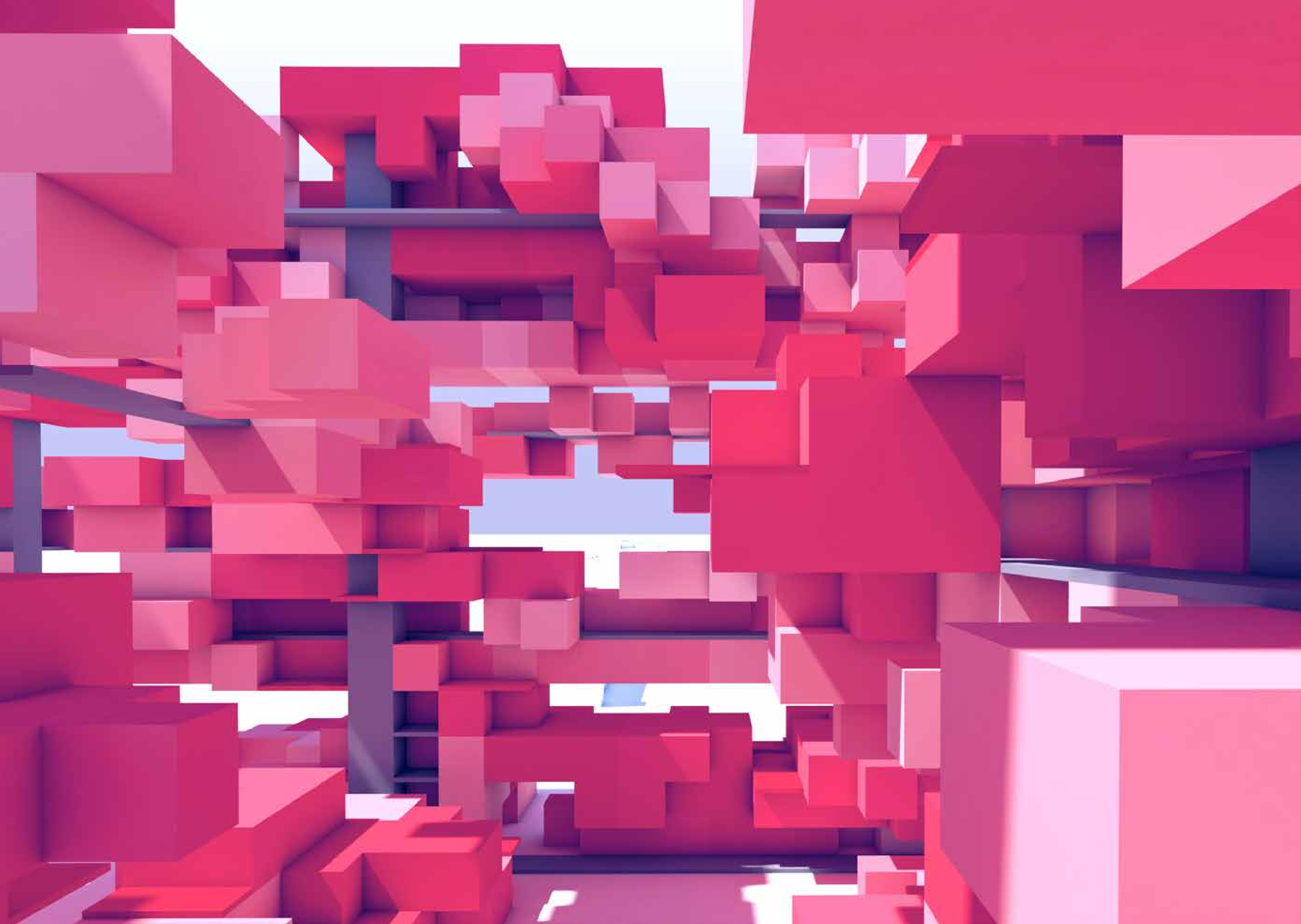
SLAB TOPOLOGY

TRADITIONAL VS. CONFIGURATIONAL ROW HOUSE

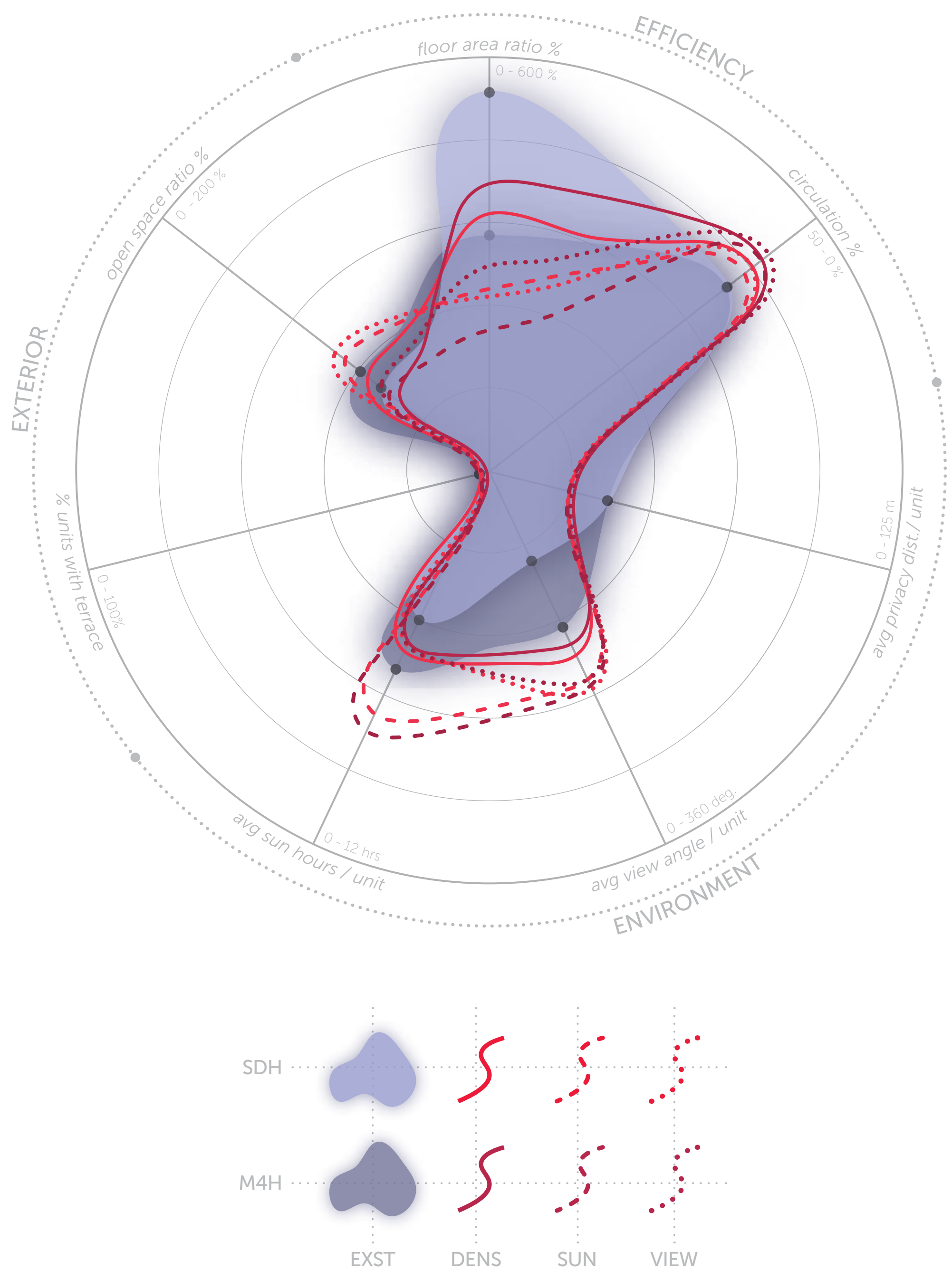


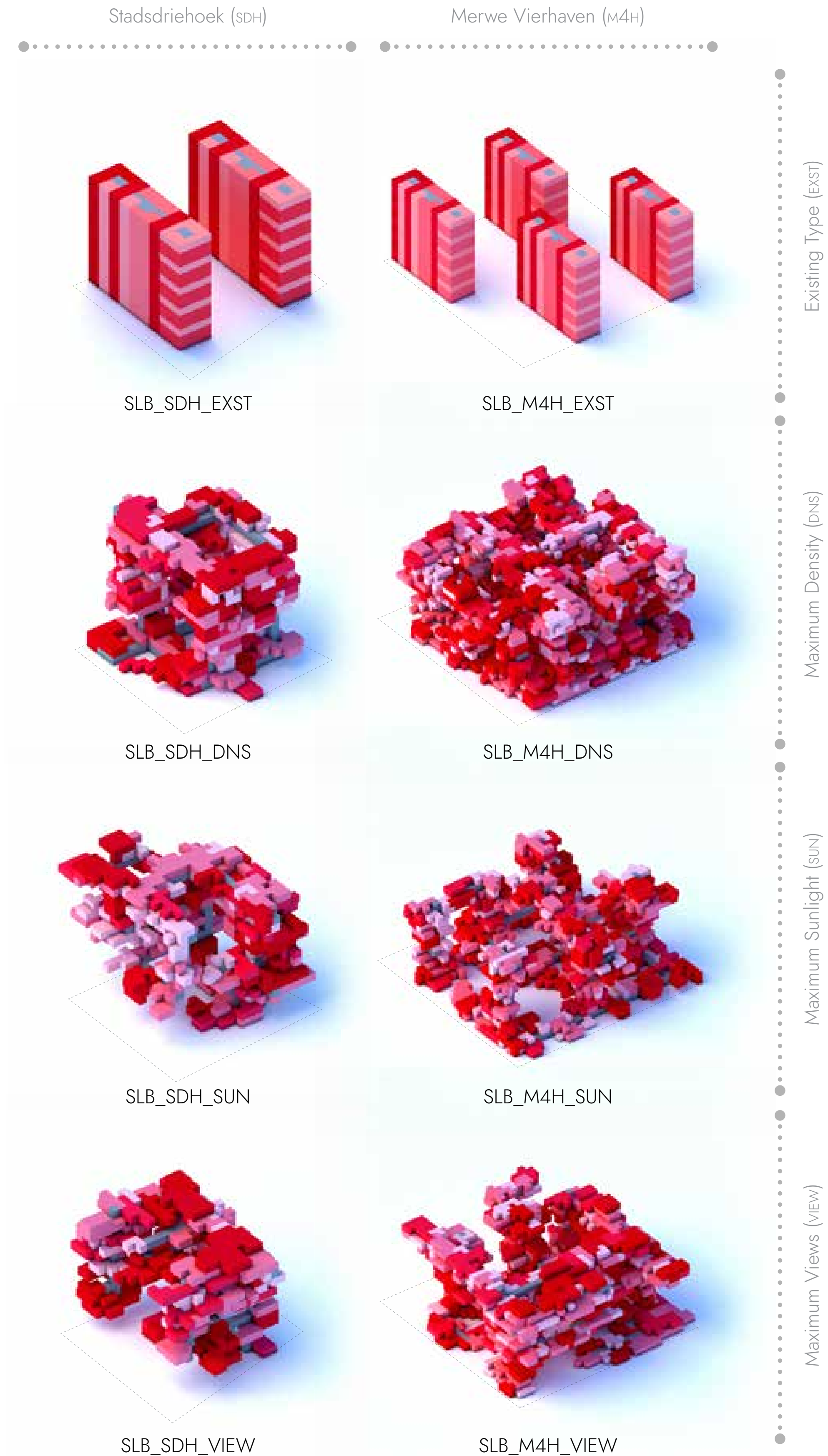


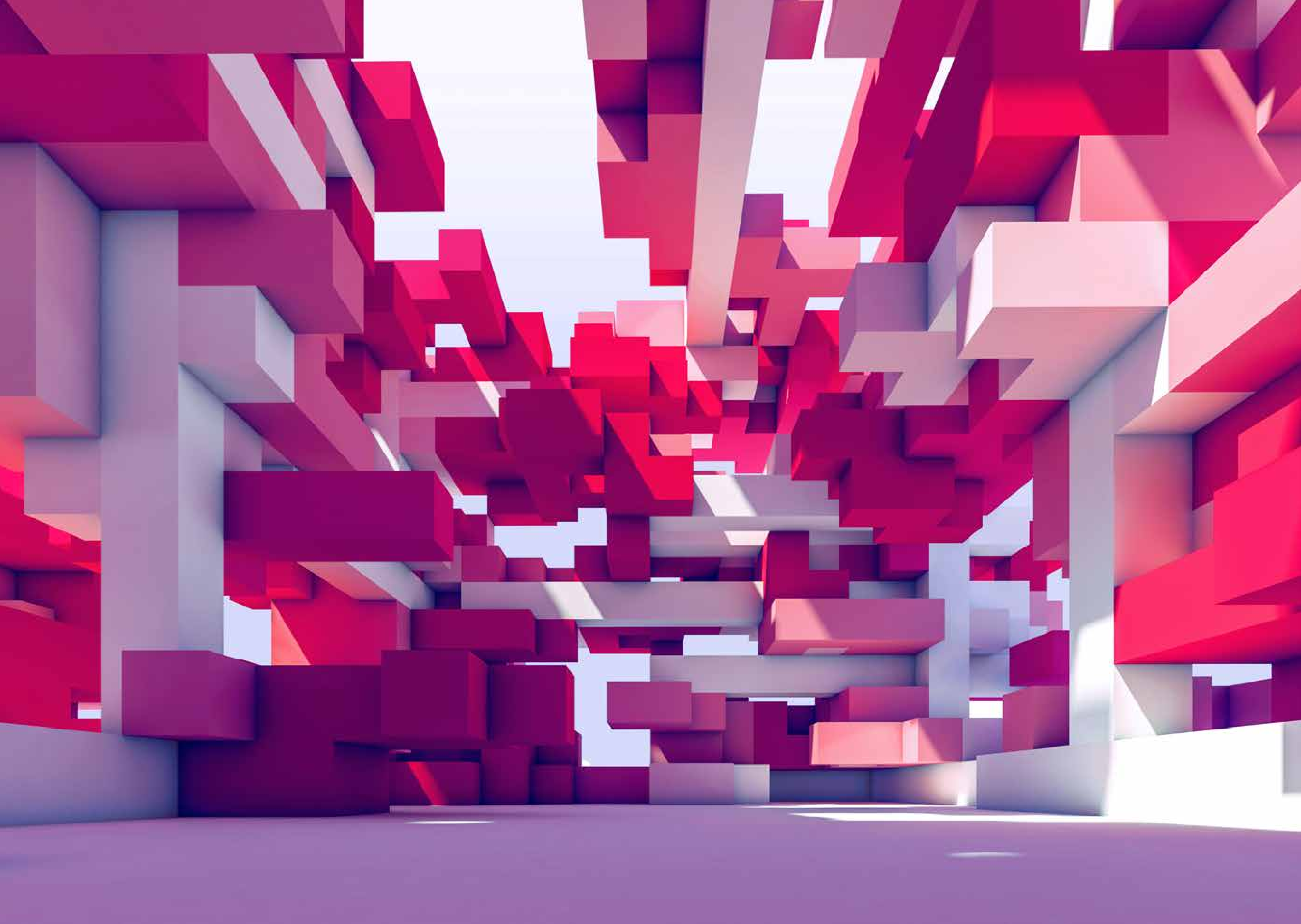




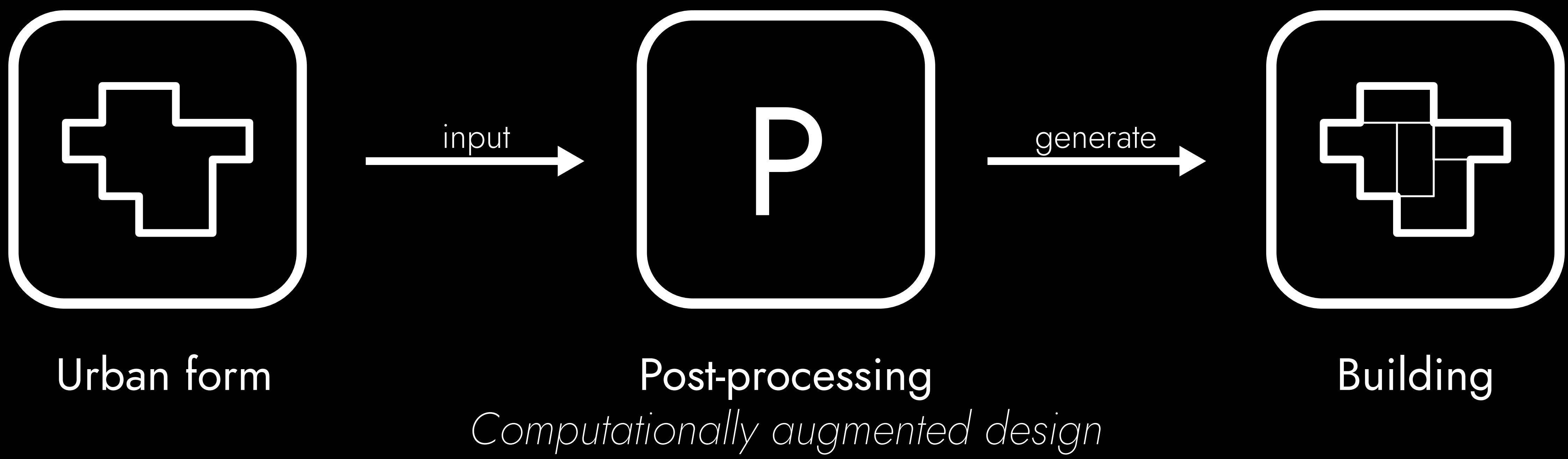
TRADITIONAL VS. CONFIGURATIONAL SLAB

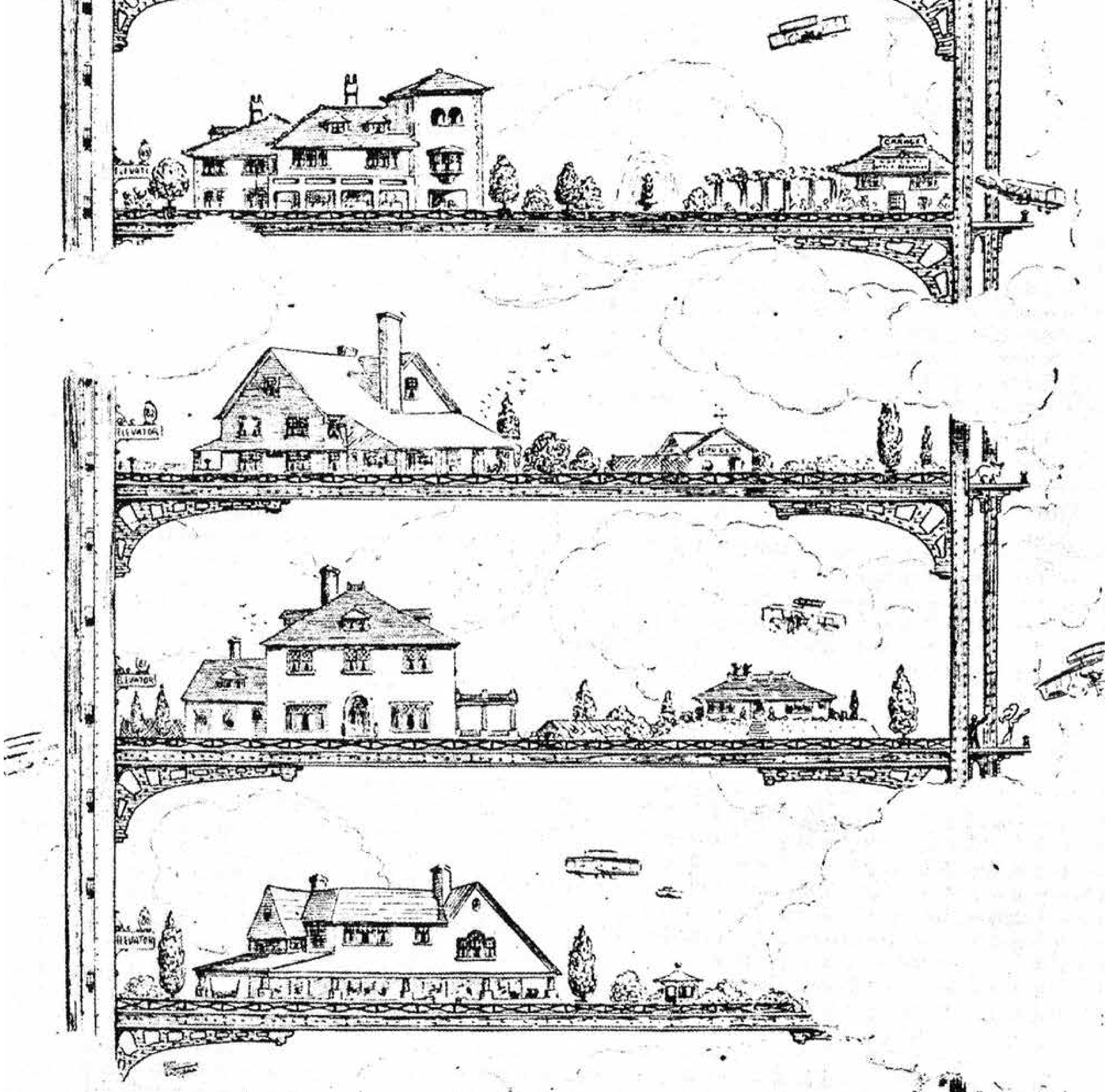






P R O J E C T


input
P
generate
Urban form
Post-processing
Computationally augmented design
Building

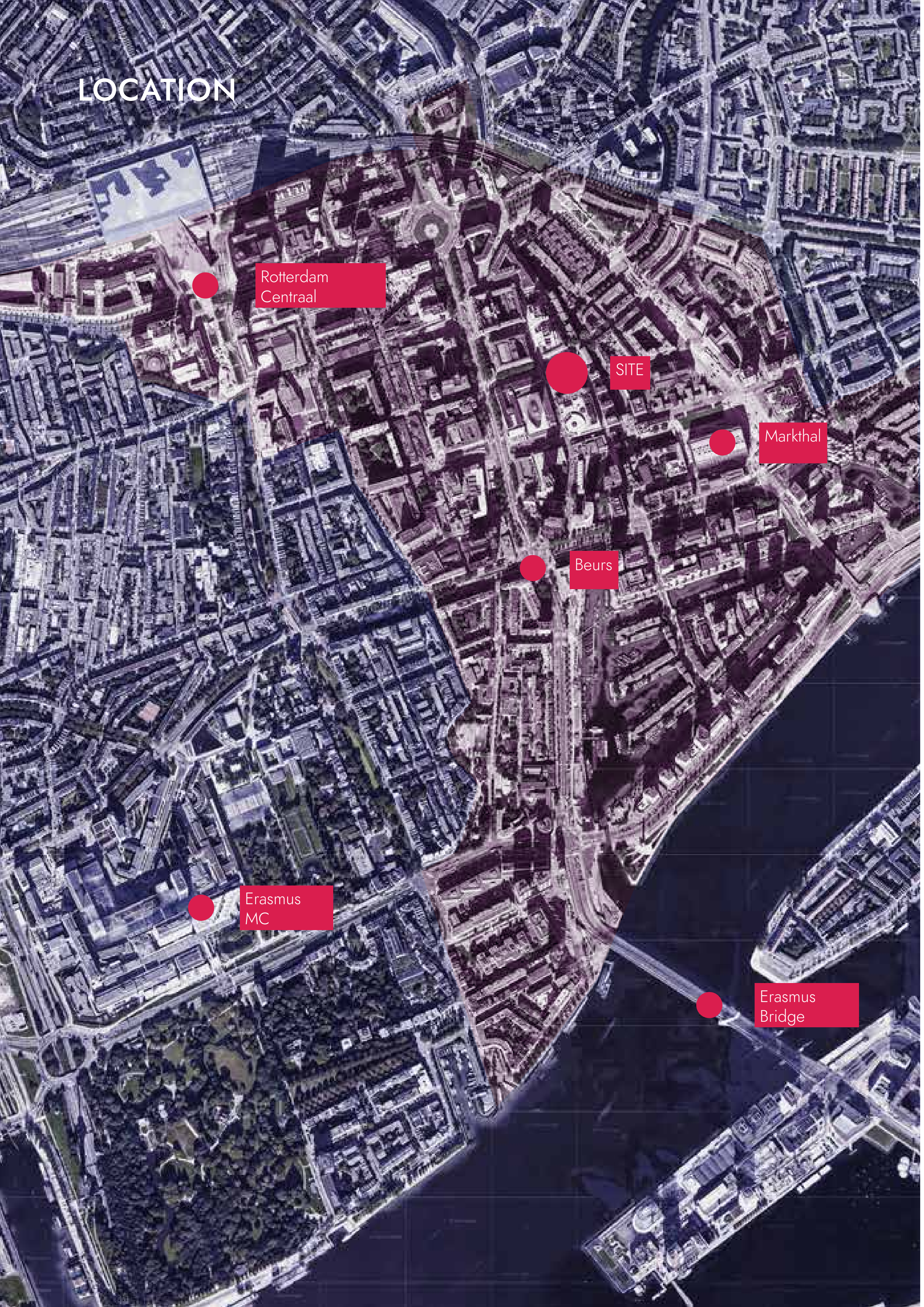

ELEVATOR
GARAGE
ELEVATOR
ELEVATOR
ELEVATOR

Tradtional Dutch row house

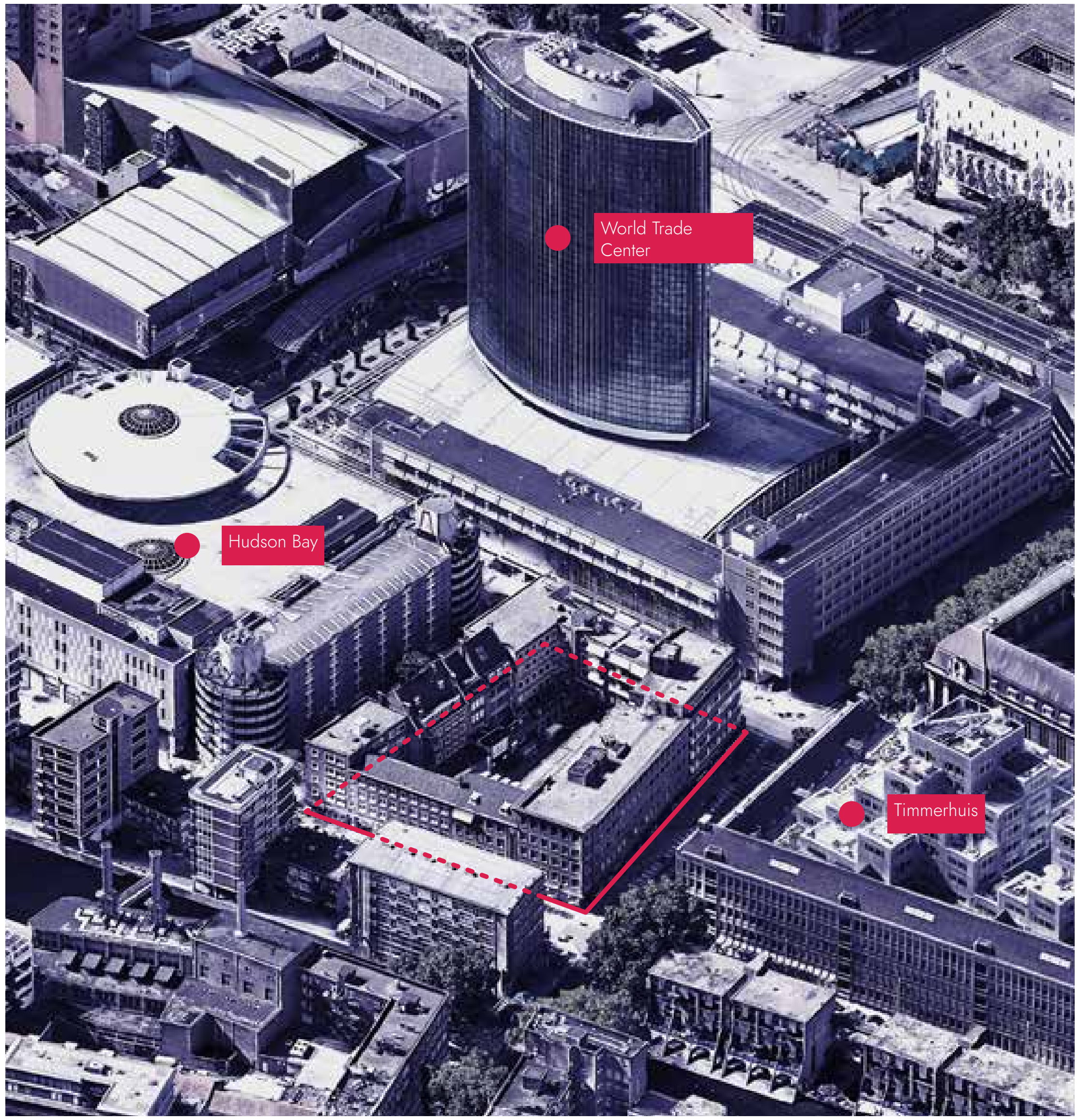
Modern high-rise tower


UNIT #
10
100
500

LOCATION



Rotterdam Centraal
SITE
Markthal
Beurs
Erasmus MC
Erasmus Bridge



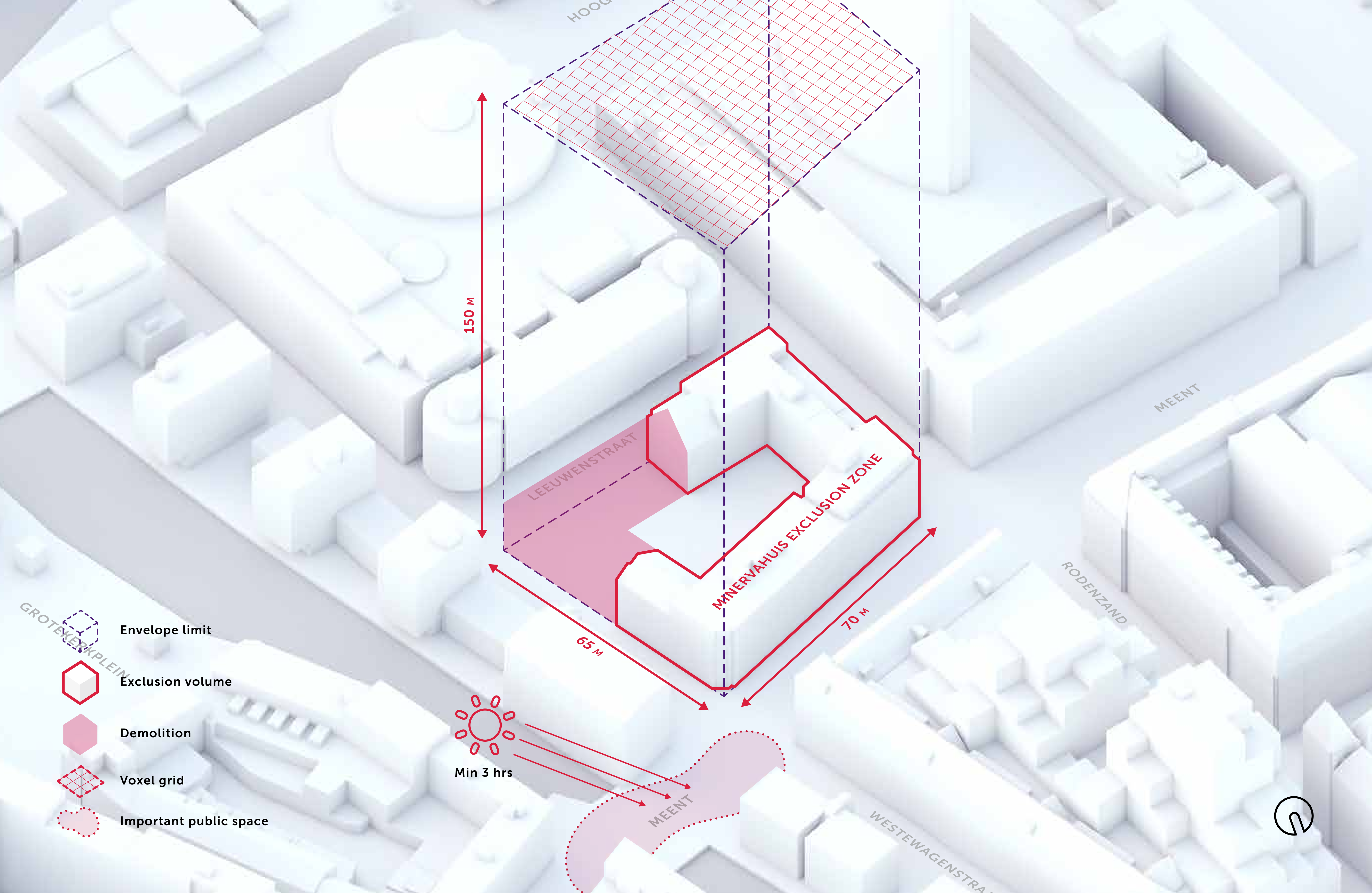
World Trade Center
Hudson Bay
Timmerhuis

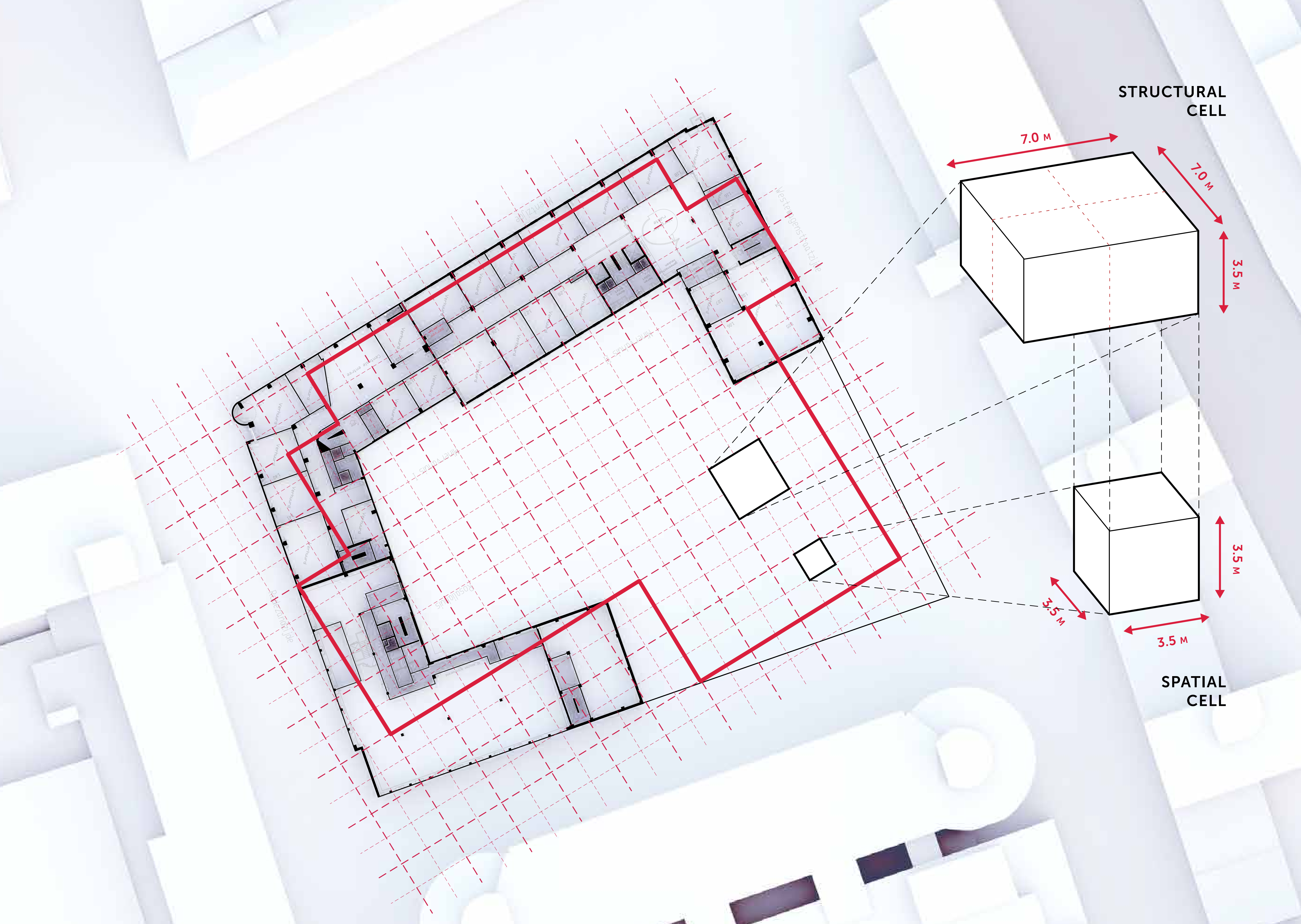
CONTEXT

MINERVAHUIS
Minervahuis I
Minervahuis II

Minervahuis III
Minervahuis IV

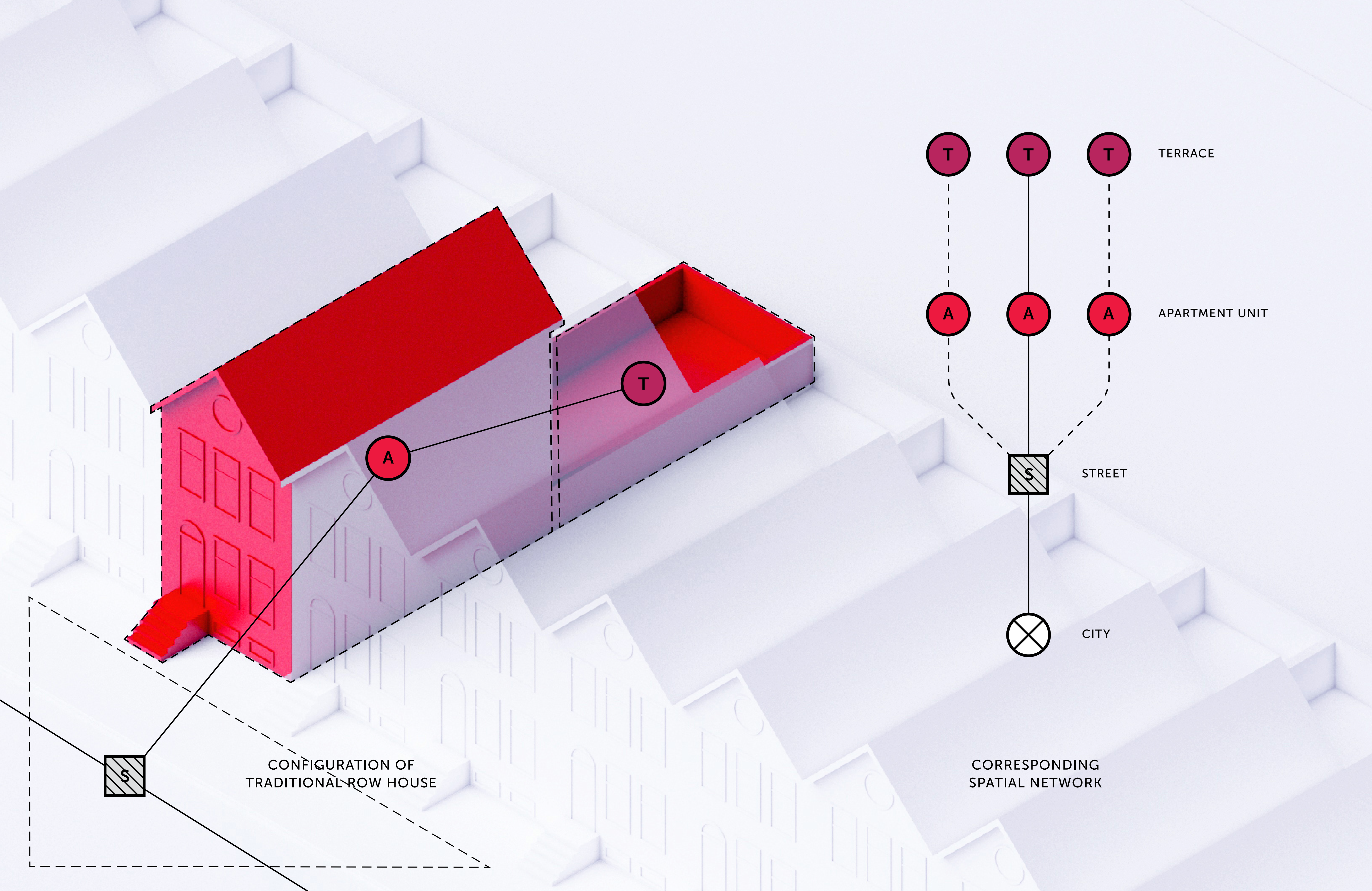
ENVELOPE


HOOGSTRAAT
150 M
LEEUWENSTRAAT
MINERVAHUIS EXCLUSION ZONE
65 M
70 M
MEENT
RODENZAND
GROTEKERKPLEIN
WESTEWAGENSTRA
Min 3 hrs
MEENT
Envelope limit
Exclusion volume
Demolition
Voxel grid
Important public space

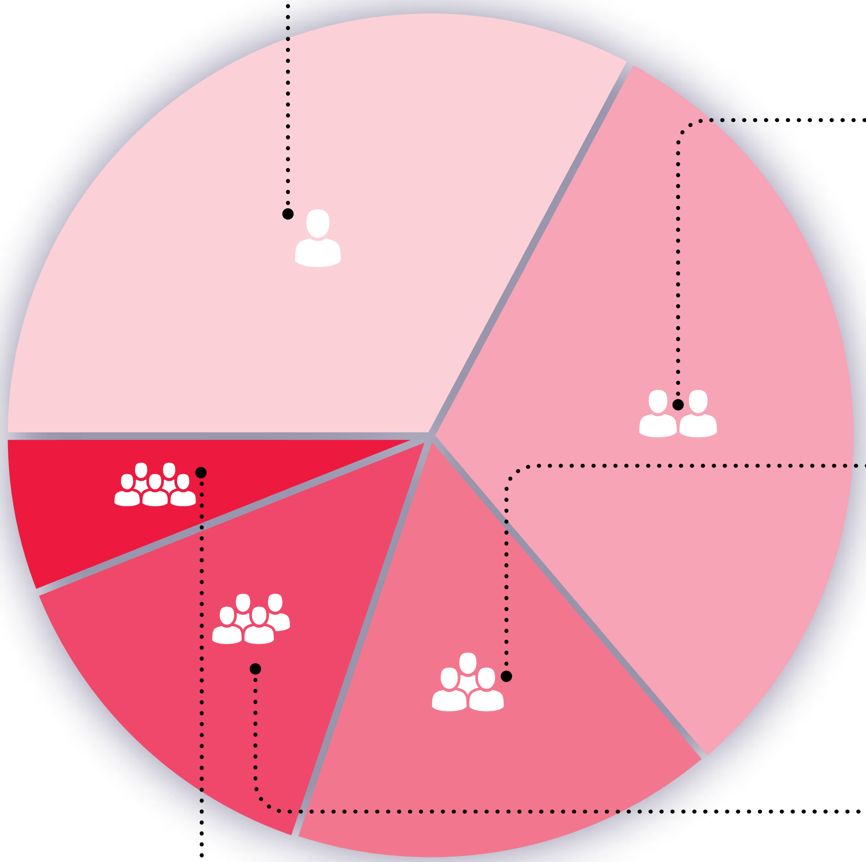


STRUCTURAL CELL
7.0 M
7.0 M
3.5 M
3.5 M
3.5 M
3.5 M
SPATIAL CELL

TOPOLOGY


T
A
S
CONFIGURATION OF
TRADITIONAL ROW HOUSE
T
T
T
TERRACE
A
A
A
APARTMENT UNIT
S
STREET
CITY
CORRESPONDING
SPATIAL NETWORK

PROGRAMME



32,9% → 1 person → 30 m²
31,1% → 2 person → 50 m2
16,2% → 3 person → 70 m2
13,6% → 4 person → 90 m2
6,2% → 5+ person → 110 m2

Netherlands average household size

A1

Size	30 m2
Levels	1 floors
Geometry	interior
Facade %	50%
Shape	compact
Sunlight	4 hrs
Views	60 deg, 50 m
Privacy	10 meters

A2

Size	50 m2
Levels	1 floors
Geometry	interior
Facade %	50%
Shape	compact
Sunlight	4 hrs
Views	60 deg, 50 m
Privacy	10 meters

A3

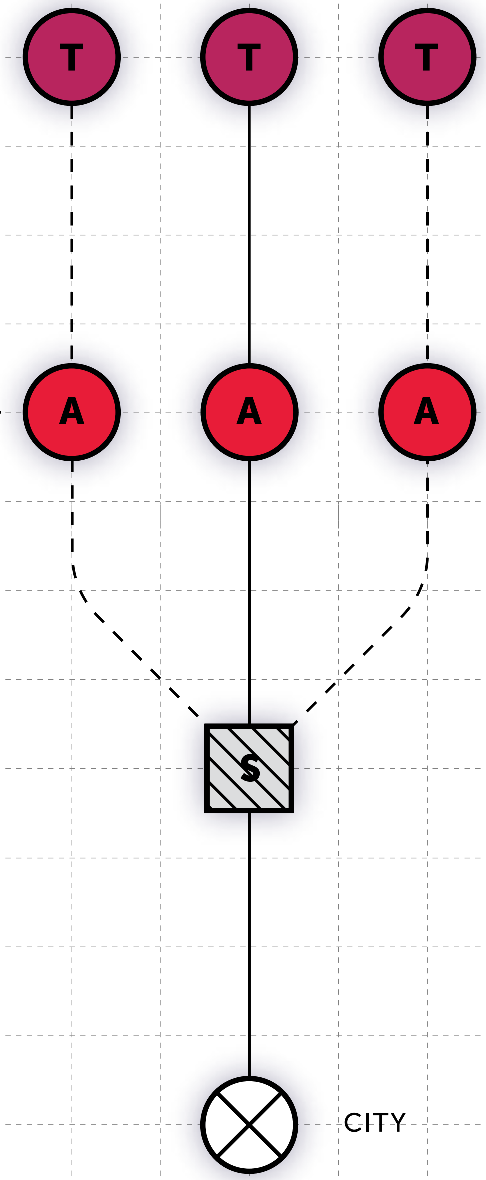
Size	70 m2
Levels	1 floors
Geometry	interior
Facade %	50%
Shape	compact
Sunlight	4 hrs
Views	60 deg, 50 m
Privacy	10 meters

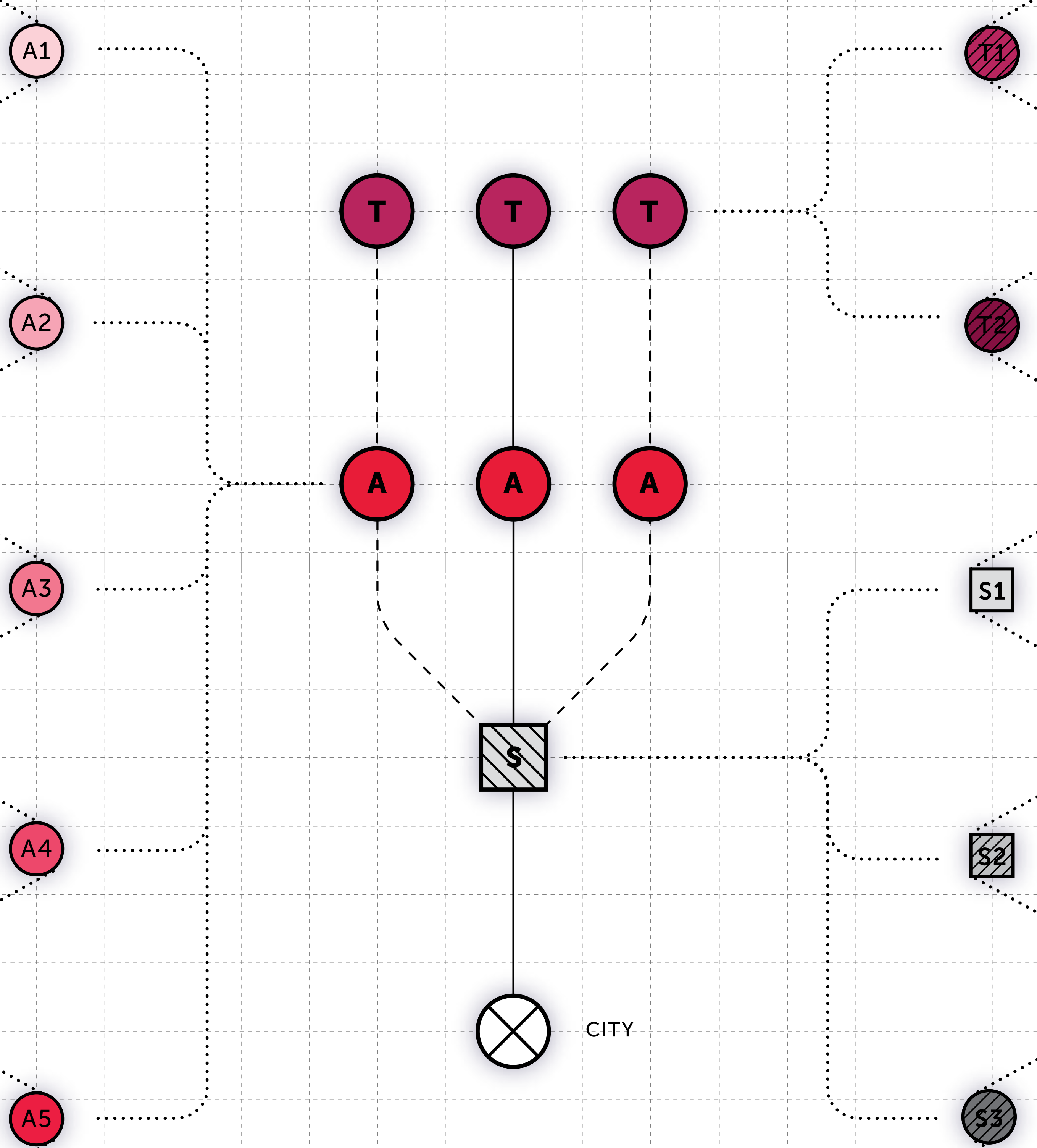
A4

Size	90 m2
Levels	1 - 2 floors
Geometry	interior
Facade %	50%
Shape	compact
Sunlight	4 hrs
Views	60 deg, 50 m
Privacy	10 meters

A5

Size	110 m2
Levels	1 - 2 floors
Geometry	interior
Facade %	50%
Shape	compact
Sunlight	4 hrs
Views	60 deg, 50 m
Privacy	10 meters





A1

Size	30 m2
Levels	1 floors
Geometry	interior
Facade %	50%
Shape	compact
Sunlight	4 hrs
Views	60 deg, 50 m
Privacy	10 meters

A2

Size	50 m2
Levels	1 floors
Geometry	interior
Facade %	50%
Shape	compact
Sunlight	4 hrs
Views	60 deg, 50 m
Privacy	10 meters

A3

Size	70 m2
Levels	1 floors
Geometry	interior
Facade %	50%
Shape	compact
Sunlight	4 hrs
Views	60 deg, 50 m
Privacy	10 meters

A4

Size	90 m2
Levels	1 - 2 floors
Geometry	interior
Facade %	50%
Shape	compact
Sunlight	4 hrs
Views	60 deg, 50 m
Privacy	10 meters

A5

Size	110 m2
Levels	1 - 2 floors
Geometry	interior
Facade %	50%
Shape	compact
Sunlight	4 hrs
Views	60 deg, 50 m
Privacy	10 meters

T1

Size	10 m2
Levels	1 floors
Geometry	exterior
Facade %	/
Shape	compact
Sunlight	1 hours
Views	60 degrees
Privacy	0 meters

T2

Size	20 m2
Levels	1 floors
Geometry	exterior
Facade %	/
Shape	compact
Sunlight	1 hours
Views	60 degrees
Privacy	0 meters

S1

Size	unlimited
Levels	unlimited
Geometry	interior
Facade %	0%
Shape	linear
Sunlight	0 hours
Views	0 degrees
Privacy	0 meters

S2

Size	unlimited
Levels	1 floors
Geometry	exterior
Facade %	/
Shape	linear
Sunlight	0 hours
Views	0 degrees
Privacy	0 meters

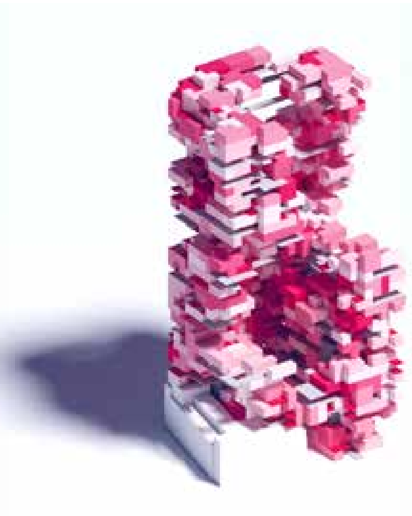
S3

Size	100 m2
Levels	1 floors
Geometry	exterior
Facade %	/
Shape	compact
Sunlight	6 hours
Views	180 degrees
Privacy	0 meters

SIMULATION

POPULATION


01


02


03


04

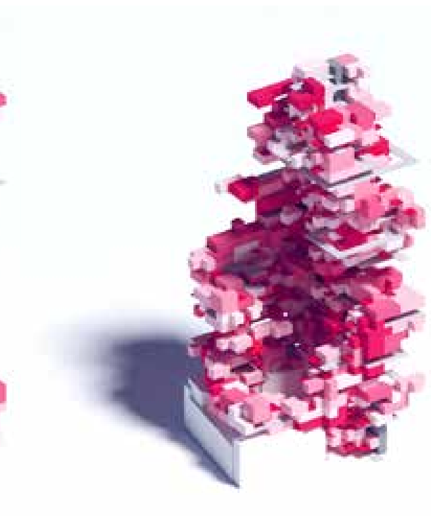

05


06


07

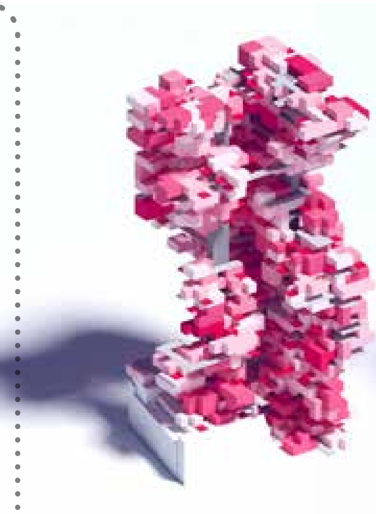

08


09

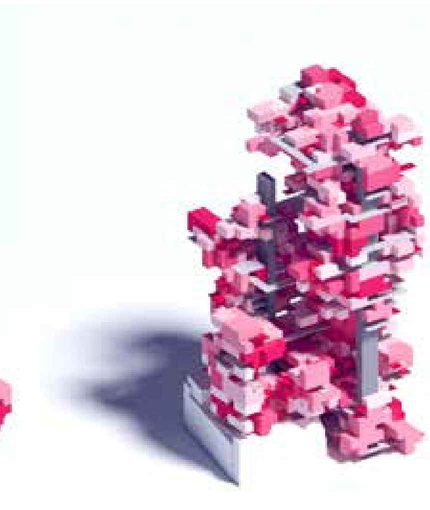

10


11


12

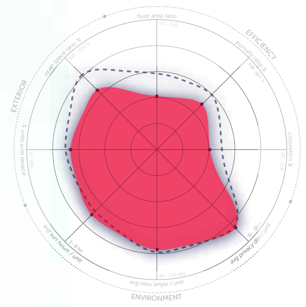

13


14


15

AGGREG. #01

Volume



Performance

Information

Units: 392

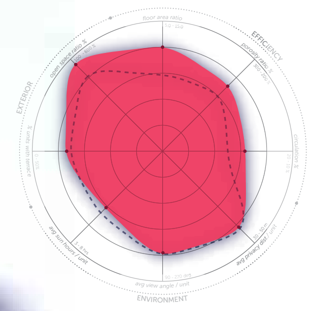
FAR: 9.11
Porosity: 251 %
Circulation: 15.9 %

OSR: 425 %
Terraces: 33.2 %

Sunlight: 6.54 HRS
View: 213.3 DEG
Privacy: 47.1 M

AGGREG. #02

Volume



Performance

Information

Units: 575

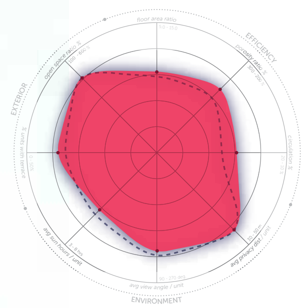
FAR: 12.98
Porosity: 229 %
Circulation: 13.7 %

OSR: 573 %
Terraces: 37.0 %

Sunlight: 6.09 HRS
View: 216.0 DEG
Privacy: 46.5 M

AGGREG. #03

Volume



Performance

Information

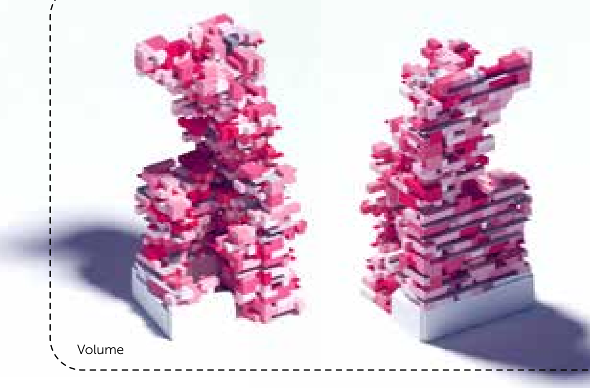
Units: 496

FAR: 11.23
Porosity: 231 %
Circulation: 13.9 %

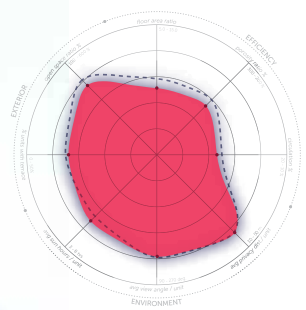
OSR: 507 %
Terraces: 37.9 %

Sunlight: 6.11 HRS
View: 211.1 DEG
Privacy: 46.8 M

AGGREG. #04



Volume



Performance

Information

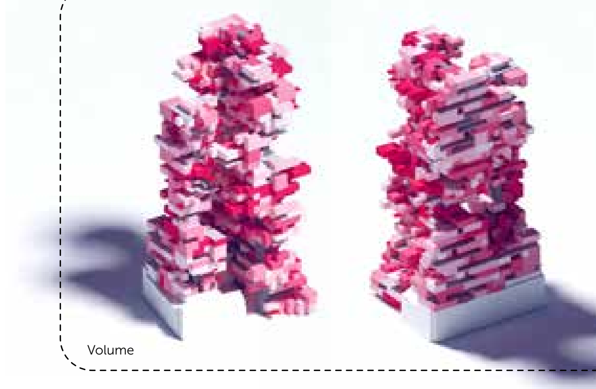
Units: 436

FAR: 10.12
Porosity: 247 %
Circulation: 15.4 %

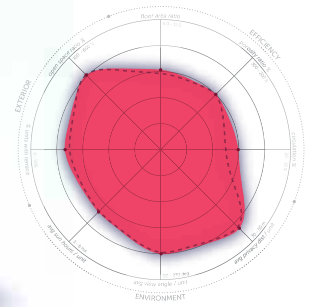
OSR: 477 %
Terraces: 34.0 %

Sunlight: 6.61 HRS
View: 215.2 DEG
Privacy: 46.9 M

AGGREG. #05



Volume



Performance

Information

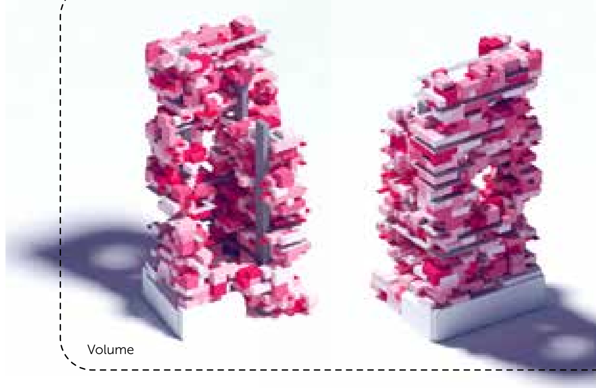
Units: 493

FAR: 11.14
Porosity: 240 %
Circulation: 14.0 %

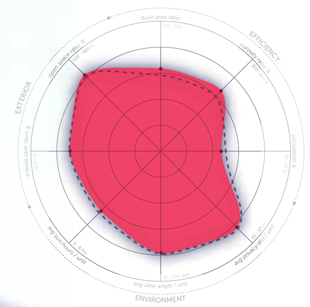
OSR: 505 %
Terraces: 36.9 %

Sunlight: 6.39 HRS
View: 218.4 DEG
Privacy: 47.1 M

AGGREG. #06



Volume



Performance

Information

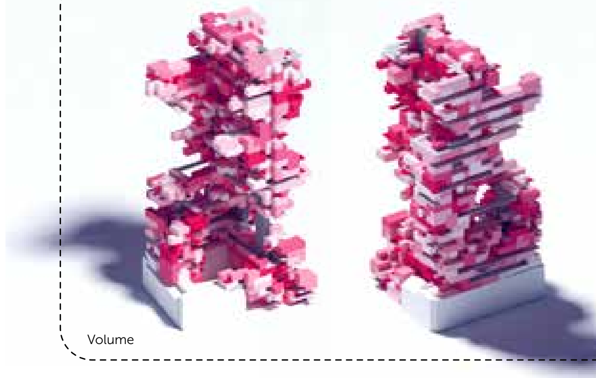
Units: 495

FAR: 11.37
Porosity: 234 %
Circulation: 15.3 %

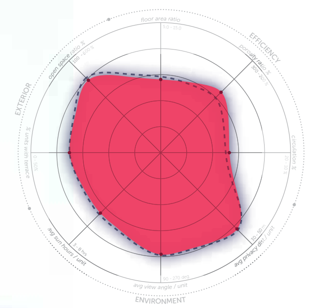
OSR: 514 %
Terraces: 34.9 %

Sunlight: 6.25 HRS
View: 215.6 DEG
Privacy: 46.6 M

AGGREG. #07



Volume



Performance

Information

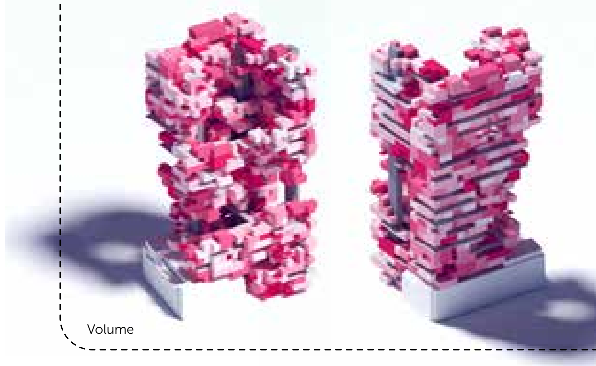
Units: 470

FAR: 10.63
Porosity: 234 %
Circulation: 14.7 %

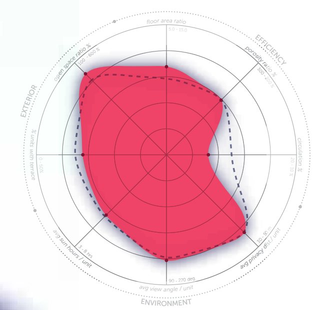
OSR: 494 %
Terraces: 35.1 %

Sunlight: 6.29 HRS
View: 215.3 DEG
Privacy: 46.6 M

AGGREG. #08



Volume



Performance

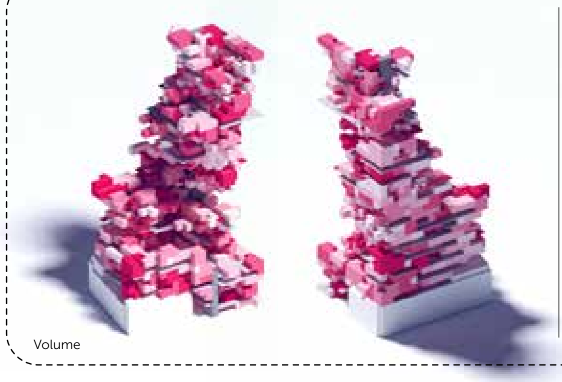
Information

Units: 509

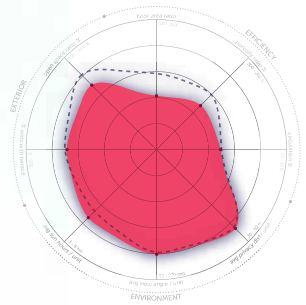
FAR: 11.78
Porosity: 240 %
Circulation: 16.8 %

OSR: 540 %
Terraces: 32.2 %

Sunlight: 6.29 HRS
View: 220.0 DEG
Privacy: 46.9 M



Volume



Performance

AGGREG. #09
Information

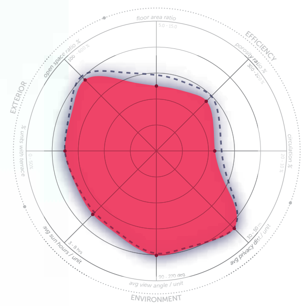
Units: 399

FAR: 9.14
Porosity: 252 %
Circulation: 15.1 %

OSR: 451 %
Terraces: 34.4 %

Sunlight: 6.70 HRS
View: 218.8 DEG
Privacy: 47.2 M

Volume



Performance

AGGREG. #10
Information

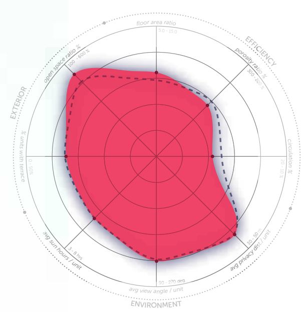
Units: 436

FAR: 10.01
Porosity: 245 %
Circulation: 15.6 %

OSR: 487 %
Terraces: 35.1 %

Sunlight: 6.45 HRS
View: 218.8 DEG
Privacy: 46.9 M

Volume



Performance

AGGREG. #11
Information

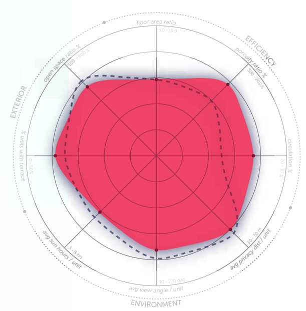
Units: 488

FAR: 11.45
Porosity: 244 %
Circulation: 15.7 %

OSR: 546 %
Terraces: 34.6 %

Sunlight: 6.36 HRS
View: 218.6 DEG
Privacy: 47.0 M

Volume



Performance

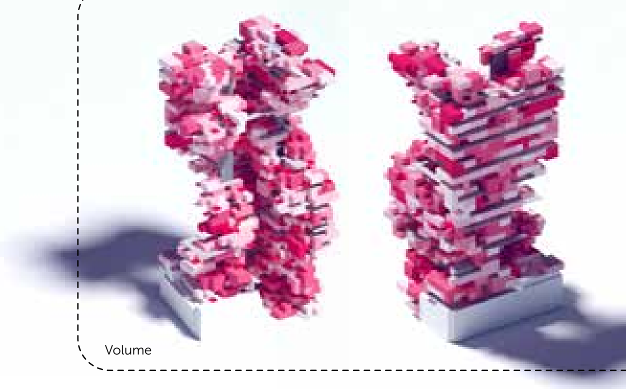
AGGREG. #12
Information

Units: 485

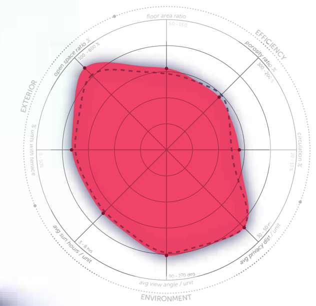
FAR: 10.87
Porosity: 222 %
Circulation: 12.5 %

OSR: 476 %
Terraces: 38.8 %

Sunlight: 6.09 HRS
View: 206.0 DEG
Privacy: 46.1 M



Volume



Performance

AGGREG. #13
Information

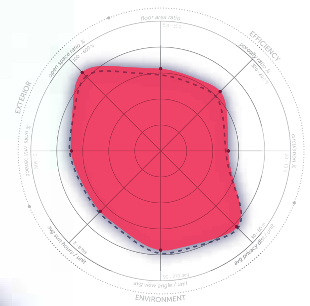
Units: 495

FAR: 11.27
Porosity: 242 %
Circulation: 14.4 %

OSR: 544 %
Terraces: 36.4 %

Sunlight: 6.45 HRS
View: 219.9 DEG
Privacy: 46.9 M

Volume



Performance

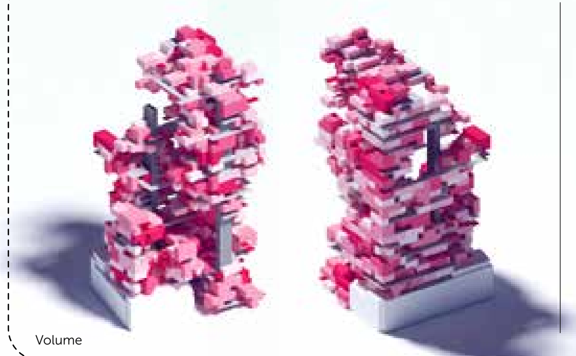
AGGREG. #14
Information

Units: 495

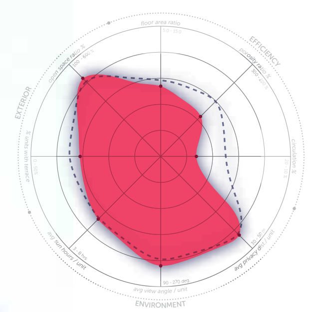
FAR: 11.33
Porosity: 235 %
Circulation: 14.8 %

OSR: 528 %
Terraces: 34.5 %

Sunlight: 6.29 HRS
View: 212.3 DEG
Privacy: 46.6 M



Volume



Performance

AGGREG. #15
Information

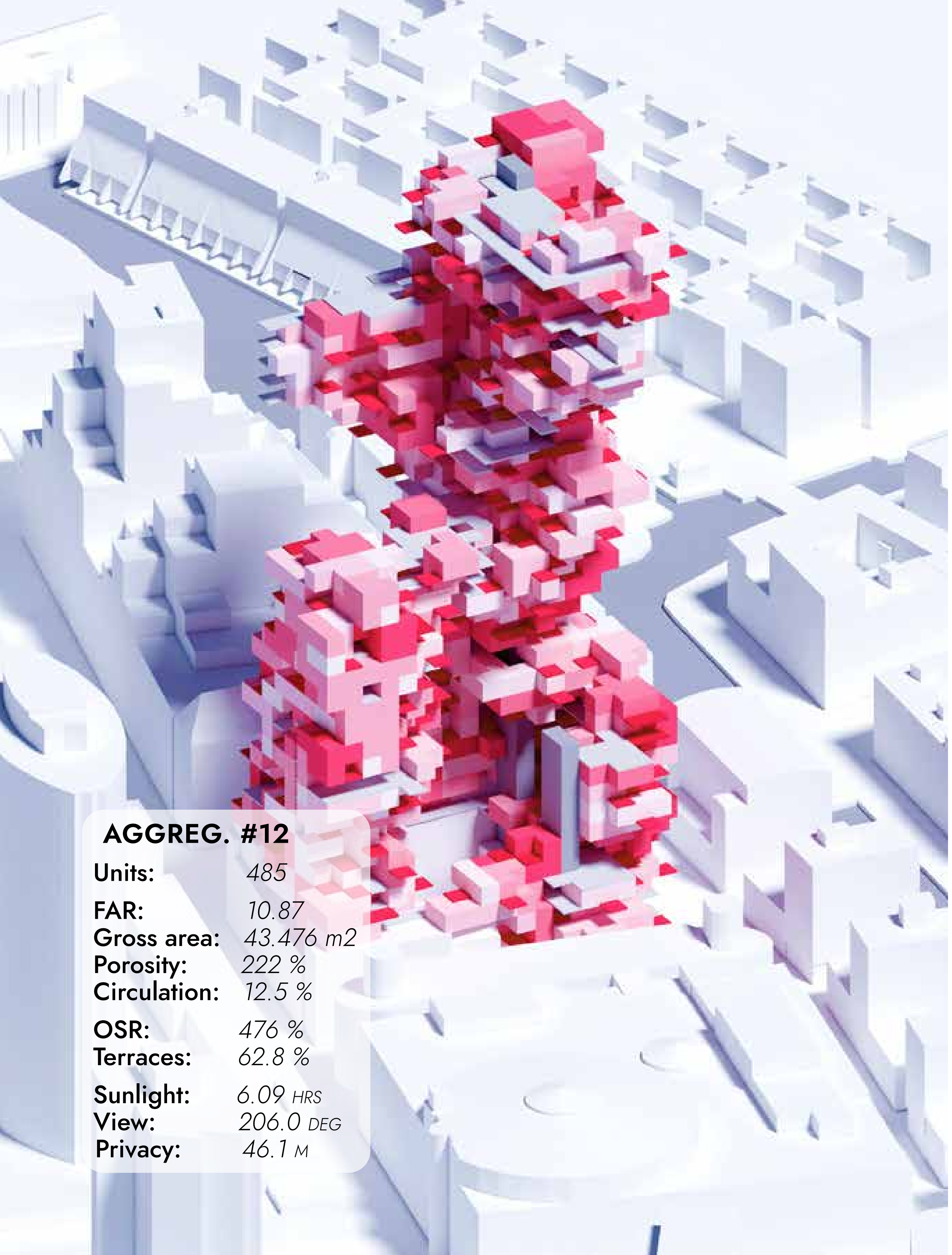
Units: 500

FAR: 10.38
Porosity: 256 %
Circulation: 17.3 %

OSR: 522 %
Terraces: 31.2 %

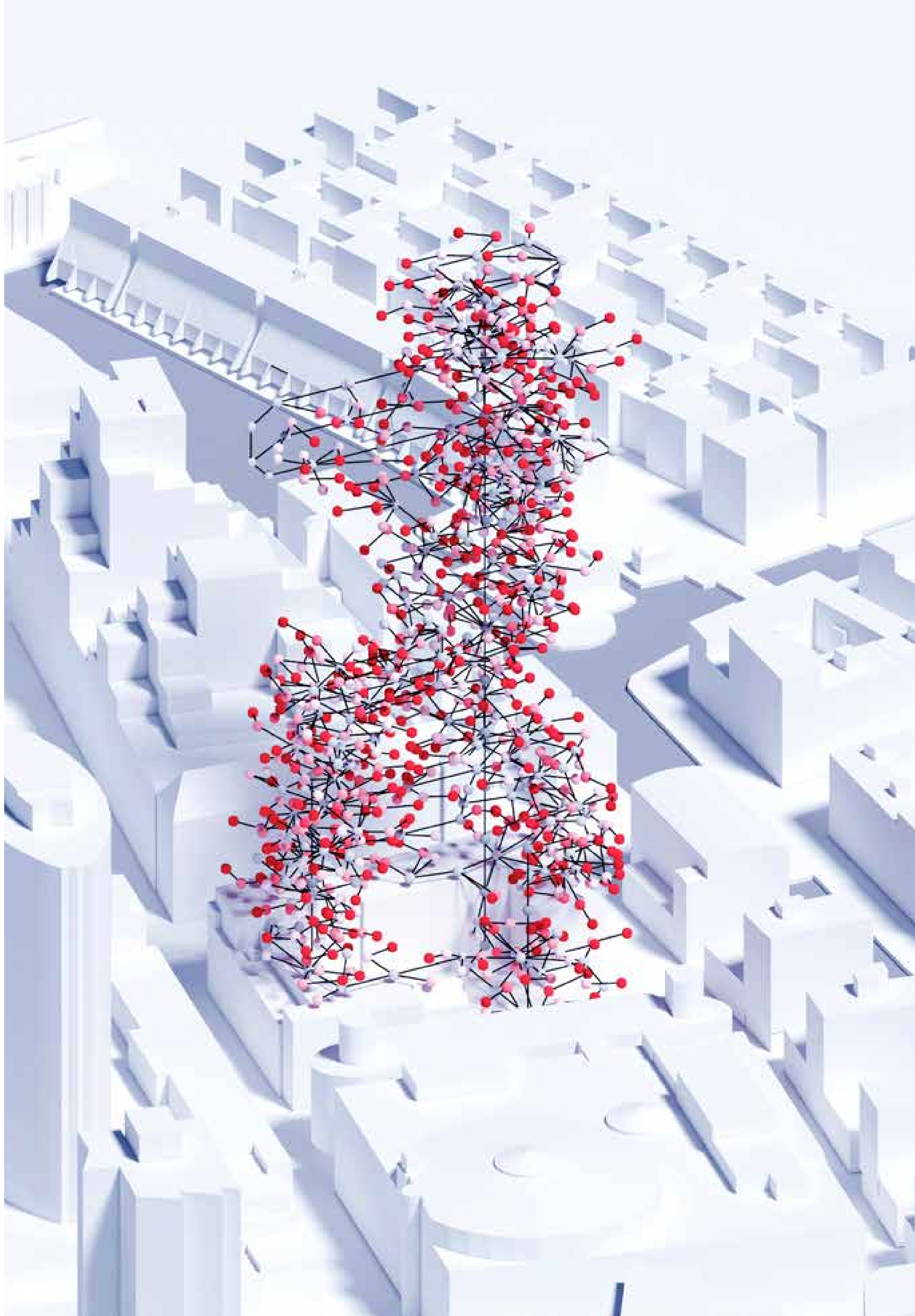
Sunlight: 6.41 HRS
View: 224.3 DEG
Privacy: 47.1 M

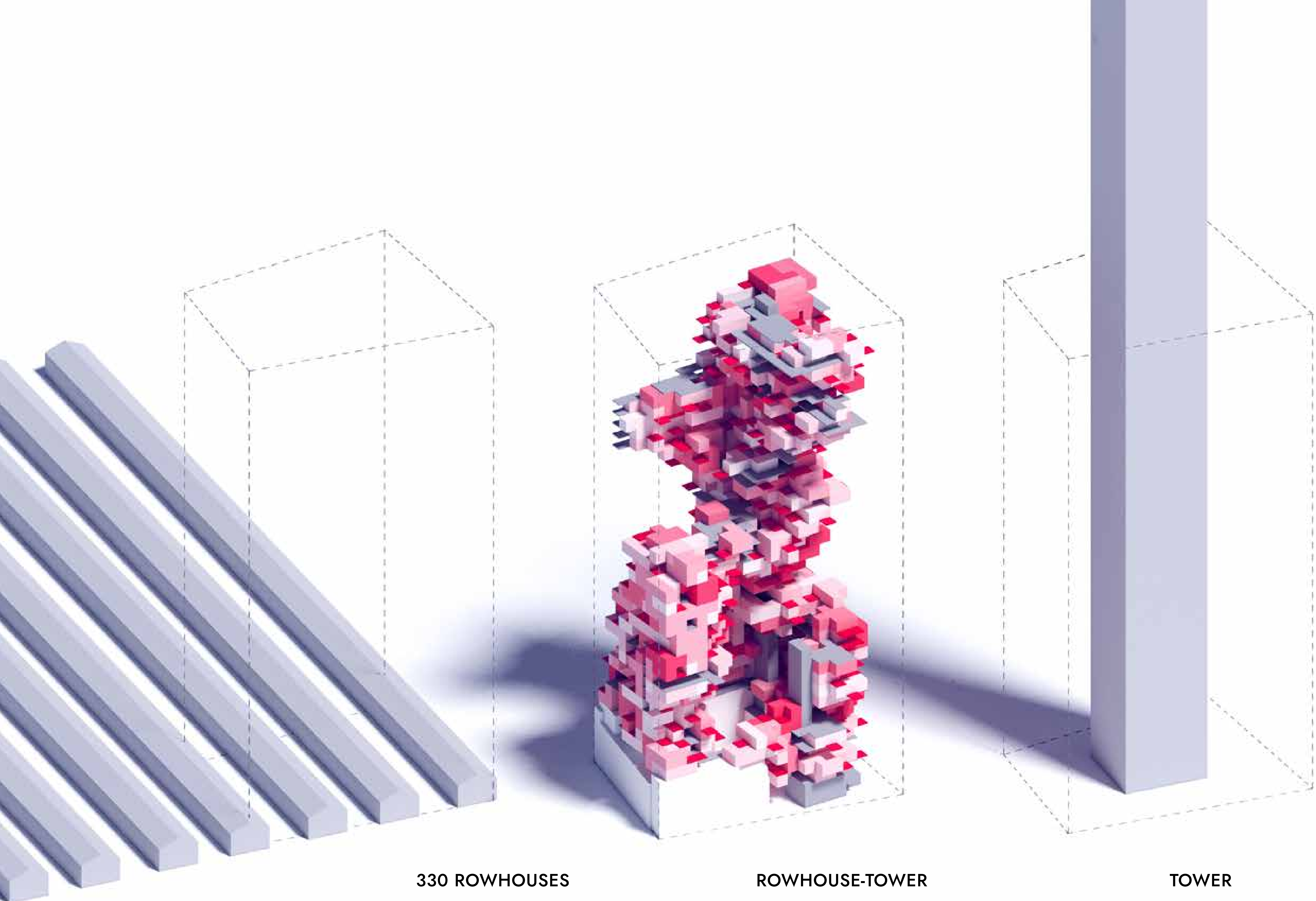
SELECTED AGGREGATION



AGGREG. #12

Units:	*485*
FAR:	*10.87*
Gross area:	*43.476 m2*
Porosity:	*222 %*
Circulation:	*12.5 %*
OSR:	*476 %*
Terraces:	*62.8 %*
Sunlight:	*6.09 HRS*
View:	*206.0 DEG*
Privacy:	*46.1 M*





330 ROWHOUSES

Gross area *47.500 m2*
Persons *1075*

Coverage *42.300 m2* ***(1075 %)***
Height *8 m* ***(5 %)***
Porosity *160 %* ***(72 %)***

ROWHOUSE-TOWER

Gross area *47.500 m2*
Persons *1075*

Coverage *4000 m2* ***(100 %)***
Height *150 m* ***(100 %)***
Porosity *223 %* ***(100 %)***

TOWER

Gross area *47.500 m2*
Persons *1075*

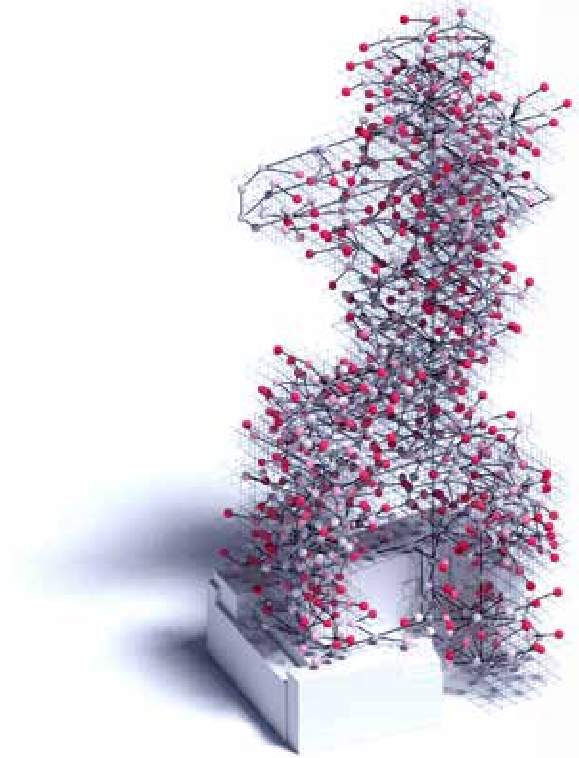
Coverage *600 m2* ***(15 %)***
Height *266 m* ***(177 %)***
Porosity *70 %* ***(32 %)***

Geometry | South

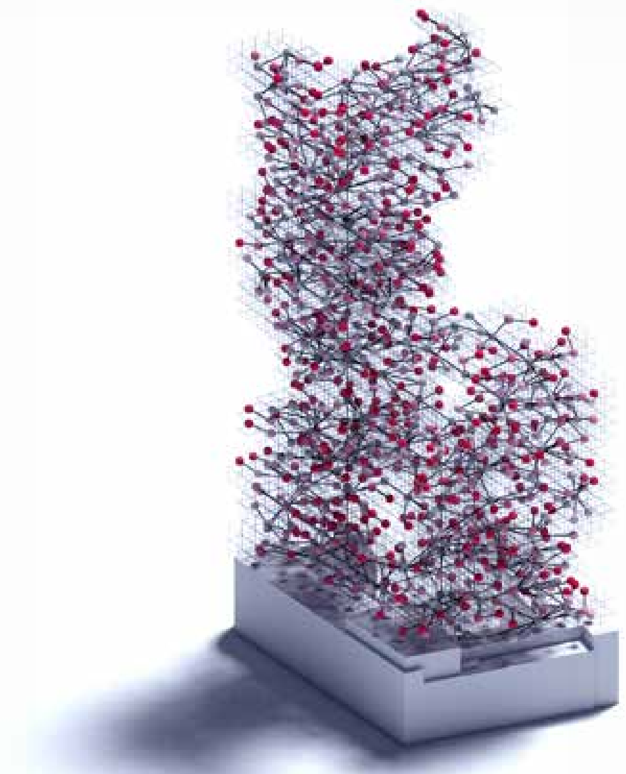
Geometry | West

Geometry | North

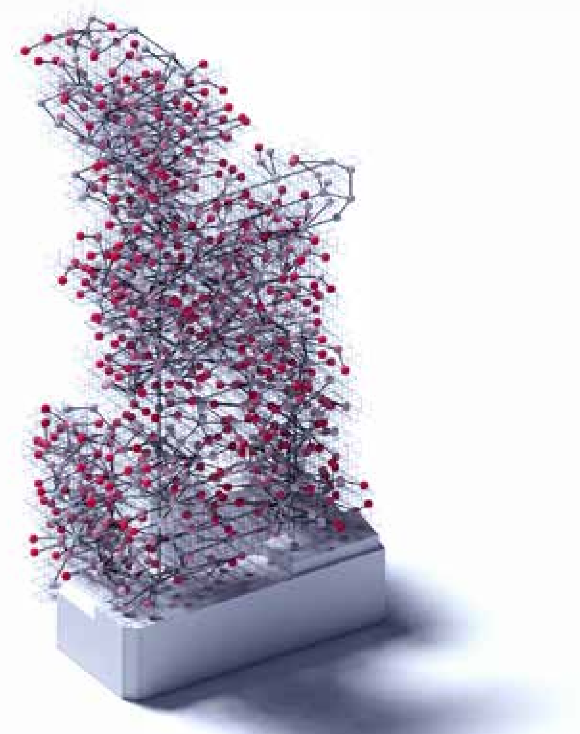
Geometry | East



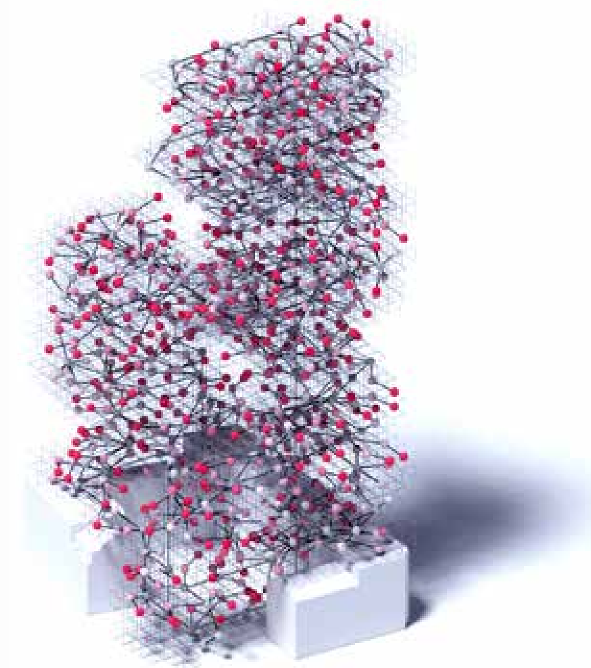
Topology | South



Topology | West

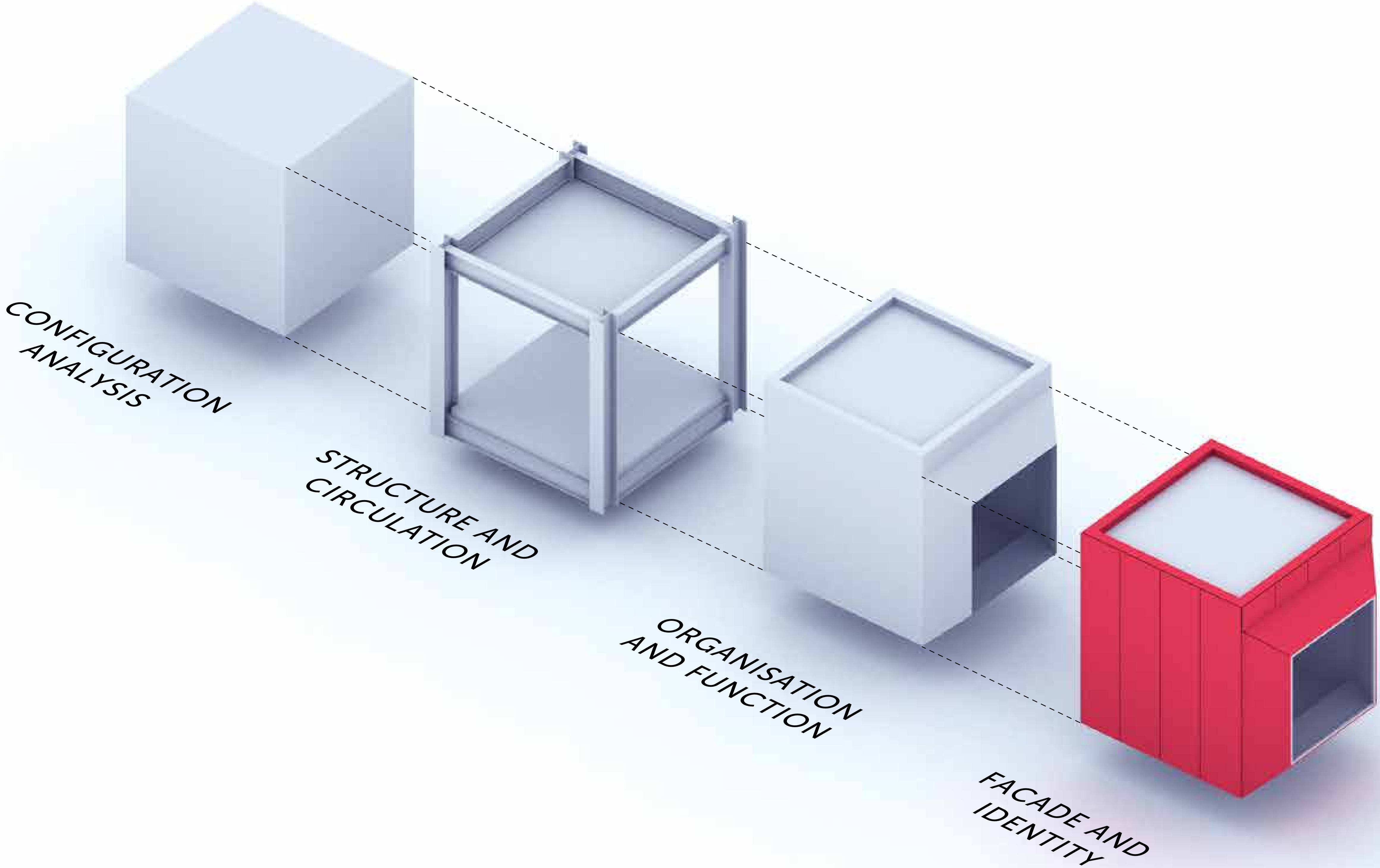


Topology | North

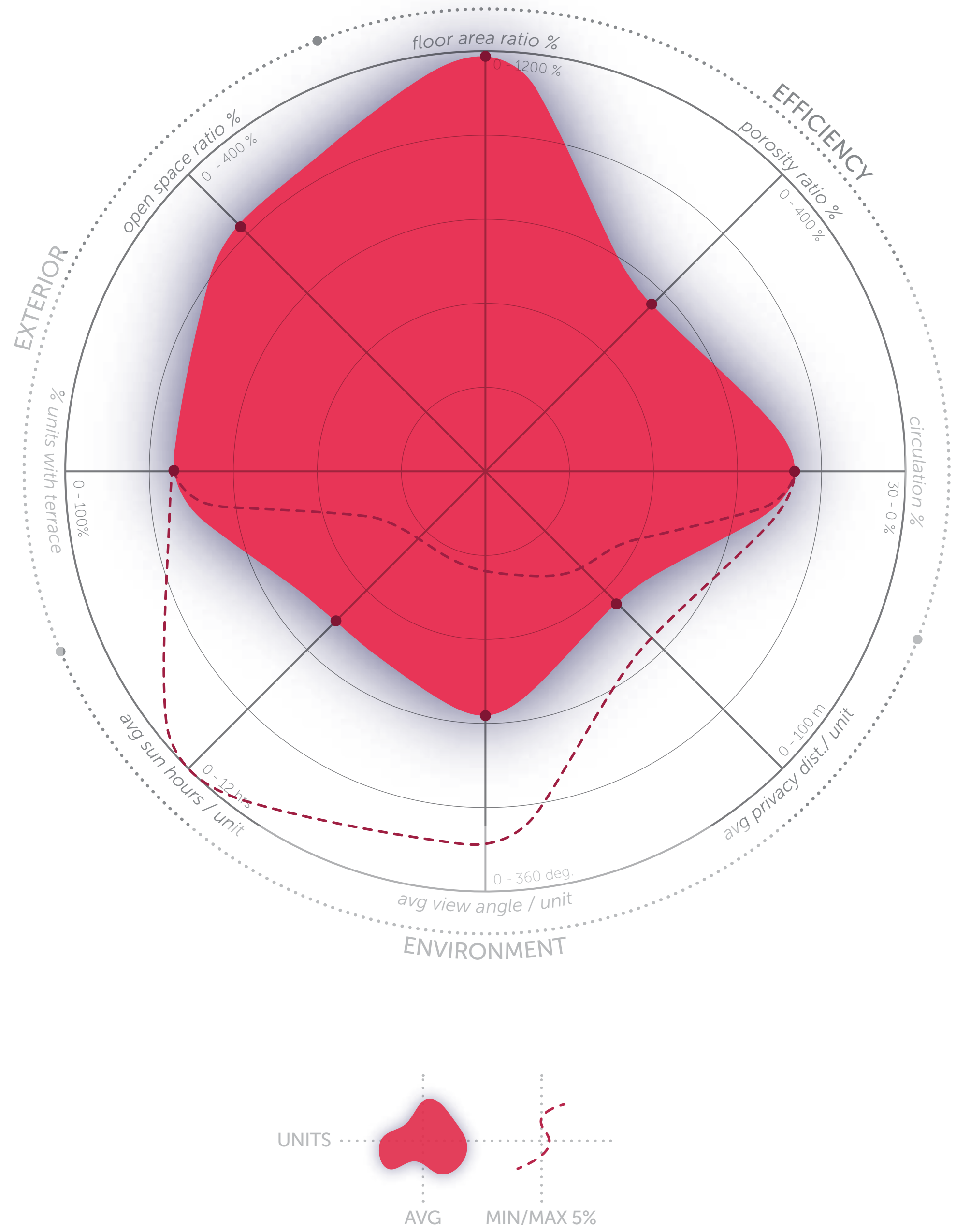


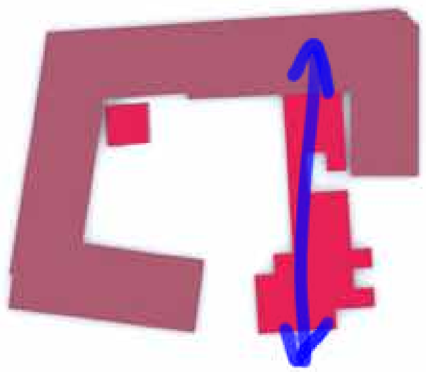
Topology | East

MATERIALISATION PROCESS



BUILDING ANALYSIS





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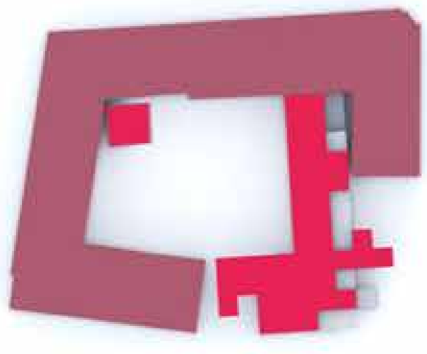
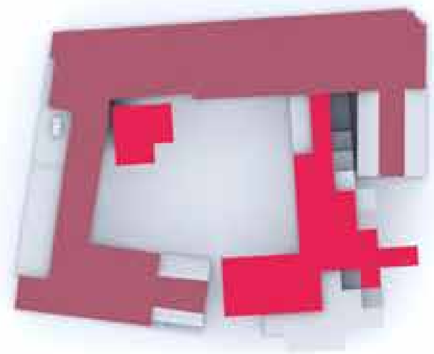


02



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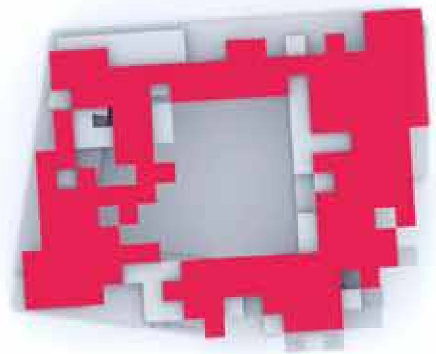
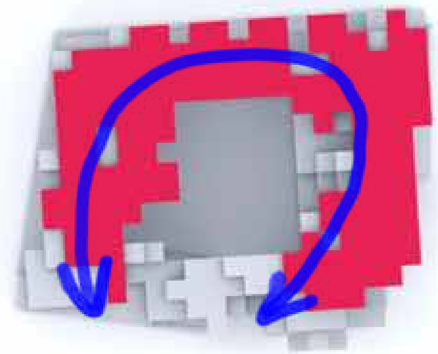


06



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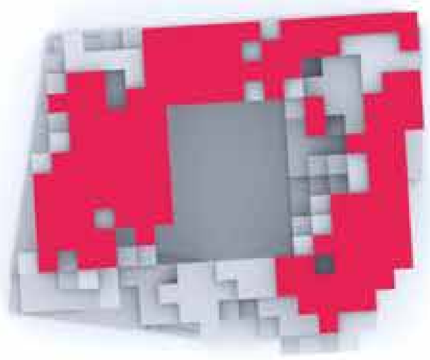

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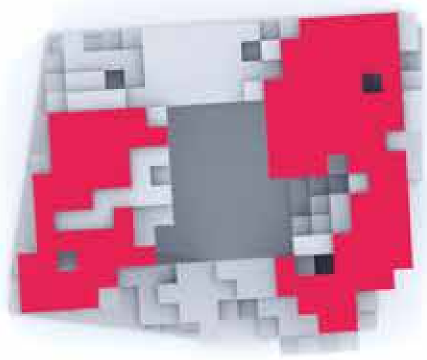

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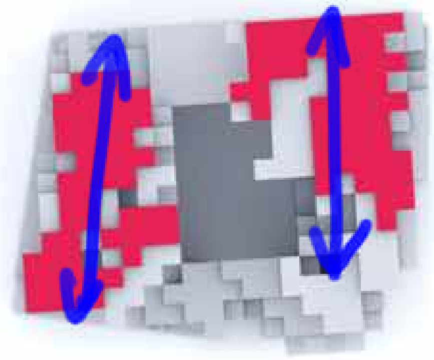

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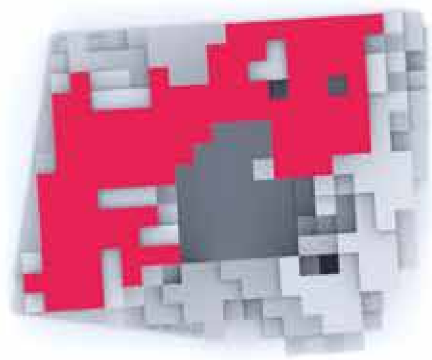

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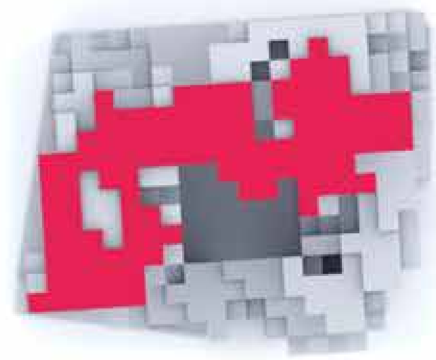

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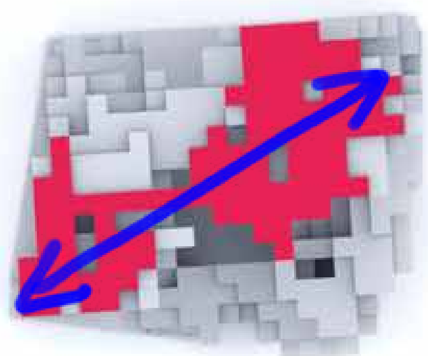

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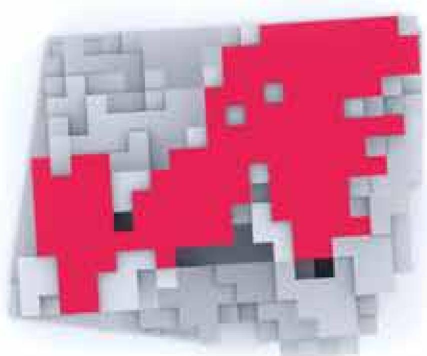

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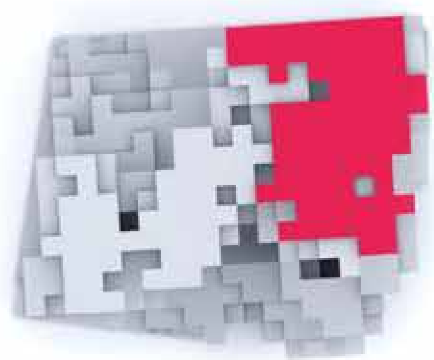

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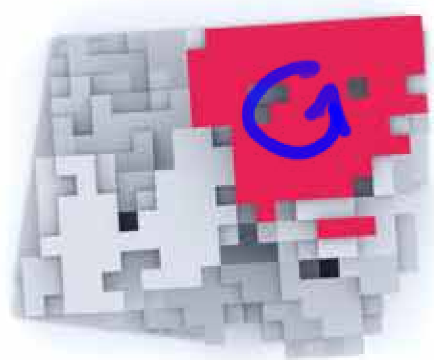

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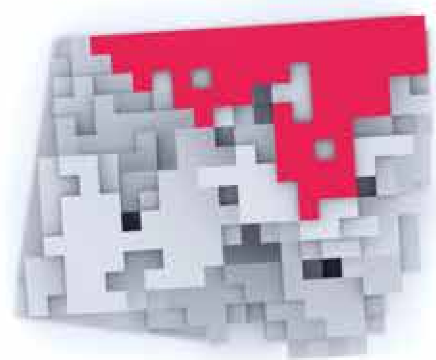

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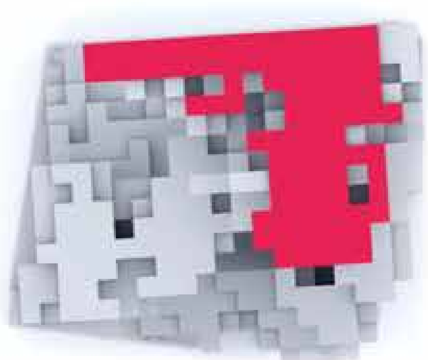

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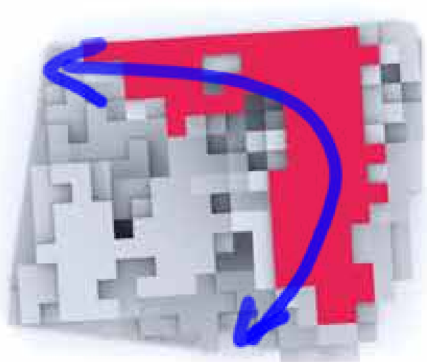

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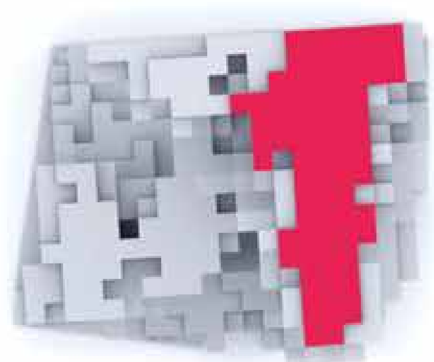

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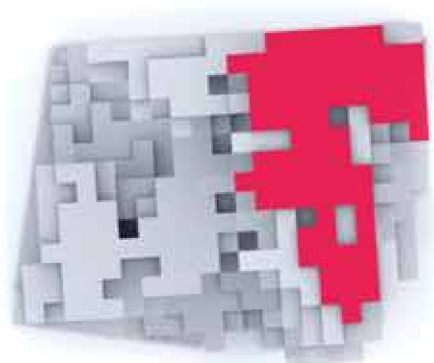

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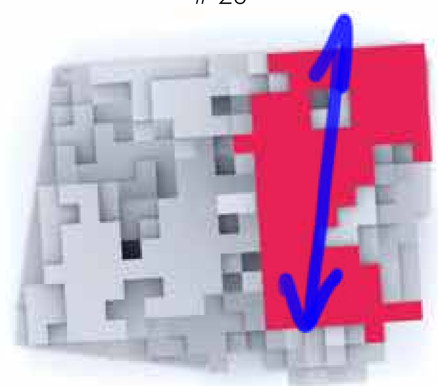

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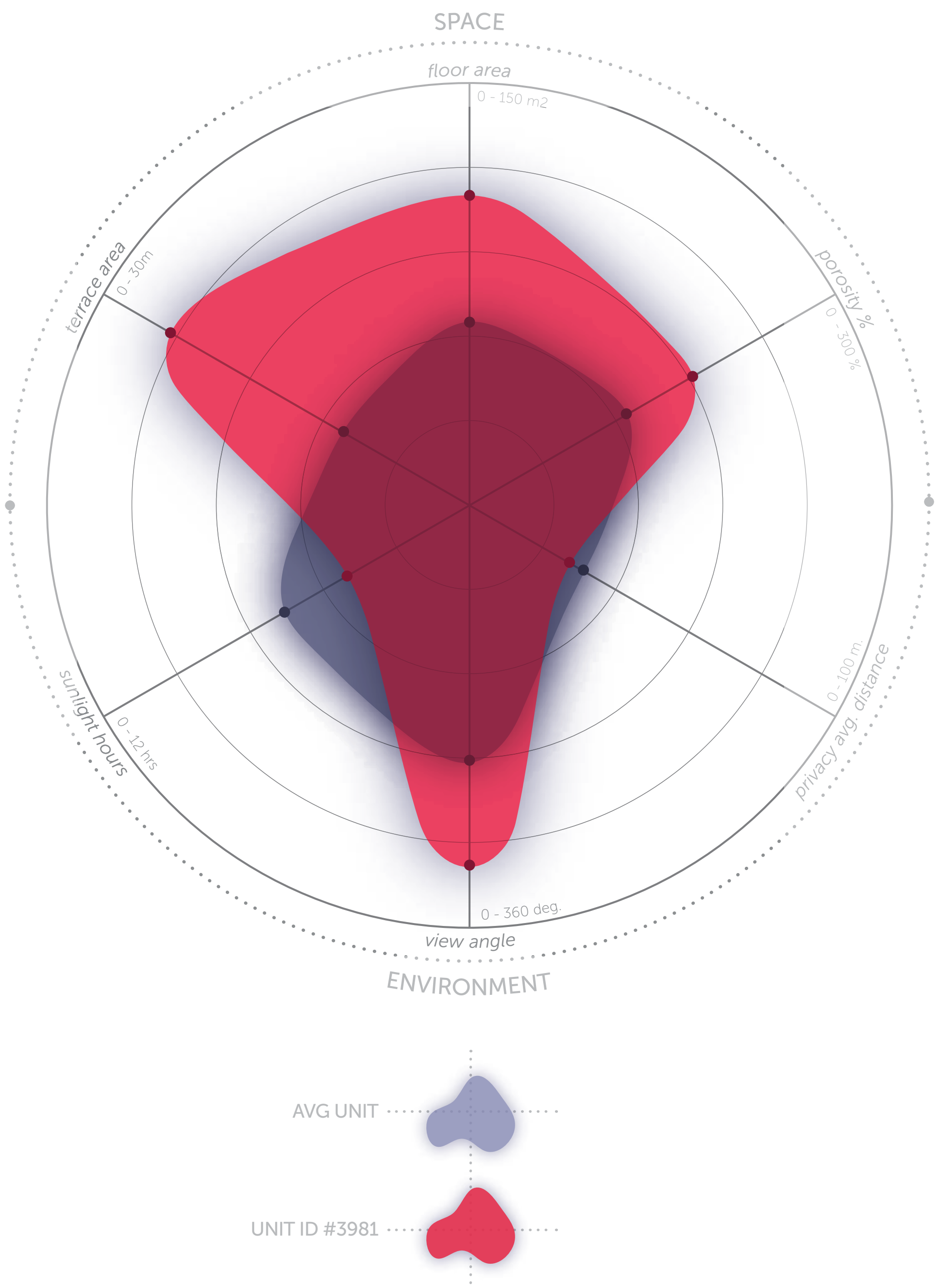
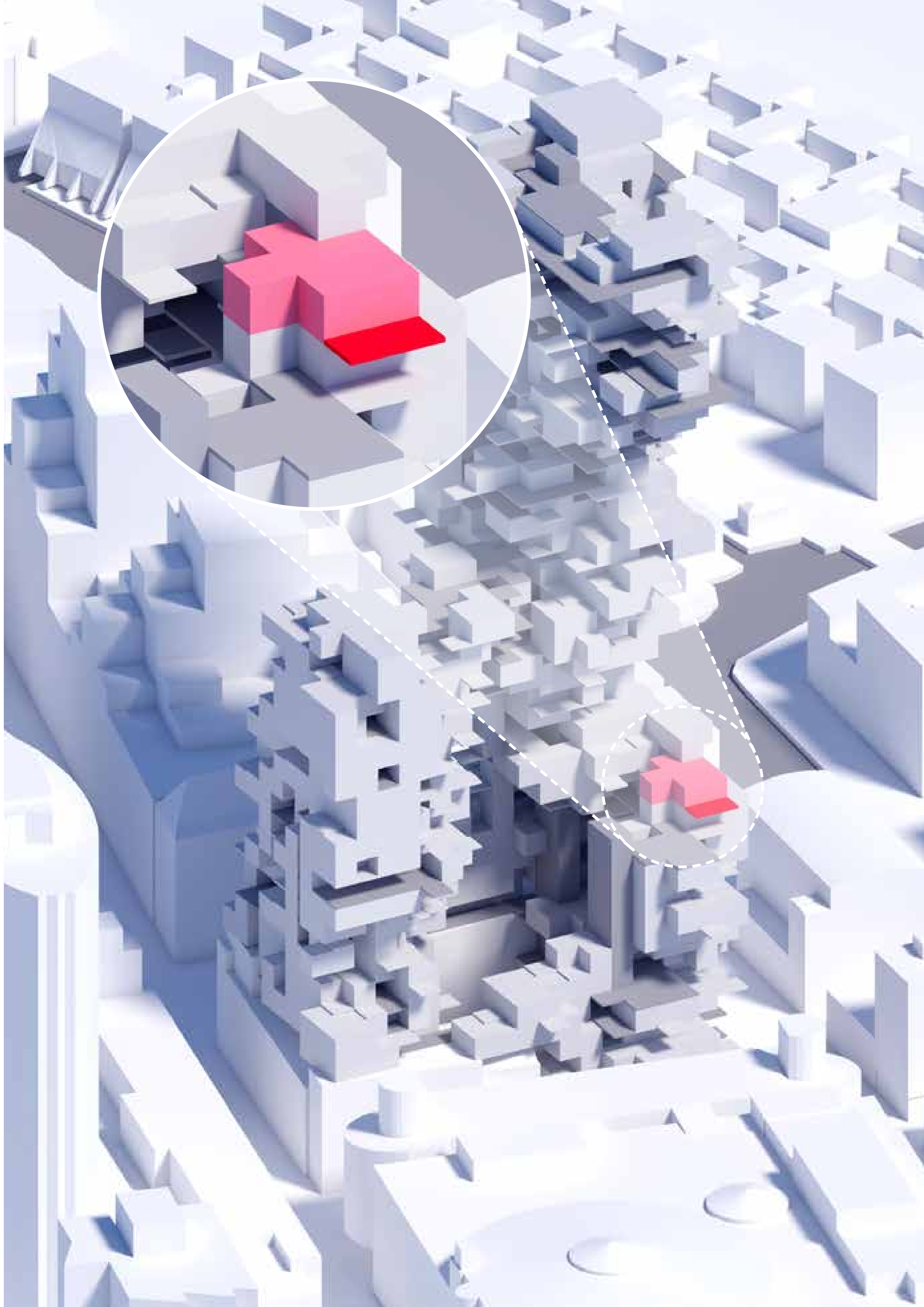
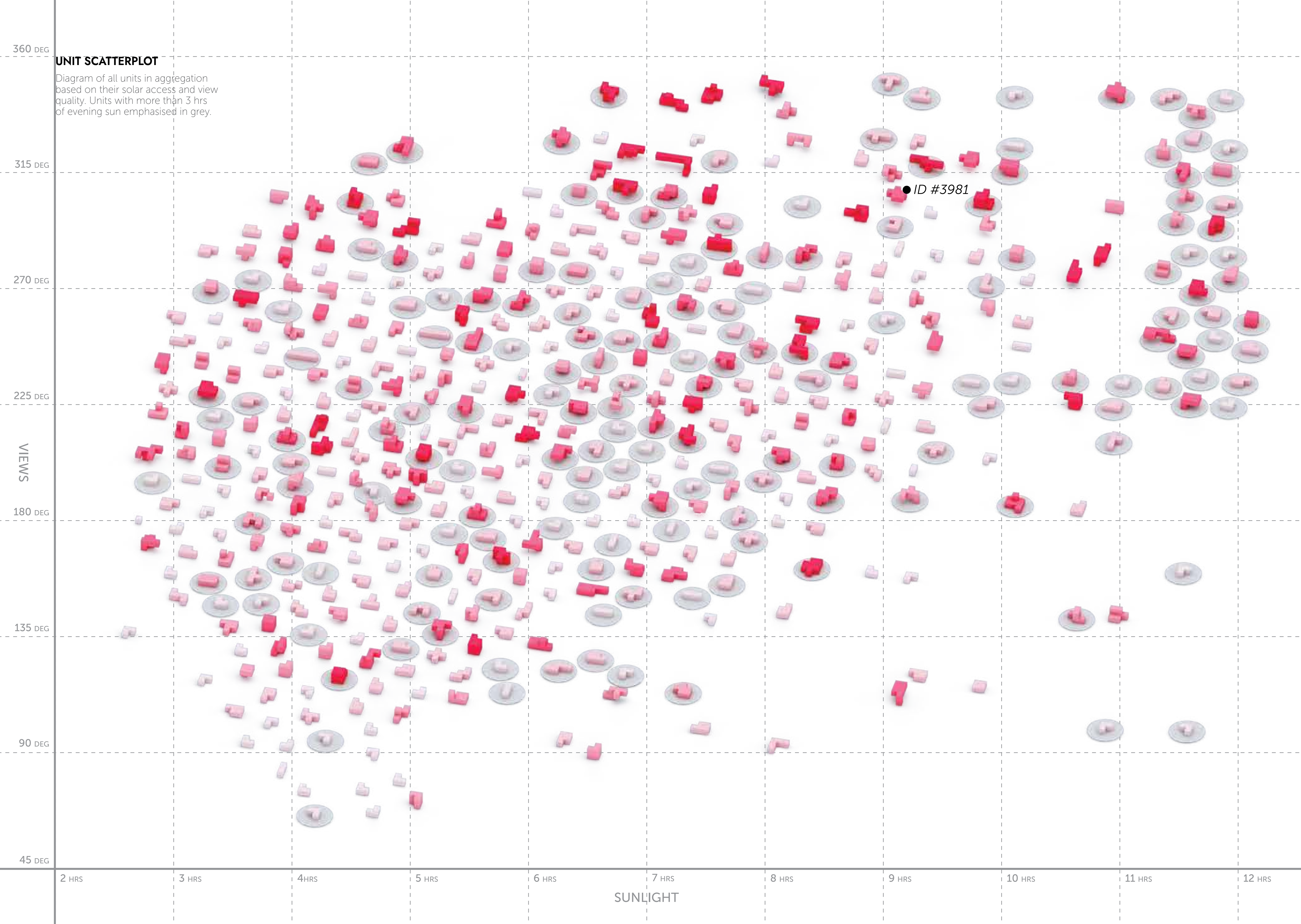
UNIT ANALYSIS






UNIT SCATTERPLOT
Diagram of all units in aggregation based on their solar access and view quality. Units with more than 3 hrs of evening sun emphasised in grey.
360 DEG
315 DEG
270 DEG
225 DEG
180 DEG
135 DEG
90 DEG
45 DEG
VIEWS
2 HRS
3 HRS
4HRS
5 HRS
6 HRS
7 HRS
8 HRS
9 HRS
10 HRS
11 HRS
12 HRS
SUNLIGHT
ID #3981

UNIT SHAPE CLUSTERING

Automated evaluation of unit geometric properties utilising
K-Means clustering to reveal distinct spatial typologies.

SURFACE ANALYSIS

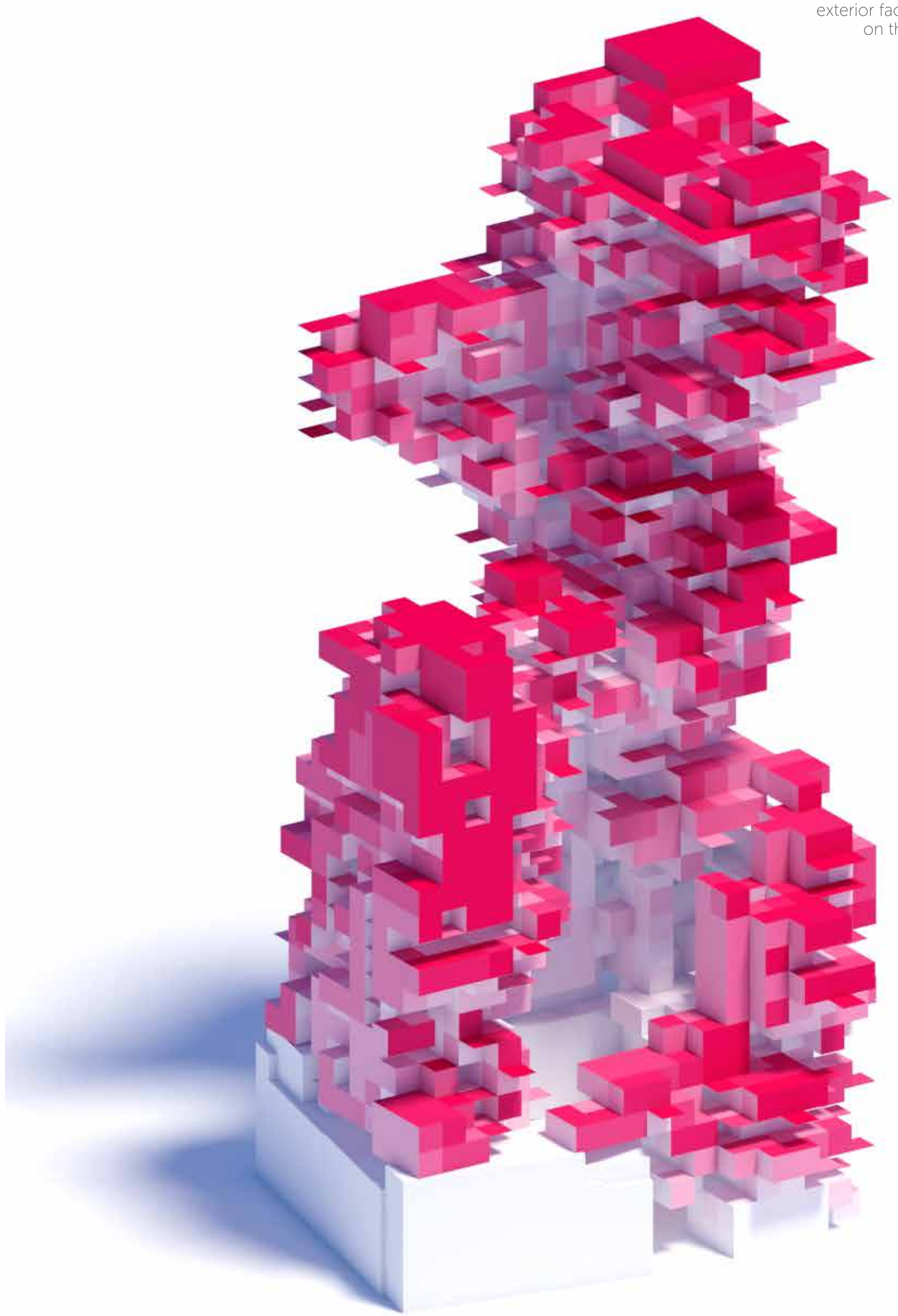
Group ID	Cluster ID	Cluster Type	Cluster Voxels	Connected Clusters	Area	Floors	Geometry
0	0	0	231;631;1031	1;10;27;200	27	3	interior
0	1	1	211,210,209	0,17,151,6,7,9	27	1	exterior
0	6	4	610;609;589;569;580;560;608;549	1	72	1	interior
0	7	2	189;168;168	1	27	1	interior
0	9	3	230;250;251;271;270;290	1	54	1	interior
0	10	0	1431,1831,2231	0,11,218,237	27	3	interior
0	11	1	1451;1450;1449	);183;192;82;84;35	27	1	exterior
0	17	1	208;207;206	1;19;36;998	27	1	exterior
0	19	1	205,204,203	17,33,20,1039	27	1	exterior
0	20	5	5;1025;1026;1006;1046;1045;1027;10	19	90	2	interior
0	27	1	651;650;649	0;44;103;31;40	27	1	exterior
0	31	3	671,691,690,670,710,711	27	54	1	interior
0	33	1	202	19;119	9	1	exterior
0	36	3	226;225;245;244;264;263	17	54	1	interior
0	40	2	1049,1069,1070	27	27	1	interior

Group ID	Cluster ID	Voxel ID	Type ID	Adjacent Voxels	Adjacent Faces	Voxel Area	Geometry
0	149	2	2	3,1,22,402	0,1,3,4,5	9	interior
0	877	11	6	12,10,31,411	7,8,9,10,11	9	interior
0	877	12	6	13;11;32;412	14;16	9	interior
0	877	13	6	14;12;33;413	19;21	9	interior
0	877	14	6	15,13,34,414	23,24,26	9	interior
0	877	15	6	16;14;35;415	27;20;29;30;31	9	interior
0	174	16	3	17;15;36;416	27;34;35;36	9	interior
0	174	17	3	18;16;37;417	39;40;41	9	interior
0	174	18	3	19,17,38,418	42,44,45,46	9	interior
0	149	22	2	23;21;42;2;422	48;49;50;51	9	interior
0	149	23	2	24;22;43;3;423	52;53;54;55;56	9	interior
0	877	32	6	33,31,52,12,432	58,59,60,61	9	interior
0	877	33	6	34,32,53,13,433	62,63,65	9	interior
0	174	36	3	37;35;56;16;436	67;60;69;70	9	interior
0	174	37	3	38;36;57;17;437	72;73;74	9	interior

Face ID	Group IDs	Cluster IDs	Voxel IDs	Face Area	Face Type	Face Is Vertical	Face Is Solid	Face Is Connecting	Sun t
0	0	149	2	9	int-ext	TRUE	TRUE	FALSE	5
1	0	149	2	9	int-ext	TRUE	TRUE	FALSE	5
3	0	149	2	9	int-ext	TRUE	TRUE	FALSE	11
4	0	149	2	9	int-ext	FALSE	TRUE	FALSE	11
5	0	149	2	9	int-ext	FALSE	TRUE	FALSE	11
7	0	877	11	9	int-ext	TRUE	TRUE	FALSE	5
8	0	877	11	9	int-ext	TRUE	TRUE	FALSE	0
9	0	877	11	9	int-ext	TRUE	TRUE	FALSE	11
10	0	877	11	9	int-ext	FALSE	TRUE	FALSE	8
11	0	877	11	9	int-ext	FALSE	TRUE	FALSE	8
14	0	877	12	9	int-ext	TRUE	TRUE	FALSE	11
16	0	877	12	9	int-ext	FALSE	TRUE	FALSE	5
19	0	877	13	9	int-ext	TRUE	TRUE	FALSE	11
21	0	877	13	9	int-ext	FALSE	TRUE	FALSE	5
23	0	877	14	9	int-ext	TRUE	TRUE	FALSE	[illegible]

SOLAR ANALYSIS

Solar access analysis of each exterior face in the building on the 21st of March.



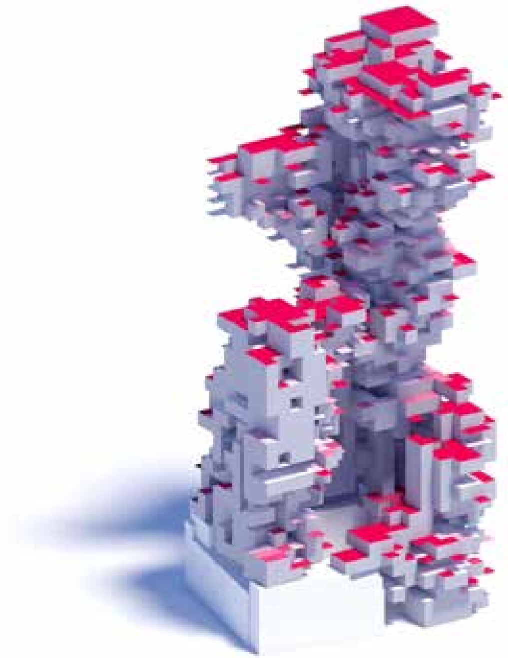
SPATIAL ANALYSIS

Analysis of spatial conditions at the level of a voxel face, together generating a performance database.

Sunlight

Views

Privacy



Height

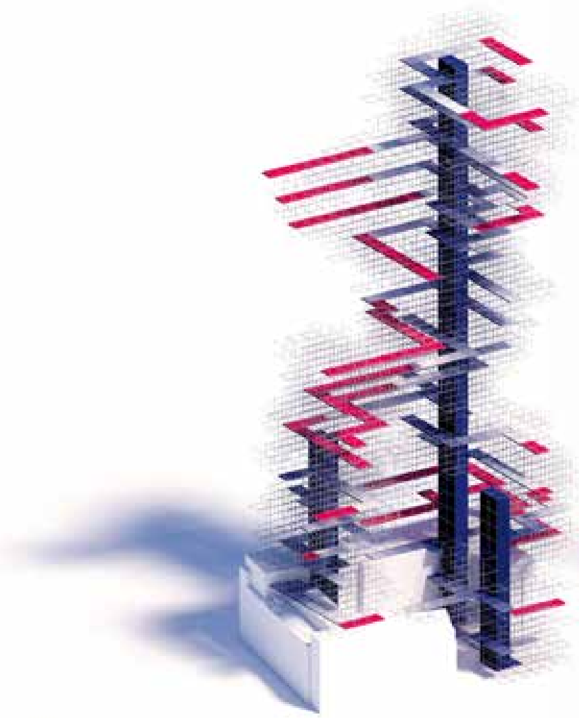
Access

Facade

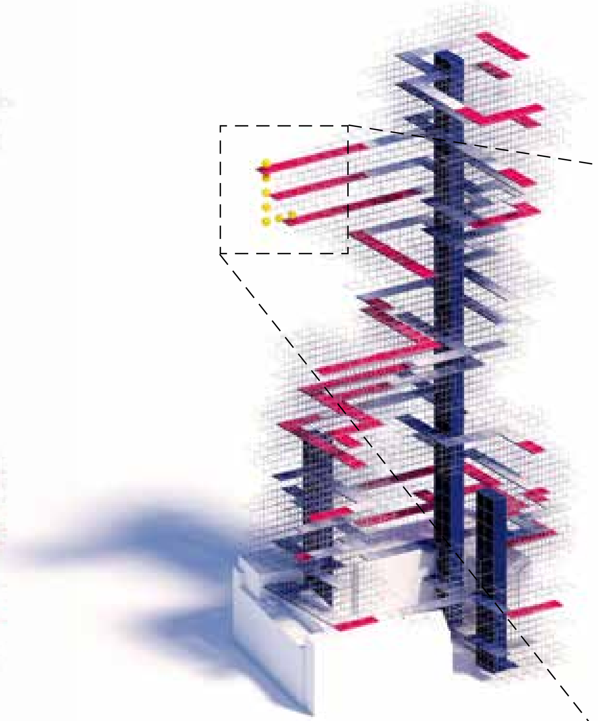
Interior walls

Connecting walls

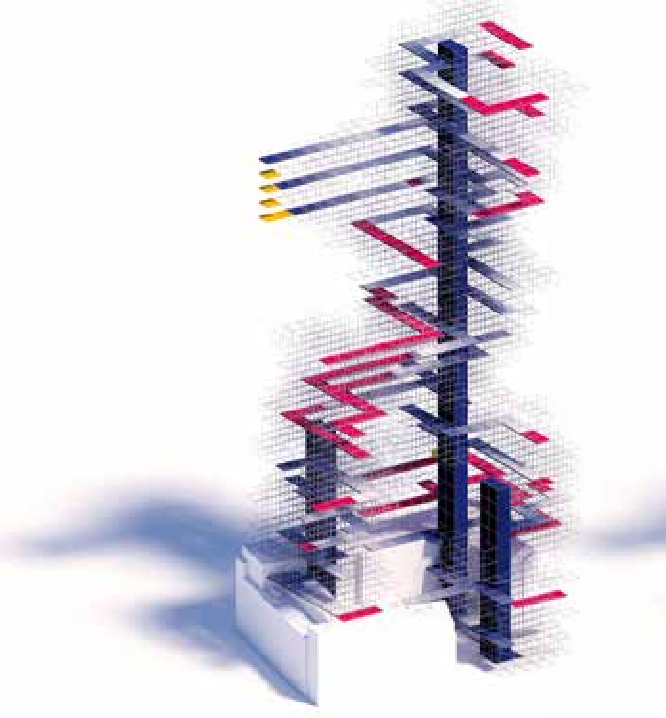
CIRCULATION



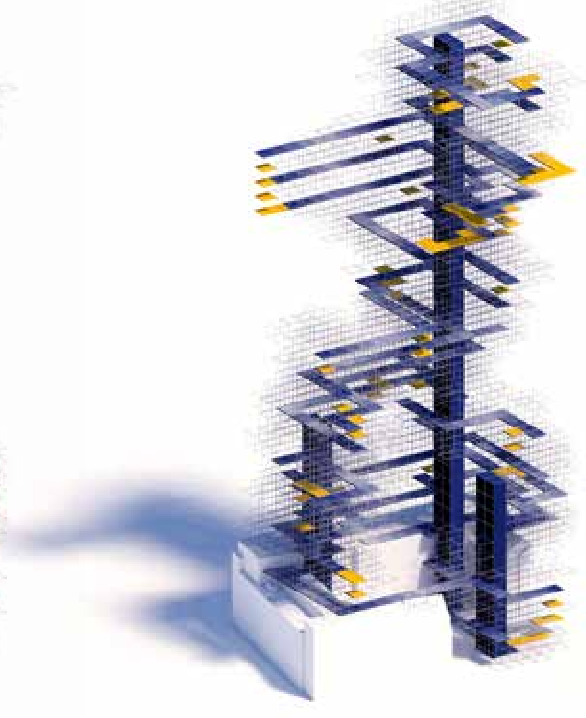
Analyze circulation distances



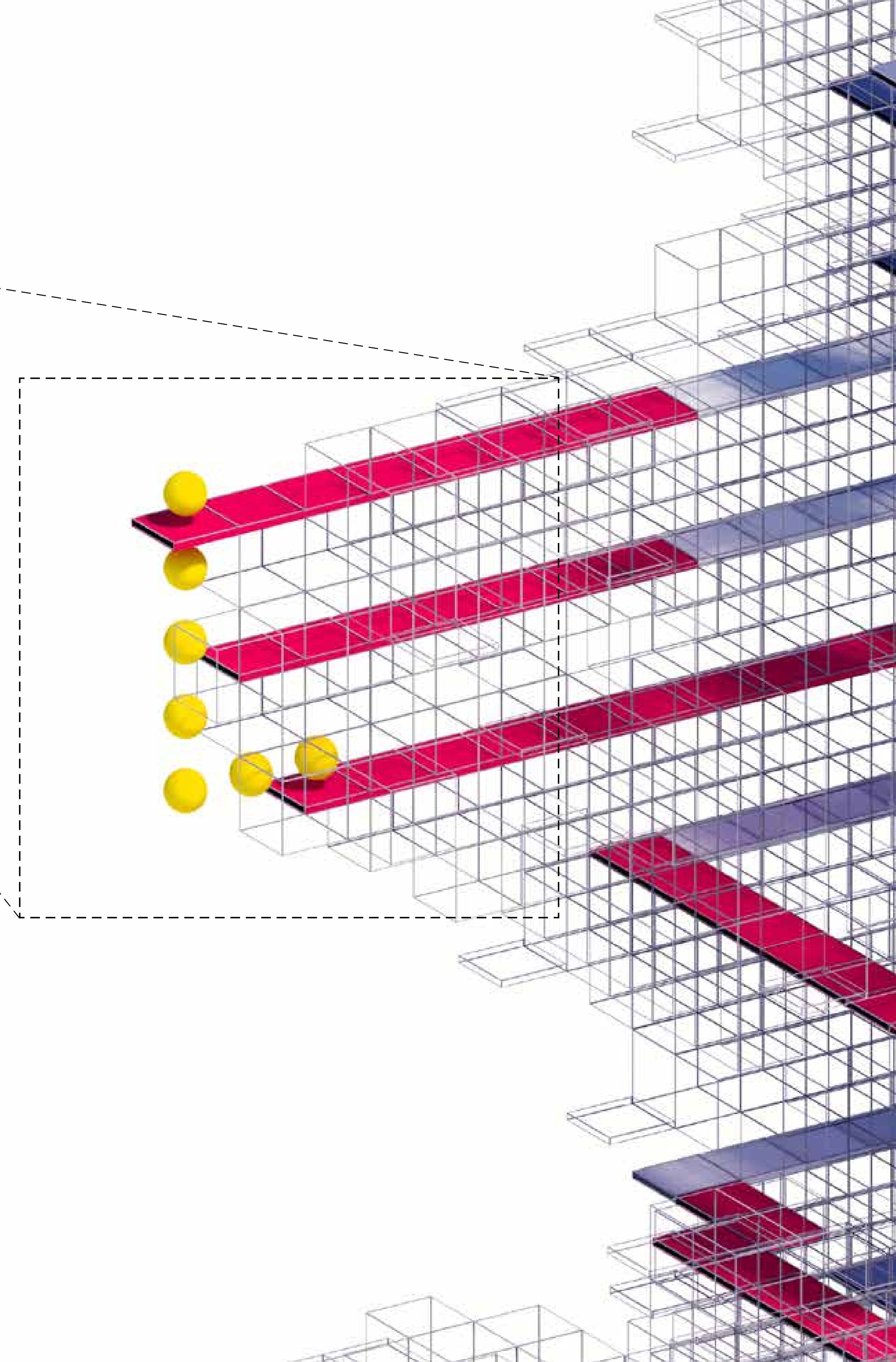
Suggest possible connections



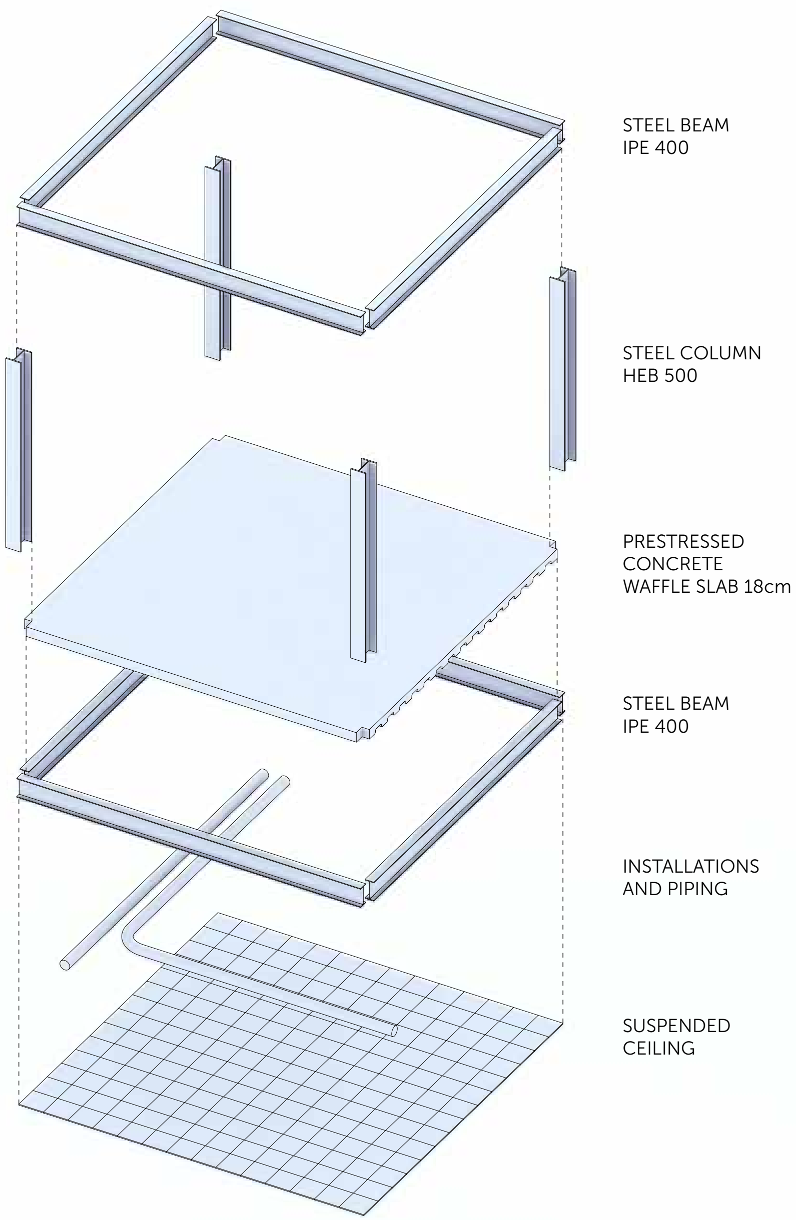
Add connection and recalculate



Repeat for entire structure



STRUCTURE



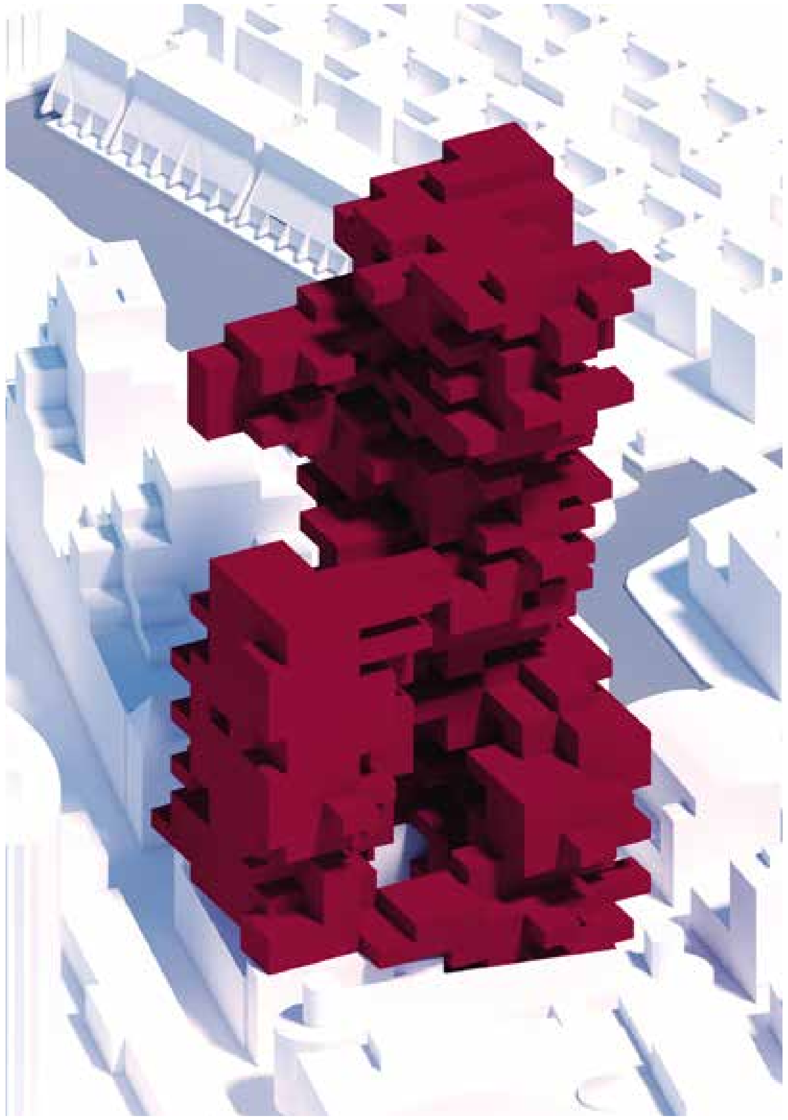
Main structural elements

TIMMERHUIS

Modular structural system of the Timmerhuis by O.M.A. in Rotterdam

STRUCTURAL RASTER OPTIMIZATION

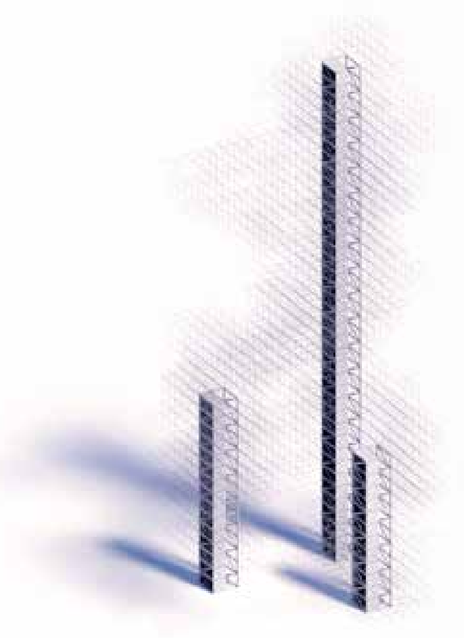
Comparing three variations of structural rasters and their efficiency; 7x7 m (left), 3.5x3.5 m (right), computationally optimized hybrid (center) offering a baalnce between efficiency and spatial flexibility



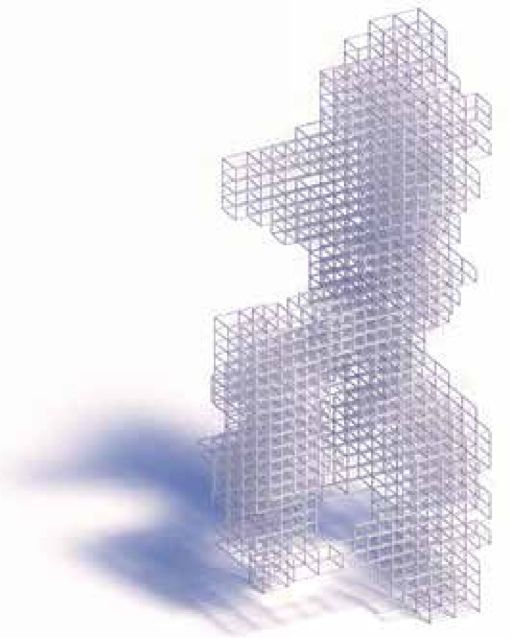
Only primary structure
9.960 elements - 100%

Primary and secondary structure mix
11.175 elements - 112%

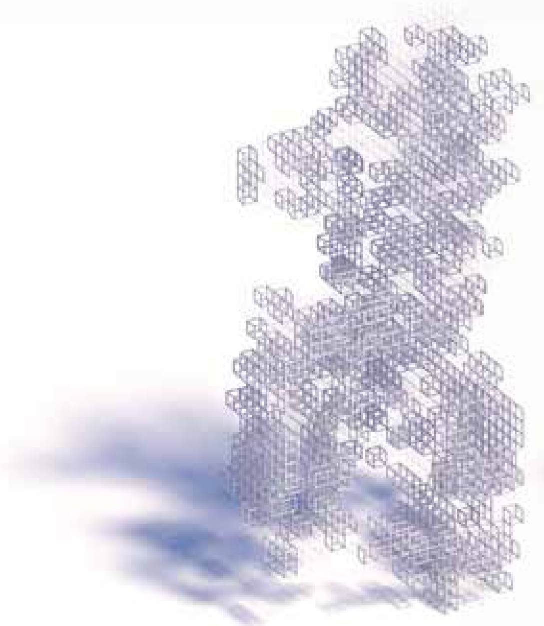
Only secondary structure
16.390 elements - 164%



Steel & concrete circulation cores

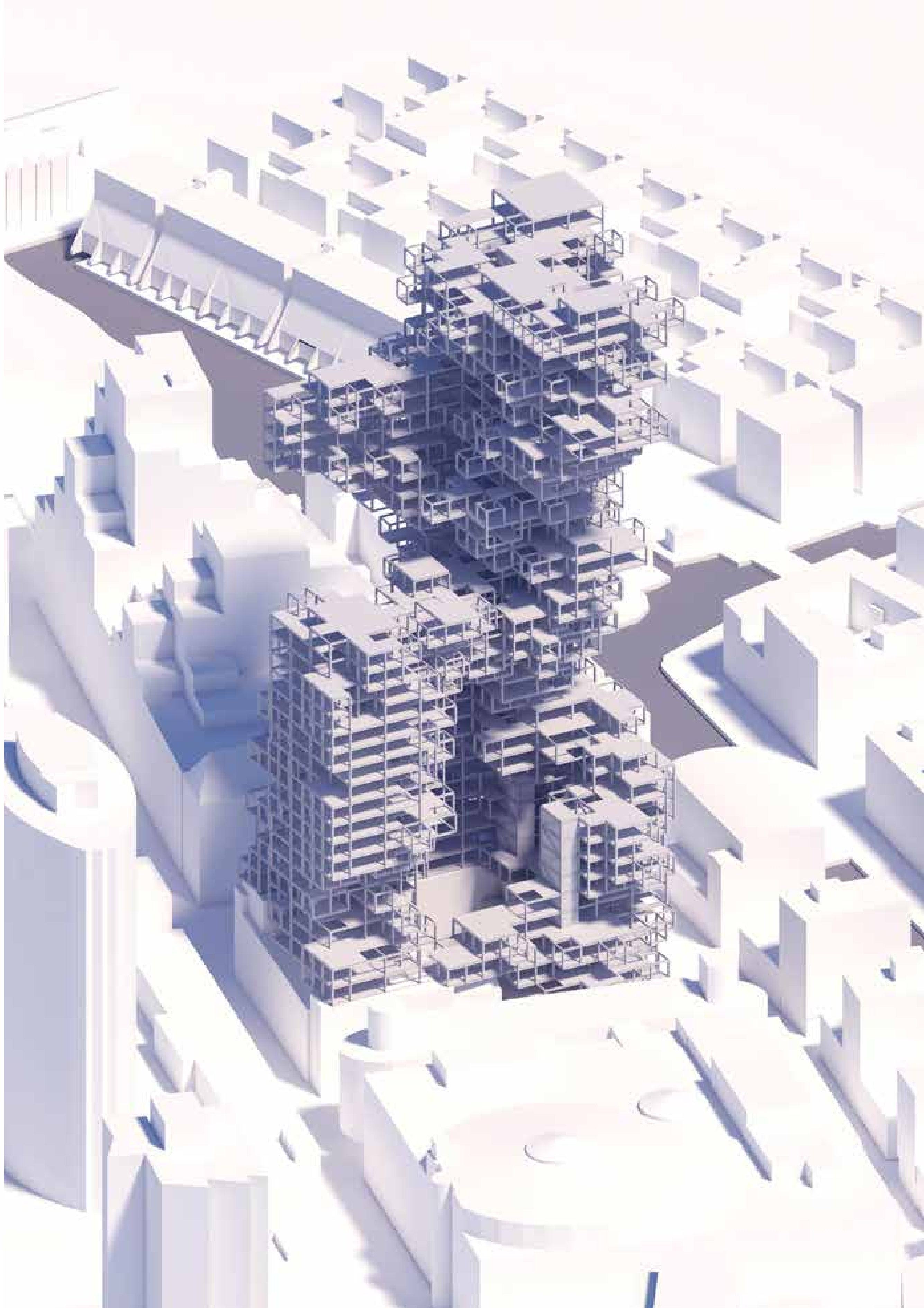


Primary steel structure

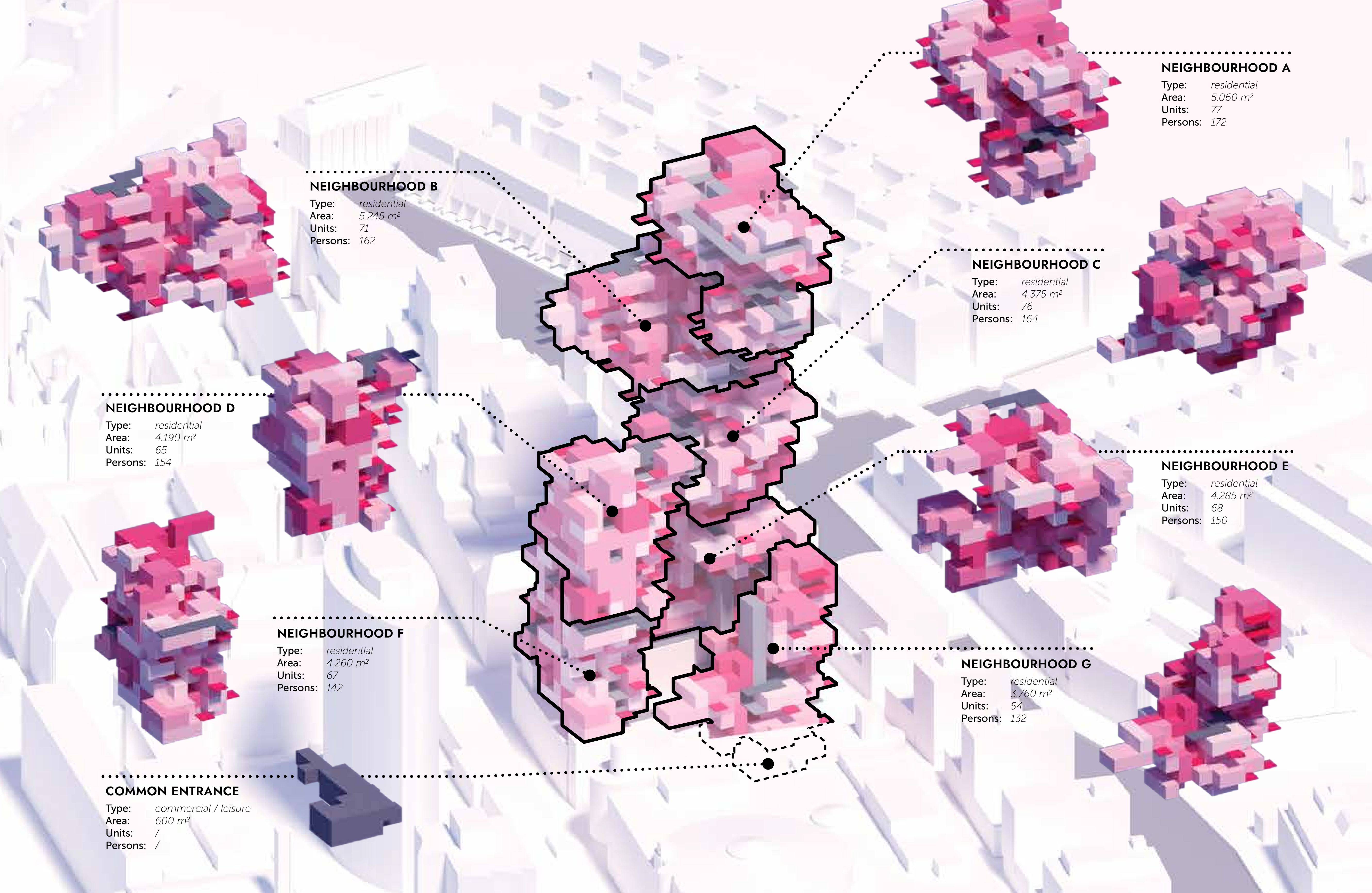


Secondary steel structure

Concrete modular floor panels



ORGANISATION



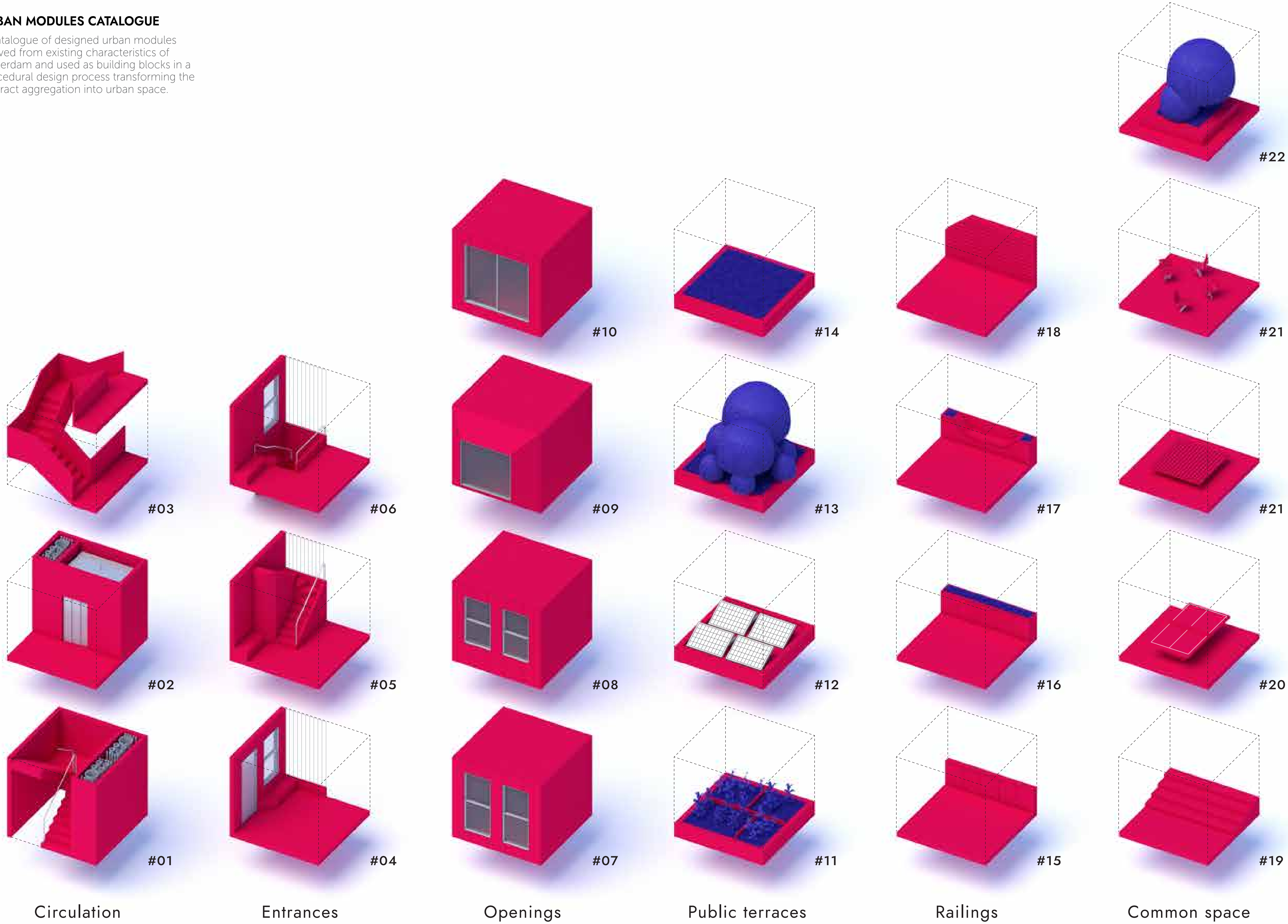
FUNCTION

ROTTERDAM FRAGMENTS

A series of urban space fragments from Rotterdam representing the predominant spatial elements constituting the existing city.

URBAN MODULES CATALOGUE

A catalogue of designed urban modules derived from existing characteristics of Rotterdam and used as building blocks in a procedural design process transforming the abstract aggregation into urban space.

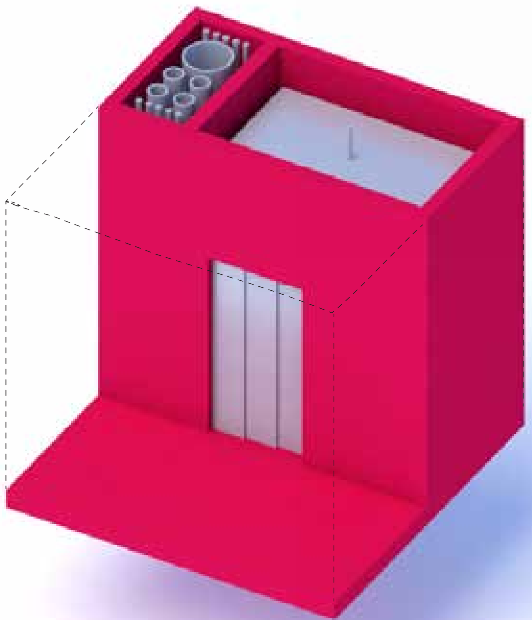


#01 | CORE STAIRS

CATEGORY: *Circulation*

ABOUT: *Primary means of vertical circulation in the building, also acting as a crucial fire-safe emergency exit. Also, a vertical shaft for utility piping such as electricity, water and sewage.*

CONDITIONS:
- *Vertically connected to same module type*
- *Combined with Core Elevator module*



#02 | CORE ELEVATOR

CATEGORY: *Circulation*

ABOUT: *Primary means of vertical circulation in the building, also appropriate for disabled persons. Large dimensions of 2.0 x 1.4 m enable transport of goods and furniture. Also, a vertical shaft for utility piping such as electricity, water and sewage.*

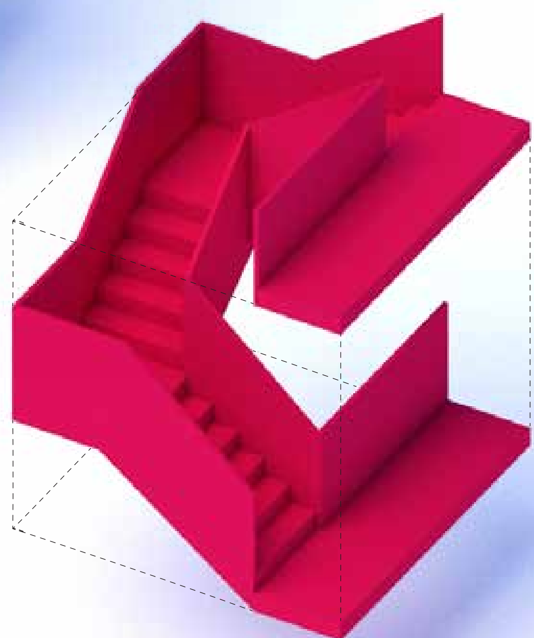
CONDITIONS:
- *Vertically connected to same module type*
- *Combined with Core Stairs module*

#03 | SECONDARY STAIRS

CATEGORY: *Circulation*

ABOUT: *Secondary vertical circulation applied in cases where the distance to the vertical core is too large for safe escape. Through creating two-way escape routes the secondary stairs also increase connectivity and flexibility in circulation.*

CONDITIONS:
- *Combined with circulation voxel*

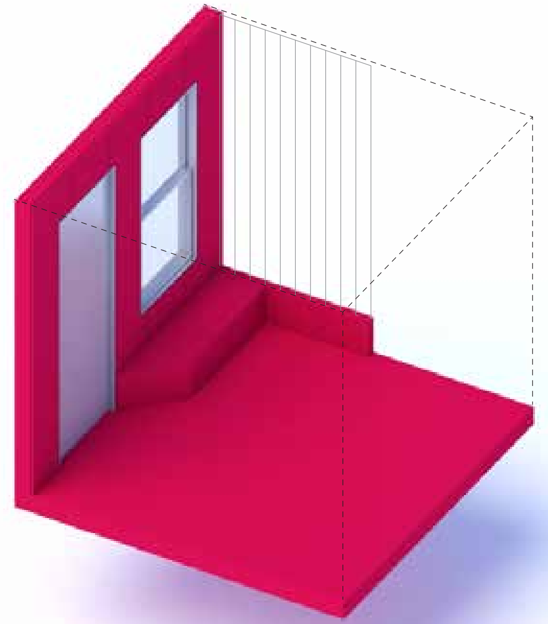


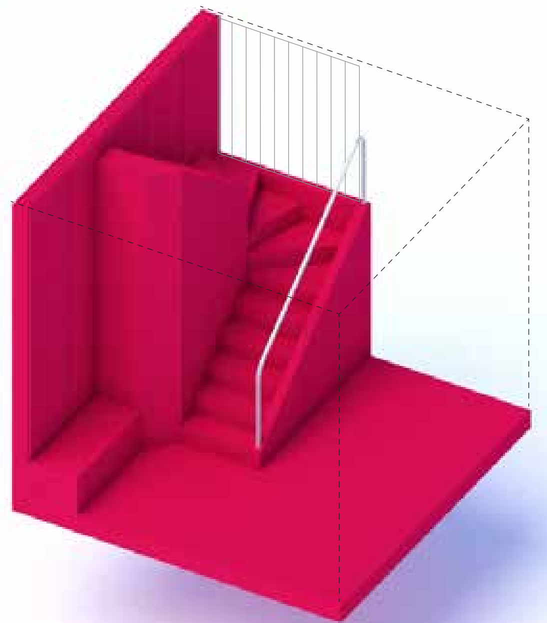
#04 | STREET ENTRANCE

CATEGORY: *Entrances*

ABOUT: *Derived from traditional row houses in which every unit has a direct entrance to the public street. Its immediate vicinity is considered an extension of the unit; a space to be occupied and approapriated with seating, plants and more.*

CONDITIONS:
- *Maximum one per unit*
- *Combined with circulation voxel*





#05 | STOOP ENTR. UP

CATEGORY: *Entrances*

ABOUT: *Inspired by the traditional Dutch stoop present in a large number of row houses, this entrance area combining stairs and an area for sitting creates a semi-private zone increasing the possibilty for appropriation by occupants.*

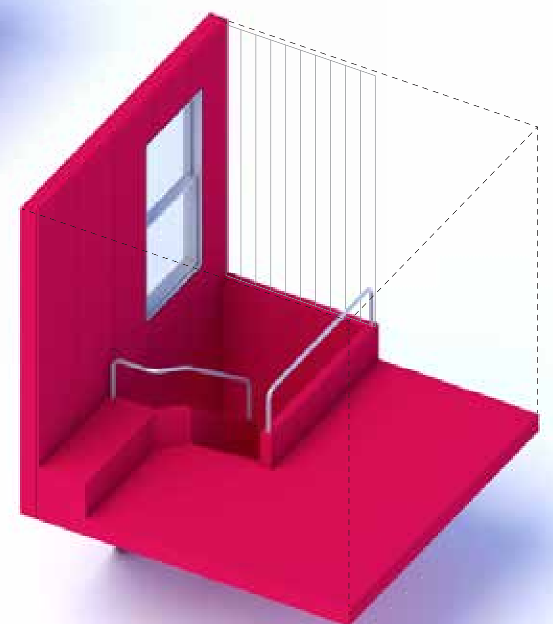
CONDITIONS:
- *Maximum one per unit*
- *Combined with circulation voxel*

#06 | STOOP ENTR. DOWN

CATEGORY: *Entrances*

ABOUT: *Inspired by the traditional Dutch stoop present in a large number of row houses, this entrance area combining stairs and an area for sitting creates a semi-private zone increasing the possibilty for appropriation by occupants.*

CONDITIONS:
- *Maximum one per unit*
- *Combined with circulation voxel*

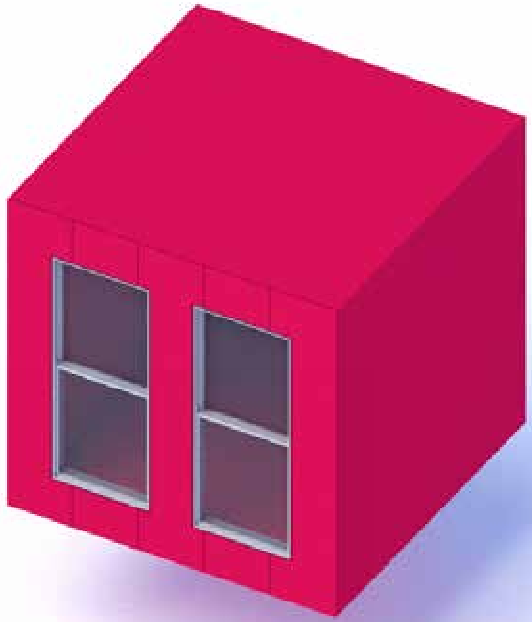


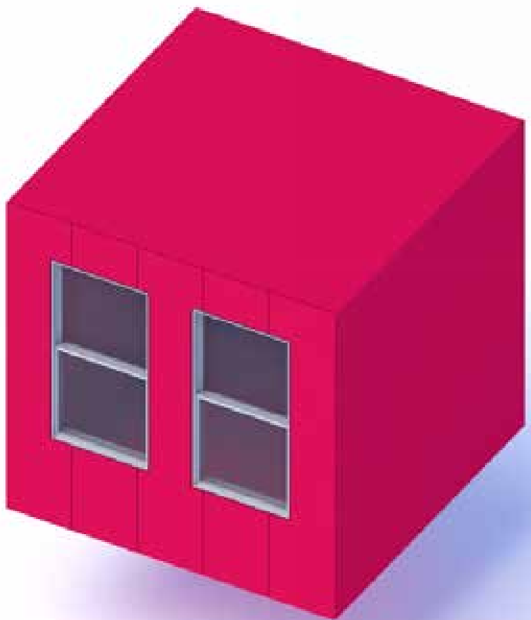
#07 | TRAD. WINDOW

CATEGORY: *Openings*

ABOUT: *Modeled after traditional Dutch row house windows with a large height-to-width ratio to maximise the daylighting depth. These qualities are emphasised in this floor to ceiling version which maximises the connection to exterior.*

CONDITIONS:
- Where other window types are not possible
- When facing an empty voxel.





#08 | STREET WINDOW

CATEGORY: *Openings*

ABOUT: *Modeled after traditional Dutch row house windows with a large height-to-width ratio to maximise the daylighting depth. This smaller version is specifically designed for positioning next to circulation streets to limit privacy conflicts as well as positioning of bench elements on its exterior side.*

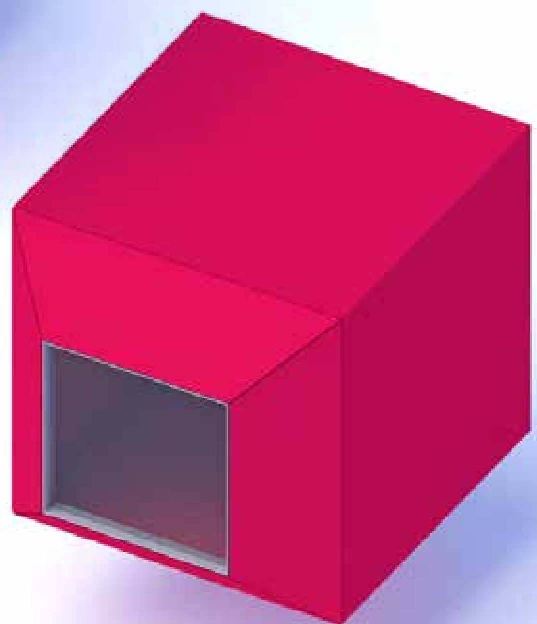
CONDITIONS:
- Where other window types are not possible
- When facing directly a circulation voxel.

#09 | BAY WINDOW

CATEGORY: *Openings*

ABOUT: *A reinterpretation of the typical row house bay window, once acting as a symbol of wealth and prosperity. It acts as a focal point of a unit's identity and extends its interior space outwards.*

CONDITIONS:
- Maximum one per unit
- Its neighbour voxel must not be occupied
- Neighbour voxel is not circulation

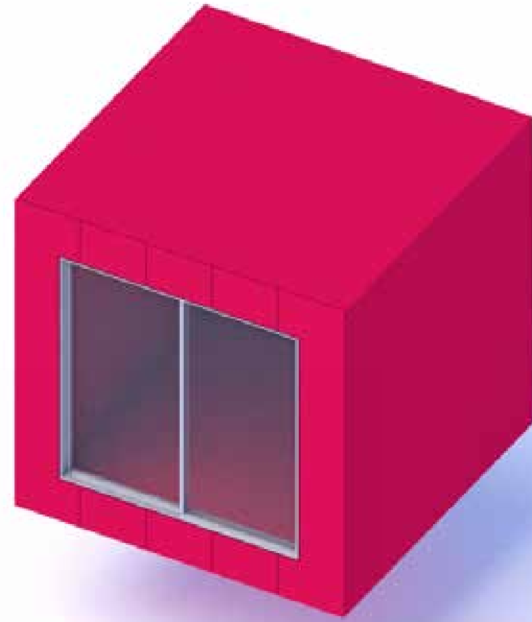


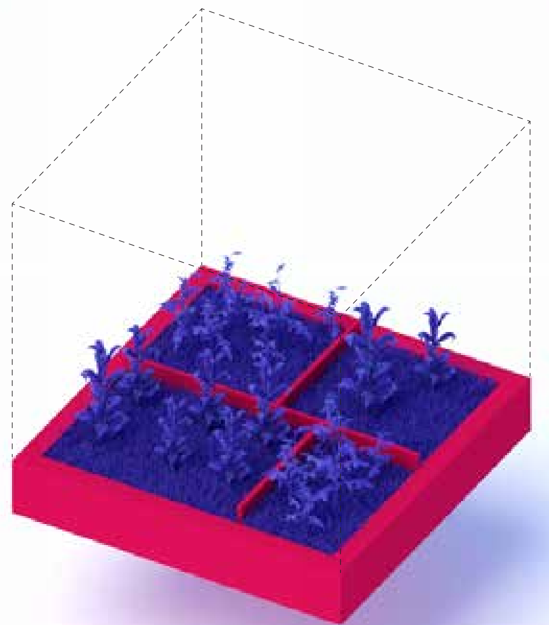
#10 | LARGE WINDOW

CATEGORY: *Openings*

ABOUT: *A translation of the large, often north-facing windows in modern Dutch housing. Maximises view and valuable sunlight at the cost of privacy, eliminated by its positioning rules. Can be transformed to a french balcony.*

CONDITIONS:
- Neighbour voxel is not circulation
- No privacy conflicts on this facade
- Maximum of 2 hours of sun





#11 | COMMUNITY GARDEN

CATEGORY: *Public terraces*

ABOUT: *Community gardens are intended for small-scale local food production, also acting as social generators, water management and retention systems, improving insulation and creating pleasant microclimates.*

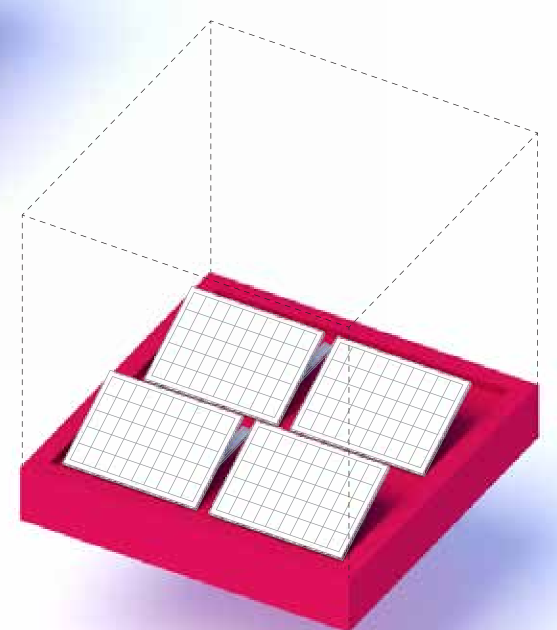
CONDITIONS:
- Rooftop must be accessible from circulation.
- Minimum 3 hours sunlight
- Roof must have rainwater access

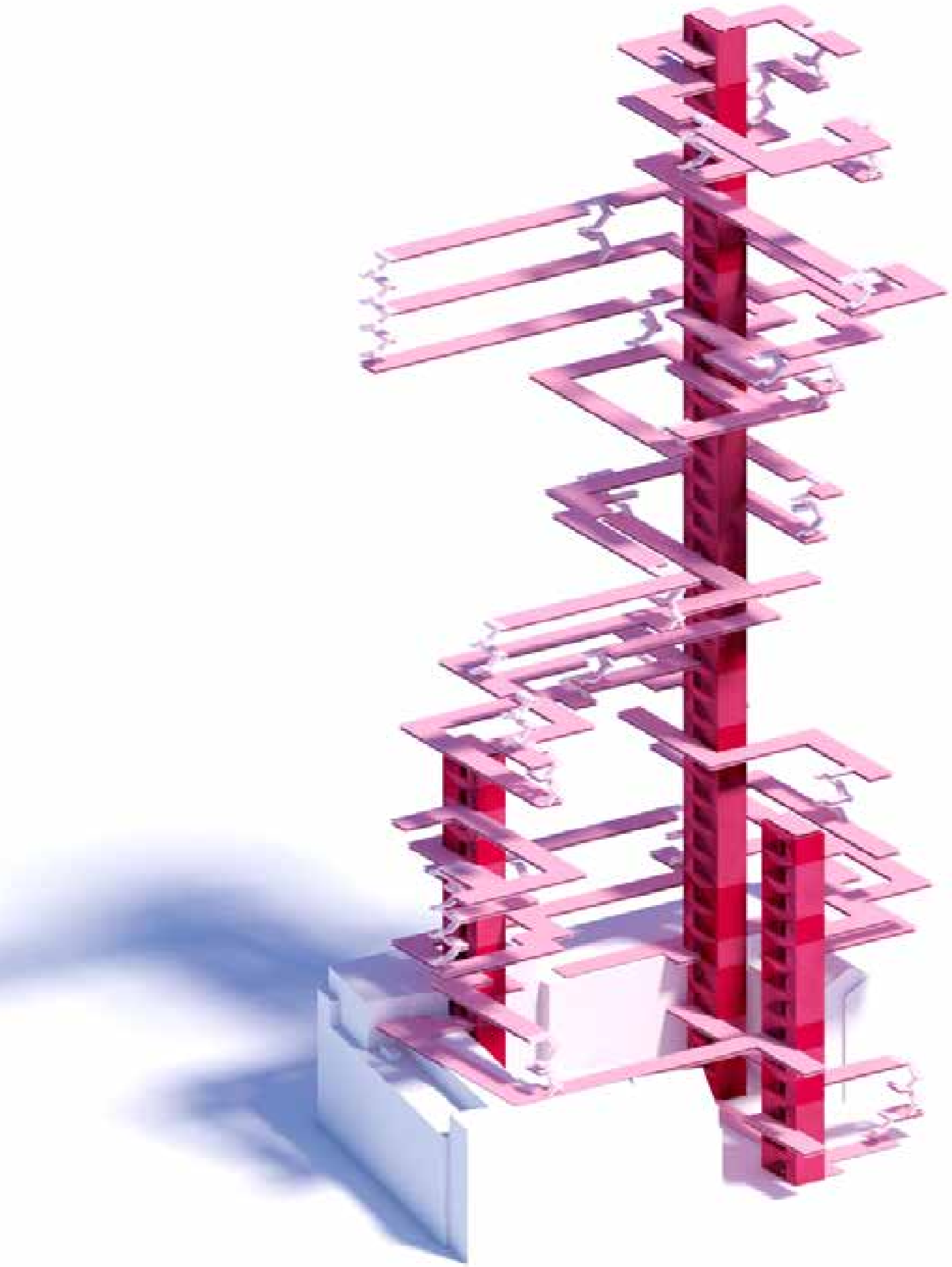
#12 | SOLAR COLLECTOR

CATEGORY: *Public terraces*

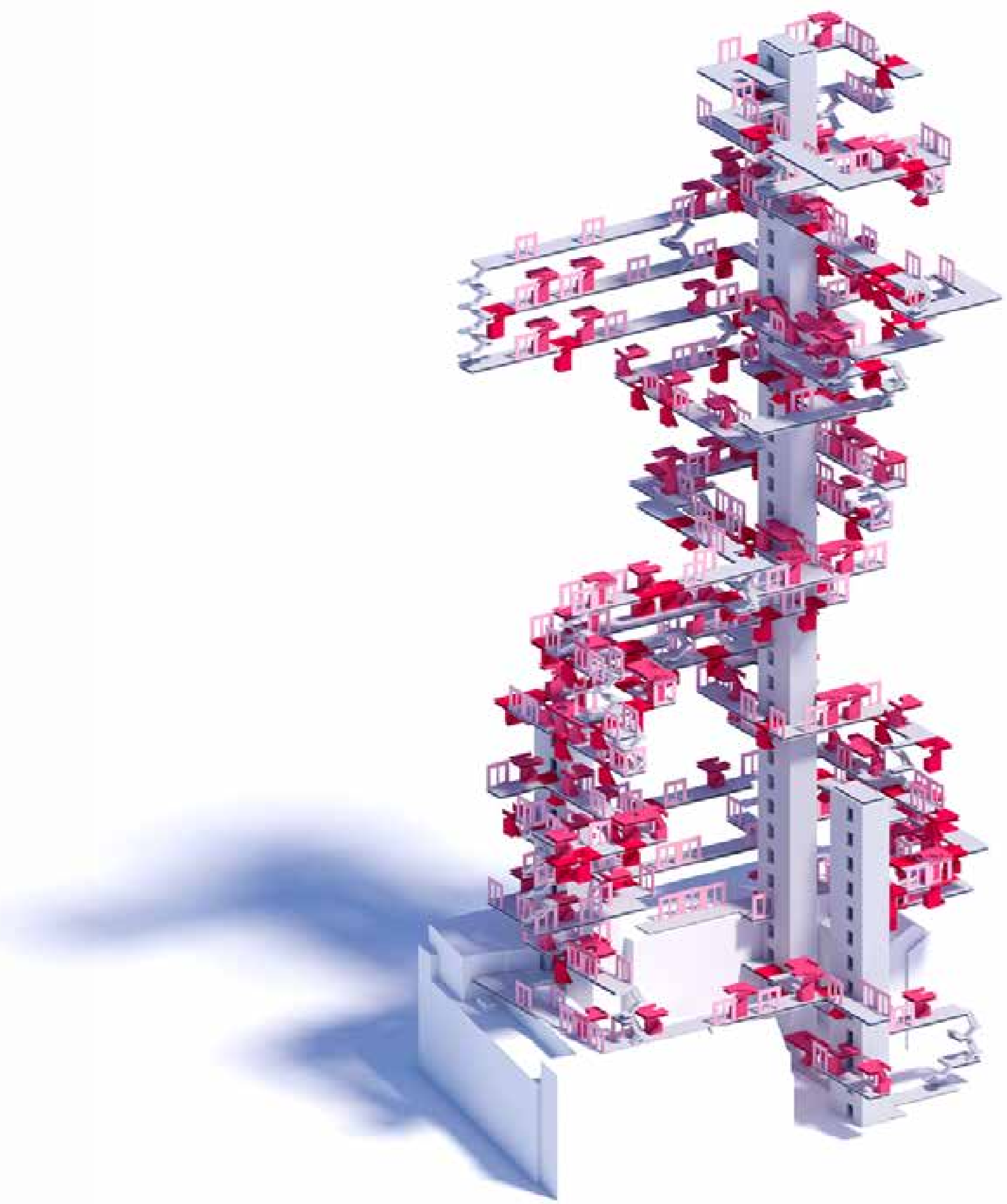
ABOUT: *Collectors in the form of solar PV-panels or solar thermal panels occupy the best-sunlit rooftops of the building and act as a source of renewable energy while putting excess porosity to good use.*

CONDITIONS:
- Minimum 5 hours of direct sunlight daily
- Maximum 20% of total rooftops





1. Circulation modules



2. Entrance modules

3. Window modules

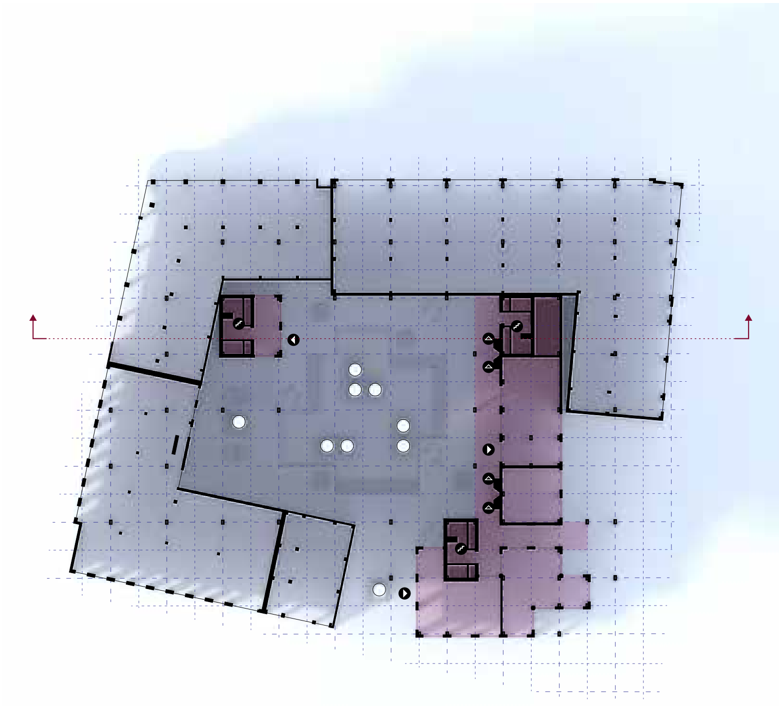
4. Floors and interior walls

5. Public terraces

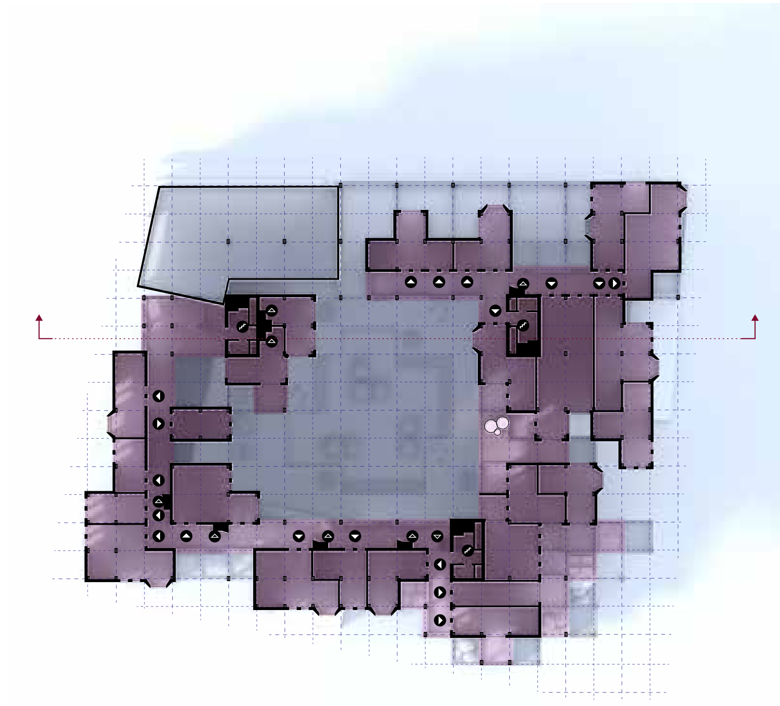
6. Fences and railings

7. Corner details

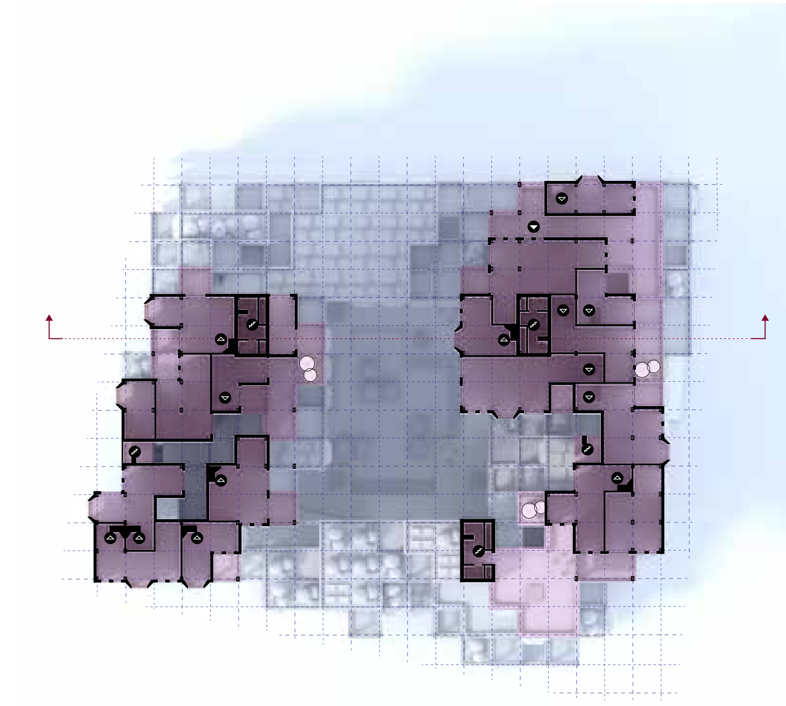
8. Output



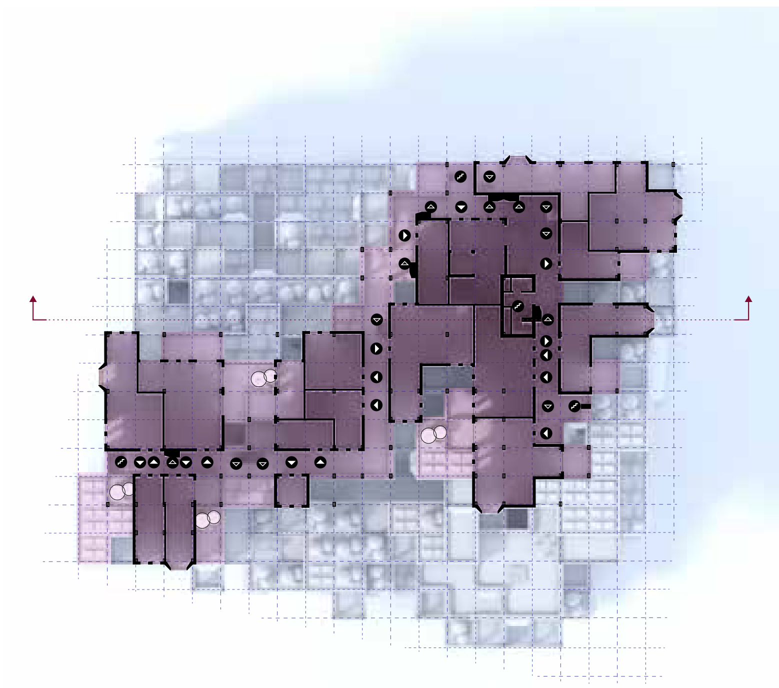
Plan | floor #0



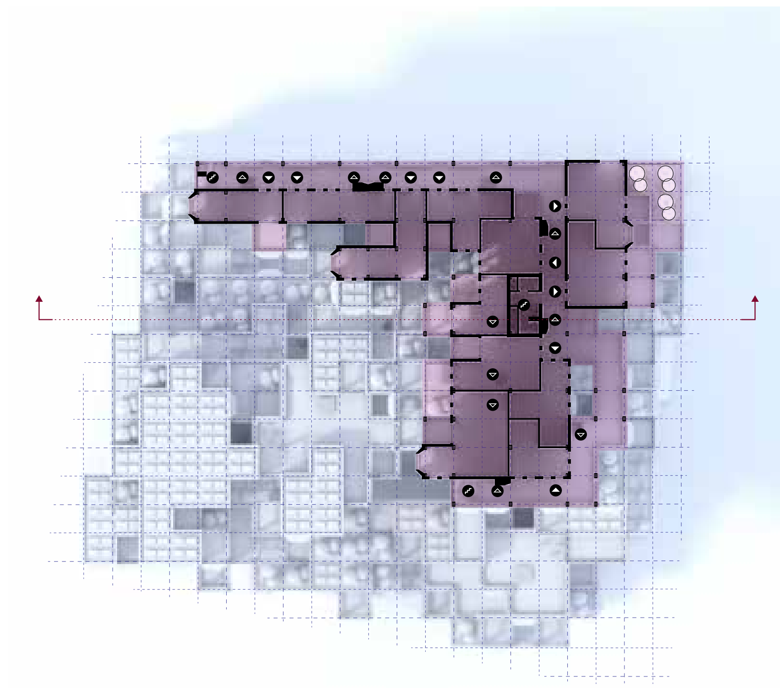
Plan | floor #7



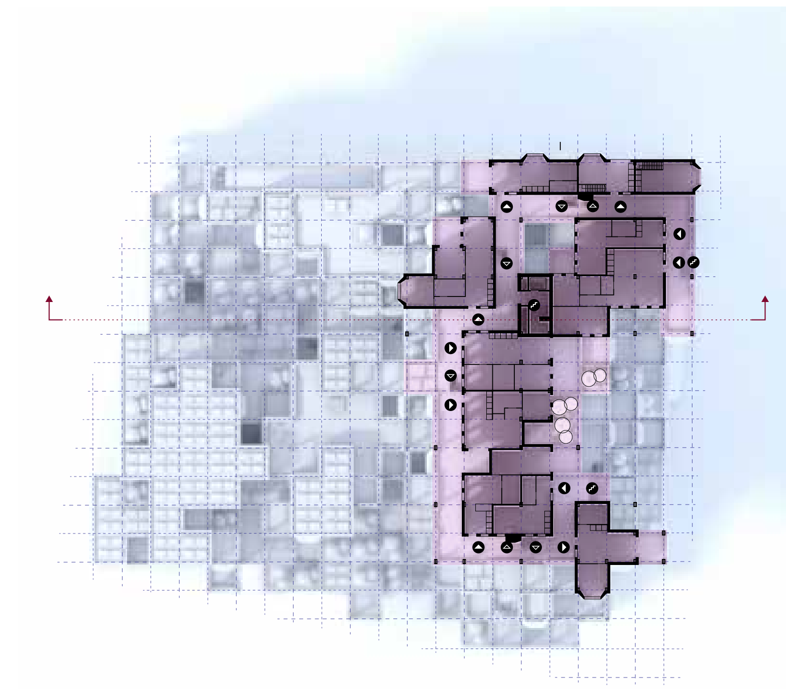
Plan | floor #13



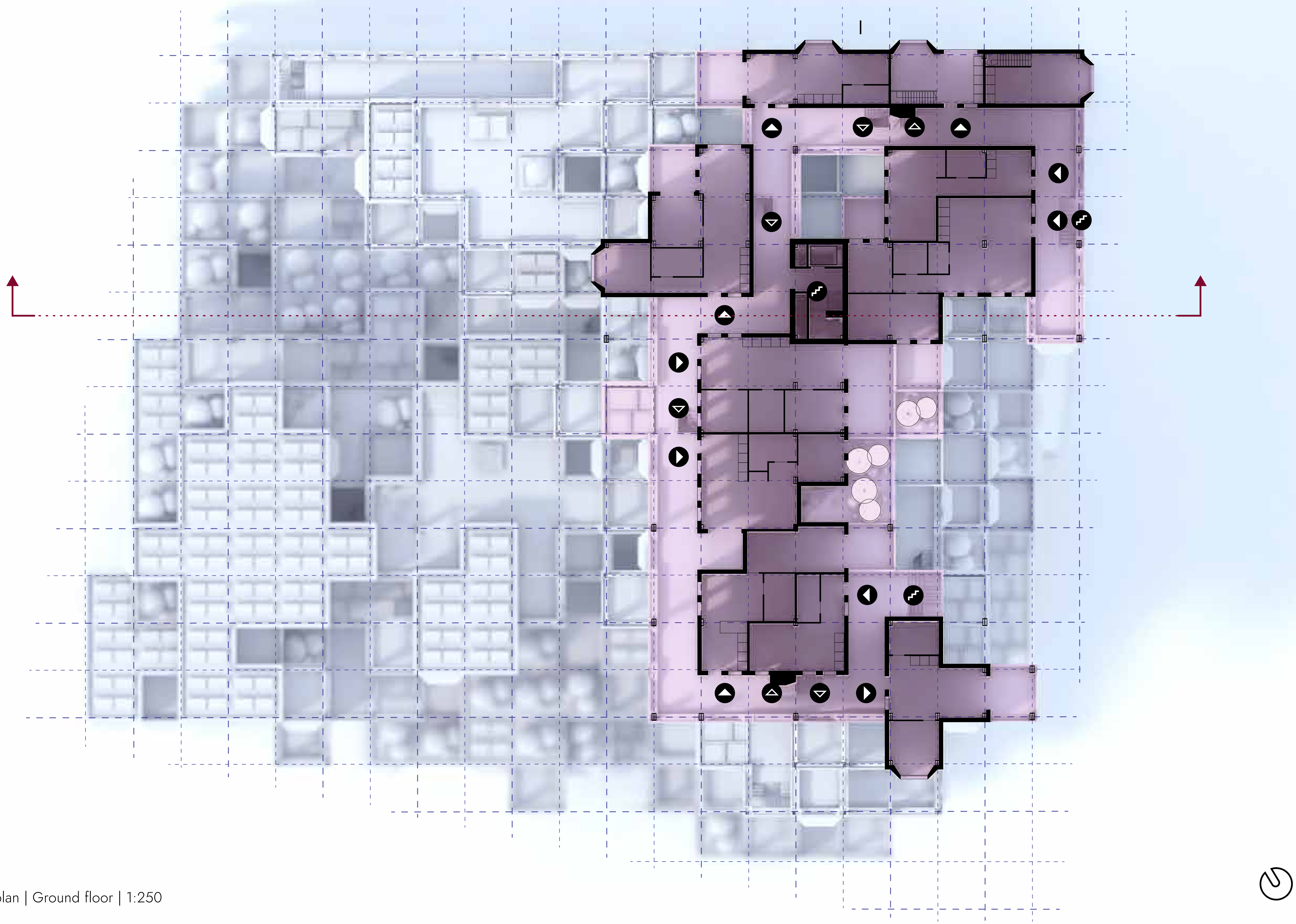
Plan | floor #23



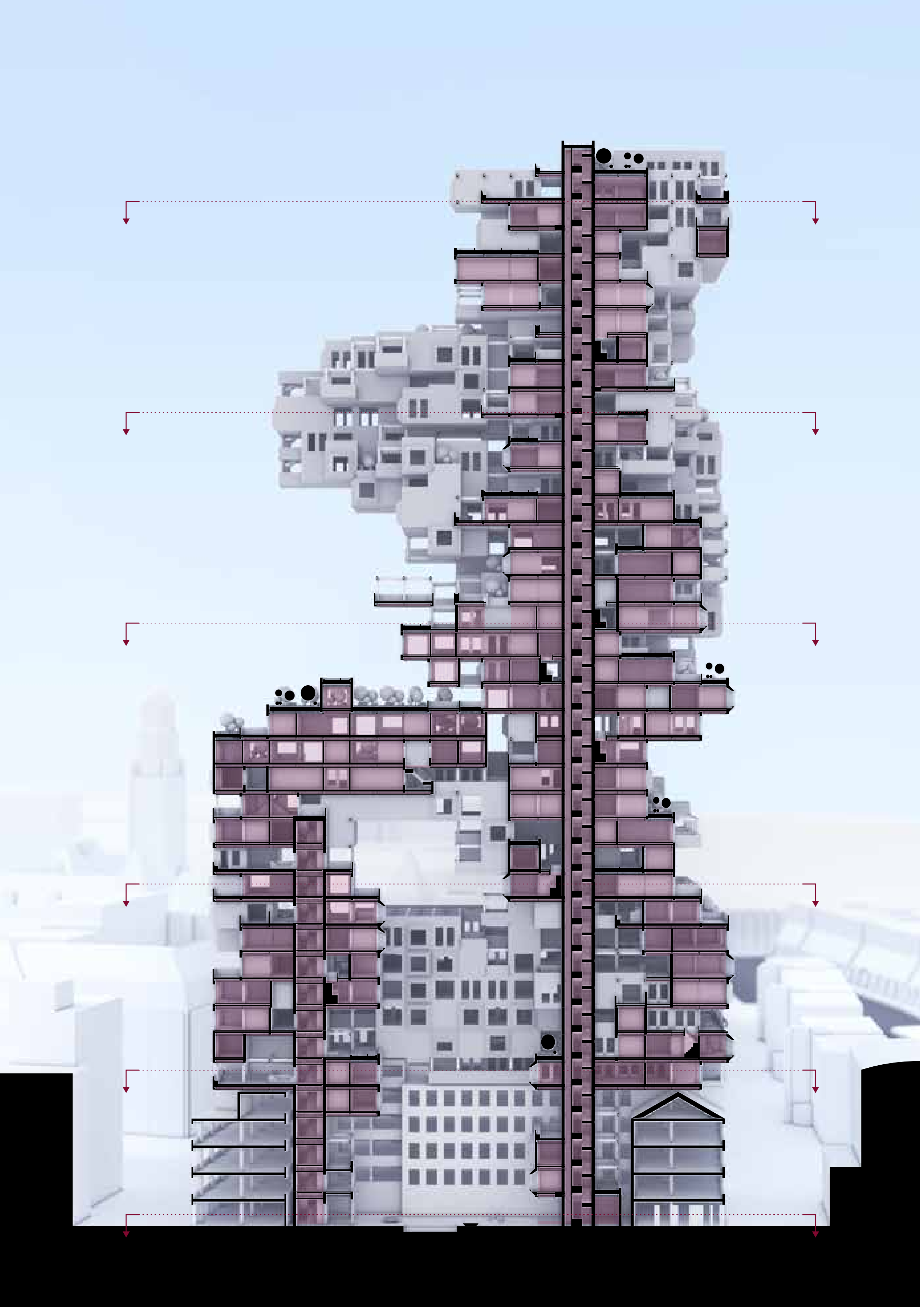
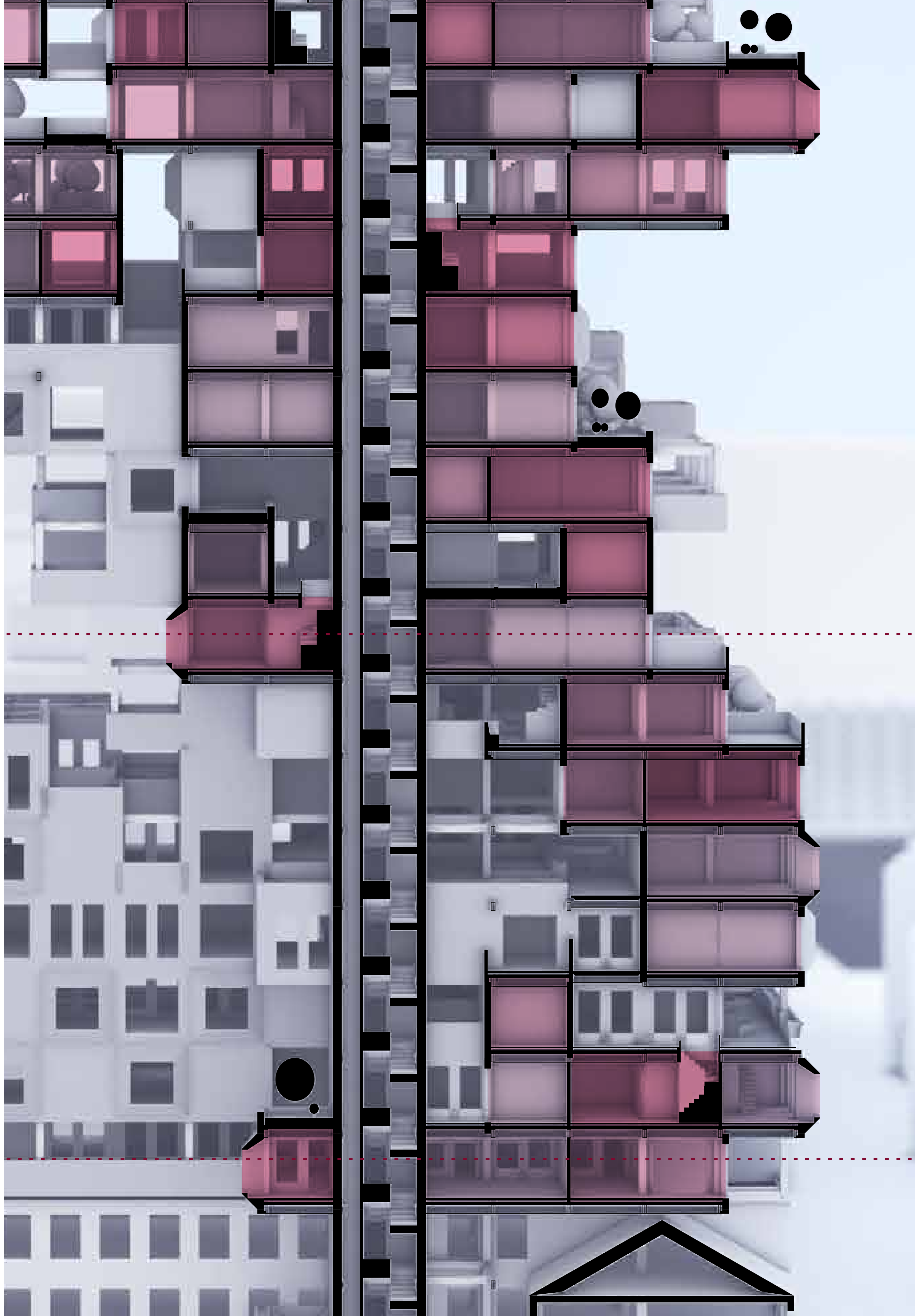
Plan | floor #31



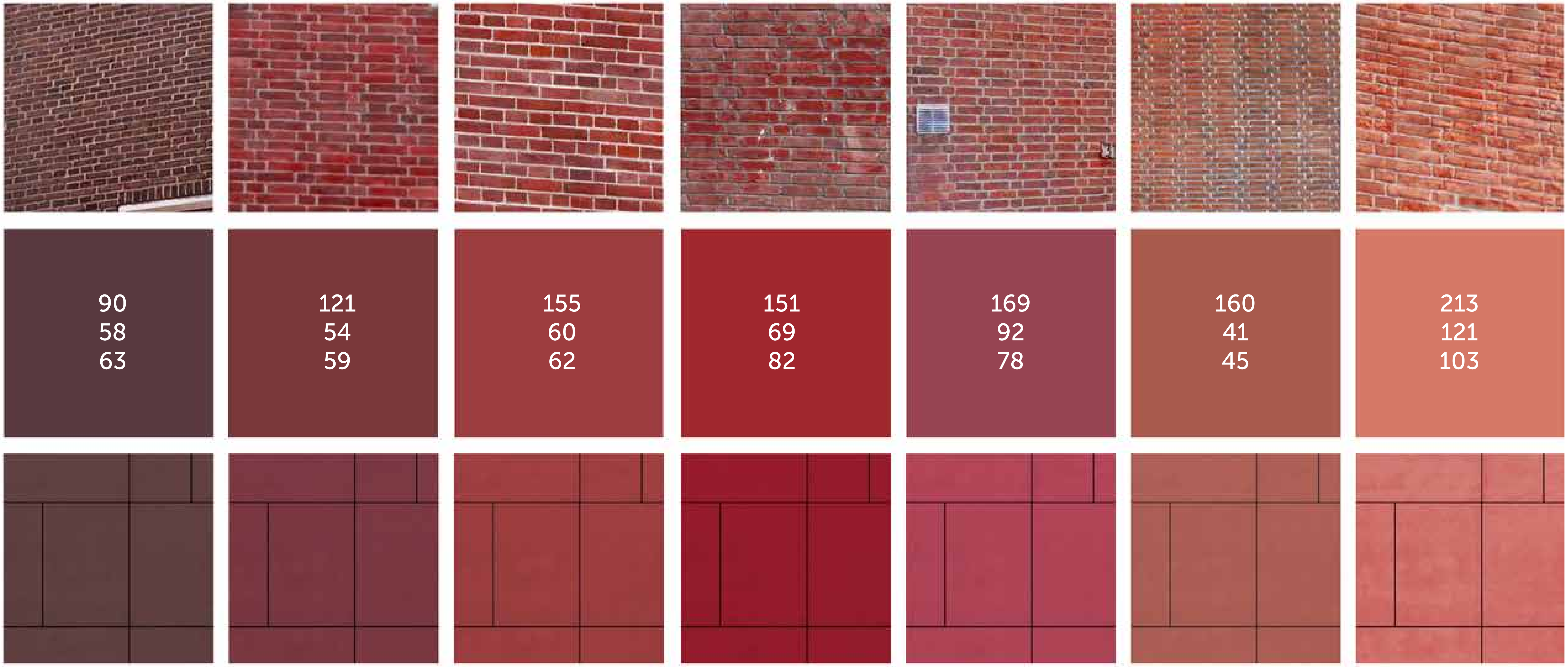
Plan | floor #39



Floor plan | Ground floor | 1:250

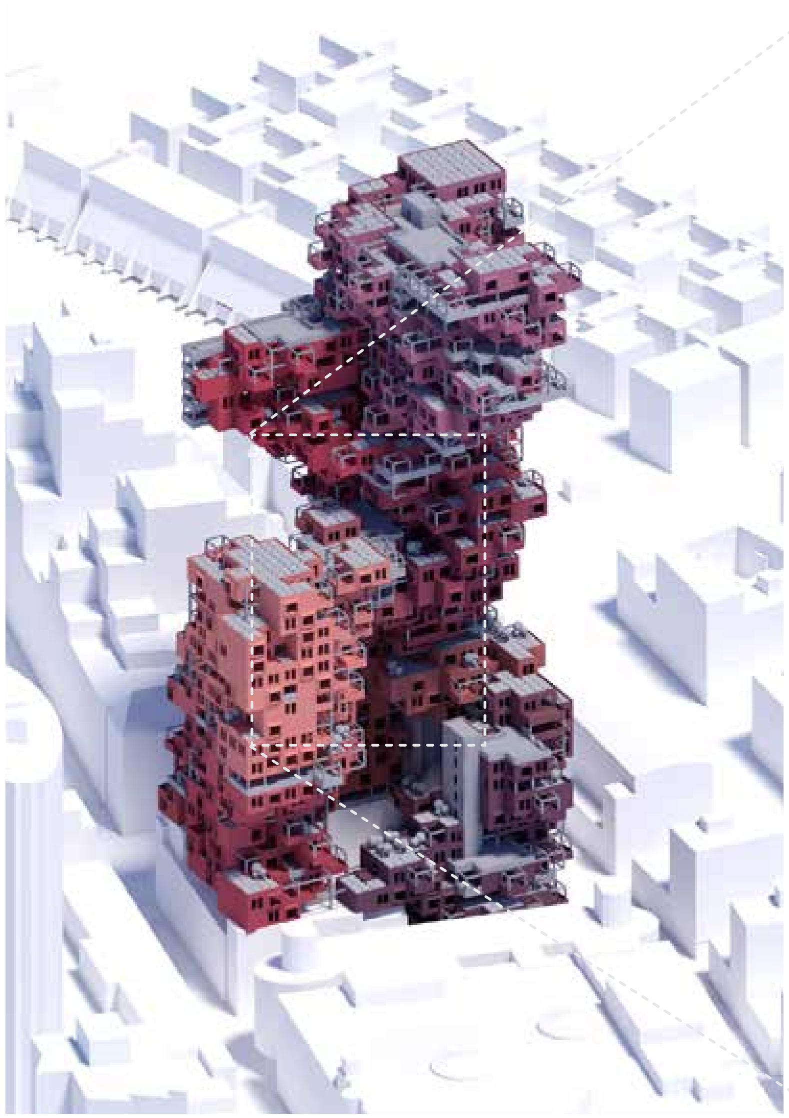



MATERIALITY



IDENTITY

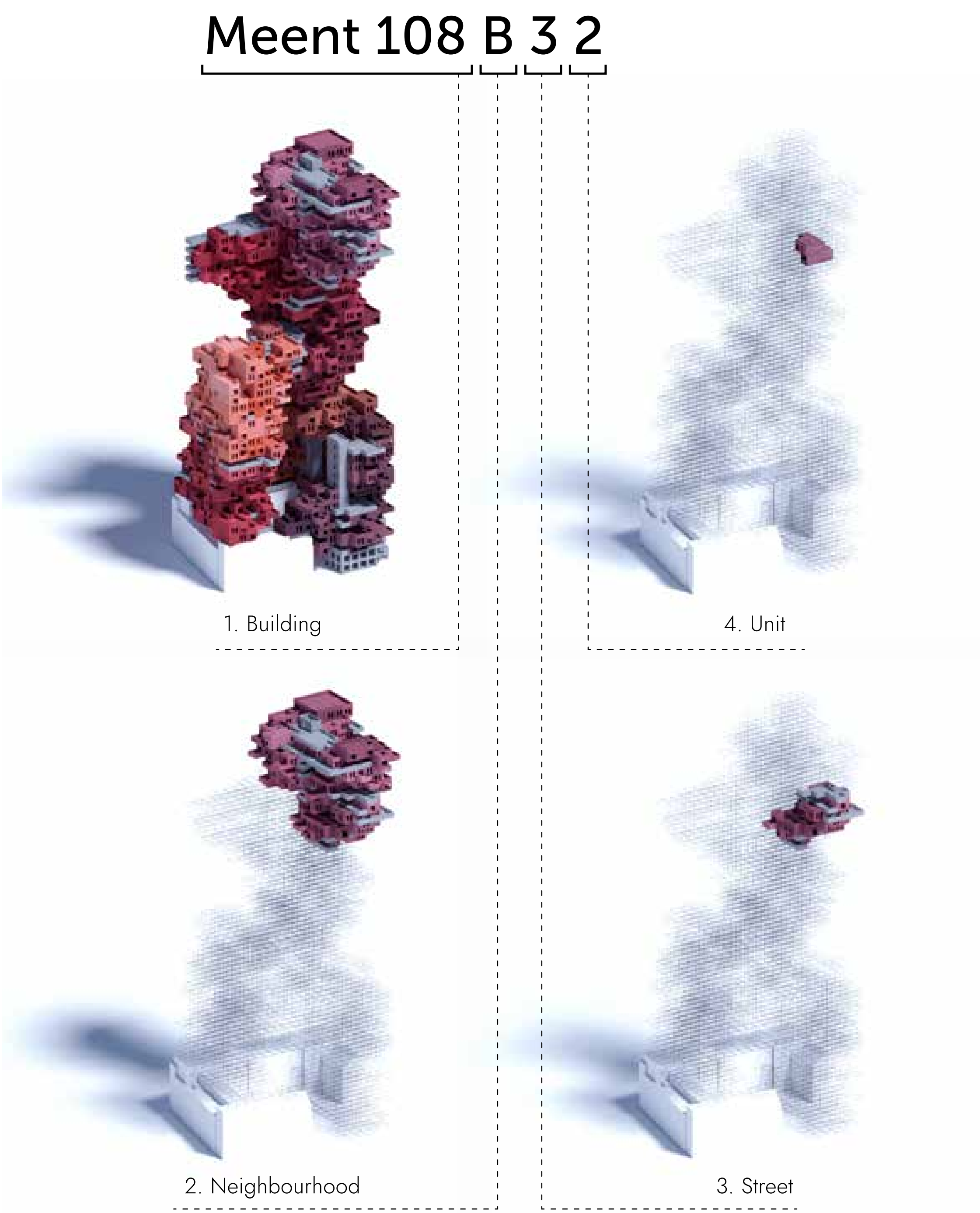
Differentiated public spaces
Circulation and common spaces in raw concrete

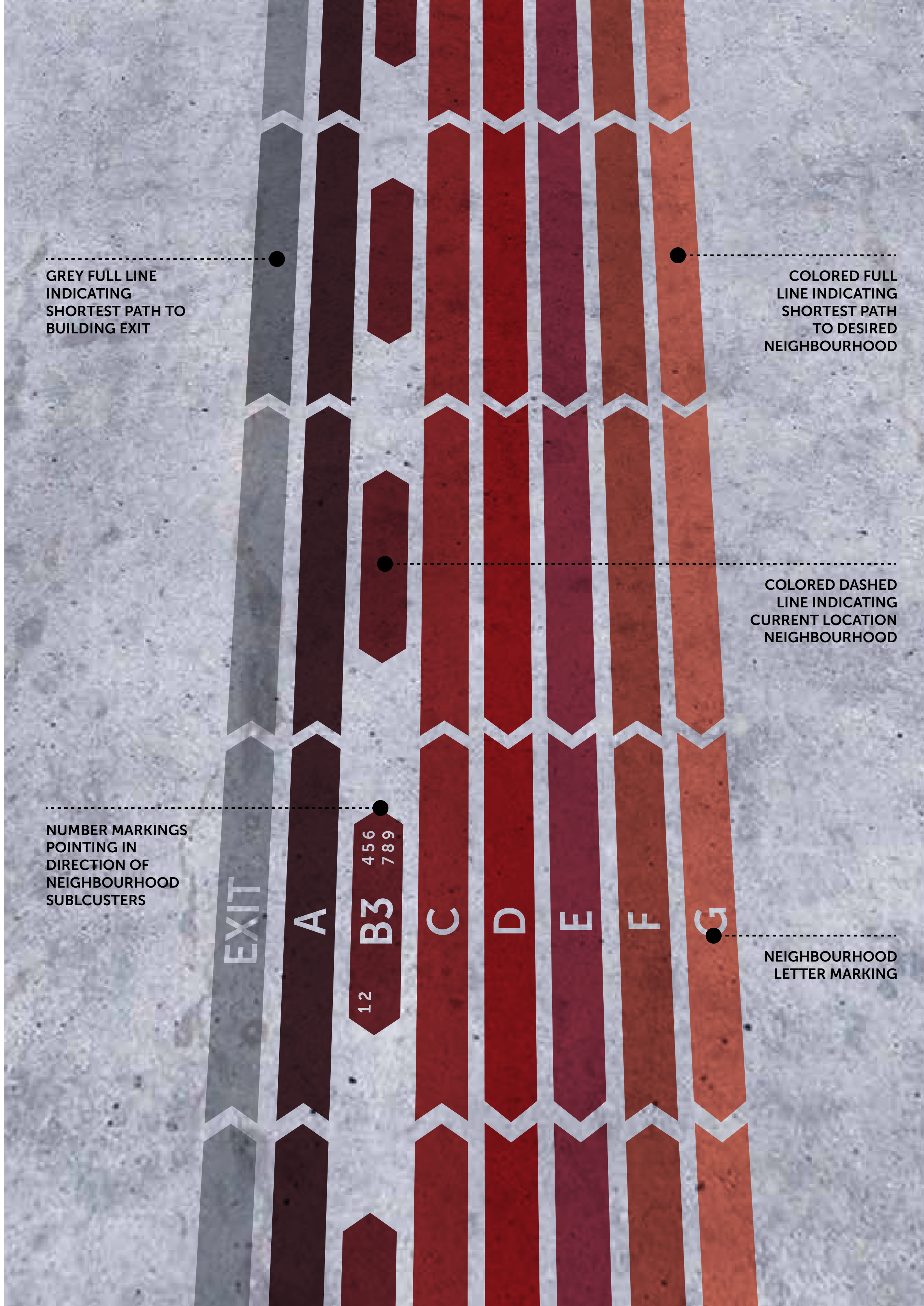


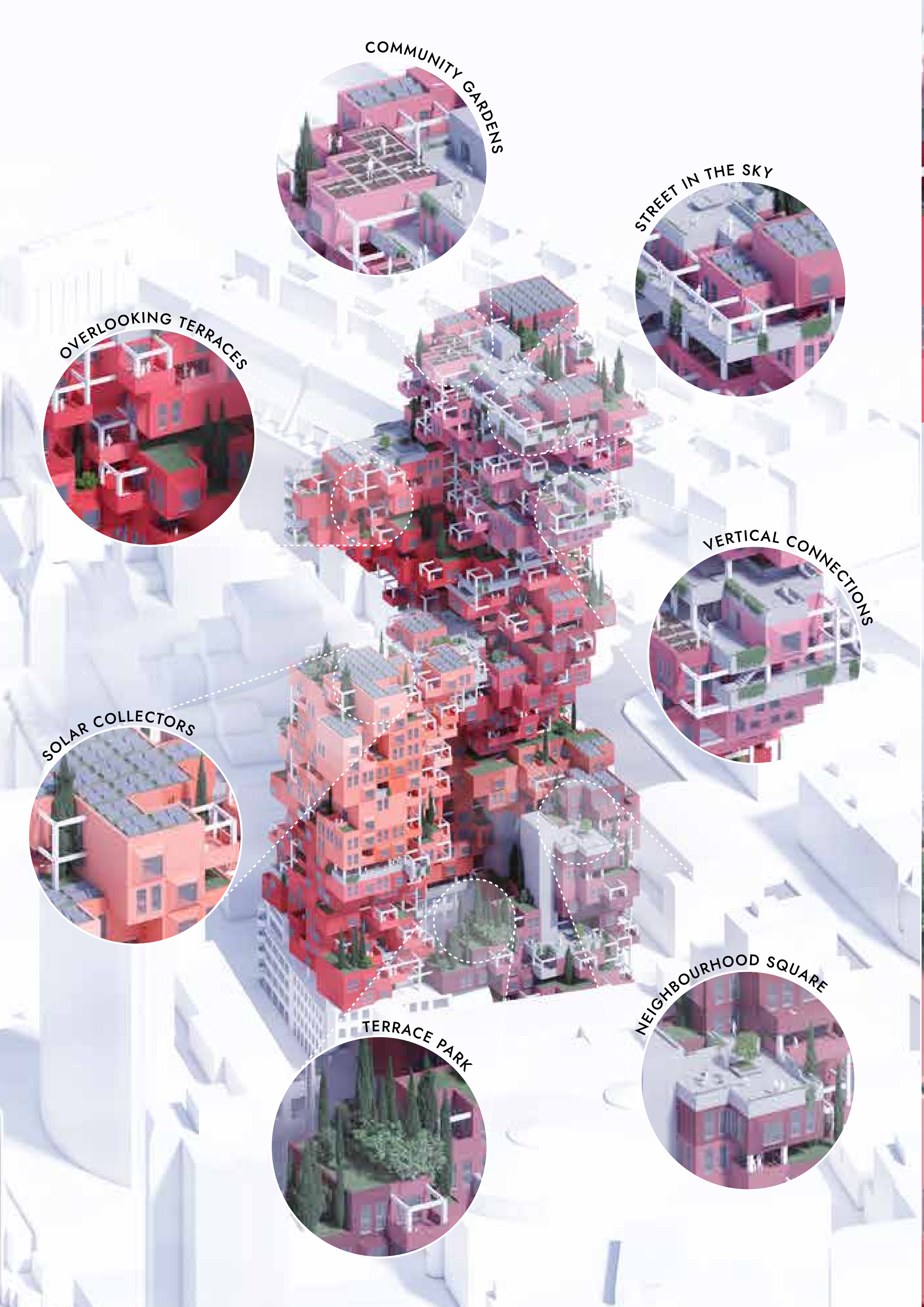
Private units; global identity
Seven residential clusters representing comunities

Private units; local identity
Differentiated color shades of individual units

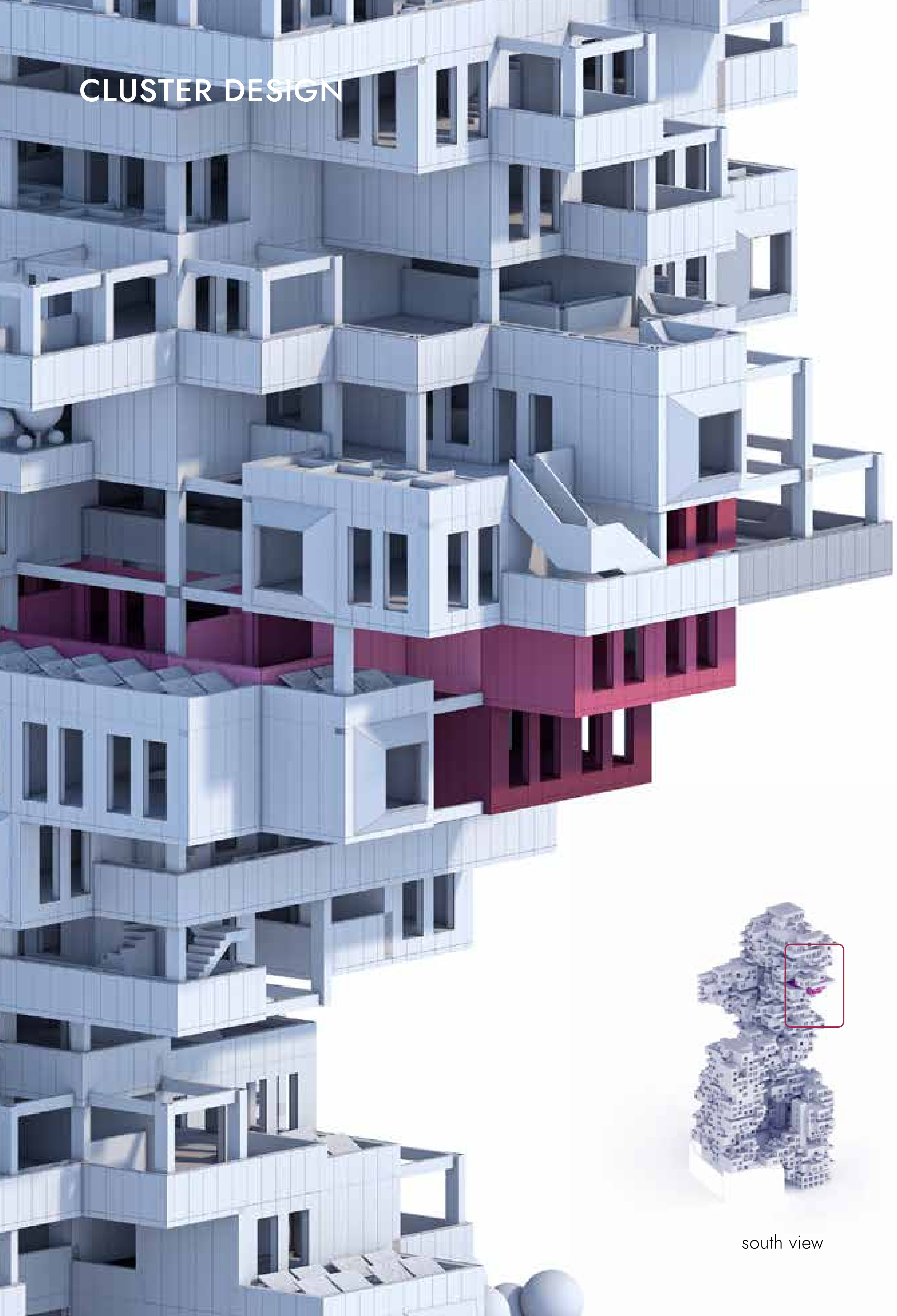
WAYFINDING


Meent 108 B 3 2
1. Building
4. Unit
2. Neighbourhood
3. Street

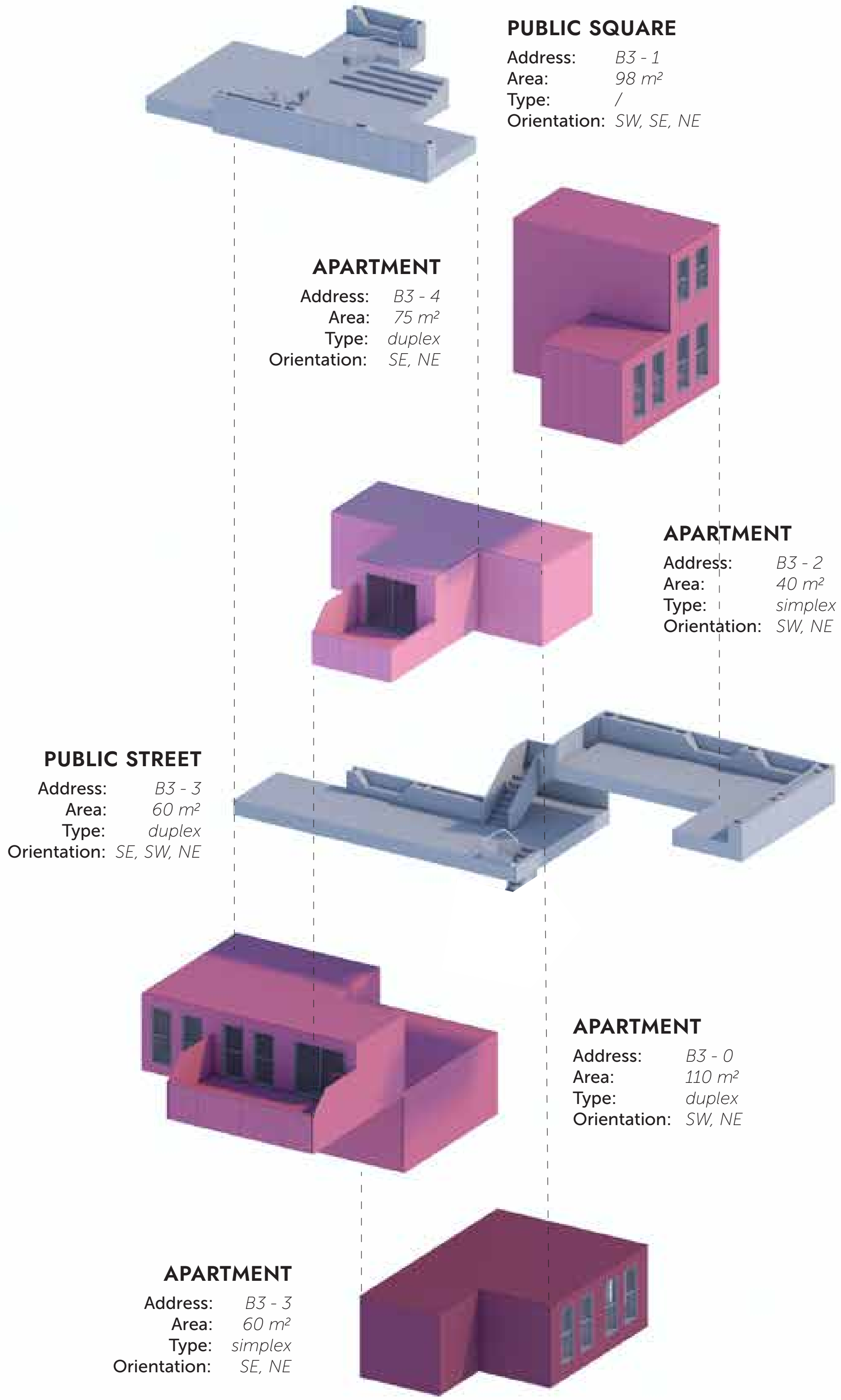

GREY FULL LINE INDICATING SHORTEST PATH TO BUILDING EXIT
COLORED FULL LINE INDICATING SHORTEST PATH TO DESIRED NEIGHBOURHOOD
COLORED DASHED LINE INDICATING CURRENT LOCATION NEIGHBOURHOOD
NUMBER MARKINGS POINTING IN DIRECTION OF NEIGHBOURHOOD SUBLCUSTERS
NEIGHBOURHOOD LETTER MARKING
EXIT
A
B3
C
D
E
F
G
456
789
12


COMMUNITY GARDENS
STREET IN THE SKY
OVERLOOKING TERRACES
VERTICAL CONNECTIONS
SOLAR COLLECTORS
NEIGHBOURHOOD SQUARE
TERRACE PARK

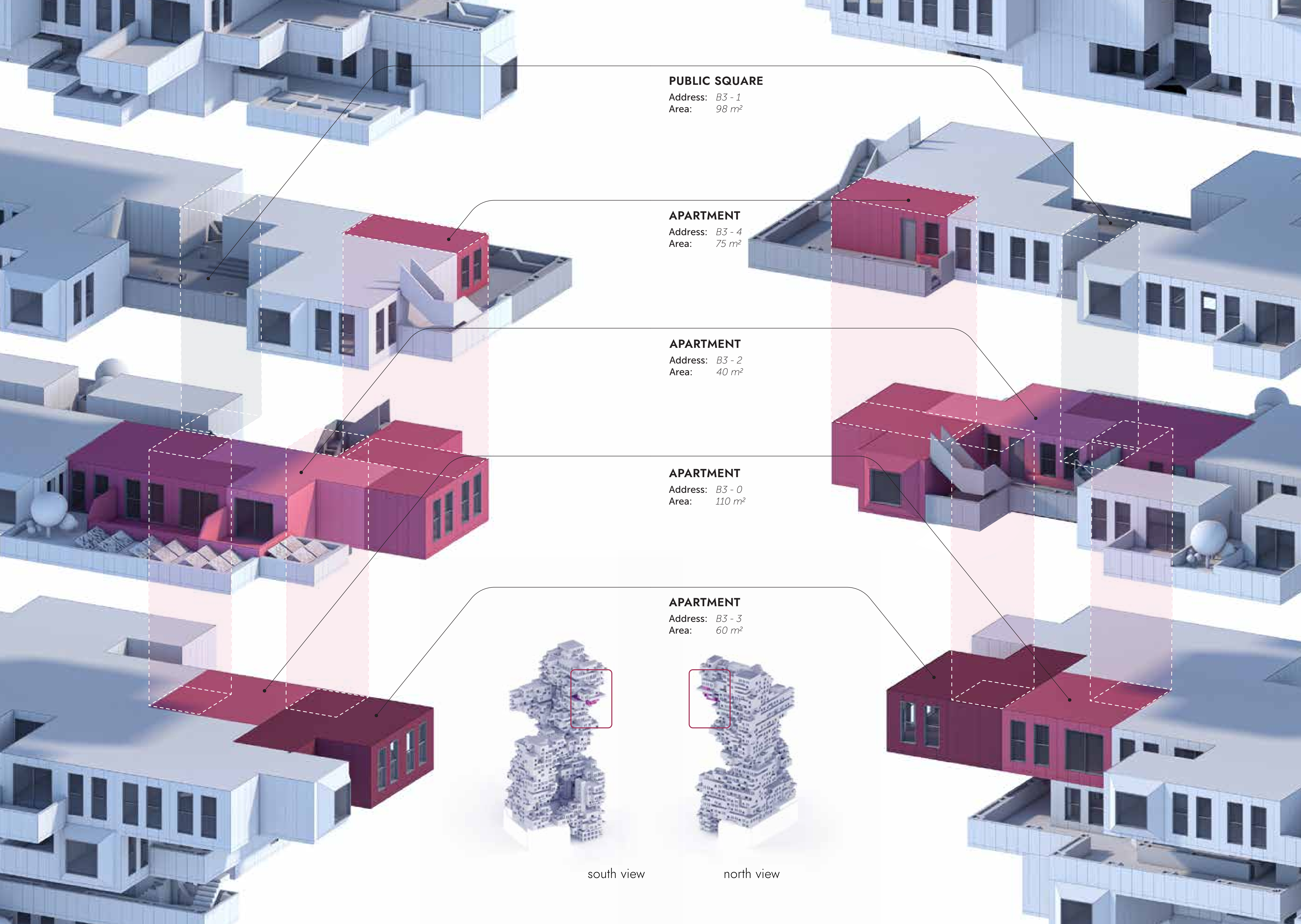

CLUSTER DESIGN

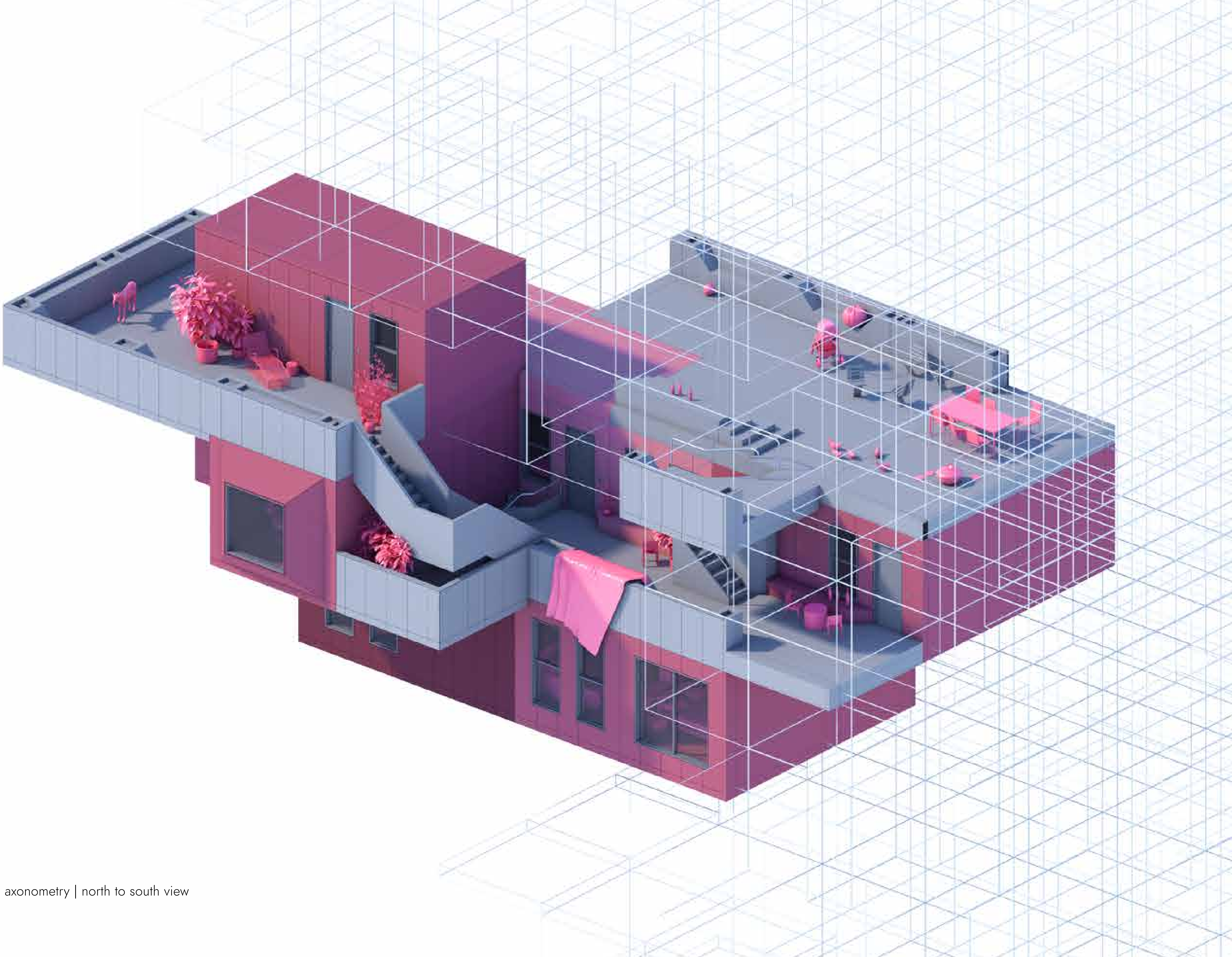


south view



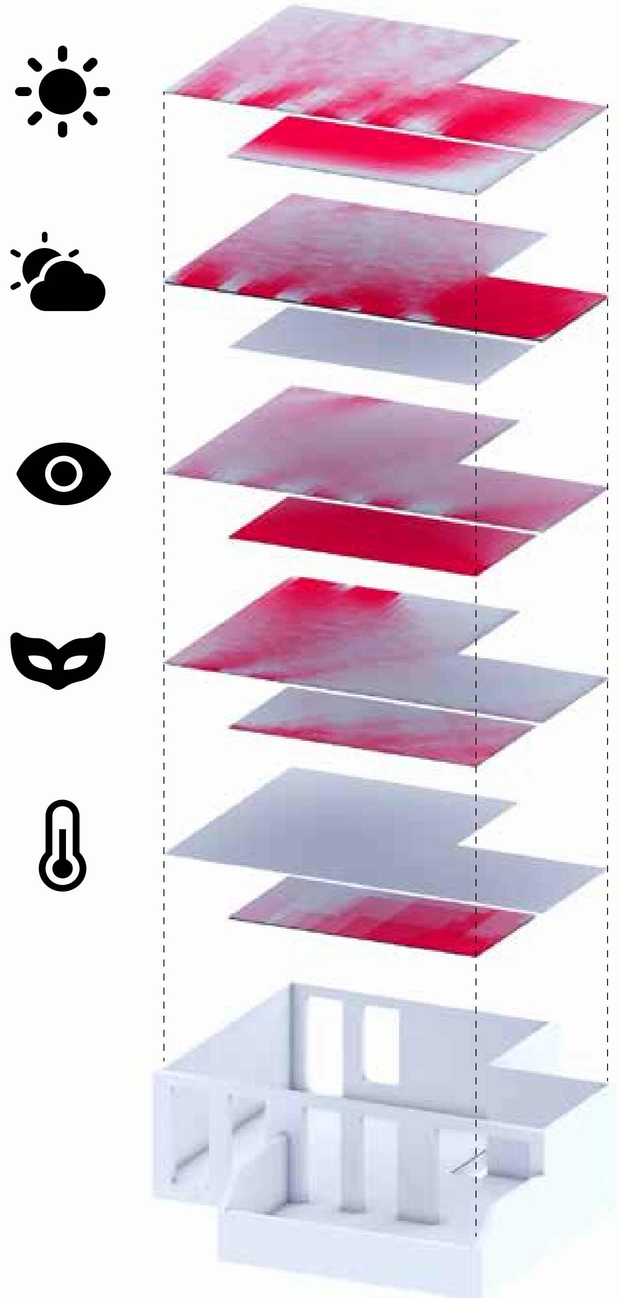
Subcluster B3 zoom-in and units

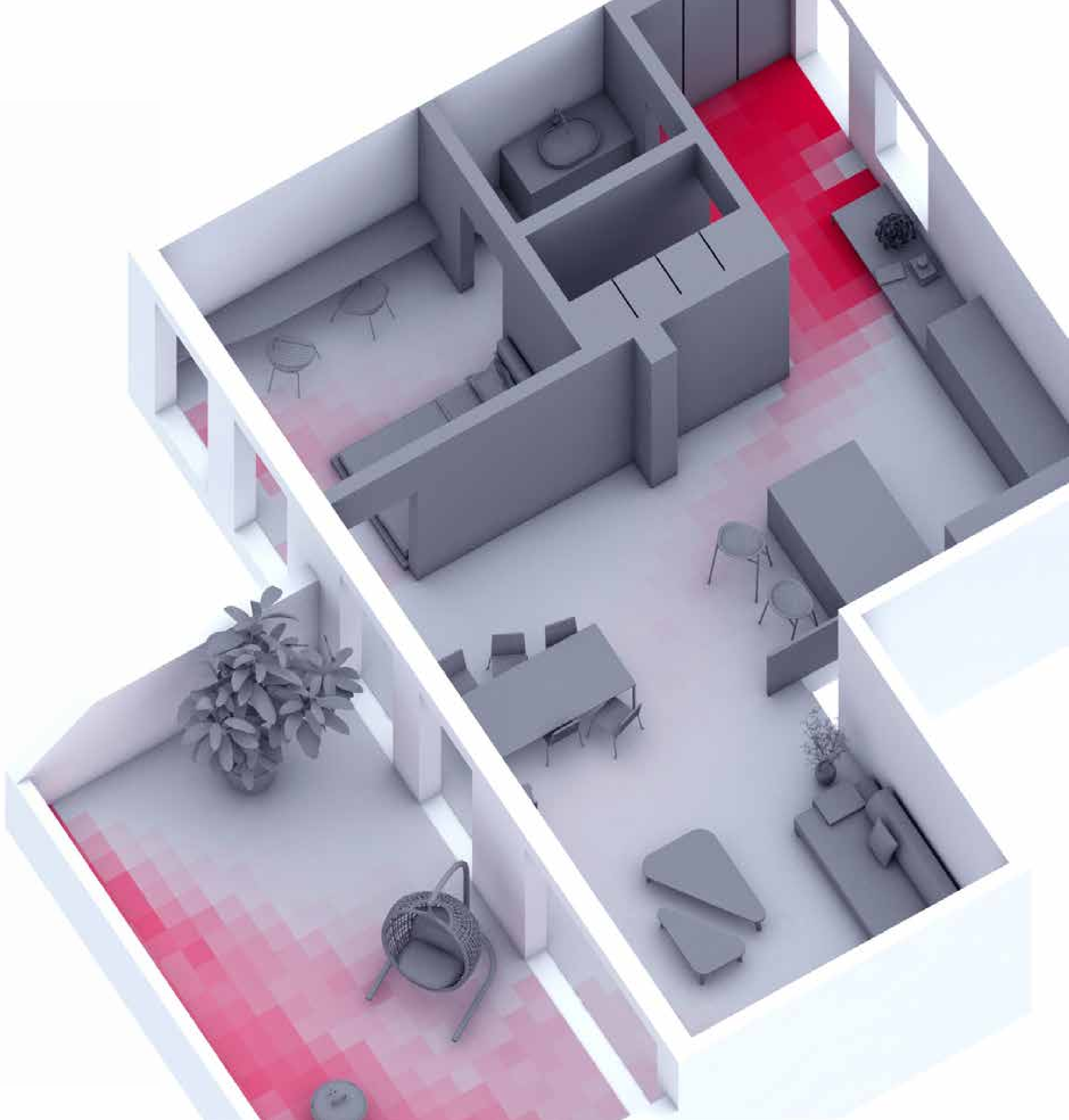

PUBLIC SQUARE
Address: B3 - 1
Area: 98 m²
APARTMENT
Address: B3 - 4
Area: 75 m²
APARTMENT
Address: B3 - 2
Area: 40 m²
APARTMENT
Address: B3 - 0
Area: 110 m²
APARTMENT
Address: B3 - 3
Area: 60 m²
south view
north view



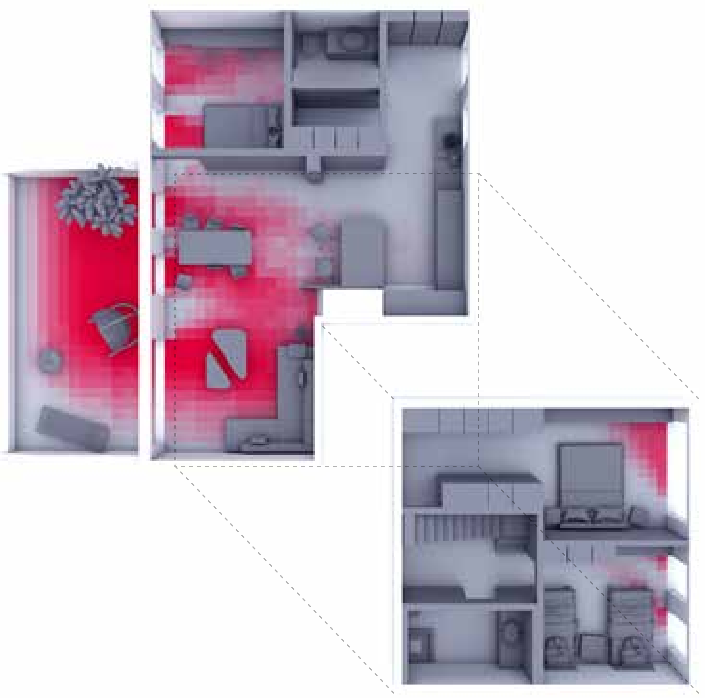
Cluster B3 axonometry | north to south view

AUGMENTED LAYOUT DESIGN

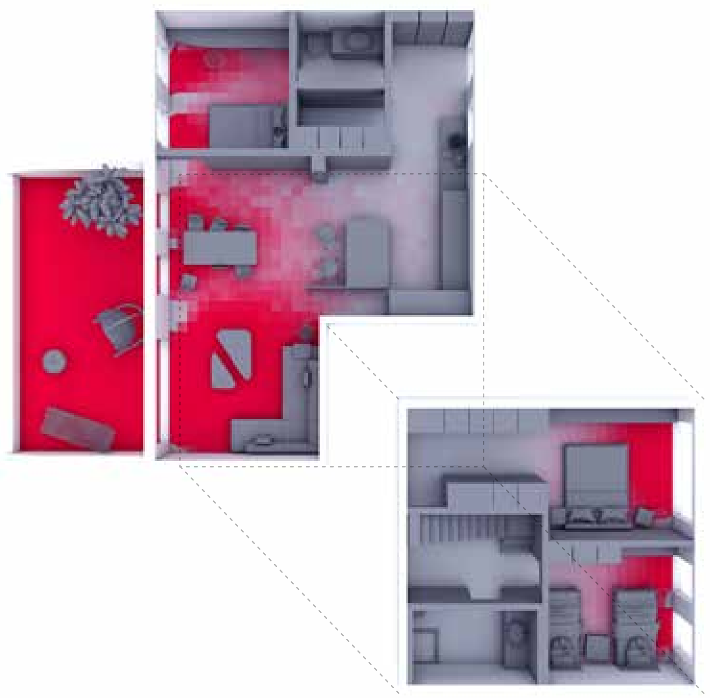




Multi-parameter plan analysis



1. Sunlight access



2. Daylight access

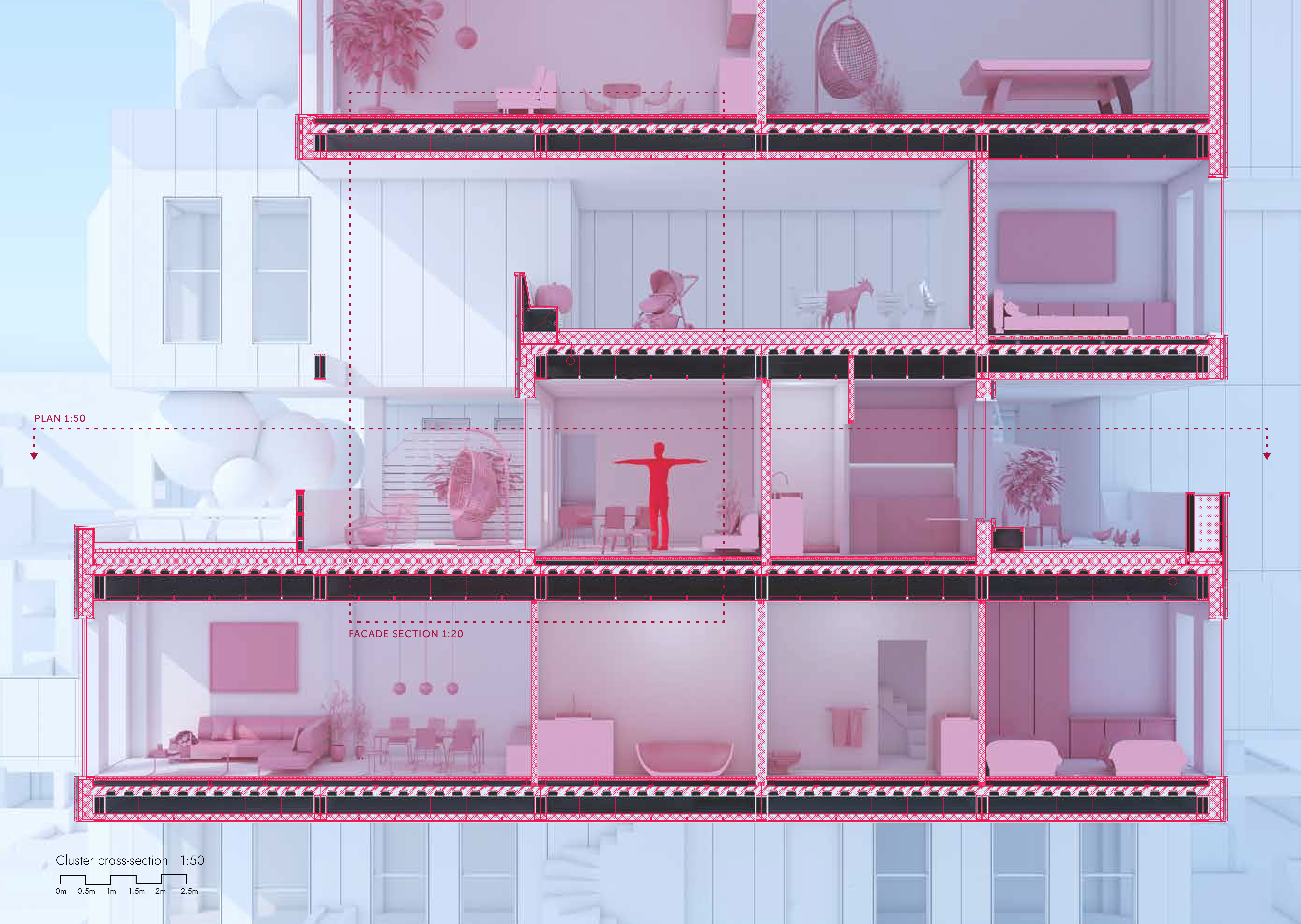
3. View angle

4. Degree of privacy

5. Outdoor comfort

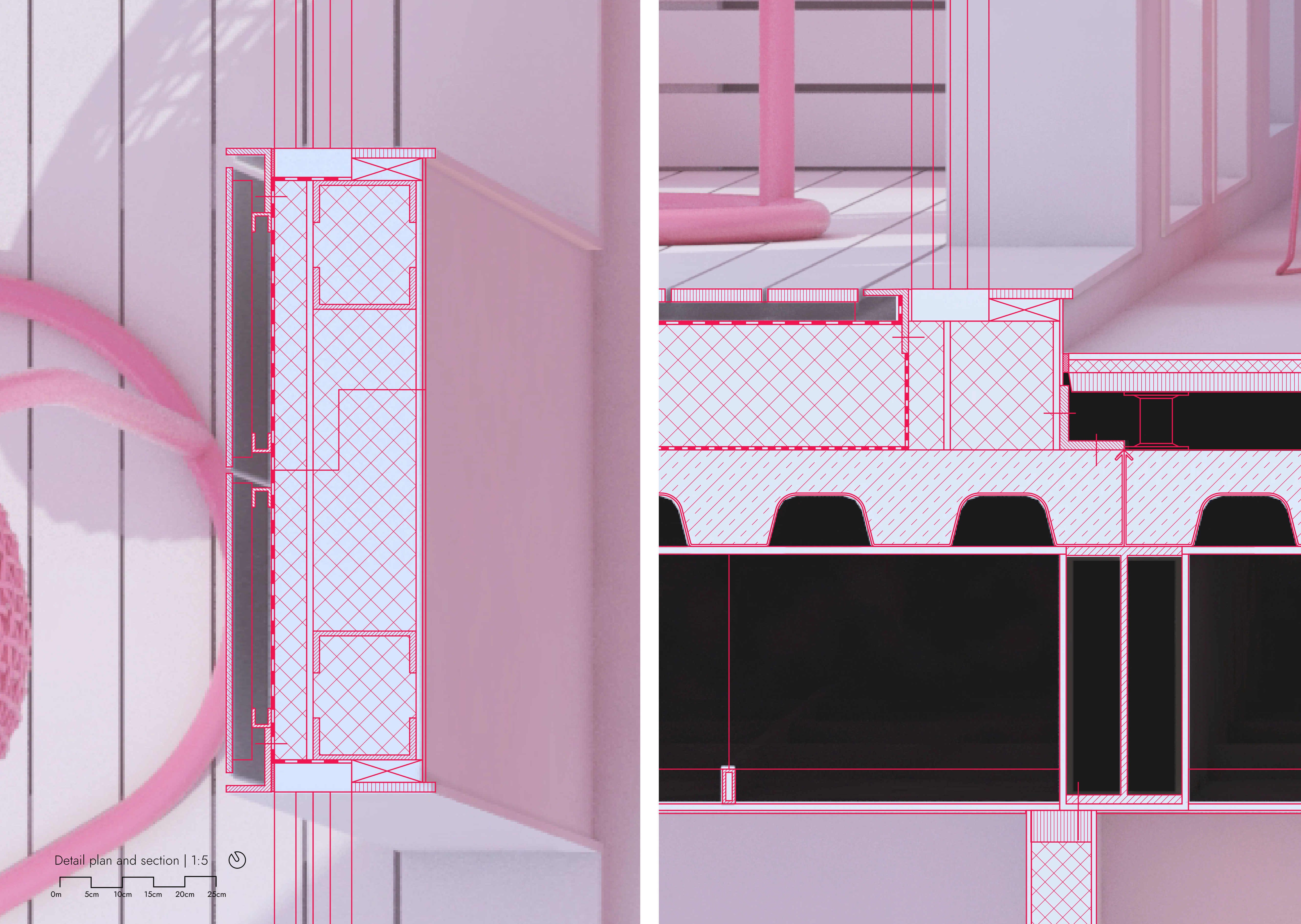
Cluster plan | 1:50

0m 1m 2m 3m 4m 5m

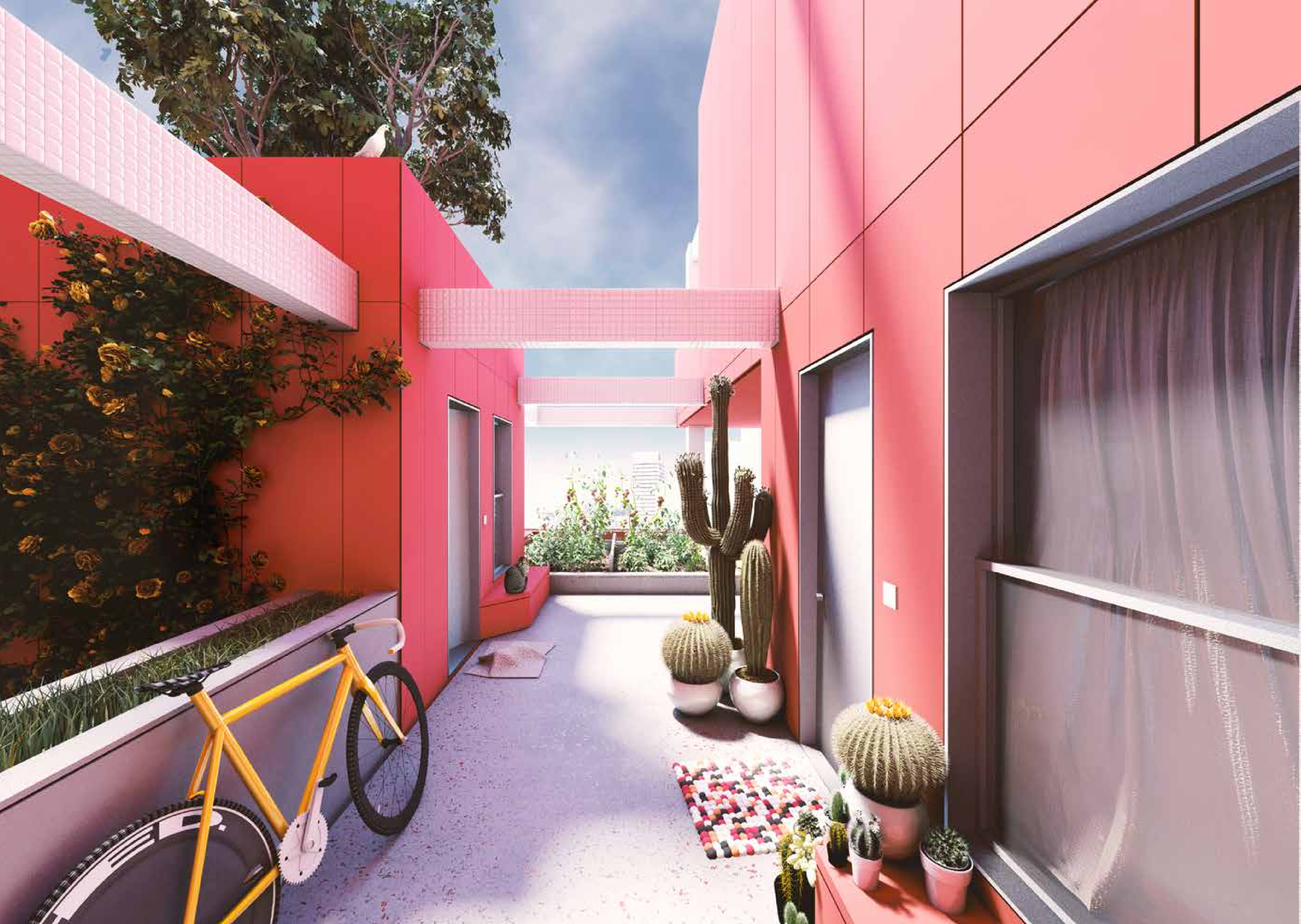


Cluster cross-section | 1:50

Detail plan and section | 1:20

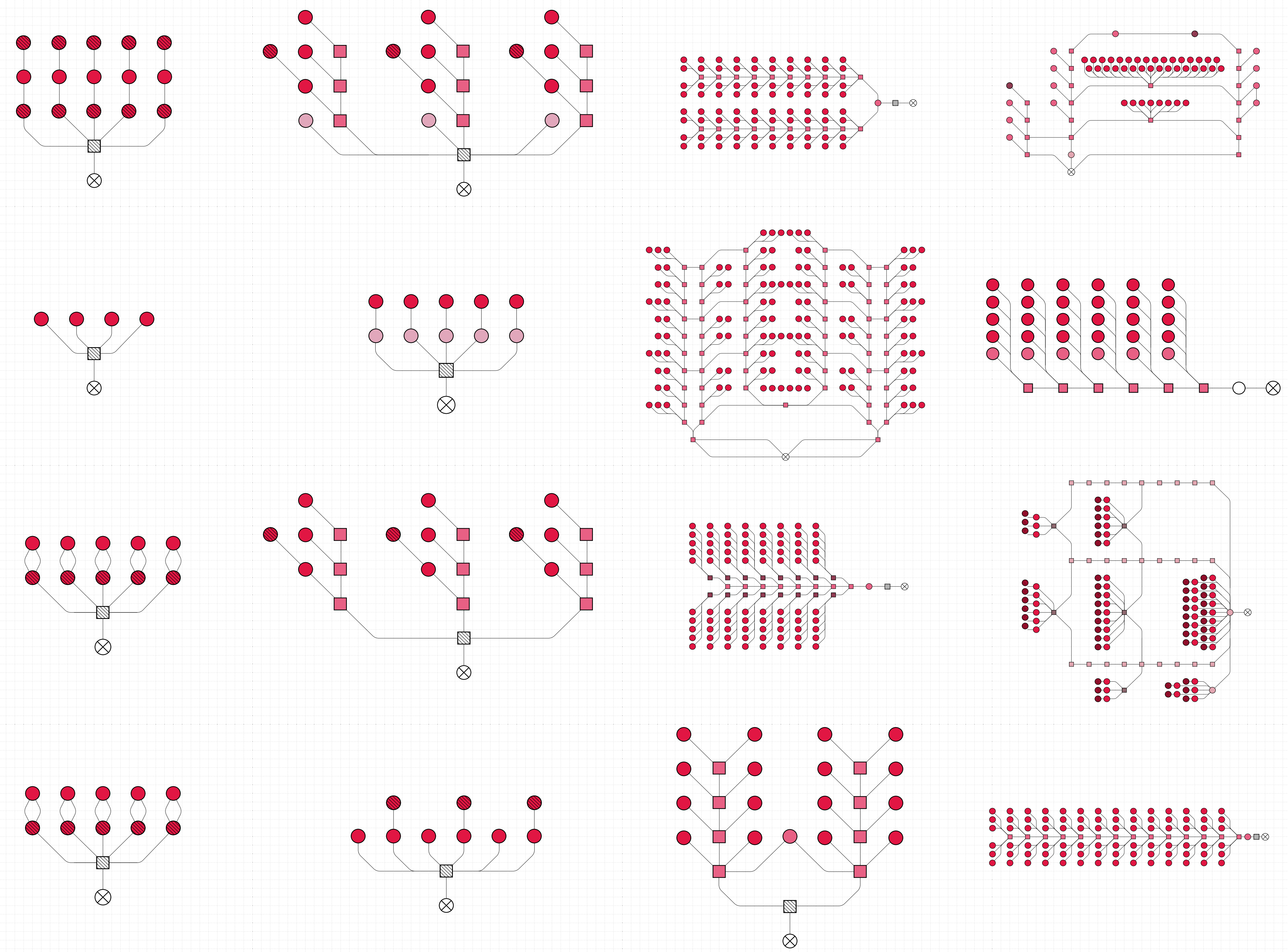


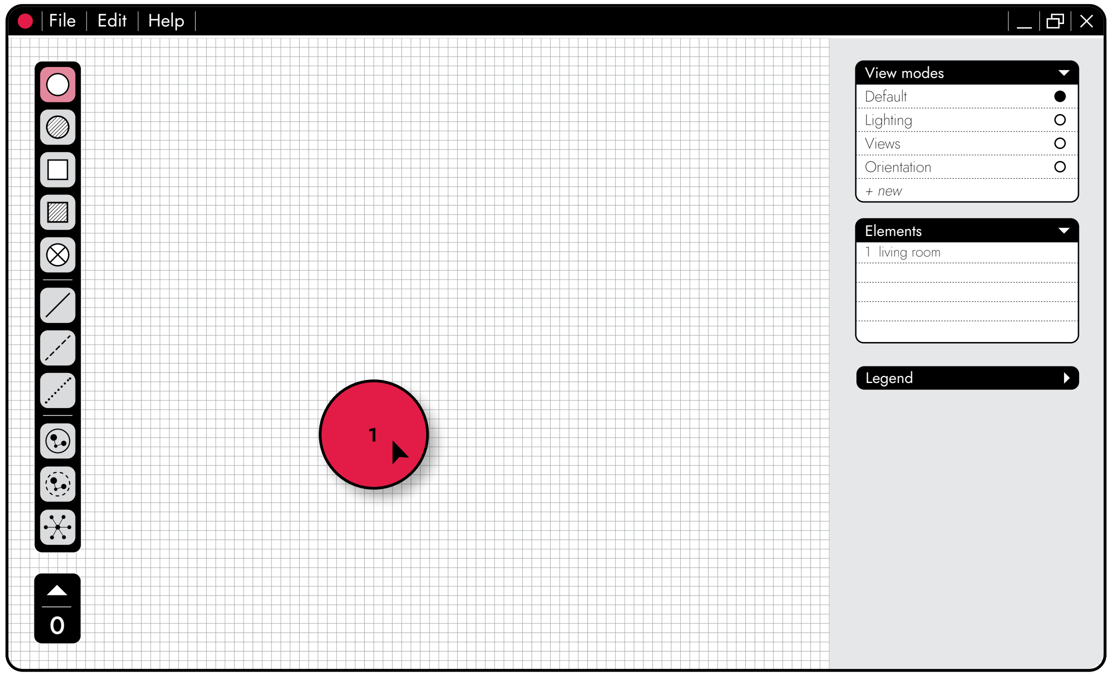
Detail plan and section | 1:5

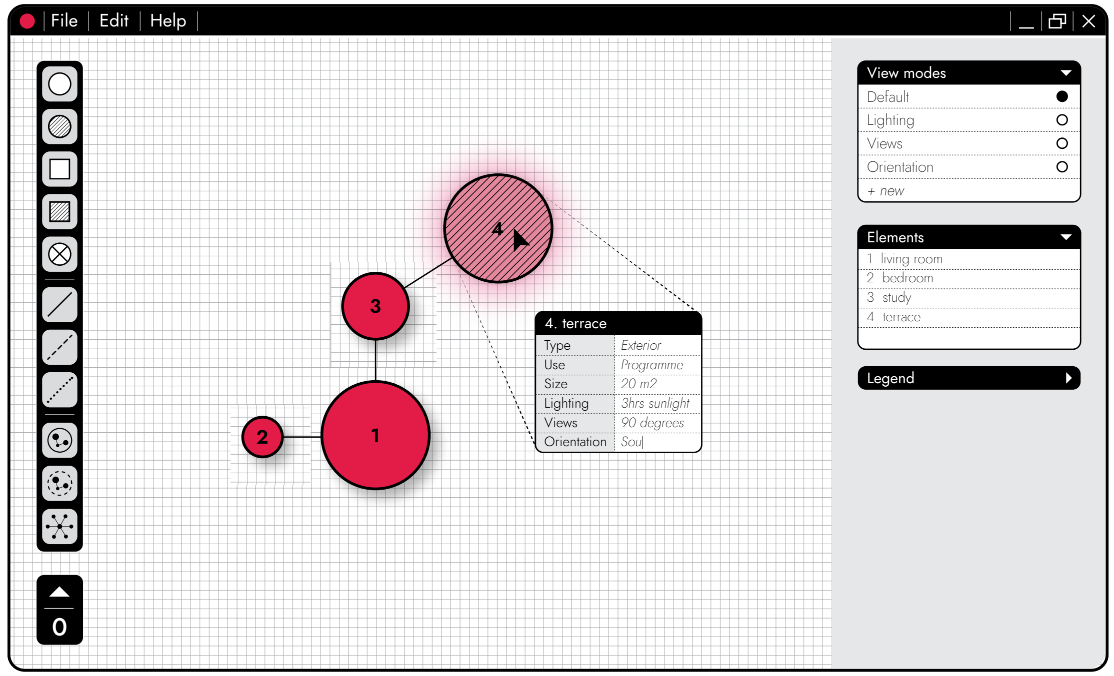


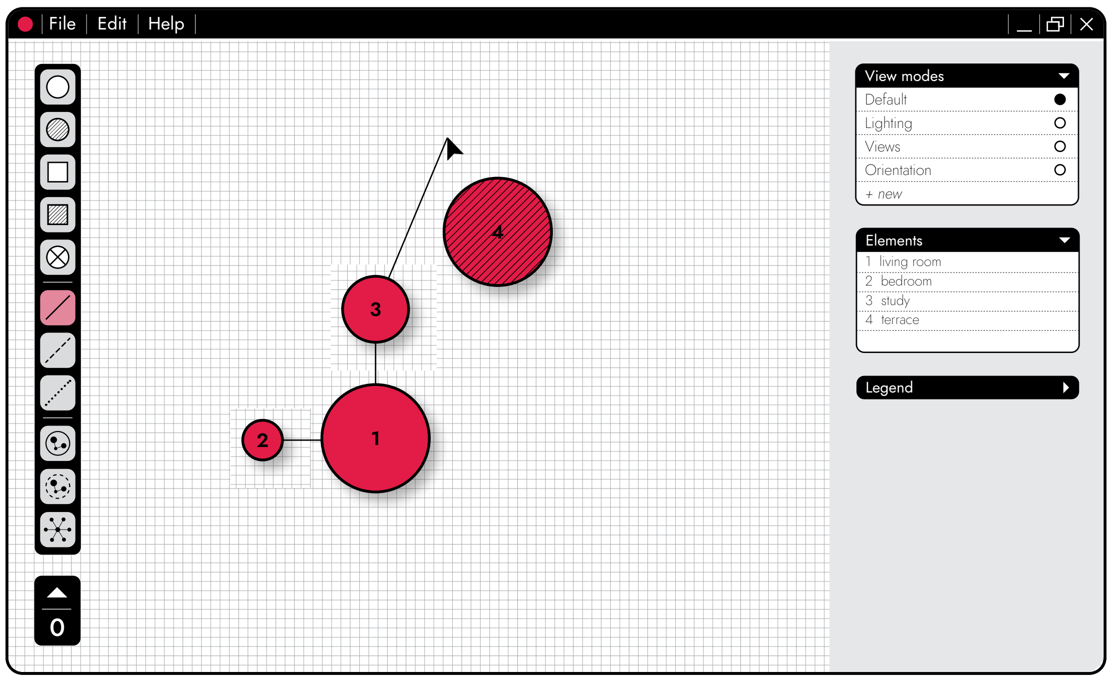
CONCLUSION

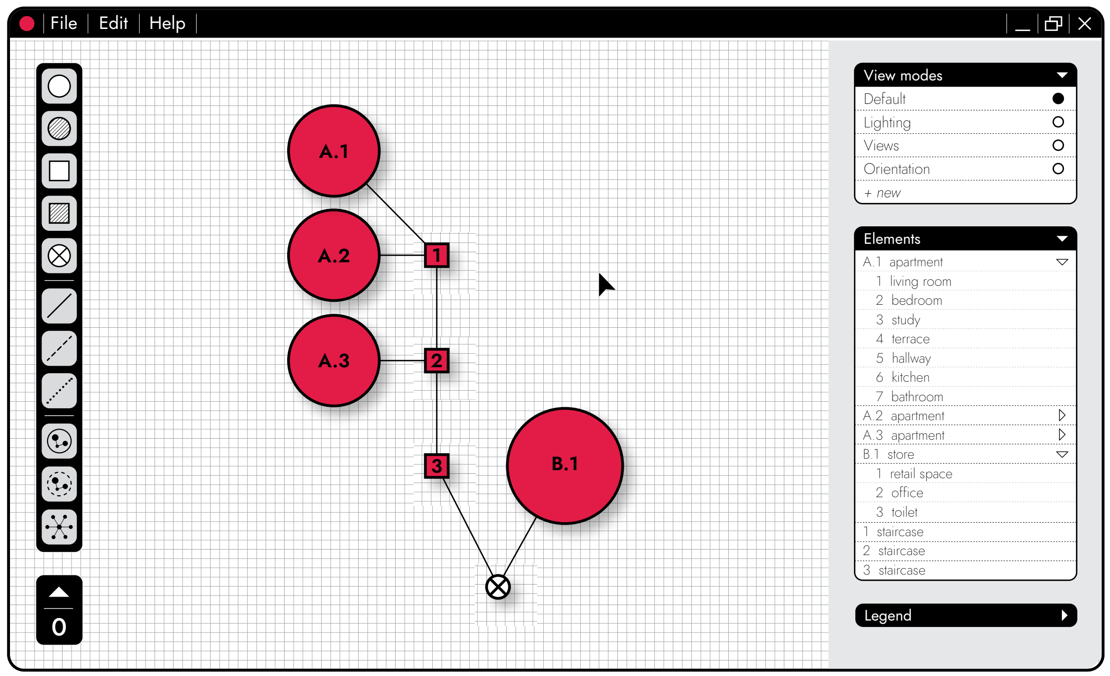
How can we design urban form adapted to the environmental, social and economic context in which it is placed?

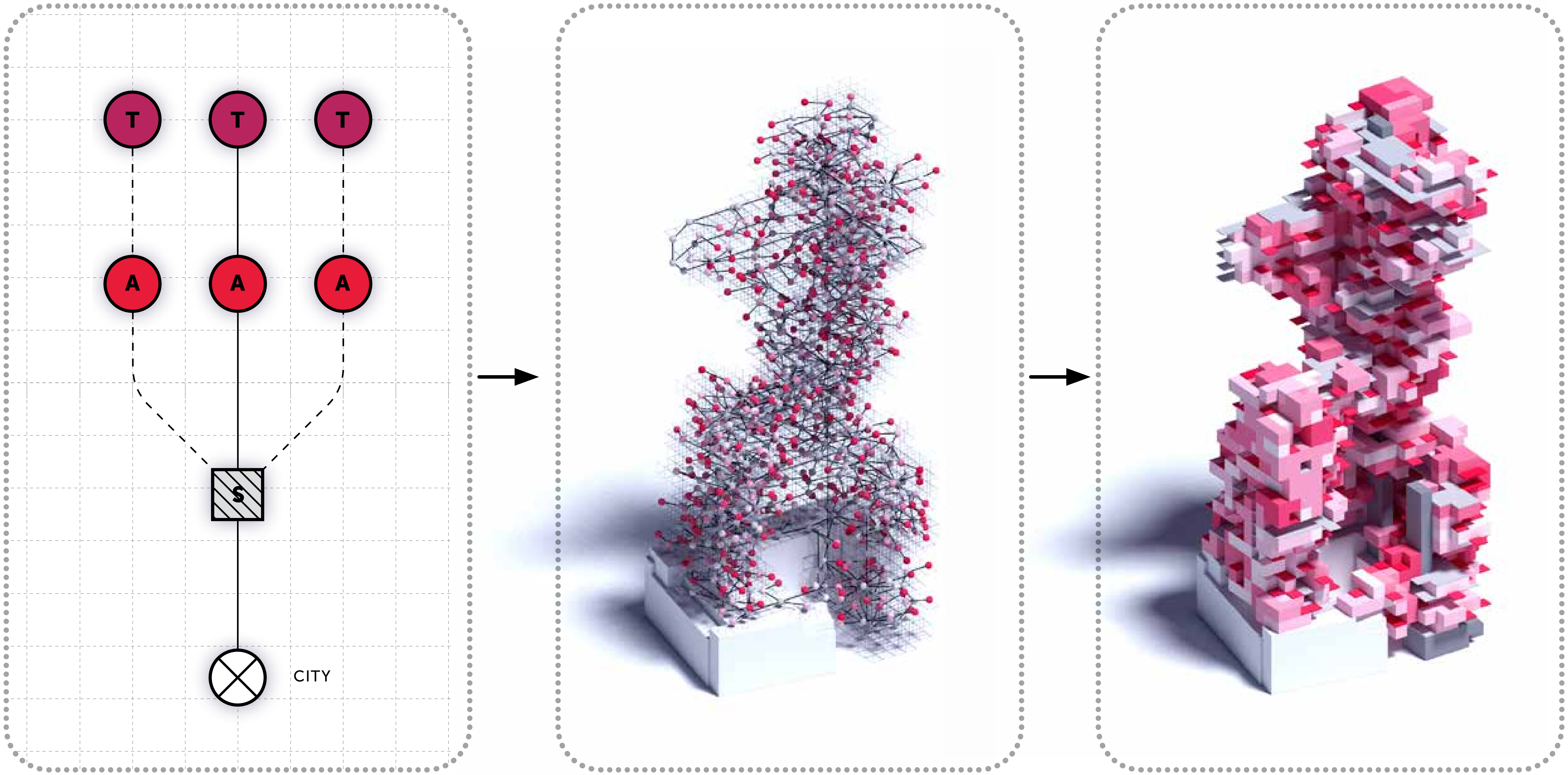


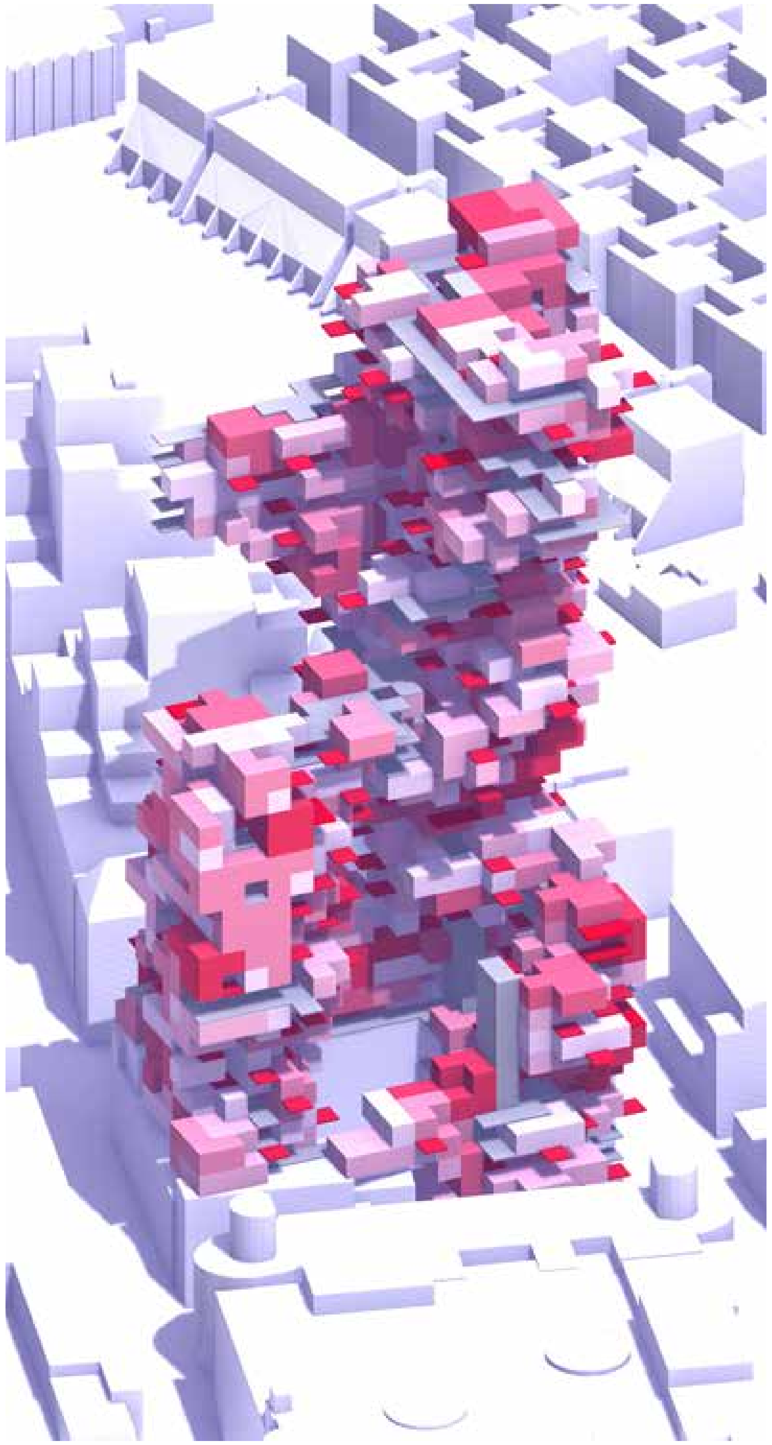

File | Edit | Help
View modes
Default
Lighting
Views
Orientation
+ new
Elements
1 living room
Legend
1
0


File | Edit | Help
4
3
2
1
4. terrace
Type Exterior
Use Programme
Size 20 m2
Lighting 3hrs sunlight
Views 90 degrees
Orientation Sou
View modes
Default
Lighting
Views
Orientation
+ new
Elements
1 living room
2 bedroom
3 study
4 terrace
Legend
0

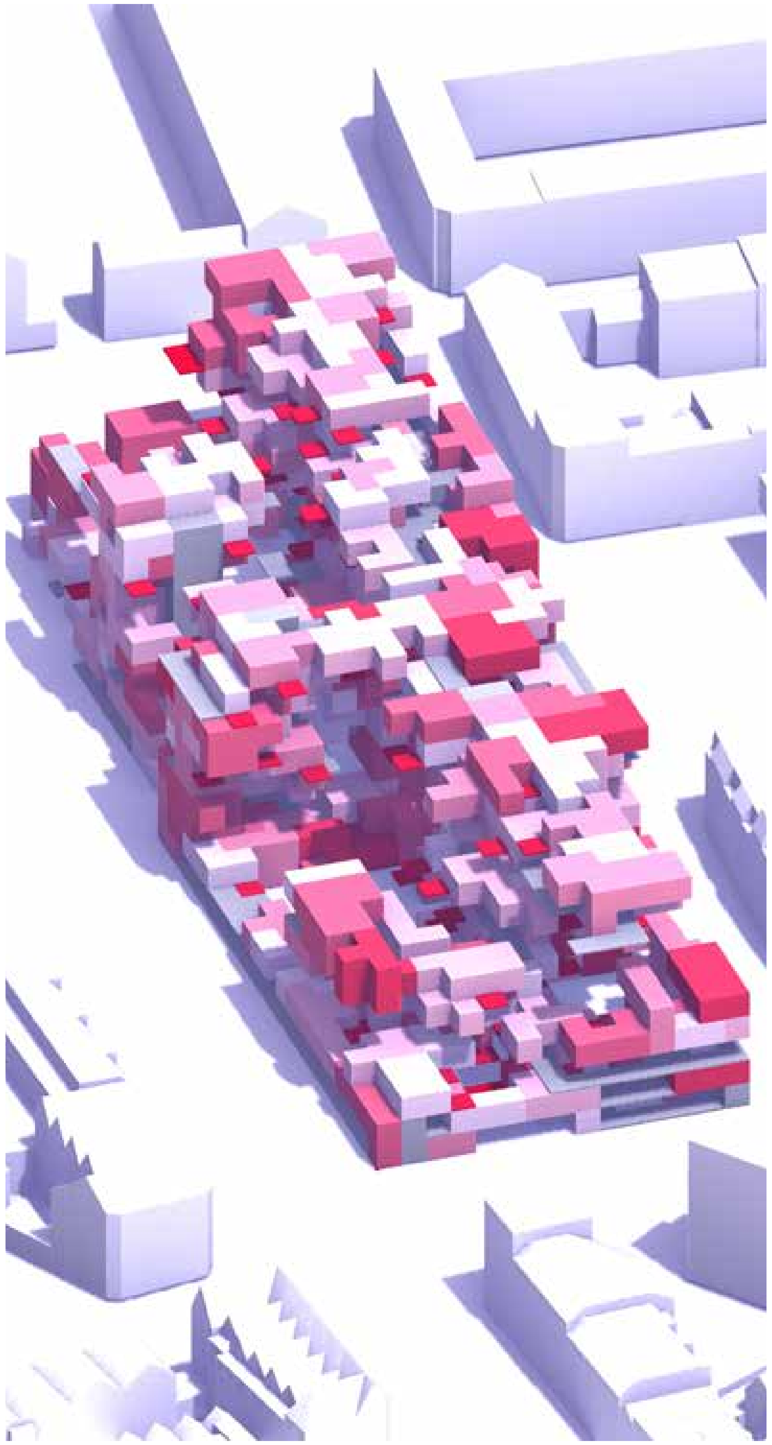

File | Edit | Help
4
3
2
1
View modes
Default
Lighting
Views
Orientation
+ new
Elements
1 living room
2 bedroom
3 study
4 terrace
Legend
0


File | Edit | Help
A.1
A.2
A.3
1
2
3
B.1
View modes
Default
Lighting
Views
Orientation
+ new
Elements
A.1 apartment
1 living room
2 bedroom
3 study
4 terrace
5 hallway
6 kitchen
7 bathroom
A.2 apartment
A.3 apartment
B.1 store
1 retail space
2 office
3 toilet
1 staircase
2 staircase
3 staircase
Legend
0

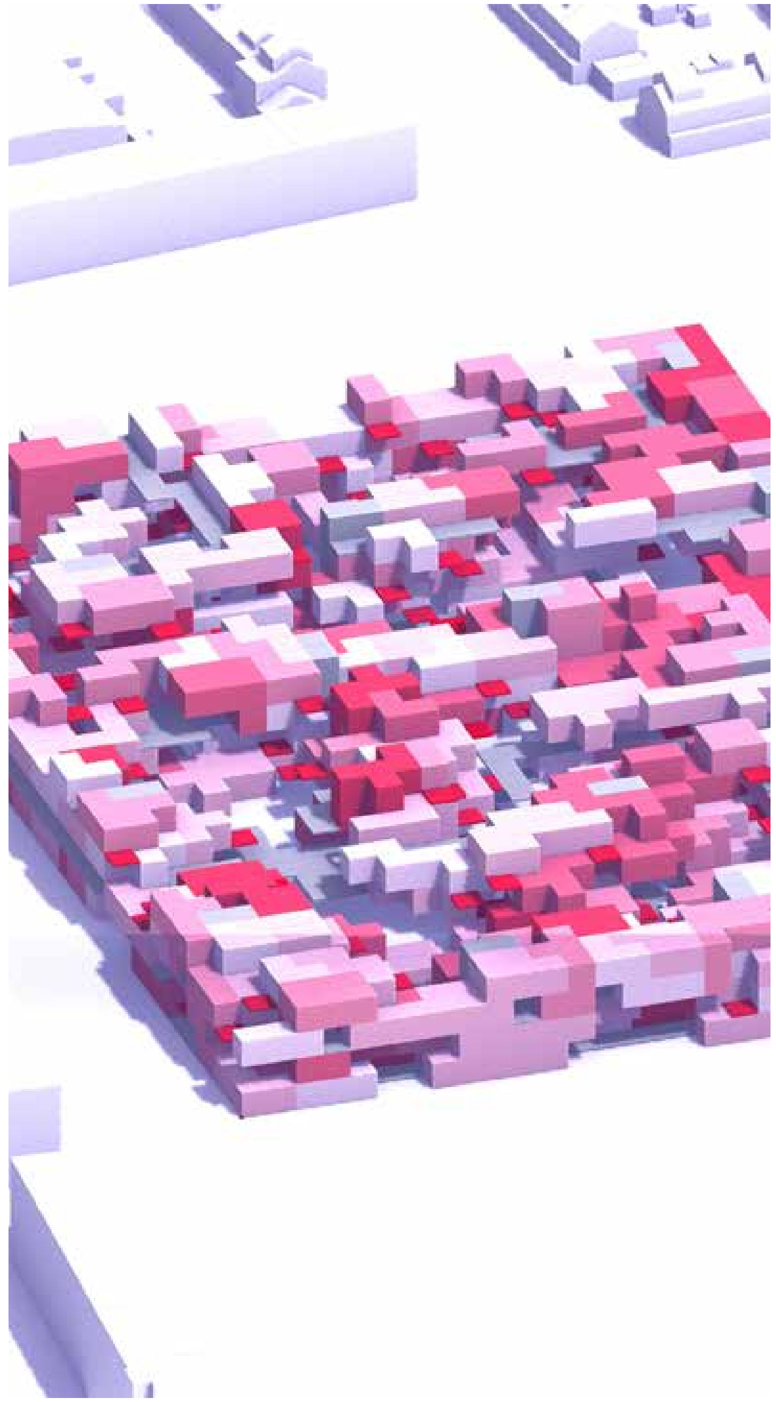

T
T
T
A
A
A
S
CITY



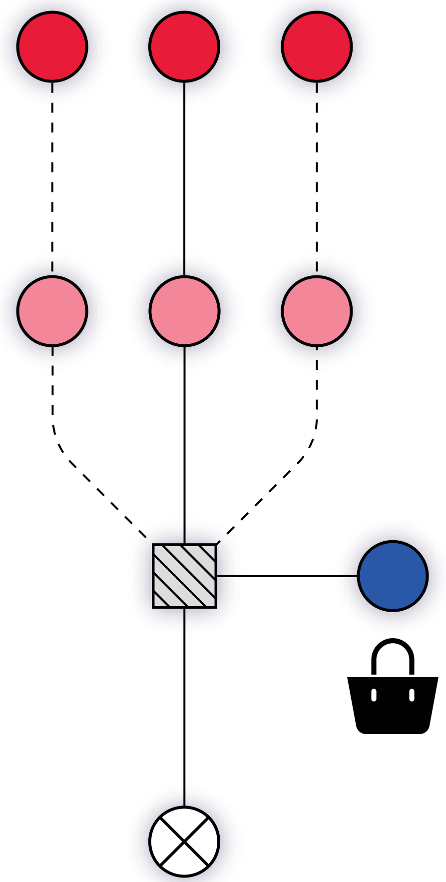
Rotterdam center



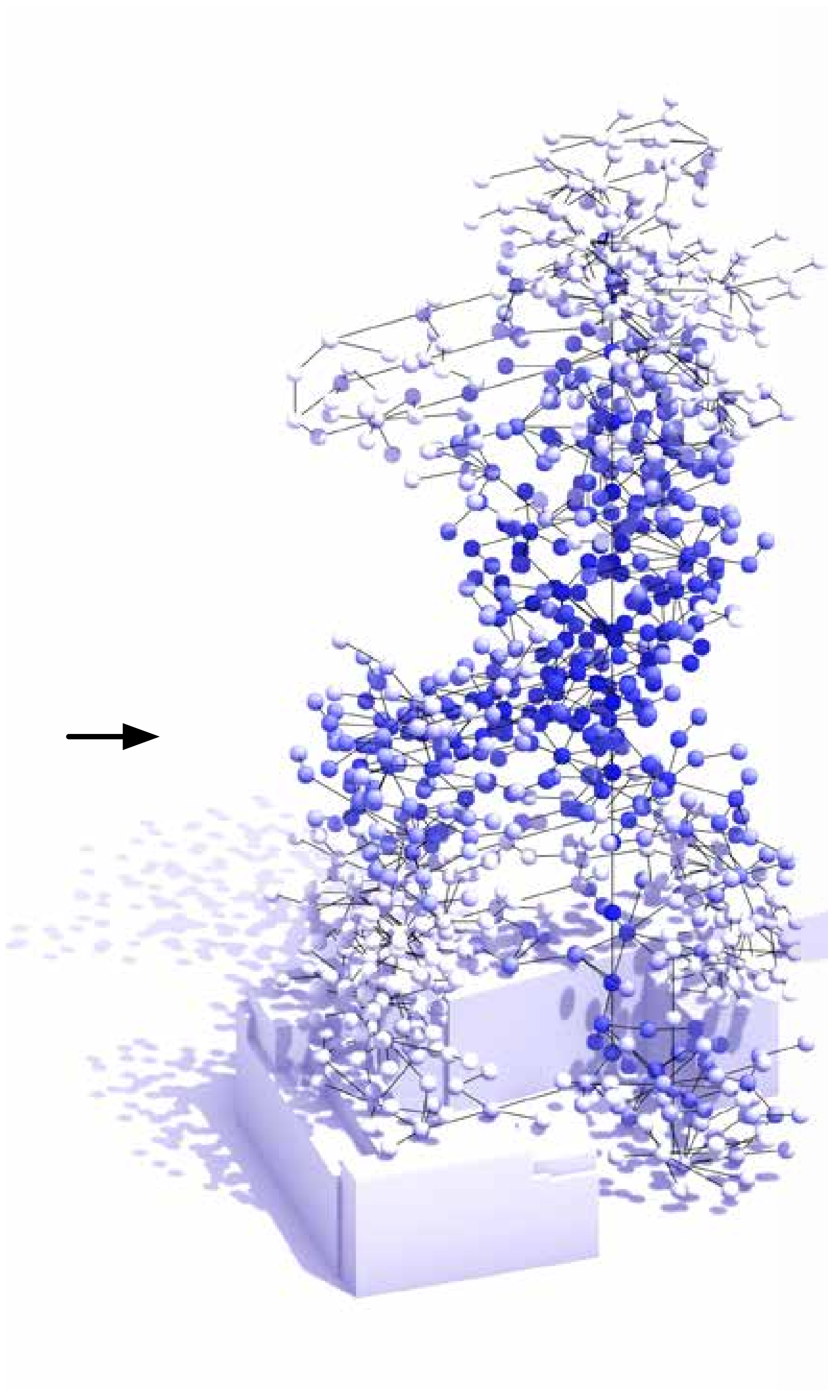
Rotterdam urban



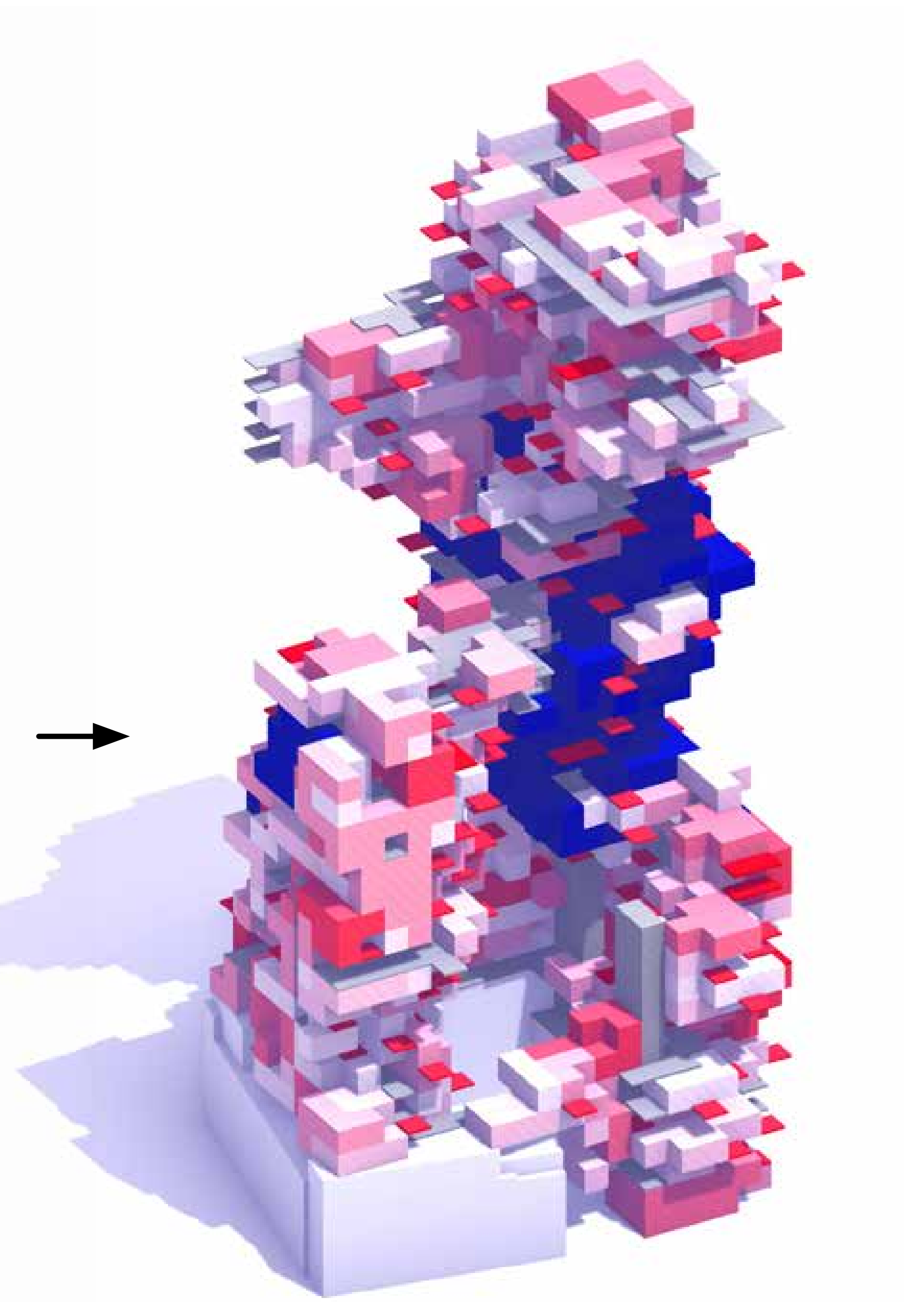
Rotterdam suburban



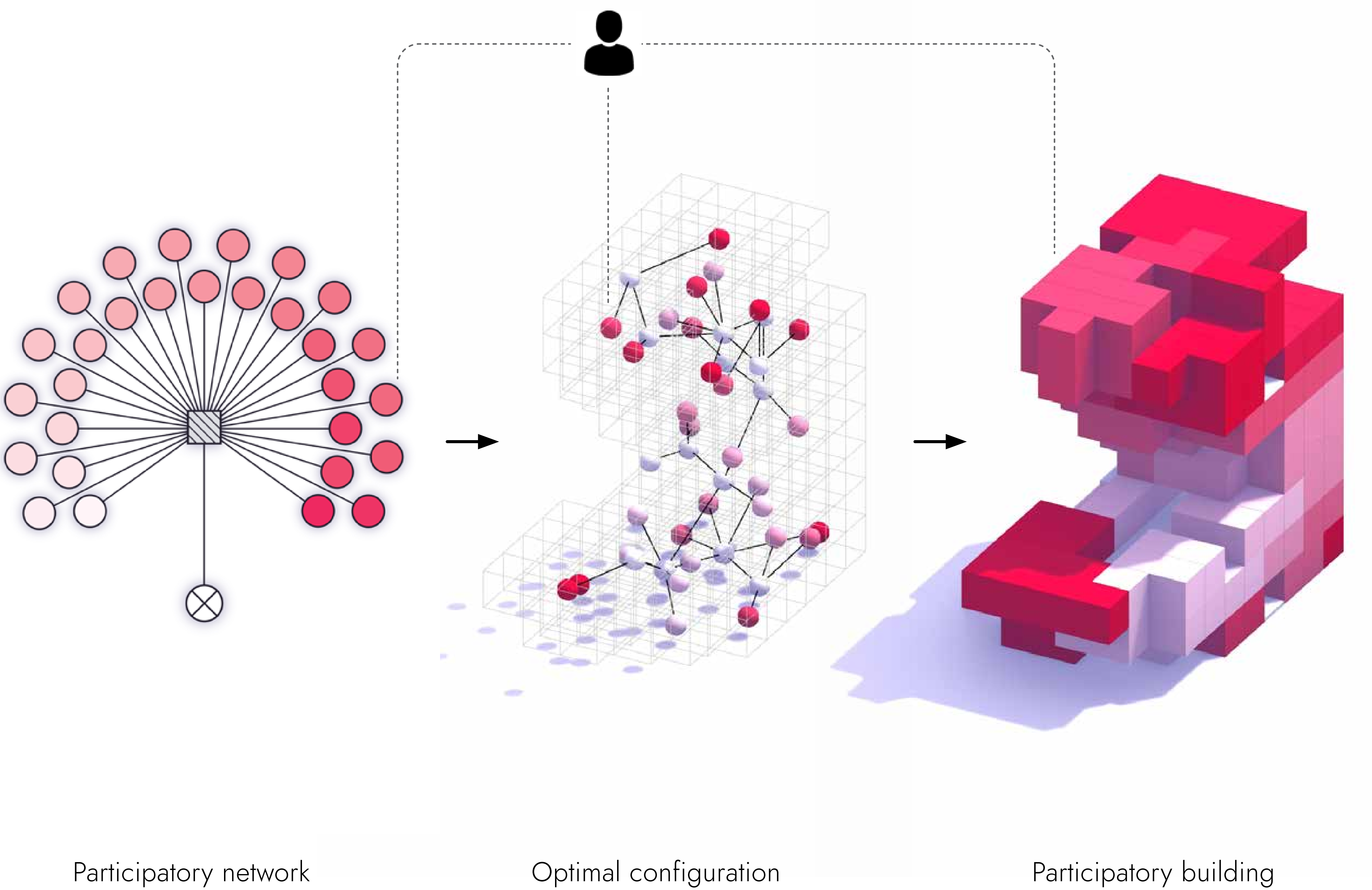
Expanded spatial network



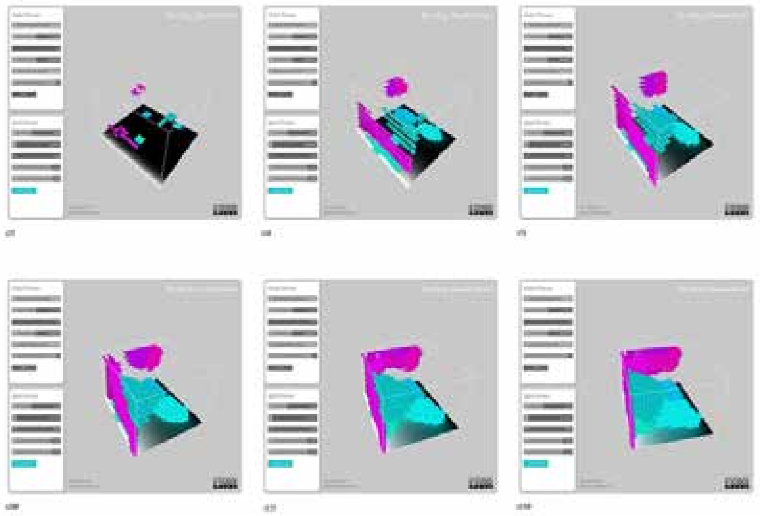
Network centrality

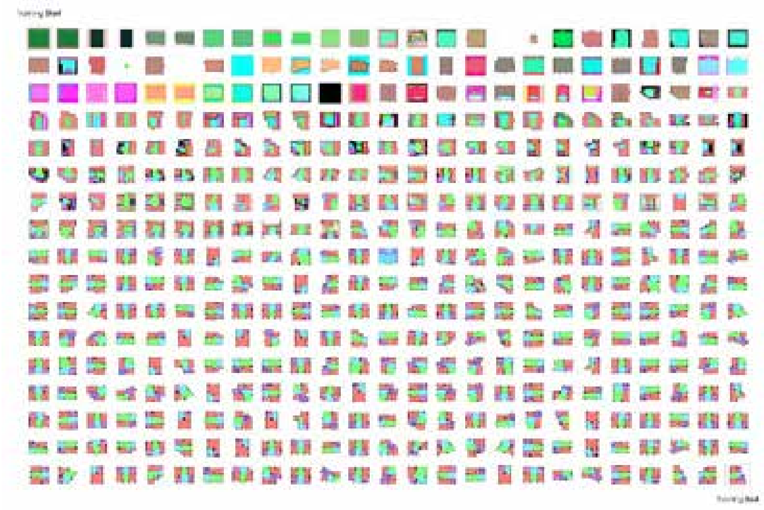


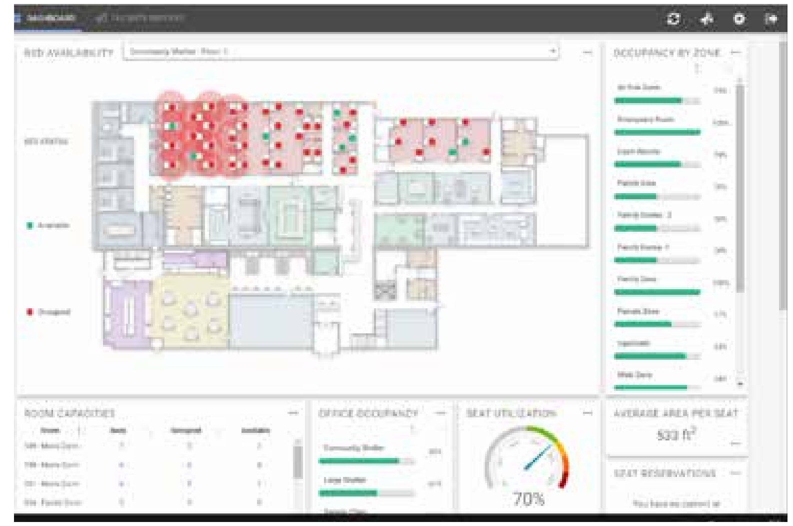
Aggregation with retail

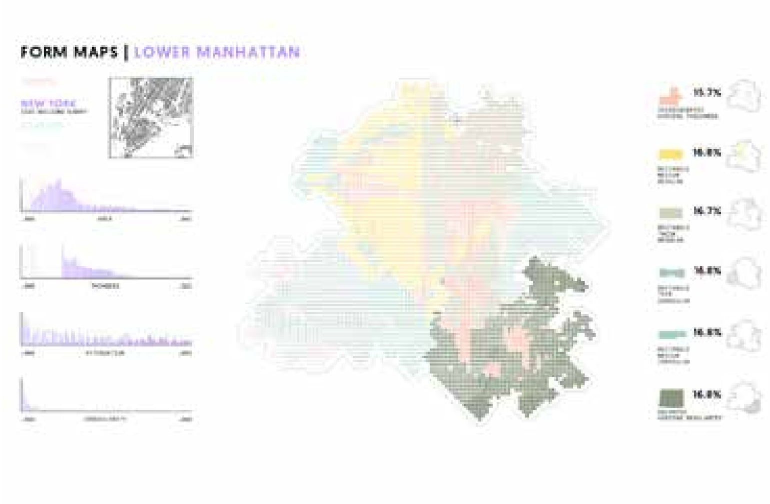


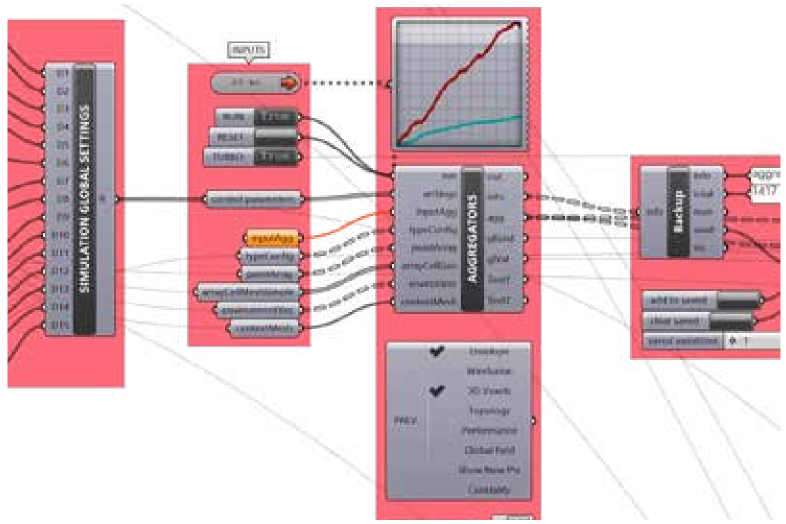
Participatory network
Optimal configuration
Participatory building

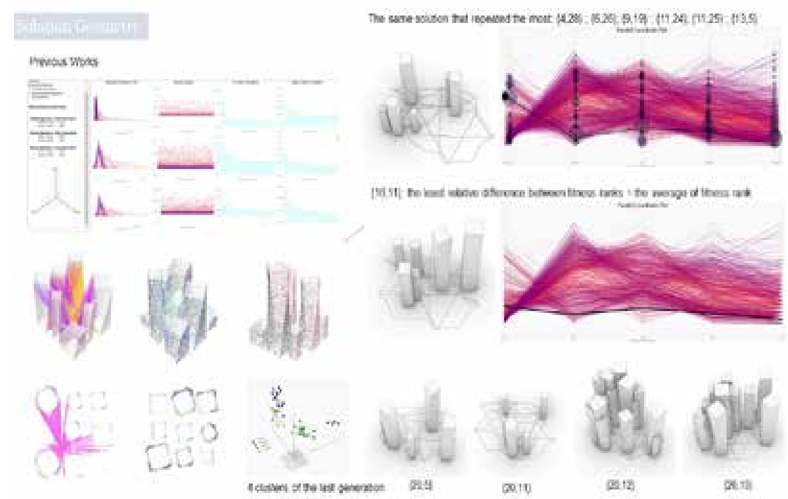


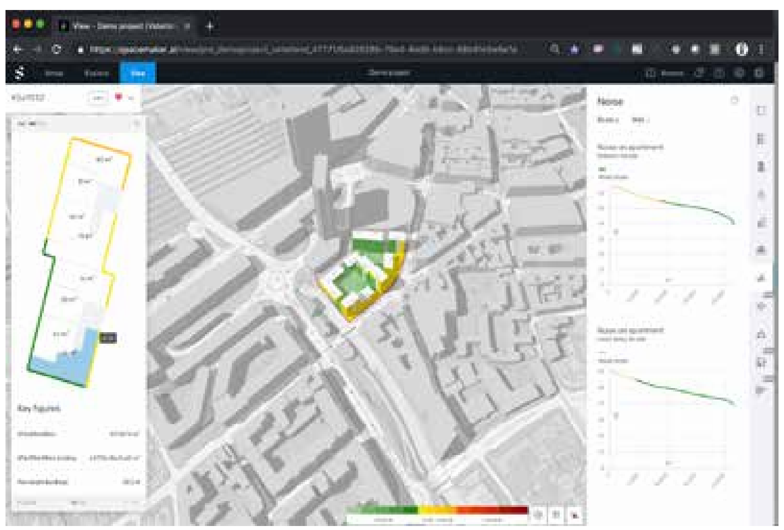


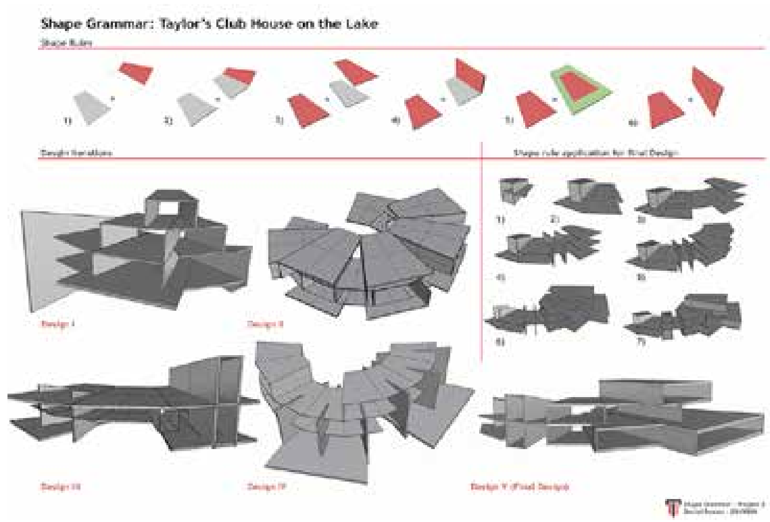

OCCUPANCY BY ZONE
ROOM CAPACITIES
OFFICE OCCUPANCY
SEAT UTILIZATION
70%
AVERAGE AREA PER SEAT
533 ft²
SEAT RESERVATIONS

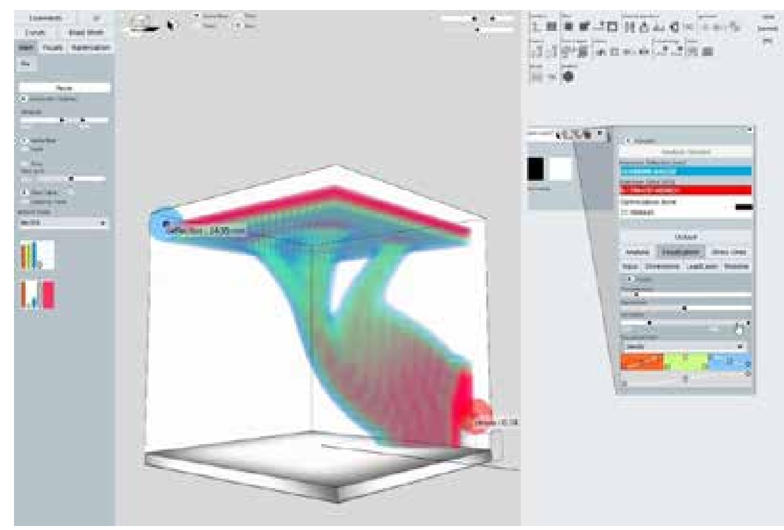

FORM MAPS | LOWER MANHATTAN
15.7%
16.8%
16.7%
16.8%
16.8%
16.8%


INPUTS
SIMULATION GLOBAL SETTINGS
AGGREGATORS
Backup


Previous Works
4 clusters of the last generation




Shape Grammar: Taylor's Club House on the Lake
Shape Rules
Design Iterations
Shape rule application for Final Design



FIN。