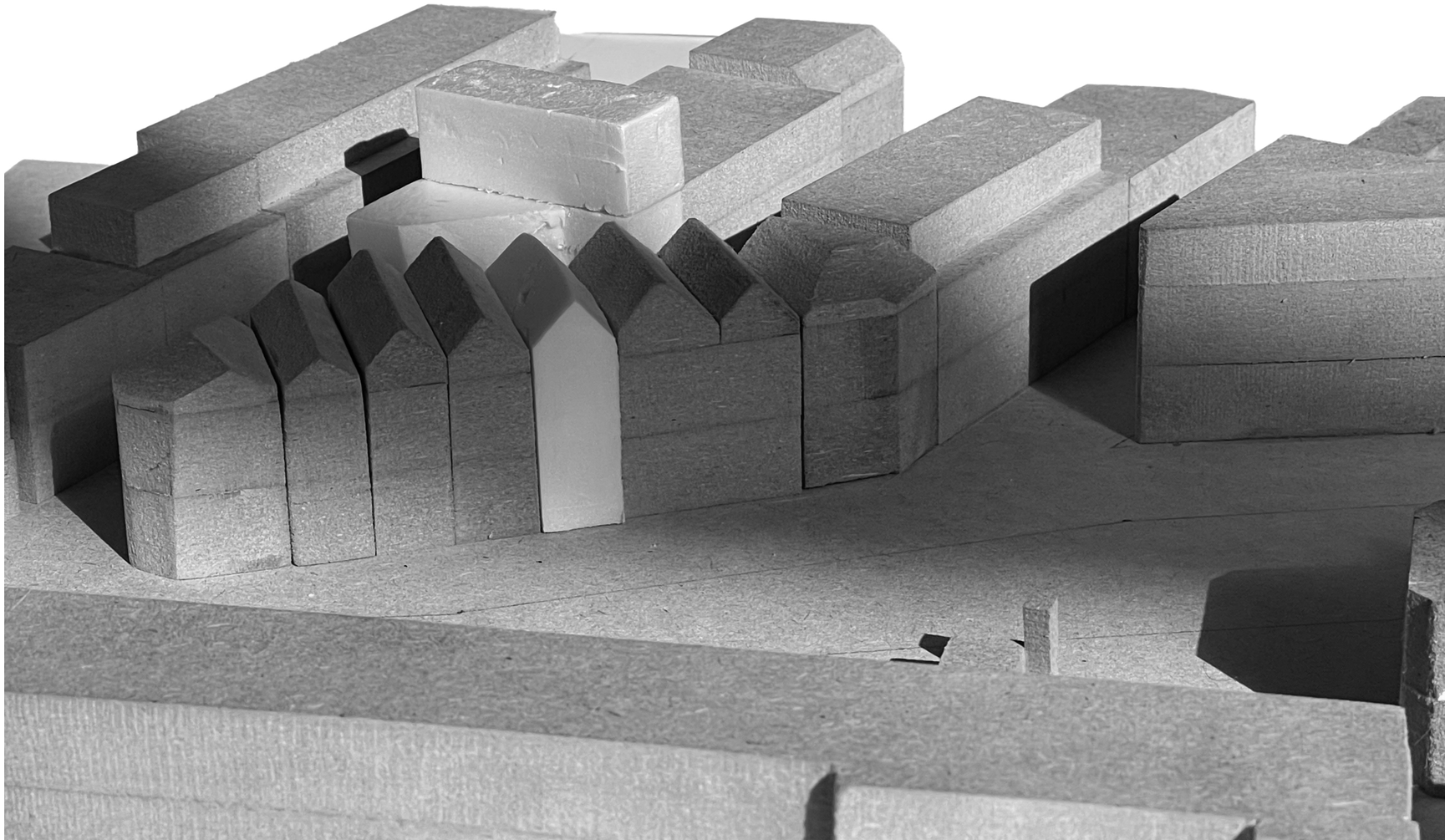
CIRCULAR DESIGN:
Research into the design process for optimal reuse in architecture



Hein van der Helm
student number: 4875060

P2 Presentation
Architectural Engineering
11-06-24

TU Delft - MSc Architecture
research tutor: Jos de Krieger
design tutor: Yannick Warmerdam

INTRODUCTION

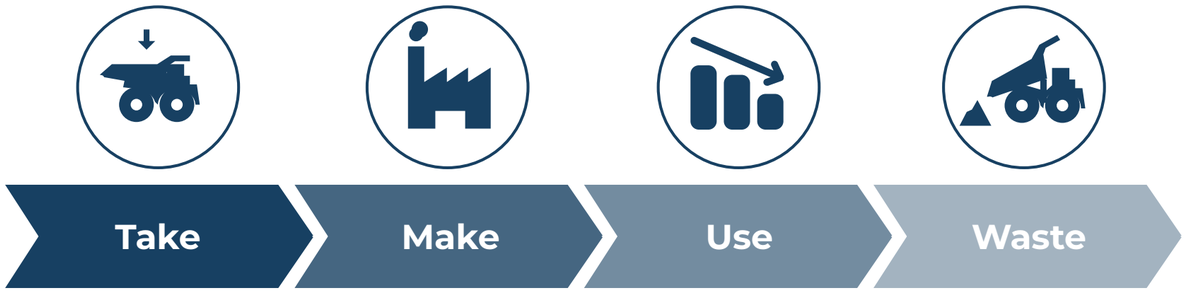
1/3 (CDW) Of all waste in the European Union[1]

1. European Union (2020)
picture: TheFifthEstate.com

Majority of construction materials is new[2].

2. Gorgolewski (2018)
picture: Alcircle.com

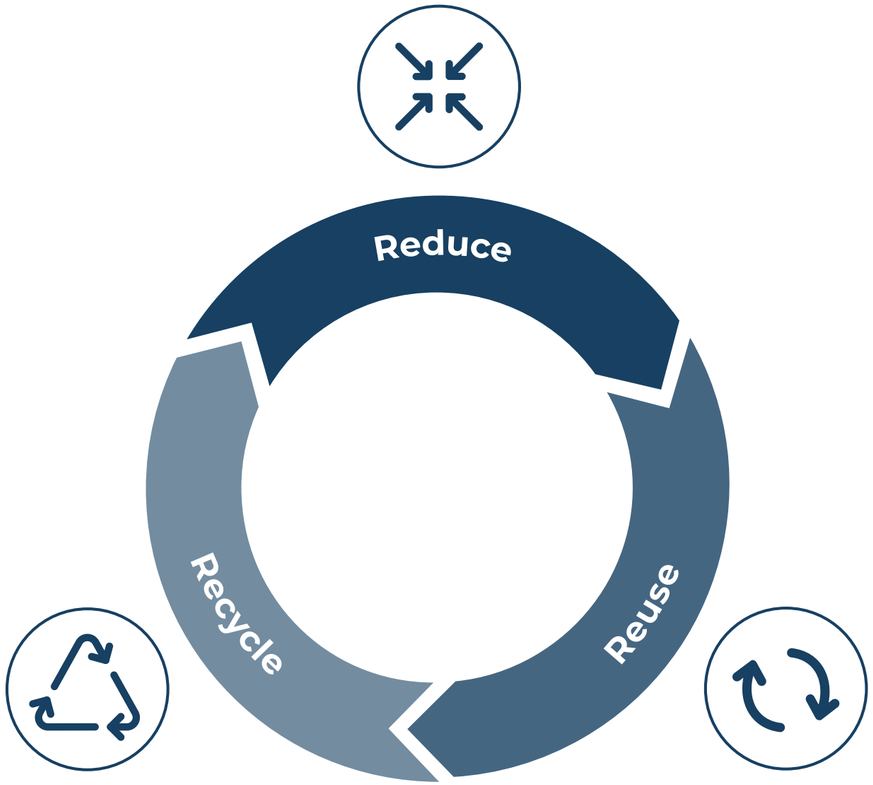
Linear economy



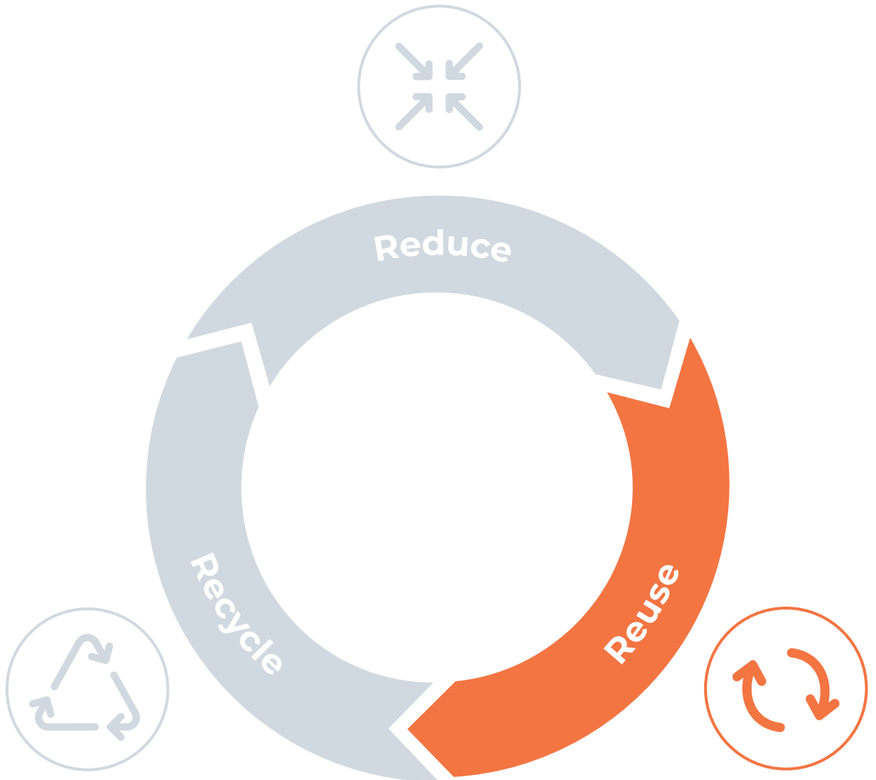
Design

Build

Circular economy



The habit of reusing and designing with those elements is not visible enough.



Start with what already exists.

CONTENT

How can design principles based on reuse in architecture be applied to transform the existing residual space in Rotterdam into a mixed-use building?

What design principles can be developed to create a circular framework that enables architects to effectively integrate reused building components during the design phase?

Understand what factors influence the potential for reuse.

Investigate challenges of designing with reuse.

Develop a framework with design principles for the design process, to make optimal use of reuse.

LITERATURE RESEARCH

-Academic and non-academic literature

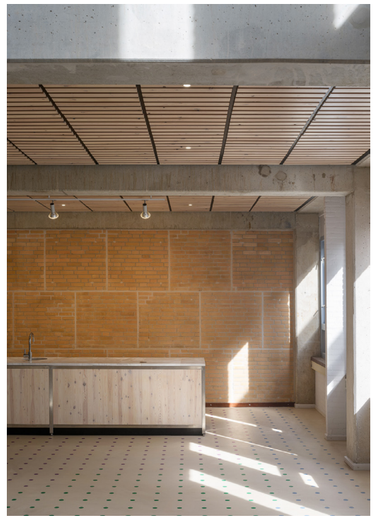
-Reports on component reuse
-Research in the conventional design process
-Design process with reuse

IN-DEPTH INTERVIEWS & CASE STUDIES

-Qualitative data on design approaches and strategies applied in the design process.
-Reports on component reuse
-Research in the conventional design process
-Design process with reuse

Apto Architecten
ir. Mark Halbmeijer

Popma Ter Steege Architecten
ir. Josse Popma



INFORMAL SESSIONS

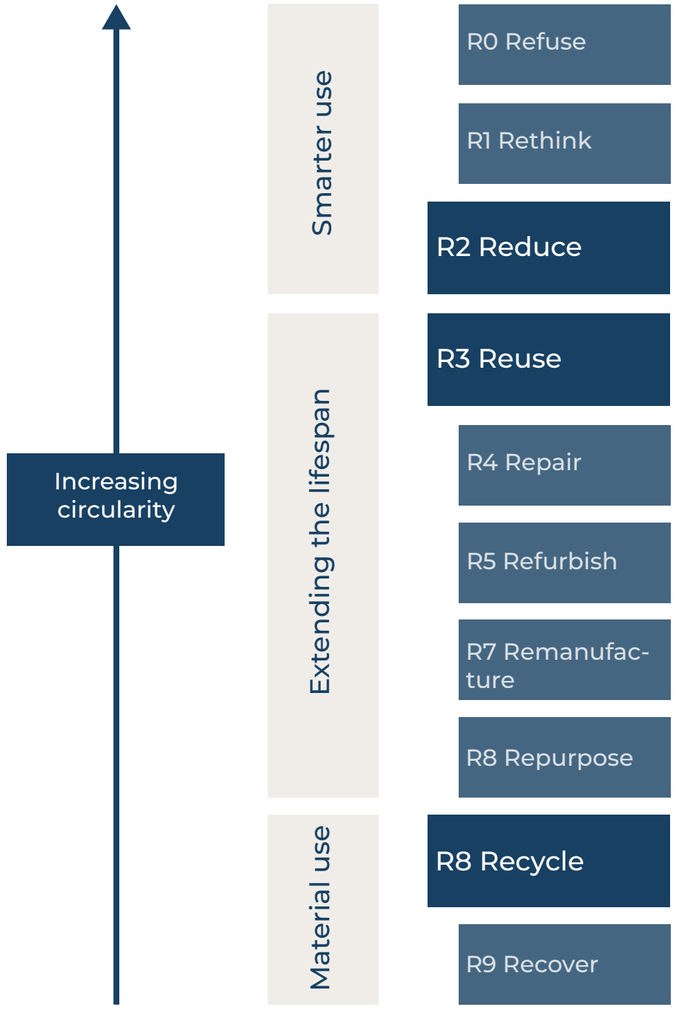
-Circularity Conference ‘The Future Envelope 15’ (2024)
-talk ’Bouwen met wat er is’ (2024)

-Veerle de Vries - teacher + architect)
-Sustainibility advisor (Dura Vermeer Bouw Heyma B.V.)

RESEARCH

Picture: Popma Ter Steege Architecten, KaVA, 2024

GENERAL STRATEGIES



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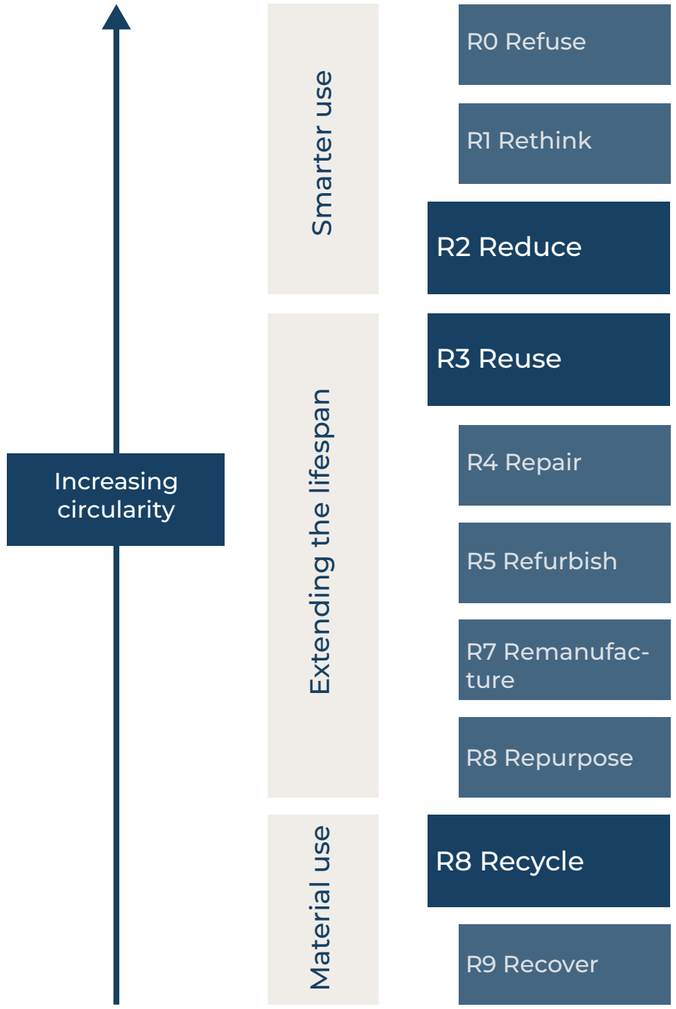
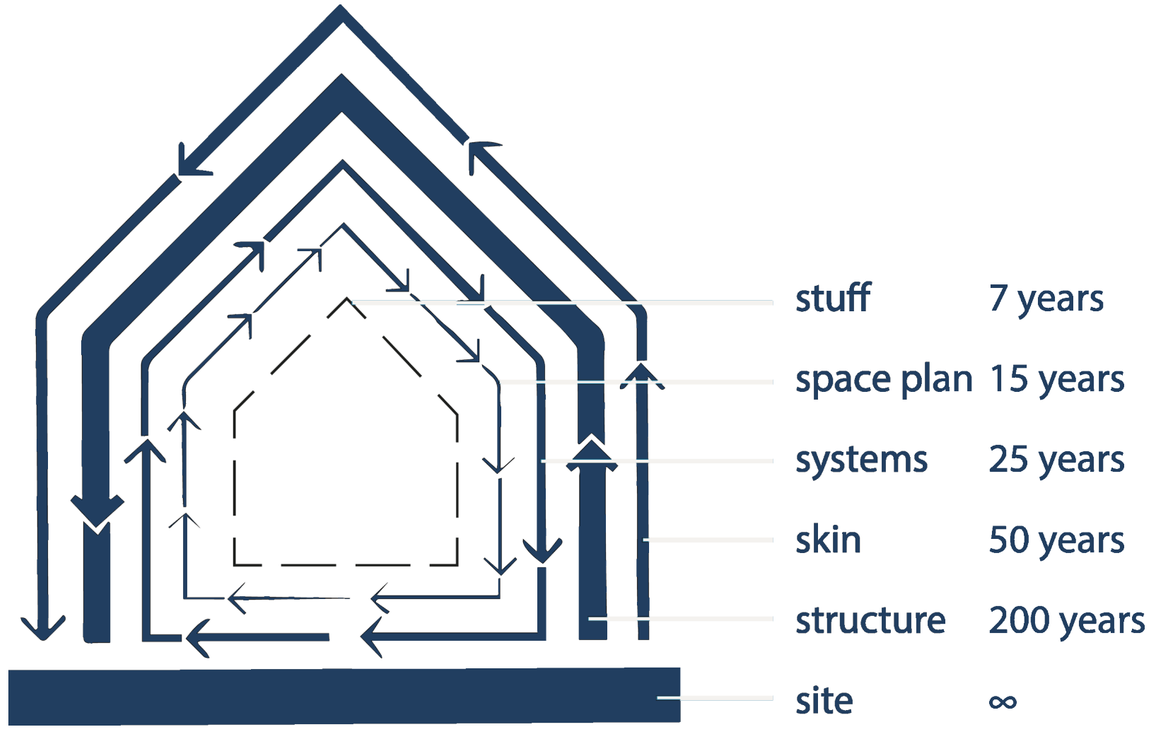
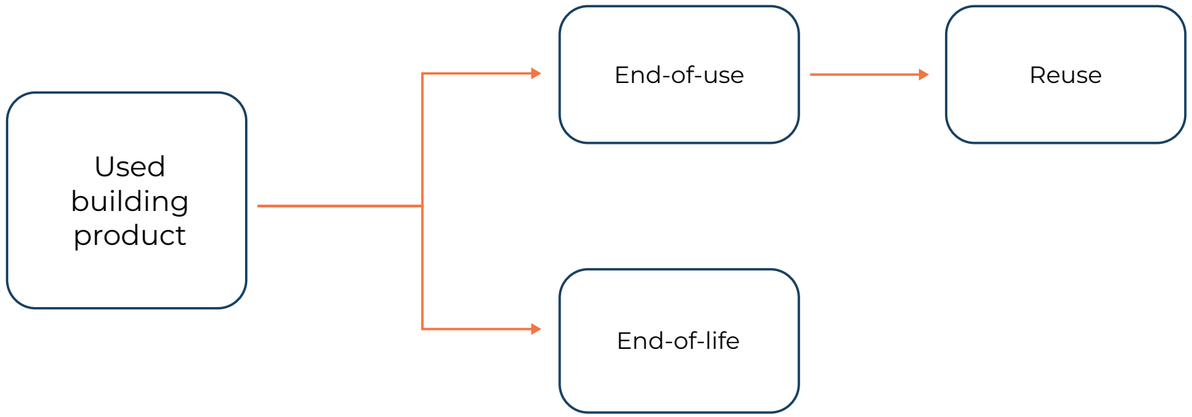
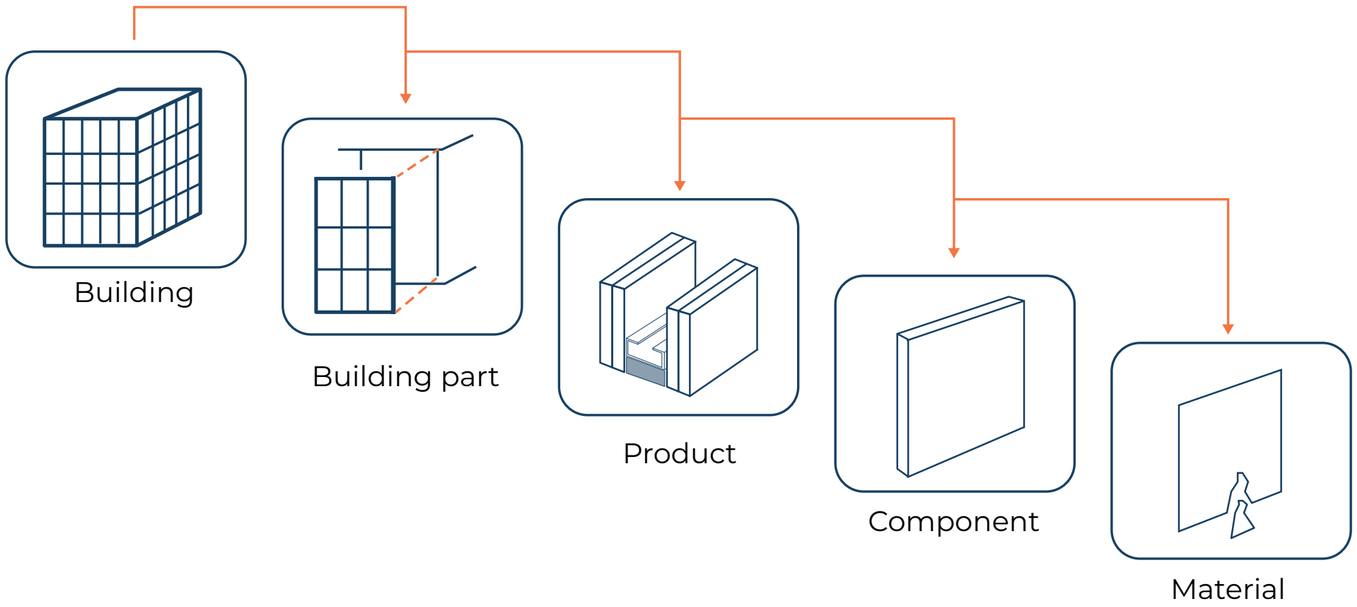




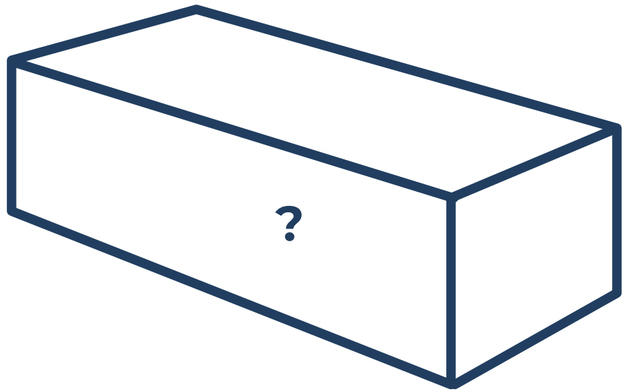
REUSED MATERIALS



REUSE STRATEGIES



FACTORS INFLUENCING REUSE POTENTIAL



FACTORS INFLUENCING REUSE POTENTIAL

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Availability

- Timing
- Location
- Quantity

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Dimensions

- Standard sizes can change
- Irregularities

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- Irregularities

Aesthetics

- Imperfections
- Add value

FACTORS INFLUENCING REUSE POTENTIAL

Availability

- Timing
- Location
- Quantity

Technical performance

- Technical condition
- Meet safety regulations

Dimensions

- Standard sizes can change
- Irregularities

Aesthetics

- Imperfections
- Add value

FACTORS INFLUENCING REUSE POTENTIAL

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- Timing
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Technical performance

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Dimensions

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Environmental impact

- Lower CO_2 impact
- Transportation
- LCA / Embodied energy

Aesthetics

- Imperfections
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Aesthetics

- Imperfections
- Add value

Costs

- Labour of deconstruction
- Storage costs
- Uncertainties

FACTORS INFLUENCING REUSE POTENTIAL

measurable

non-measurable

Availability

- Timing
- Location
- Quantity

Technical performance

- Technical condition
- Meet safety regulations

Dimensions

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Environmental impact

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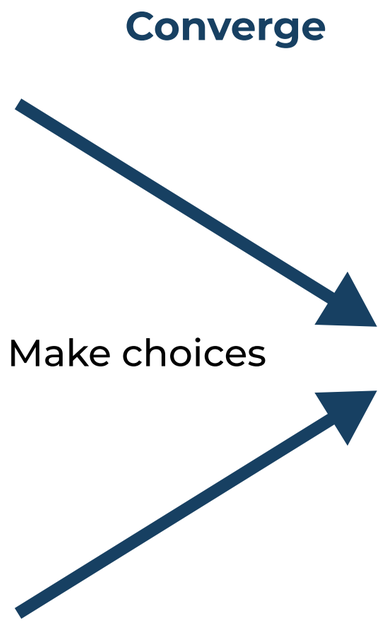
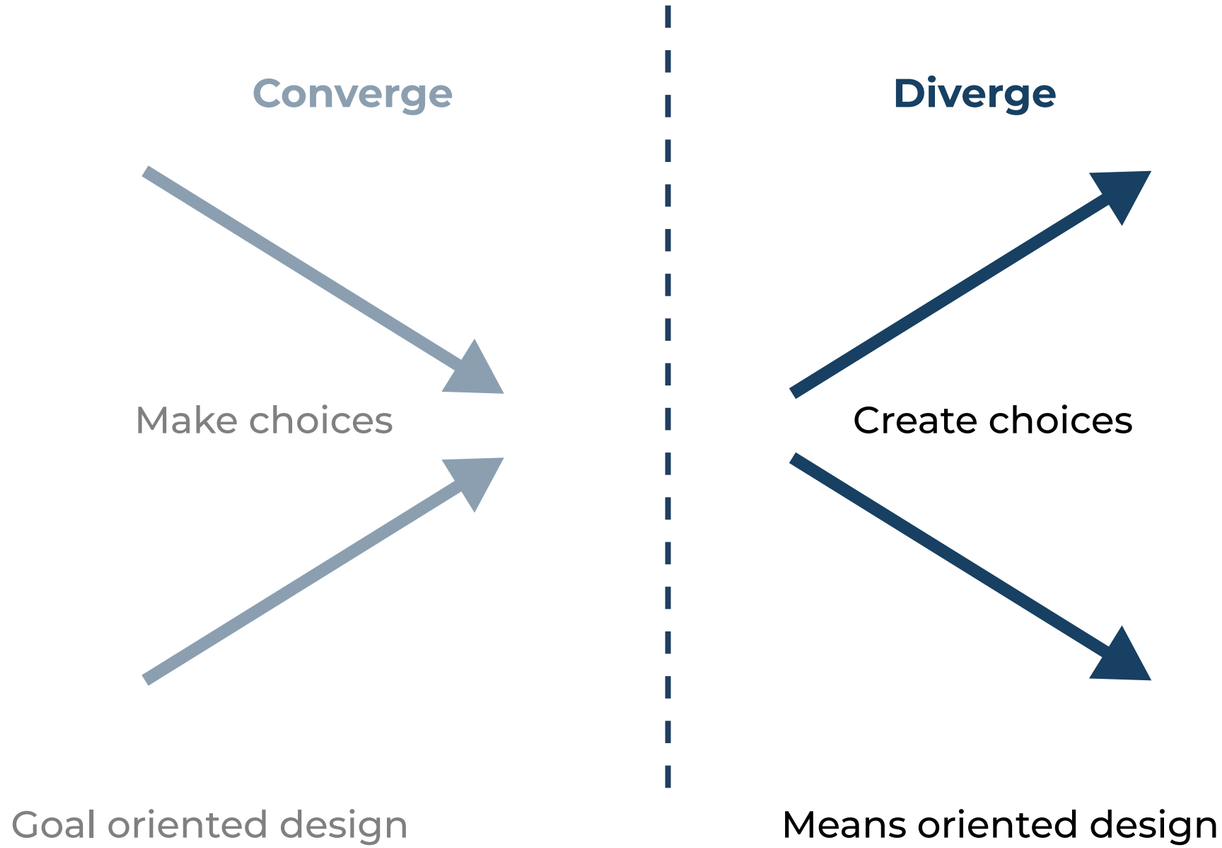
IMPLICATIONS
DESIGN PROCESS



Goal oriented design

IMPLICATIONS
DESIGN PROCESS



APTO ARCHITECTS

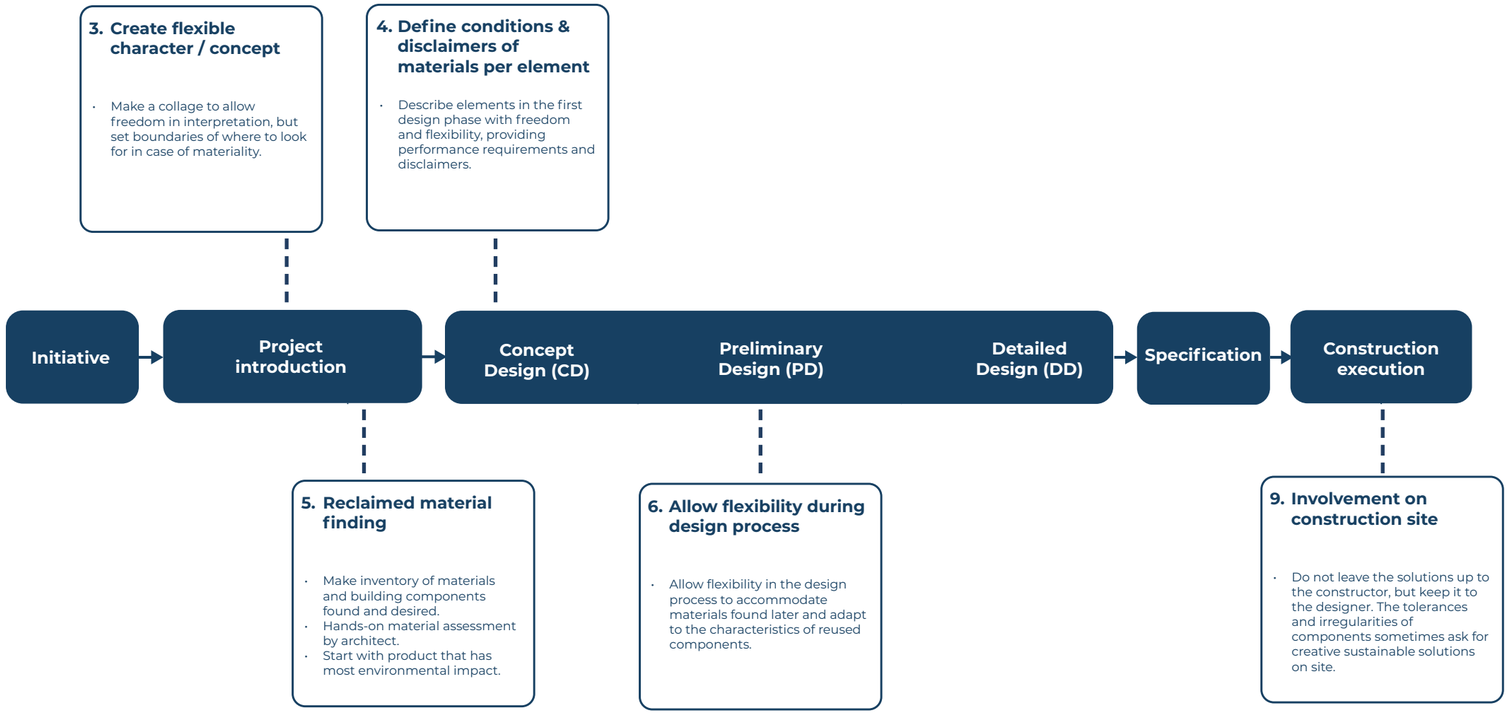
Project Kokomo

Timing 2021 - 2024

Location Amterdam

Size 1000 m²


FLOAT BAR
ENTRE


3. Create flexible character / concept
Make a collage to allow freedom in interpretation, but set boundaries of where to look for in case of materiality.
4. Define conditions & disclaimers of materials per element
Describe elements in the first design phase with freedom and flexibility, providing performance requirements and disclaimers.
Initiative
Project introduction
Concept Design (CD)
Preliminary Design (PD)
Detailed Design (DD)
Specification
Construction execution
5. Reclaimed material finding
Make inventory of materials and building components found and desired.
Hands-on material assessment by architect.
Start with product that has most environmental impact.
6. Allow flexibility during design process
Allow flexibility in the design process to accommodate materials found later and adapt to the characteristics of reused components.
9. Involvement on construction site
Do not leave the solutions up to the constructor, but keep it to the designer. The tolerances and irregularities of components sometimes ask for creative sustainable solutions on site.

Design by availability

- Use products that are widely available in the region
- Design sometimes follows material.

Standardisation and simplicity in construction

- Use standard sizes and connections for components

Design for disassembly

- Use reversible connections
- Use dry connections
- Universal screws

Design for adaptability

- Design spaces and products that can be easily modified to meet the changing needs.

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POPMA TER STEEGE ARCHITECTEN

Project Kantoor Vol Afval (KaVA) renovation project

Timing 2021 - 2024

Location Katwijk

Size 2100 m^2

1. Early stakeholders engagement

- At start of design process, elongated introduction phase with all stakeholders.
- Possible stakeholders from start: architect, contractor demolition contractor, material scientist, circularity advisor, reclaimed material scout.

2. Specify measurable reuse goals

- Define specific, measurable goals, such as the minimum percentage of reused building materials.

4. Define conditions & disclaimers of materials per element

- Describe elements in the first design phase with freedom and flexibility, providing performance requirements and disclaimers.

8. Building components documentation

- Clearly describe all components and materials used in the building.
- Standardised information about the components in a building: material, quality and quantity.

Initiative → **Project introduction** → **Concept Design (CD)** → **Preliminary Design (PD)** → **Detailed Design (DD)** → **Specification** → **Construction execution**

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7. Provide detailed drawing details

- Design for tolerances.
- Ensure clear guidance for construction and integration of reused materials.

9. Involvement on construction site

- Do not leave the solutions up to the constructor, but keep it to the designer. The tolerances and irregularities of components sometimes ask for creative sustainable solutions on site.

Deep understanding of material knowlegde

- More material knowlegde is needed about requirements.

Design in components

- Start with building part > product > component.

Design for adaptability

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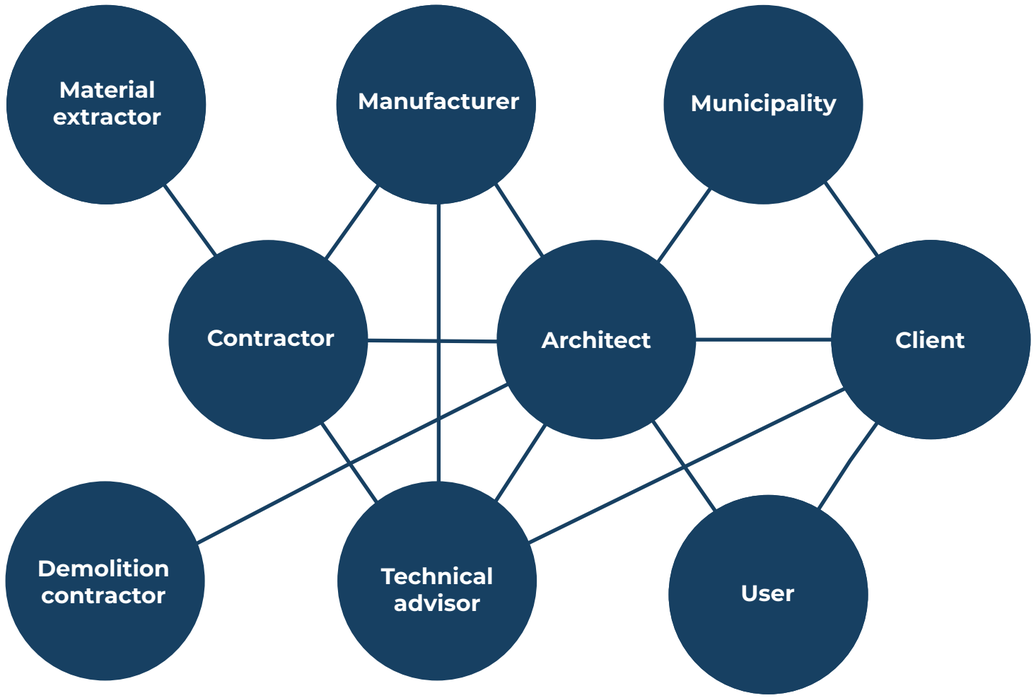
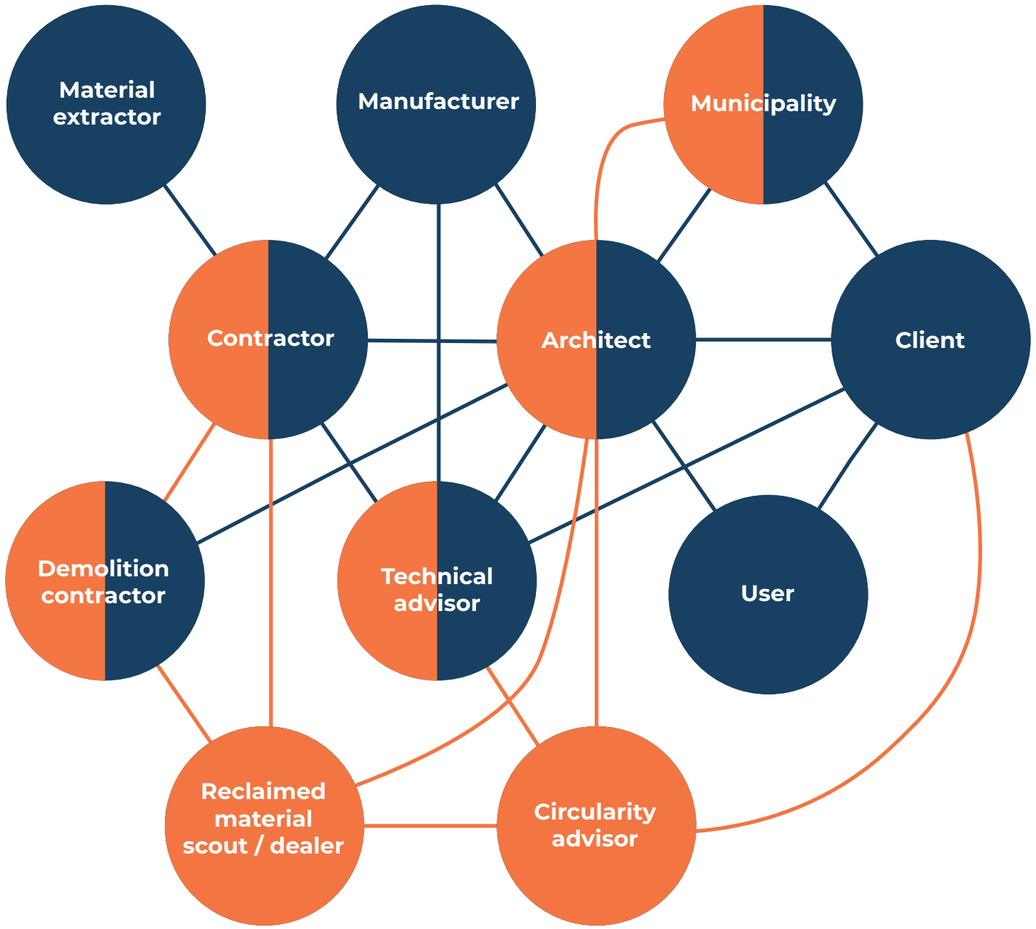
STAKEHOLDERS



conventional relation

conventional stakeholder

CIRCULAR STAKEHOLDERS



conventional relation

conventional stakeholder

potential new relation

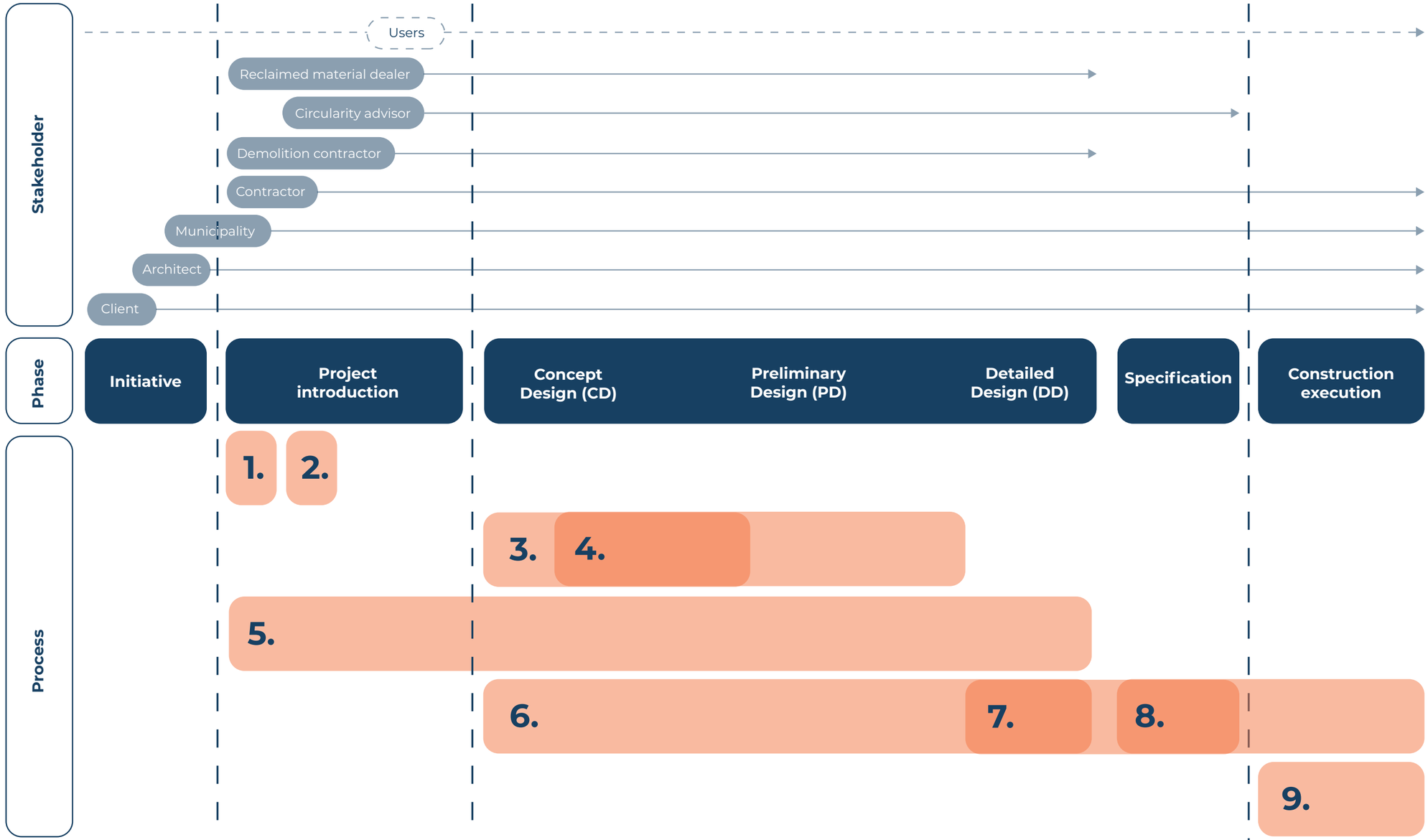
new stakeholder

shifting stakeholder

CONCLUSION

What design principles can be developed to create a circular framework that enables architects to effectively integrate reused building components during the design phase?

1. Early stakeholders engagement
2. Specify measurable reuse goals
3. Create flexible character / concept
4. Define conditions & disclaimers of element
5. Reclaimed material finding
6. Allow flexibility during design process
7. Provide detailed drawing details
8. Building components documentation
9. Involvement on construction site



Design process principles

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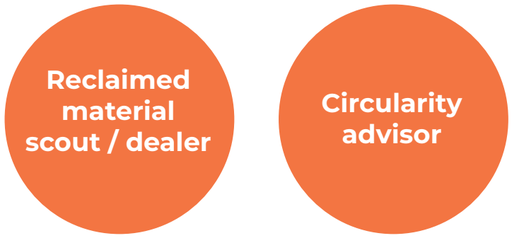
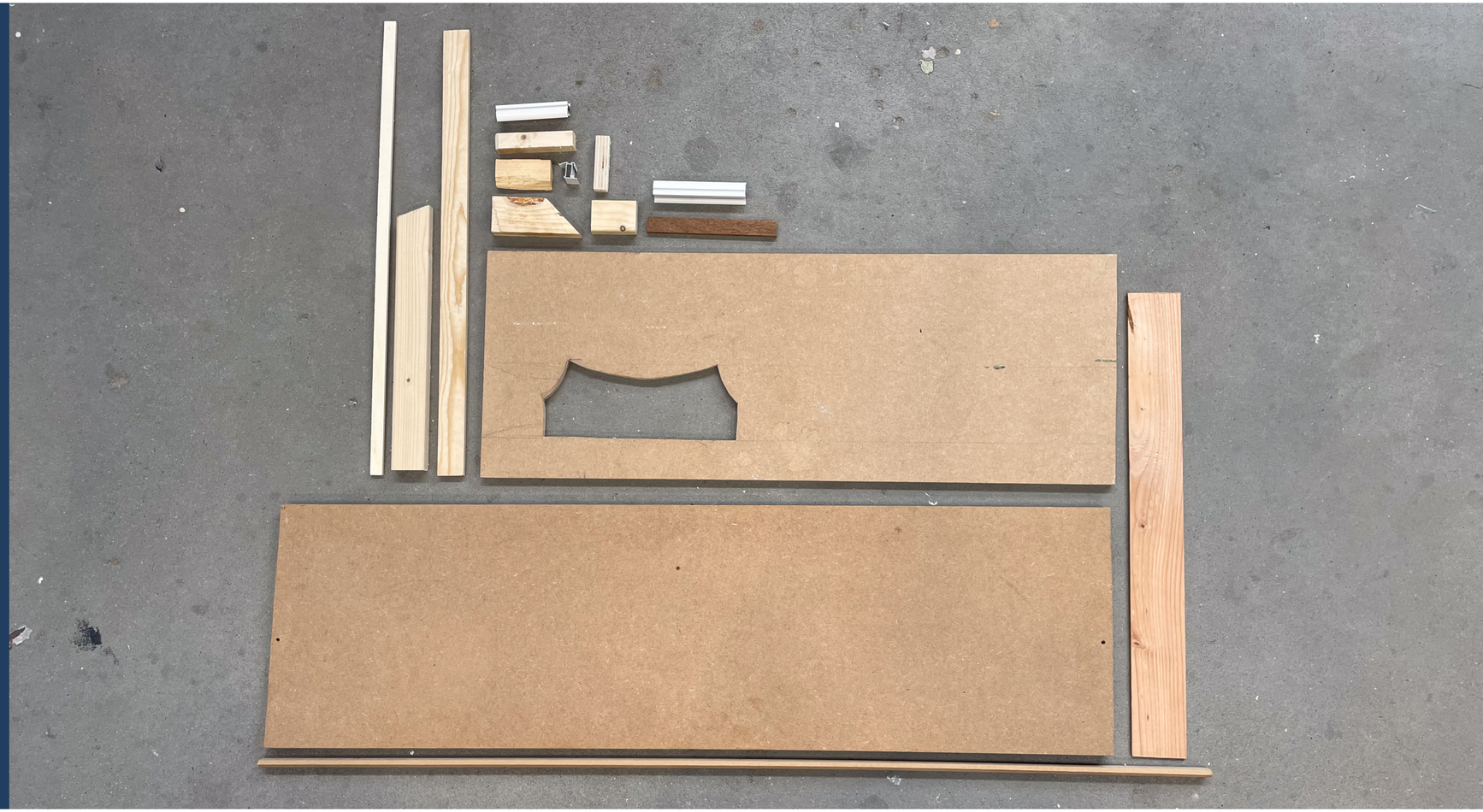
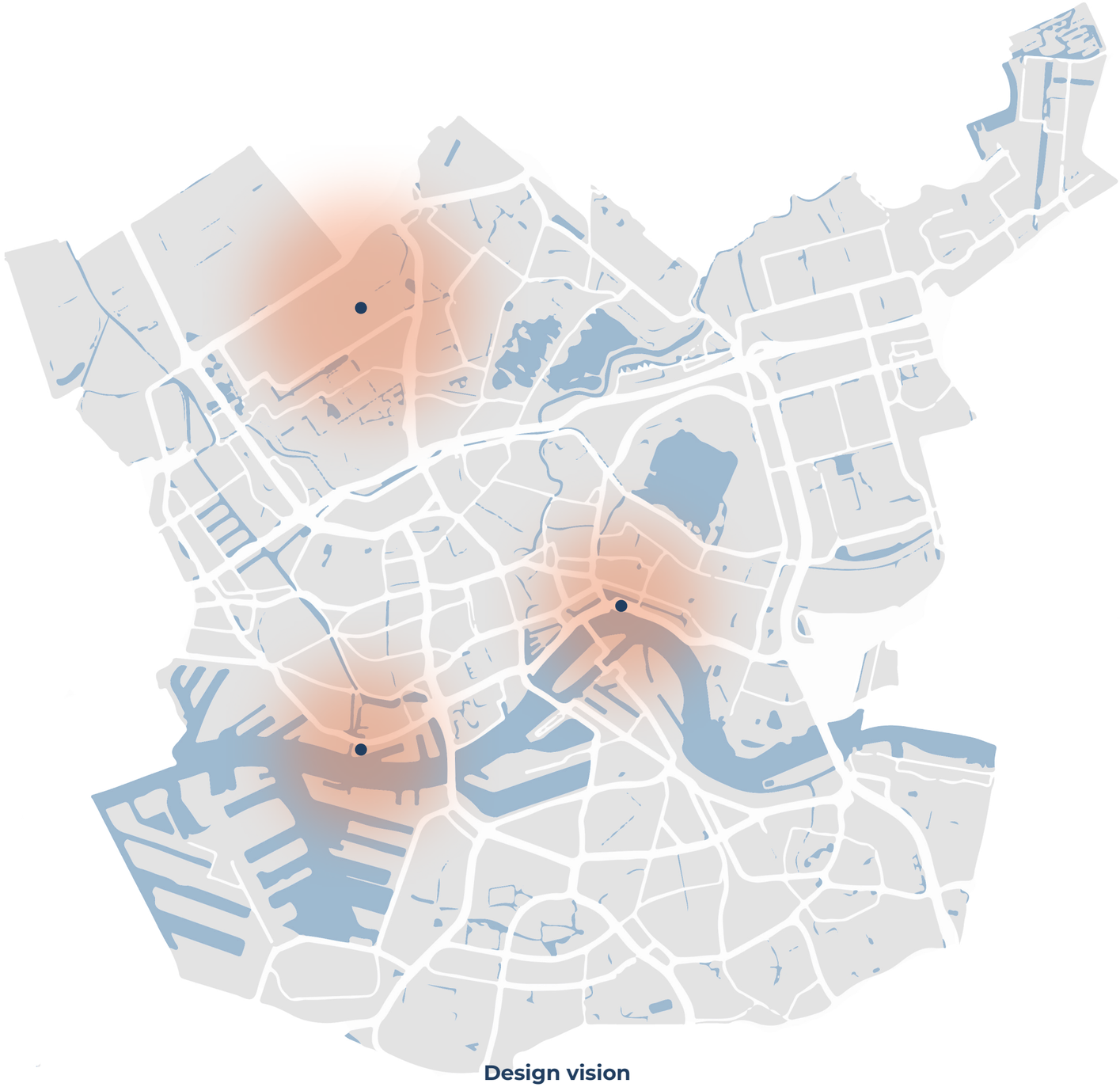
Stakeholders

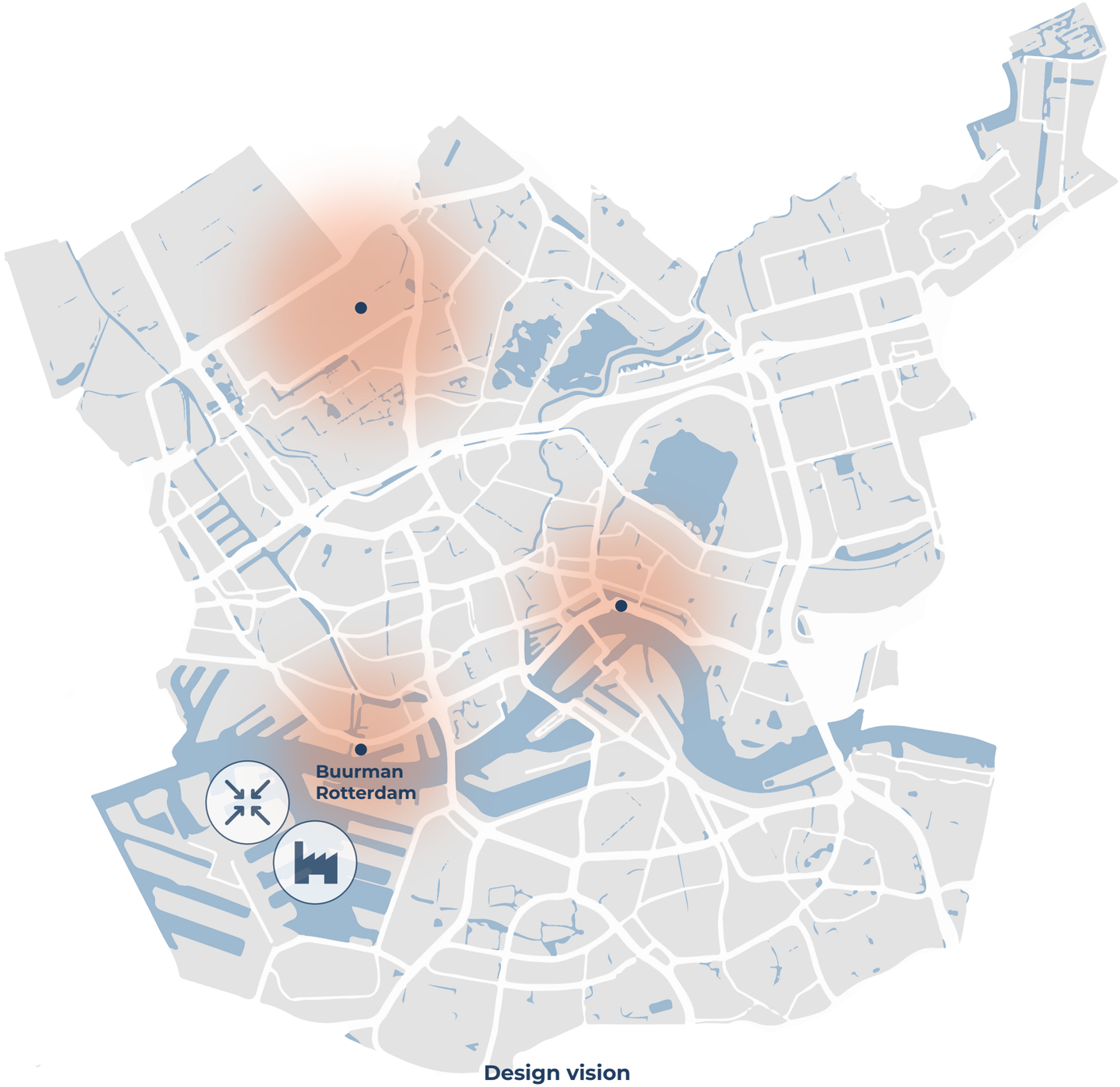


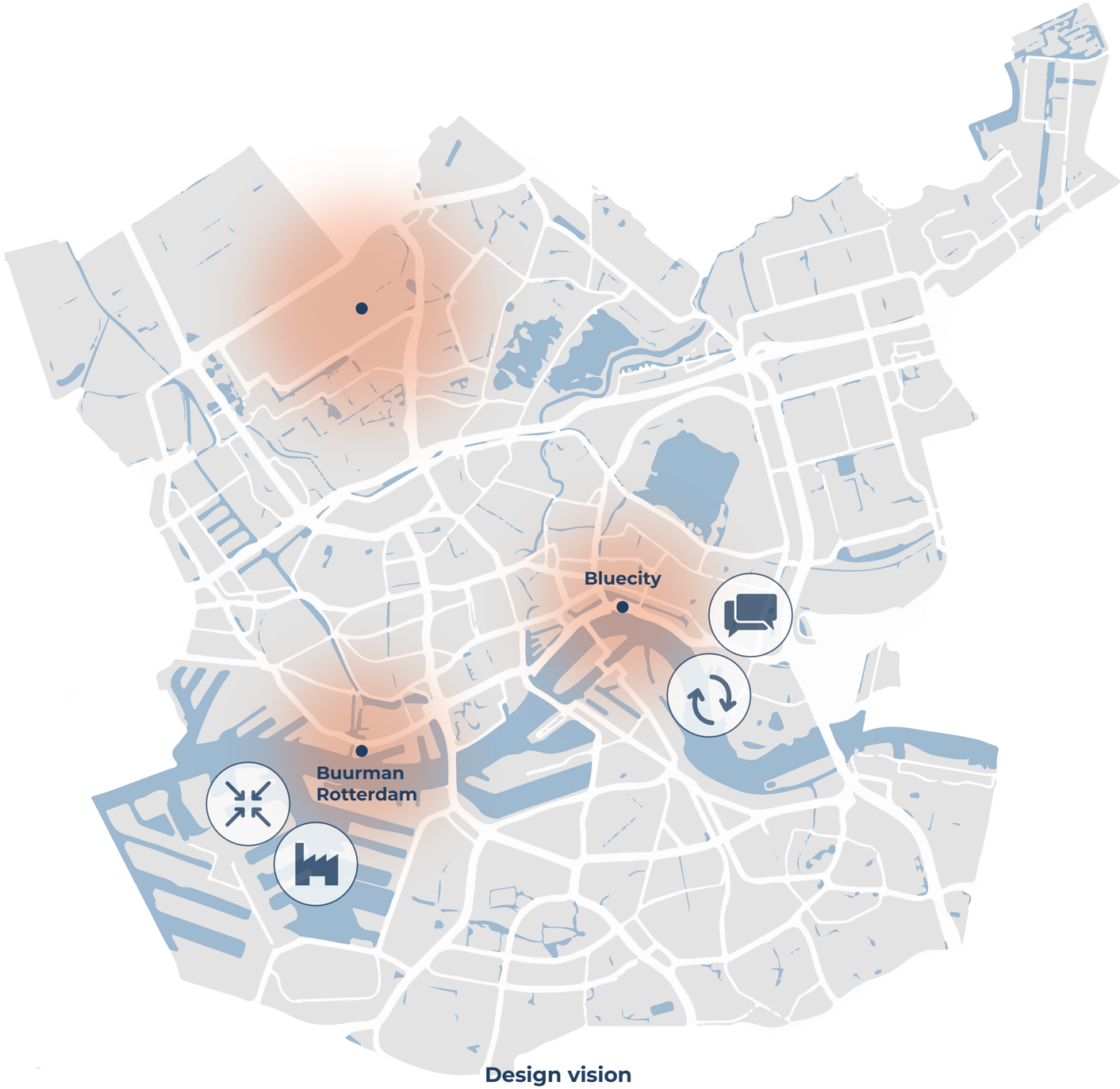
DESIGN VISION



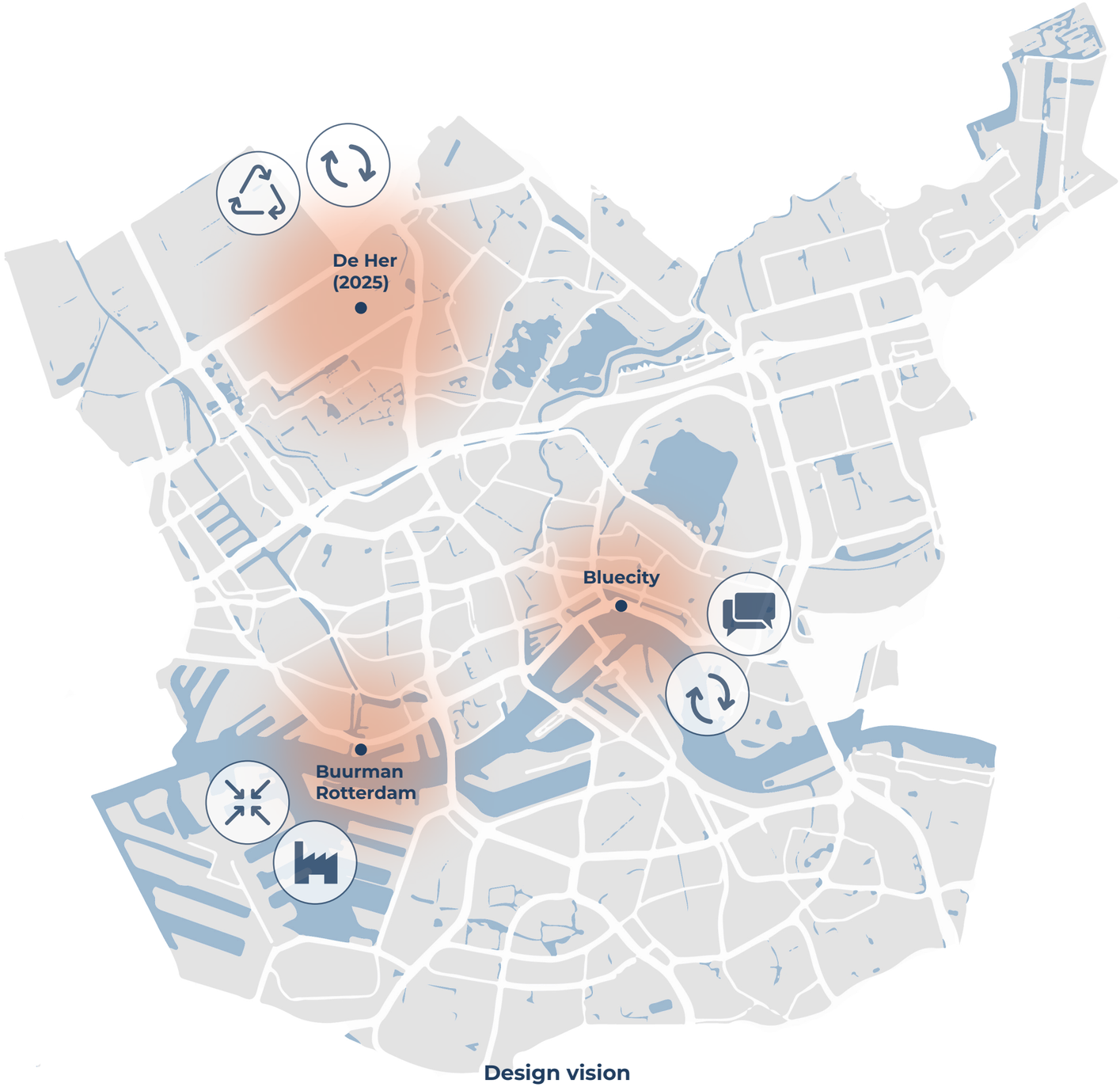
Create an architecture firm and knowlegde centre, where applied design principles lead to optimal reuse and stakeholders can make reuse the new norm.



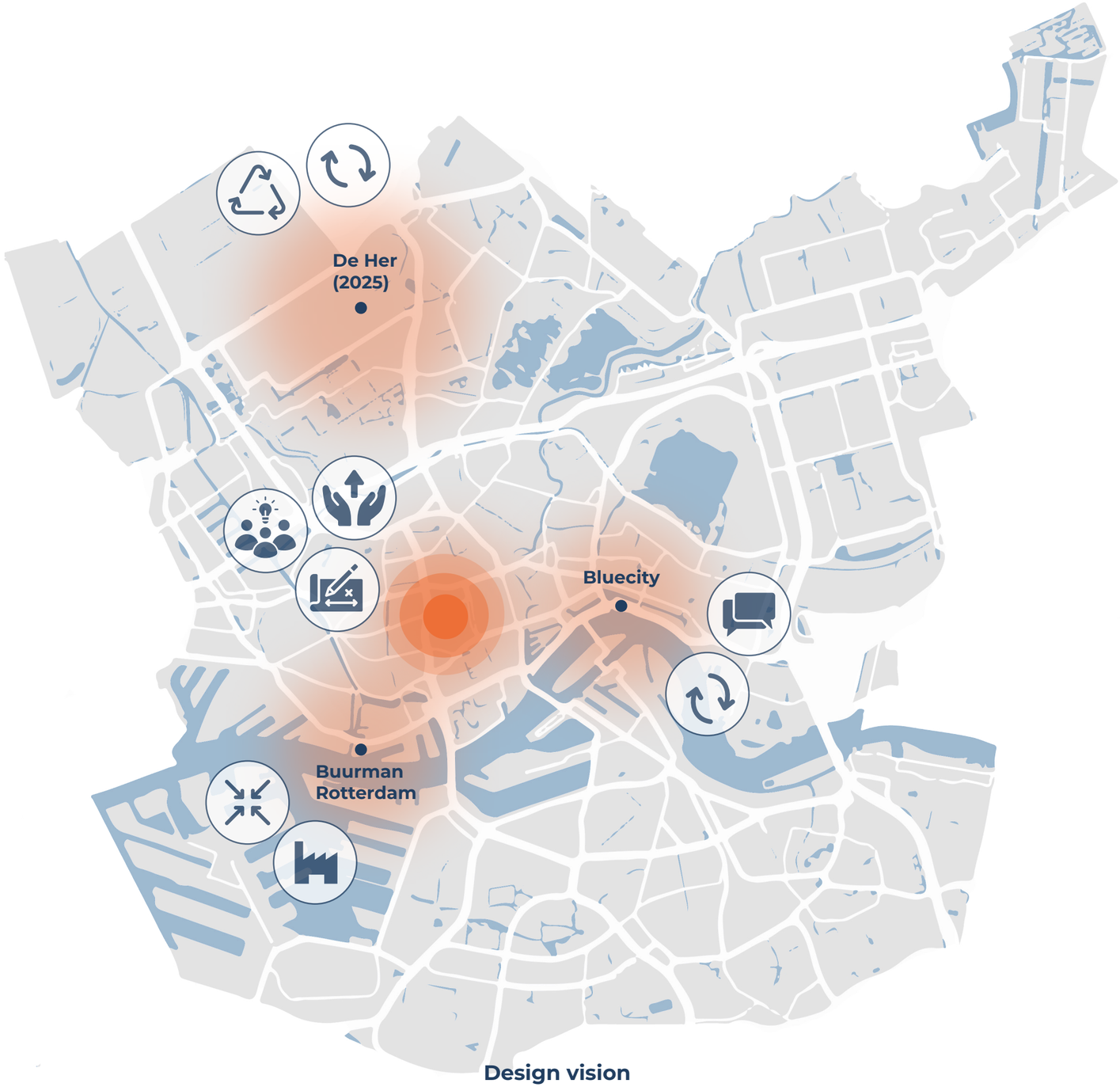

Buurman
Rotterdam



Design vision



Design vision



Design vision

Design vision

Design vision

0 100 m 300 m

N

Design vision

0 100 m 300 m

N

Anna Paulownastraat

10.

Suitable program:

-Dwelling

15

Gouvernestraat / Park Het Oude Westen

12.

Suitable program:

-Dwelling

17

Van Speykstraat

18.

Suitable program:

-Dwelling
-Mixed use

Design vision

0 100 m 300 m

N

Anna Paulownastraat

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Suitable program:

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Gouvernestraat / Park Het Oude Westen

12.

Suitable program:

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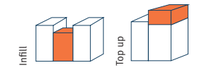
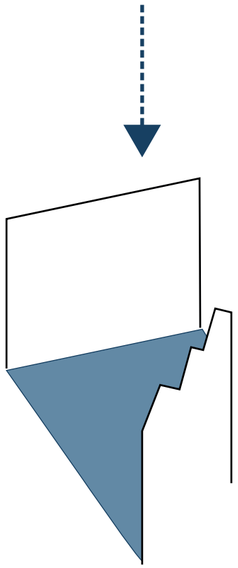
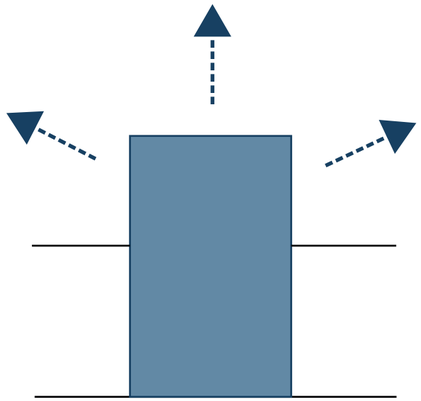
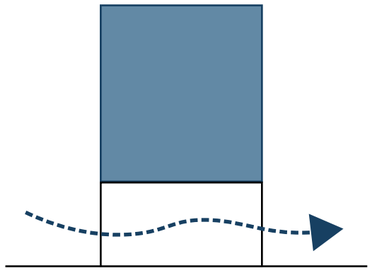




Existing space



Reuse visible



Accessible

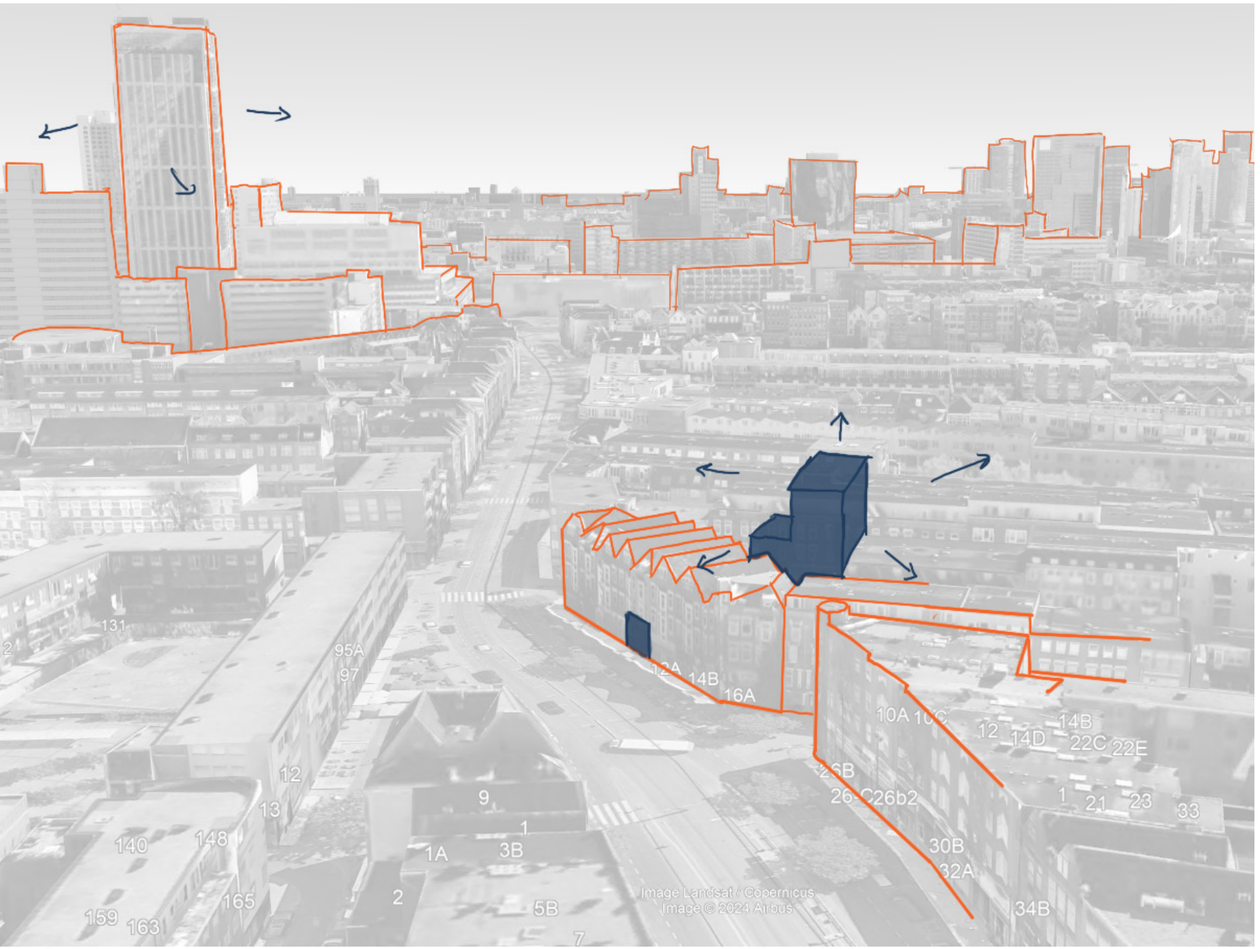
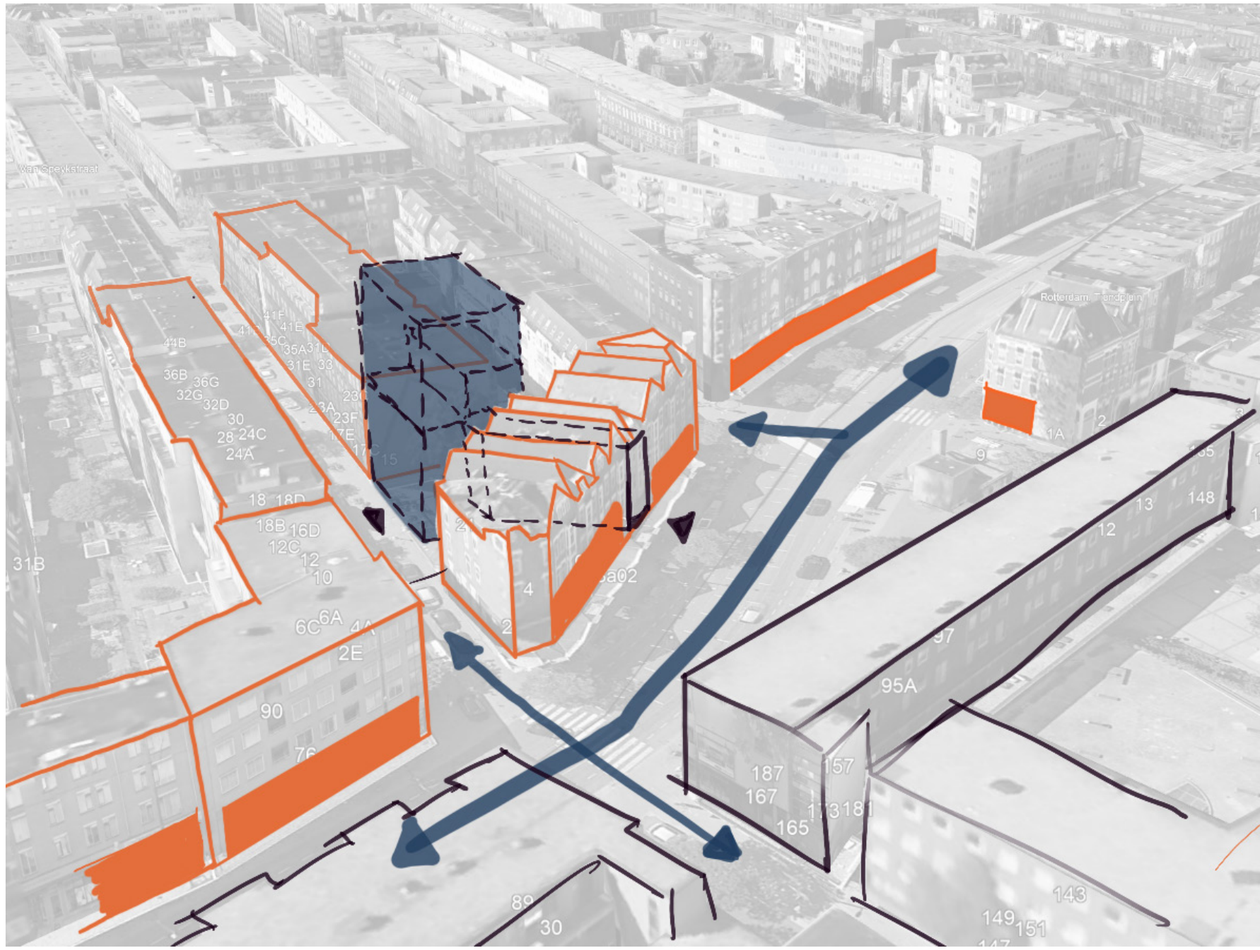


Image Landsat / Copernicus
Image © 2024 Airbus



2.

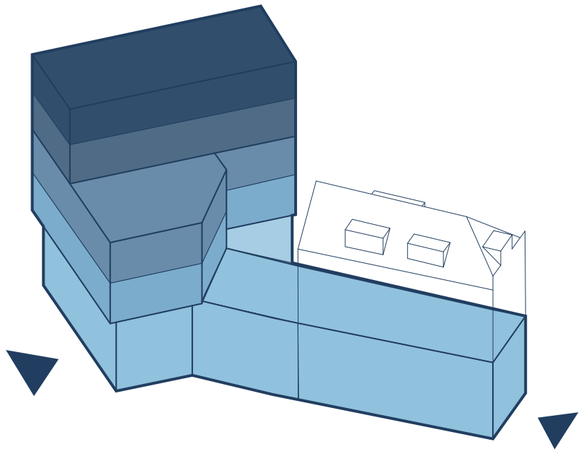
Collaboration area
Open workspace
Meeting rooms

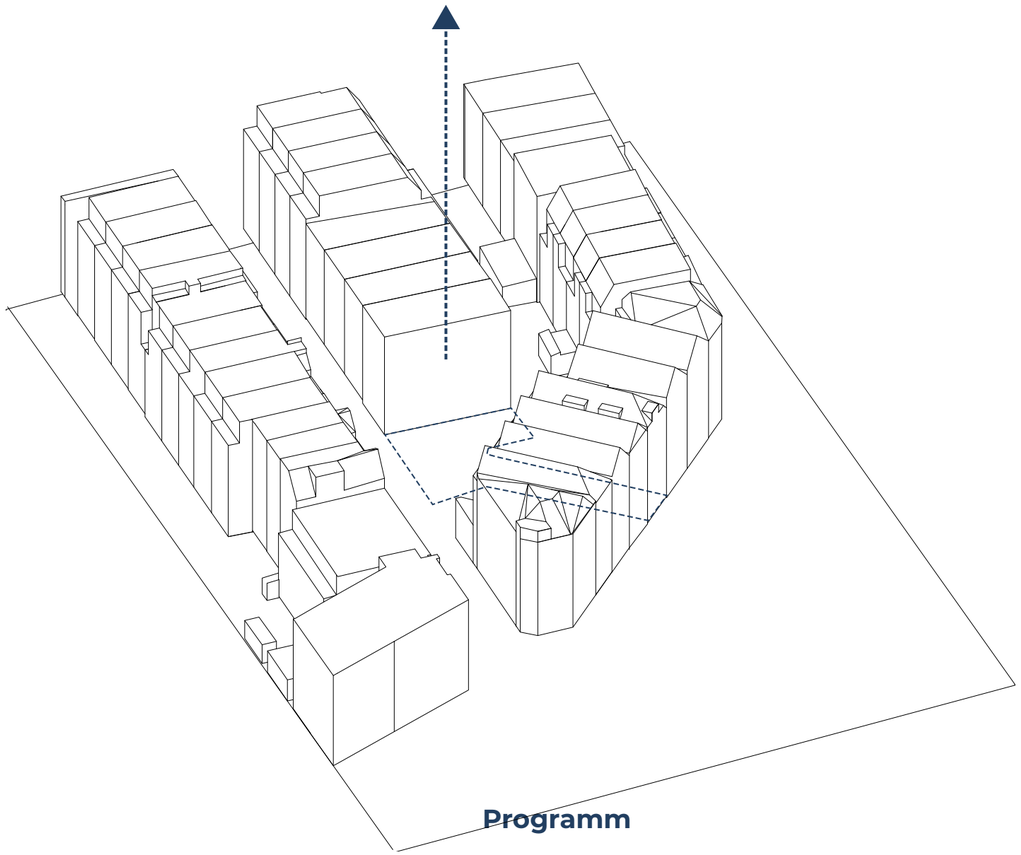
1.

Storage
Workspace
+Vide/Void

GF.

Reception
Exhibition space
Materials library
Coffee cafe





5.

Offices
Large meeting room
Project rooms

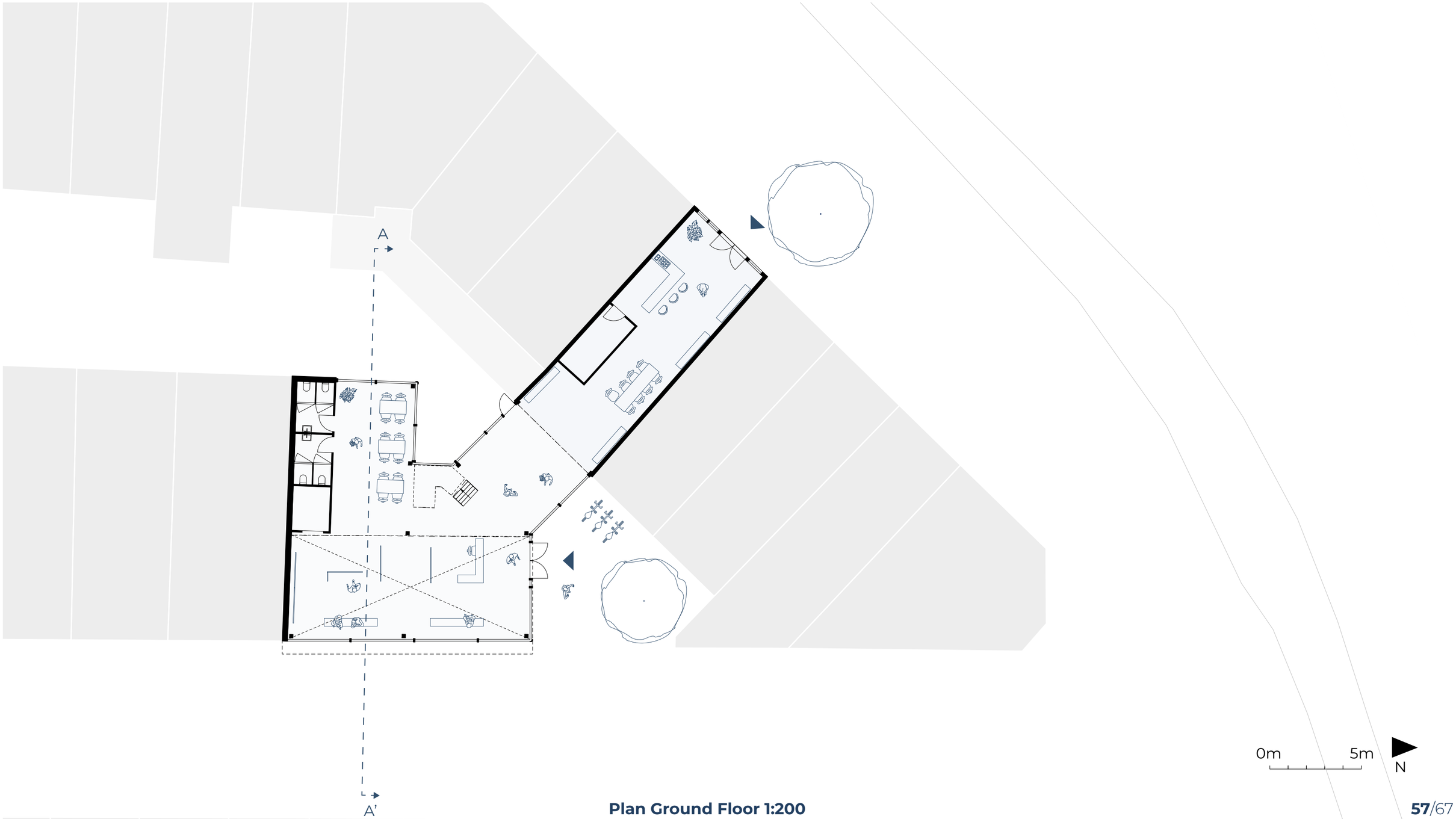
4.

Design studio
Project rooms
Print/copy
+Terrace

3.

Seminar / lecture room
Open workspace

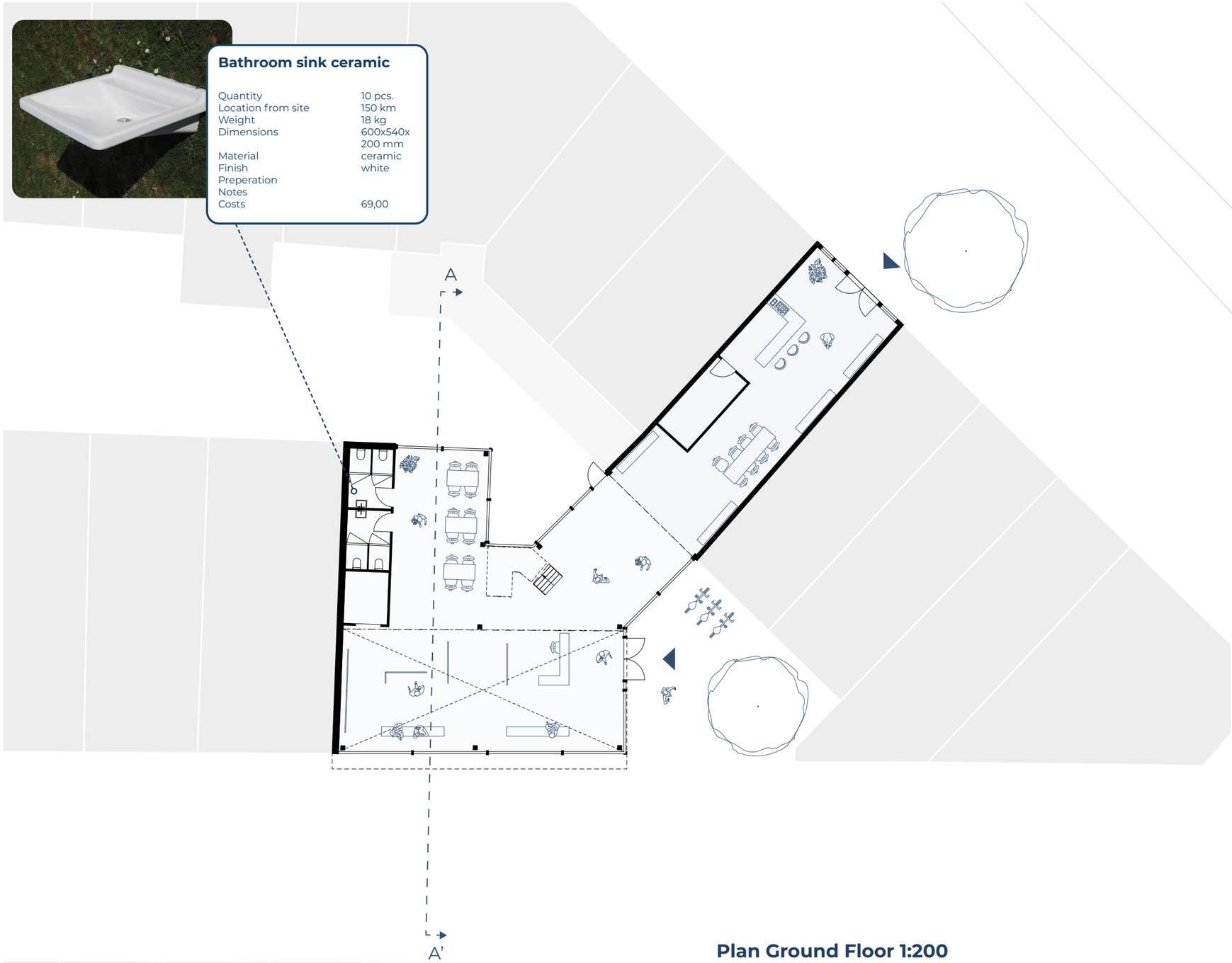
Programm



Plan Ground Floor 1:200

Bathroom sink ceramic

Quantity	10 pcs.
Location from site	150 km
Weight	18 kg
Dimensions	600x540x 200 mm
Material	ceramic
Finish	white
Preperation	
Notes	
Costs	69,00



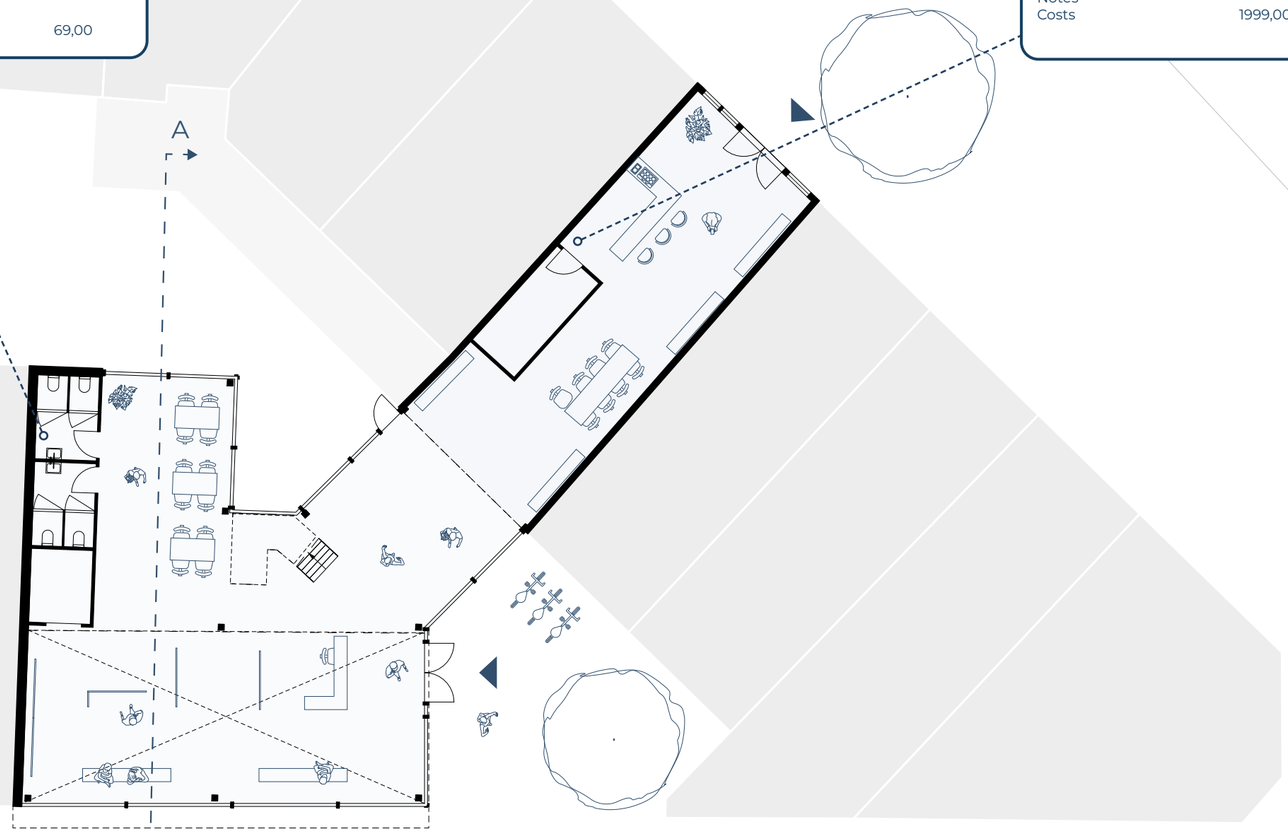
Plan Ground Floor 1:200

Bathroom sink ceramic

Quantity	10 pcs.
Location from site	150 km
Weight	18 kg
Dimensions	600x540x 200 mm
Material	ceramic
Finish	white
Preperation	
Notes	
Costs	69,00

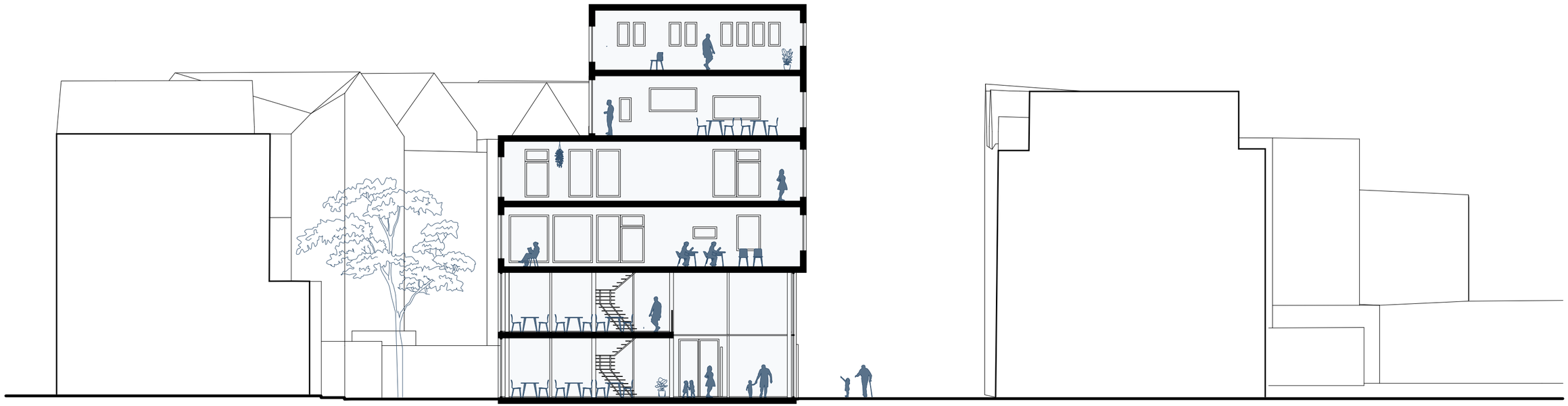
Door - stainless steel

Quantity	1
Location from site	120 km
Weight	50 kg
Dimensions	1980 x 925
Material	stainless steel, bronze handles
Notes	
Costs	1999,00



0m 5m N

Plan Ground Floor 1:200

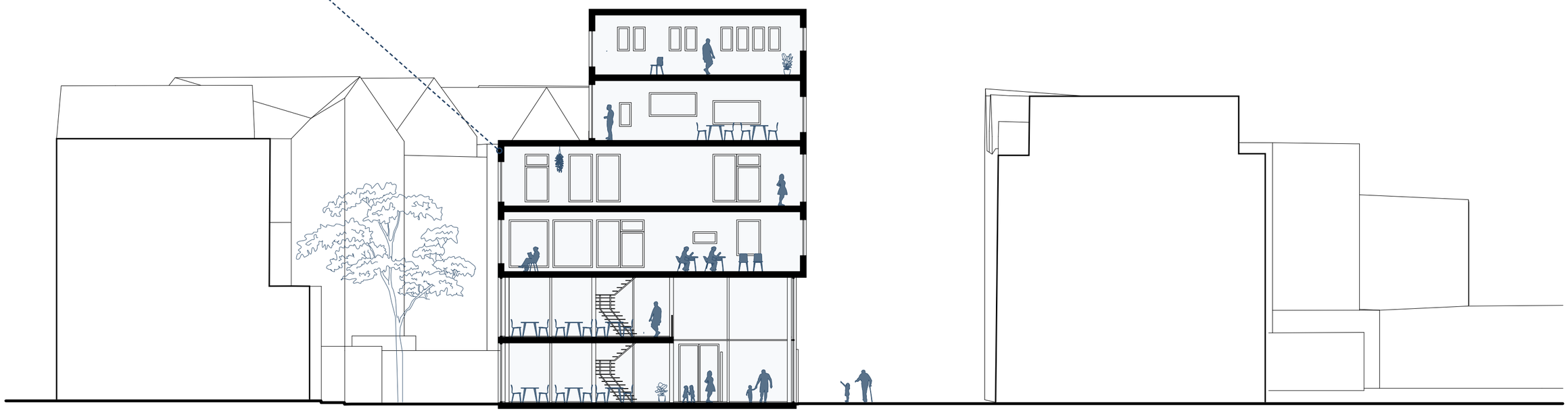


0m 5m

Section AA' 1:200

Bricks - red

Quantity	800 pcs.
Location from site	120 km
Weight	1600 kg
Dimensions	180x80x60
Material	red brick machine
Notes	
Costs	499,00



0m 5m

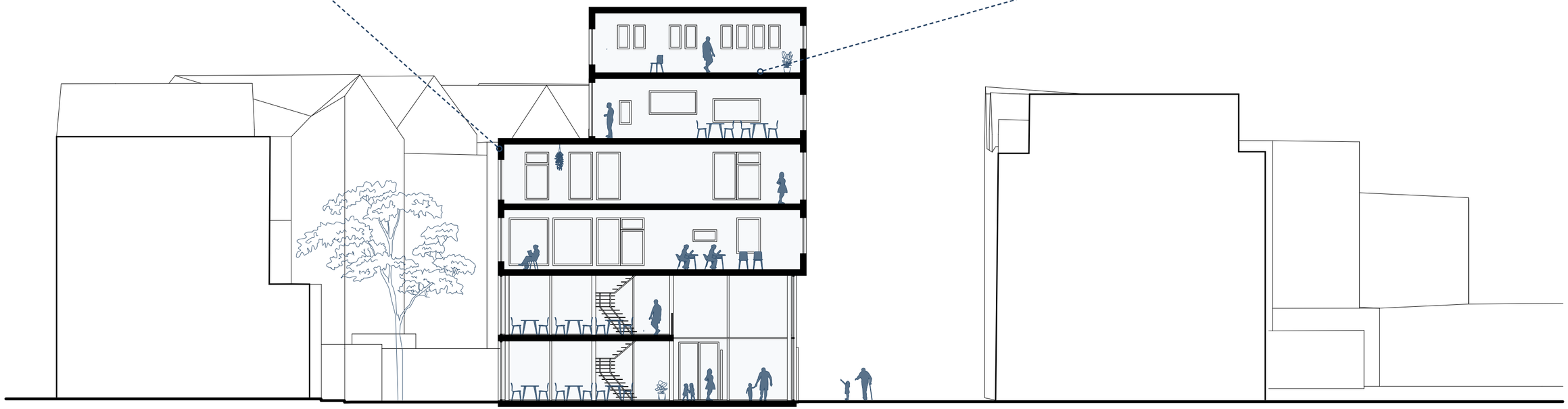
Section AA' 1:200

Bricks - red

Quantity	800 pcs.
Location from site	120 km
Weight	1600 kg
Dimensions	180x80x60
Material	red brick machine
Notes	
Costs	499,00

CLT wood - walls / floor elements

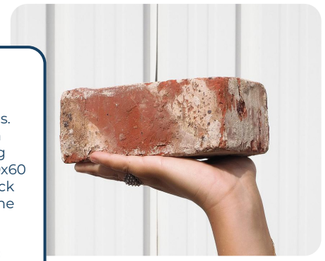
Quantity	80 m³
Location from site	15 km
Weight	18 kg
Dimensions	vary
Material	construction
Finish	
Preperation	
Notes	< Jan 2025
Costs	300,00 /m³



0m 5m

Section AA' 1:200

Bricks - red



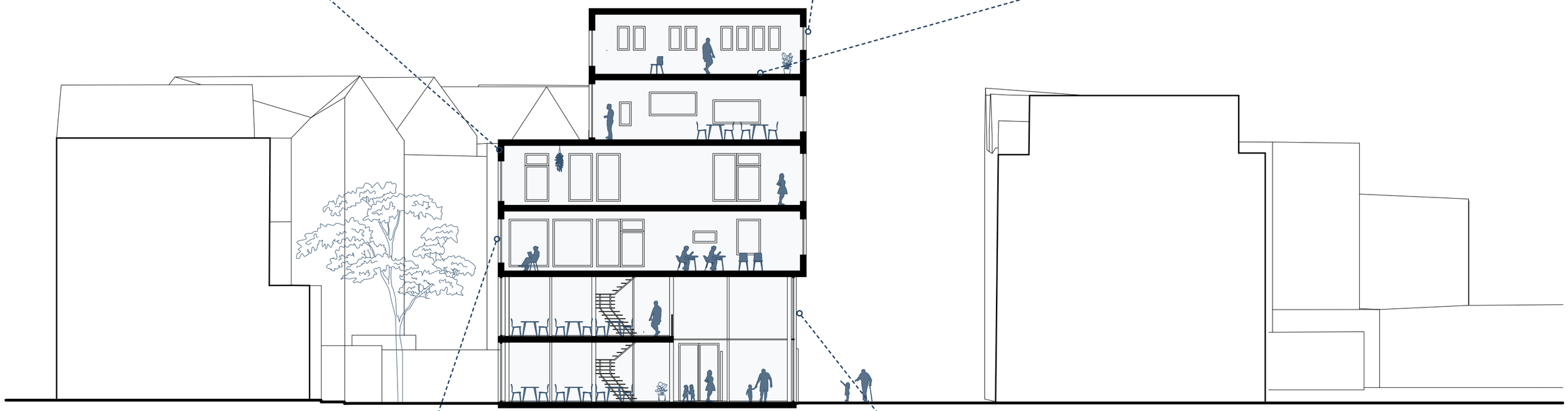
Quantity	800 pcs.
Location from site	120 km
Weight	1600 kg
Dimensions	180x80x60
Material	red brick machine
Notes	
Costs	499,00

Facade element top floors

Dimensions	min	-
	max	-
Requirements Material		Different colour than red/brick, light element
Notes		Large quantity

CLT wood - walls / floor elements

Quantity	80 m³
Location from site	15 km
Weight	18 kg
Dimensions	vary
Material	construction
Finish	
Preperation	
Notes	< Jan 2025
Costs	300,00 /m³



Windows

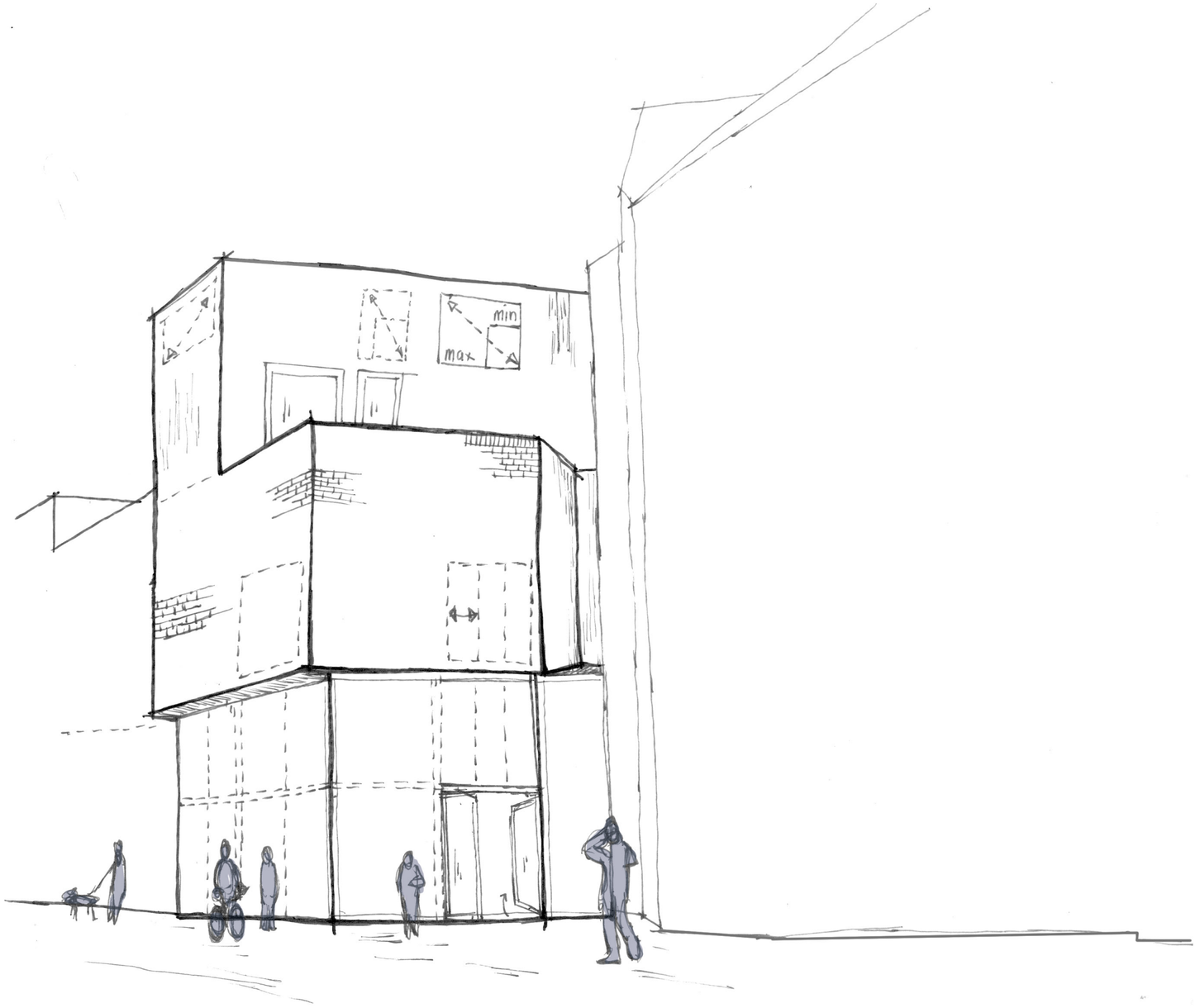
Dimensions	min	h. 1000mm
	max	h. 3000mm
Requirements Material		Material t.b.s. Glass elements
Notes		

Transparant elements/ windows

Dimensions	min	900x1100
	max	1500x3000
Requirements Material		transparant, clean, semi transparant.
Notes		Large quantity

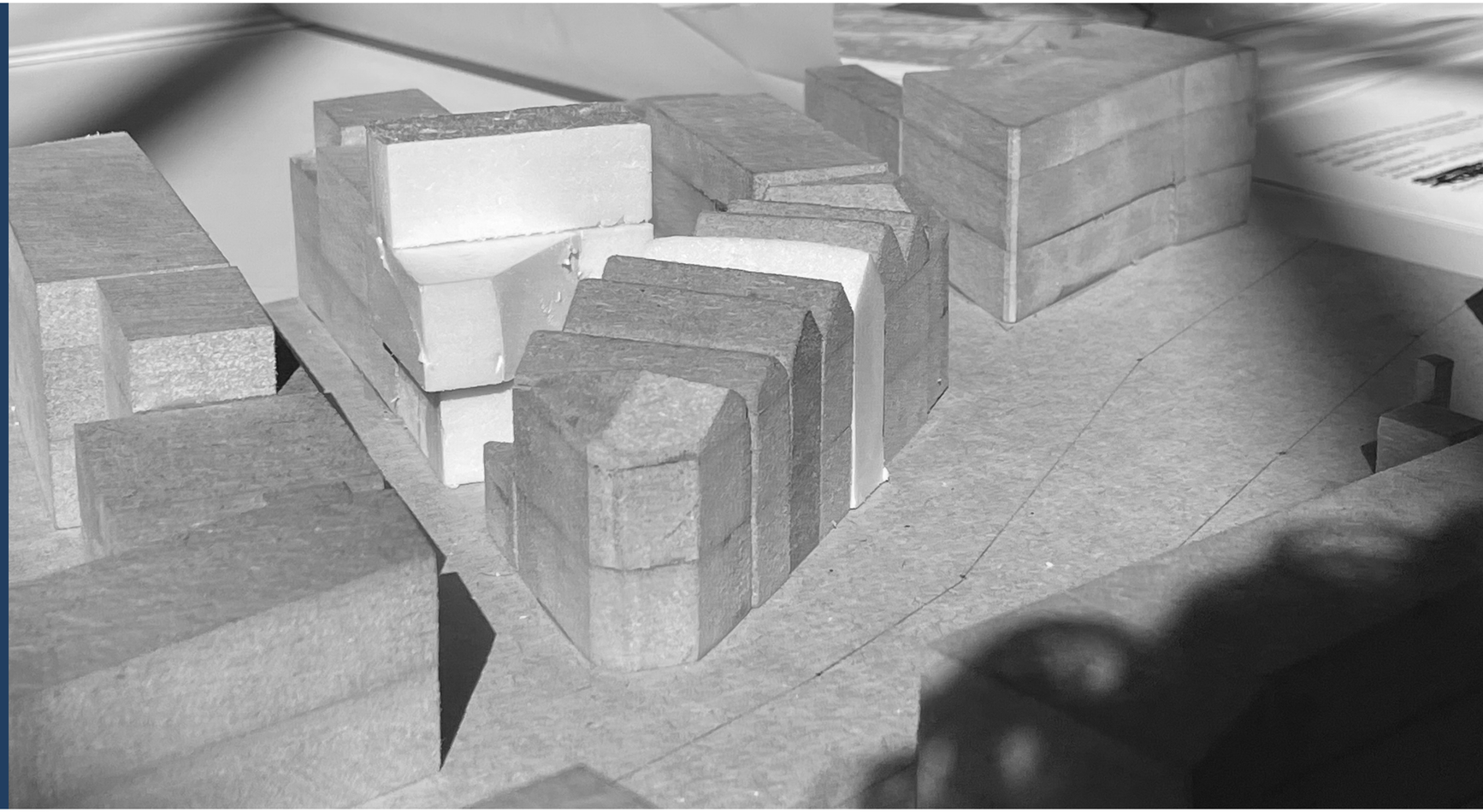
0m 5m

Section AA' 1:200



Impression

AFTER P2



Use the design process principles as formulated in the research.

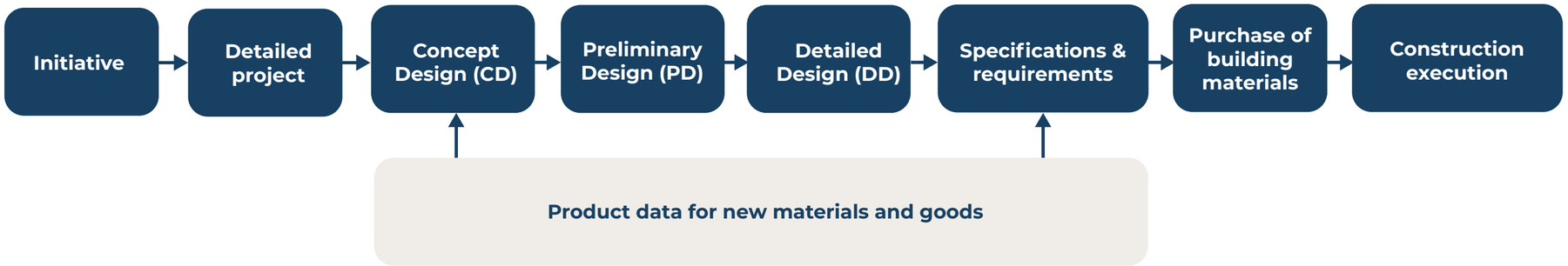
Design and formulate the boundaries of the design and the specific design location.
-What are the regulations for this site
-what are the building regulations for an architecture firm
-Investigate the climate
-Specify the programm of requirements
-Start writing down the performances of the elements and disclaimers

Use the strategies for finding materials and investigate whether donor buildings are suitable for this design.

Explore the main design strategies and how they can be applied:
design for disassembly & design for adaptibility.

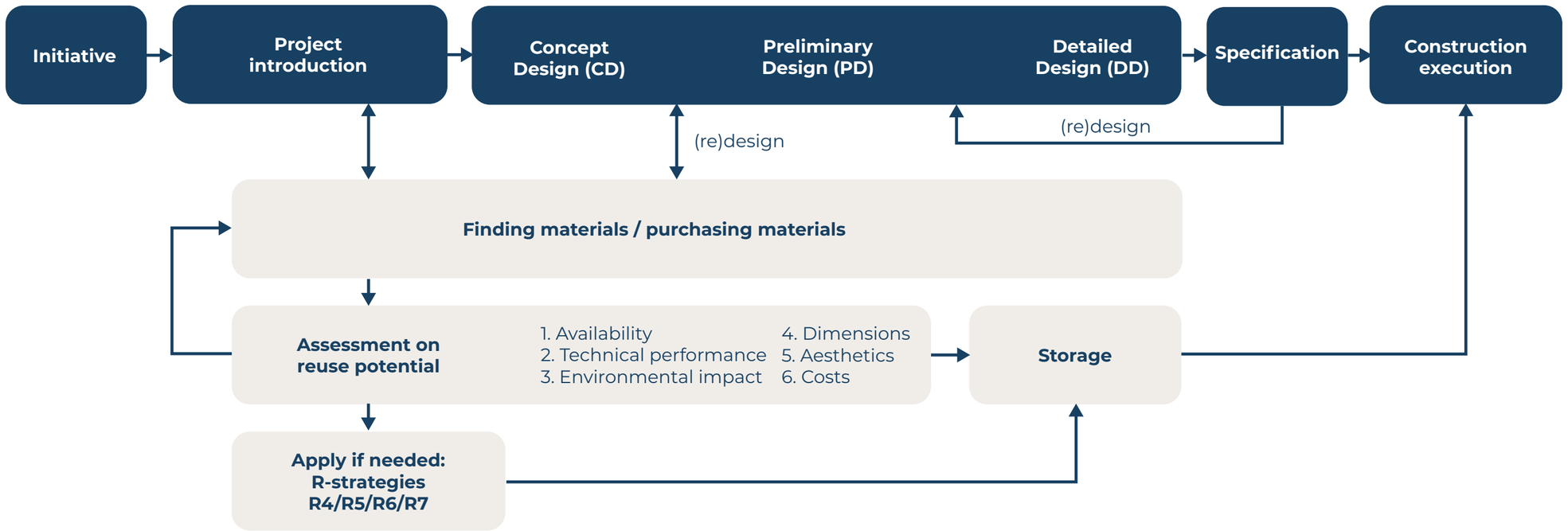
Investigate potential use of existing building and test alternatives.

CONVENTIONAL DESIGN AND CONSTRUCTION PROCESS



DESIGN AND CONSTRUCTION PROCESS INVOLVING REUSE

DESIGN AND CONSTRUCTION PROCESS INVOLVING REUSE



MATERIAL FINDING