The Marinepassage

a case study project for circular design & material usage strategies in architecture

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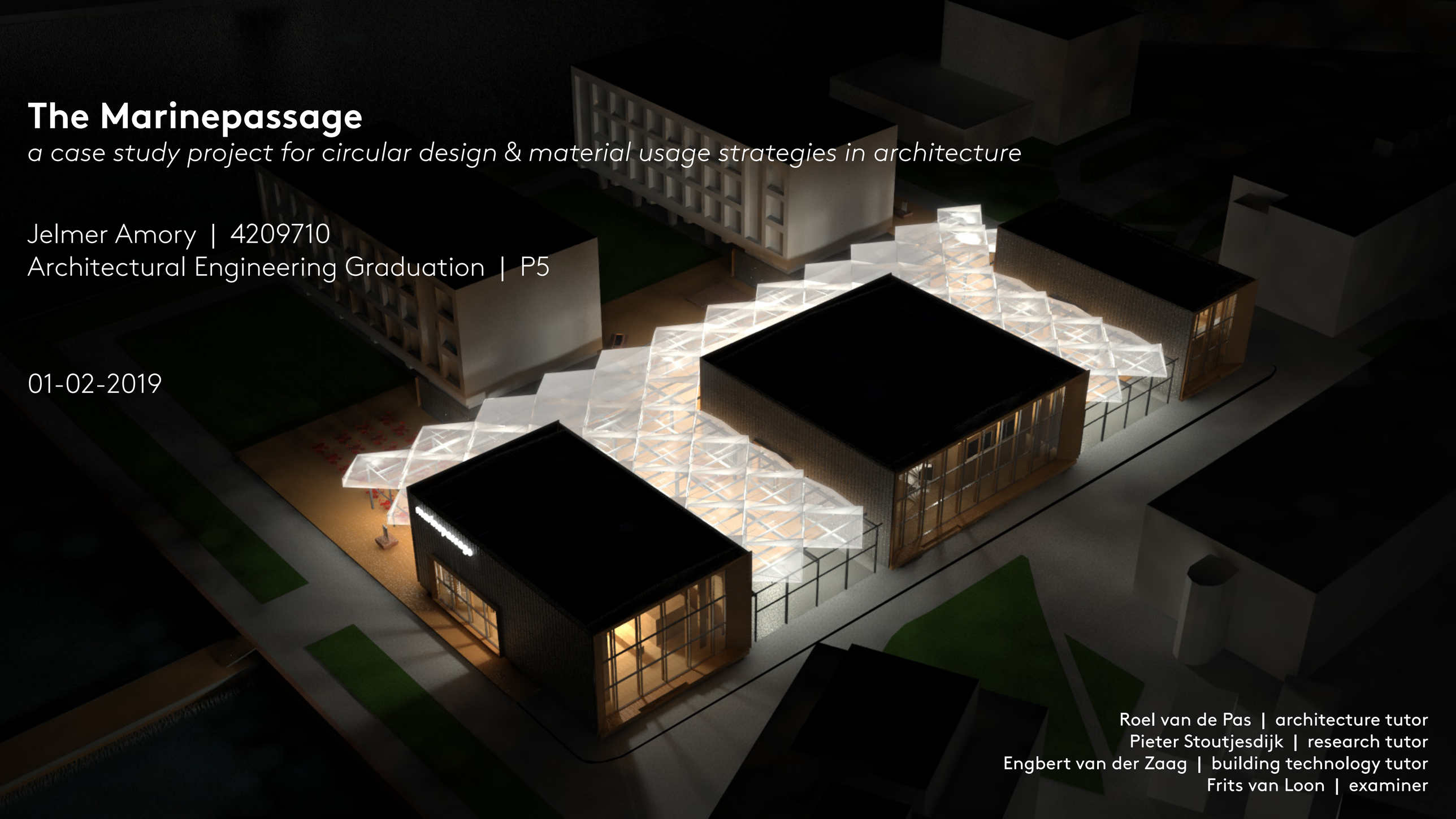
Architectural Engineering Graduation | P5

01-02-2019



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Pieter Stoutjesdijk | research tutor
Engbert van der Zaag | building technology tutor
Frits van Loon | examiner

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Project Context

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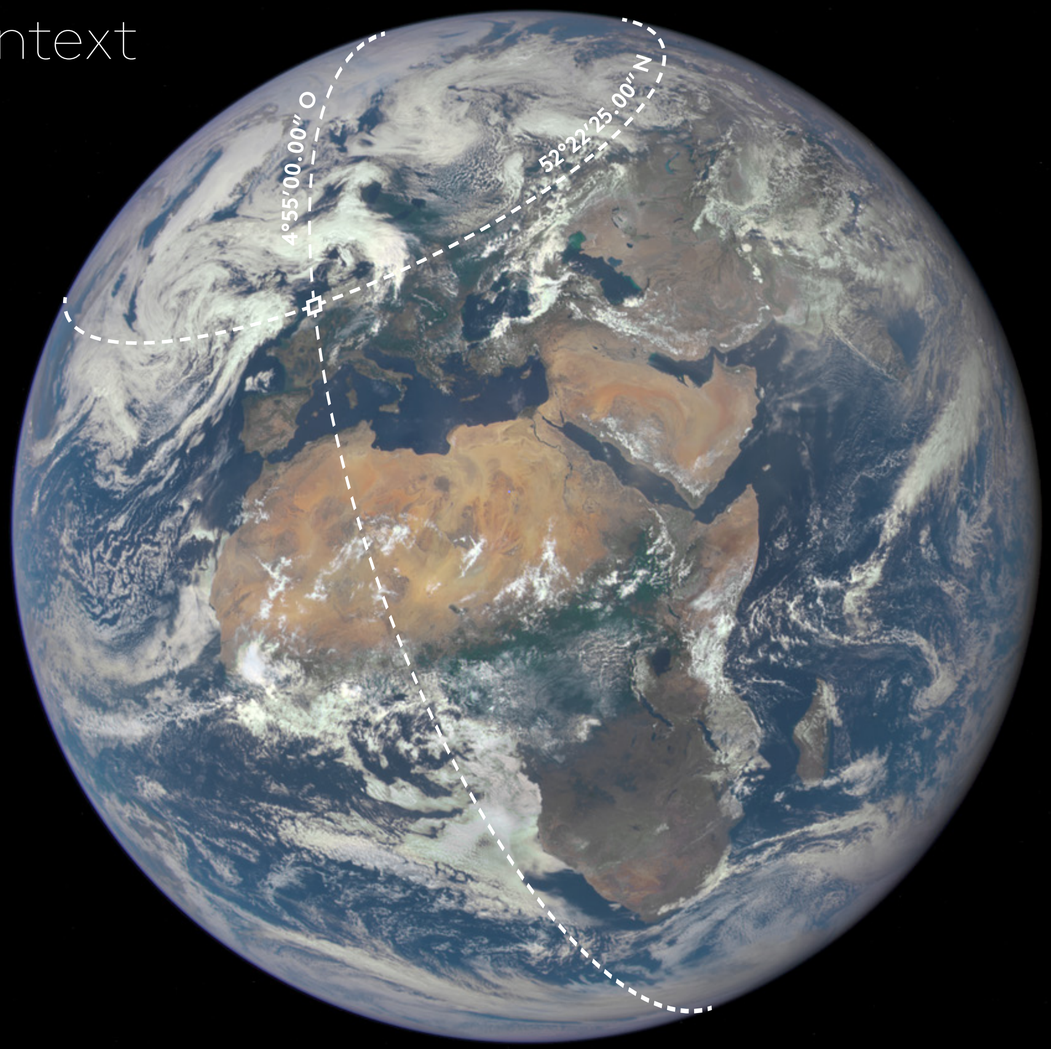
Introduction

Project Context



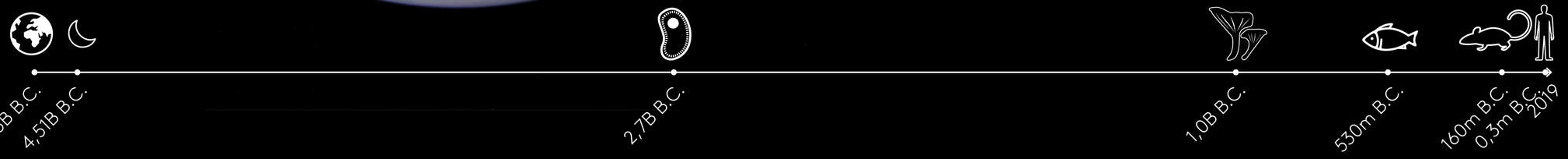
Planet Earth

Introduction

Project Context

Planet Earth

Marinepassage



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source: 1 Marshall, M. (2014), Timeline - The Evolution of Life, *NewScientist*, Retrieved from https://www.newscientist.com/article/dn17453-timeline-the-evolution-of-life/ on 22-01-19

Introduction
Project Context

Planet Earth is a closed system

There are only two possible long run fates for waste materials:
recycling / reuse or *dissapative loss* [2]

[1]

source:
1 Marshall, M. (2014), Timeline - The Evolution of Life, *NewScientist*, Retrieved from https://www.newscientist.com/article/dn17453-timeline-the-evolution-of-life/ on 22-01-19
2 Bocken, N.M.P., Pauw, I. de, Bakker, C. & Grinten, B. van (2016), Product design and business model strategies for a circular economy, *Journal of Industrial and Production Engineering* (33, 5)

Introduction

Circular Economy

Linear Economy (LE) model: "take-make-dispose" [3]

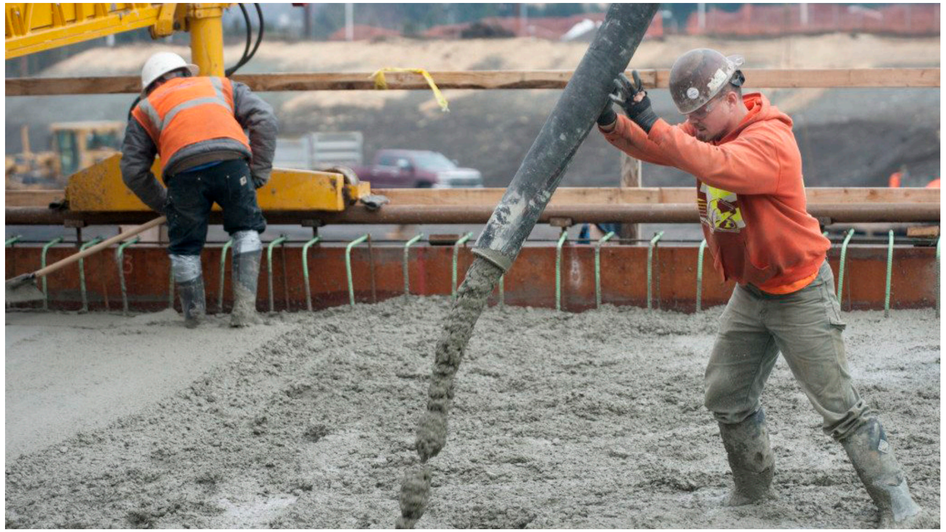
source: 3 Ellen MacArthur Foundation (2013), *Towards the Circular Economy vol.1 - Economic and business rationale for an accelerated transition*

Introduction

Circular Economy

Familiar sights in the building industry:

construction → *demolition*



input of resources

output of waste streams

Negative effects:

resource depletion
climate change
pollution
…

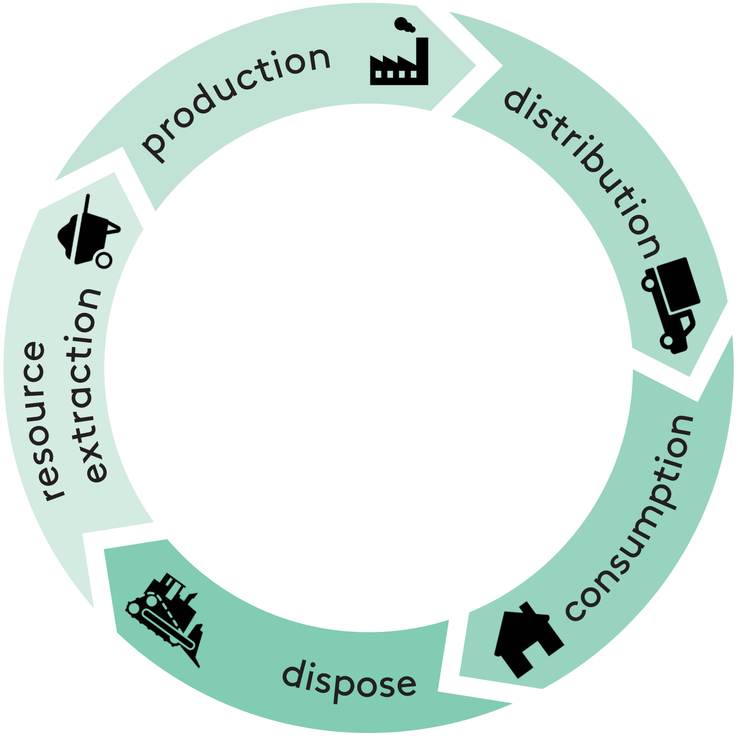
Introduction

Circular Economy

Circular Economy (CE) model: *"an industrial system that is restorative or regenerative by intention and design"* [4]

ultimate goal: *to eliminate the concept of waste* [5]

achieved by circularity: *restoration of resource flows* [6]



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4 Ellen MacArthur Foundation (2013), *Towards the Circular Economy vol.1 - Economic and business rationale for an accelerated transition*
5 McDonough, W. & Braungart (2003), *The Hannover Principles 10th Anniversary Edition*, Retrieved from http://www.mcdonough.com/writings/from-principles-to-practices/ on 13-01-19
6 Ellen MacArthur Foundation, Granta & LIFE (2015), *Circularity Indicators; An Approach to Measuring Circularity; Project Overview*

Introduction

Circular Economy

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ultimate goal: *to eliminate the concept of waste* [5]

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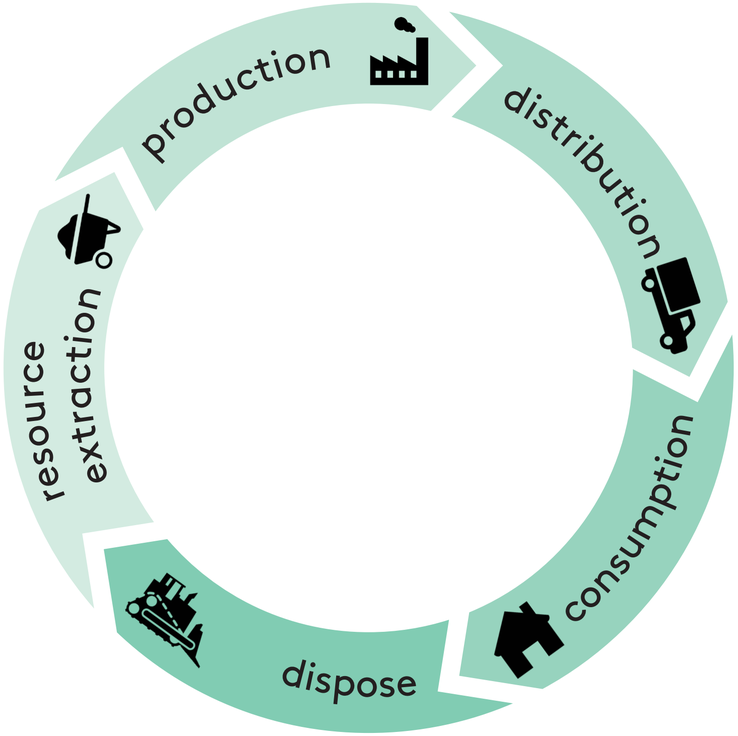
transition to a CE model:

- *new business models*
- *new ownership models*
- *new actor groups*
- *new products*
- *new design strategies*
- *new material usage strategies*



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6 Ellen MacArthur Foundation, Granta & LIFE (2015), *Circularity Indicators; An Approach to Measuring Circularity; Project Overview*

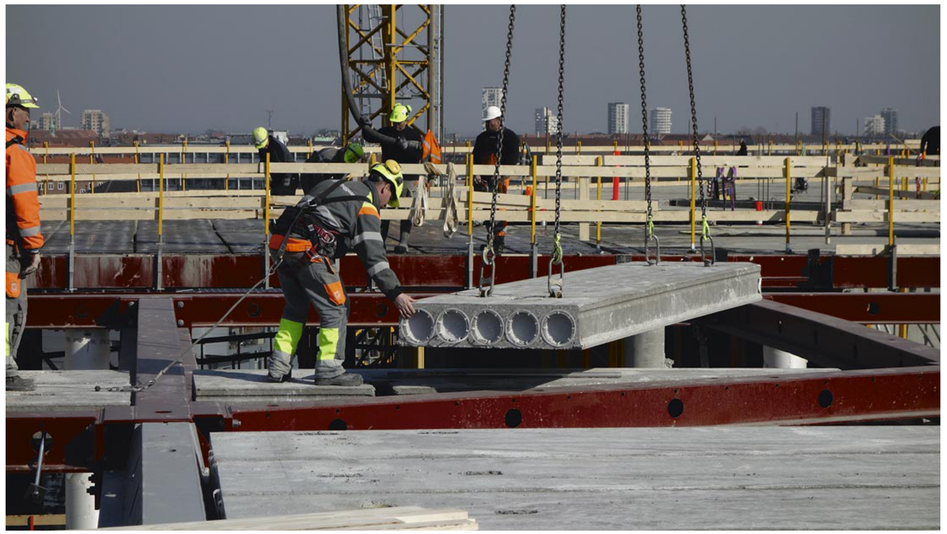
Introduction

Circular Economy

Circularity in the building industry:

circular building: *"a building that is designed, planned, built, operated, maintained, and deconstructed in a manner consistent with CE principles"* [7]

construction / deconstruction [8]



reusable components

source:
7 Pomponi, F. & Moncaster, A. (2017), Circular Economy for the built environment: a research framework, *Journal of Cleaner Production* (143)
8 Jensen, K.G. & Sommer, J. (n.d.), *Building a Circular Future*, Retrieved from https://urbannext.net/building-a-circular-future/ on 13-01-19

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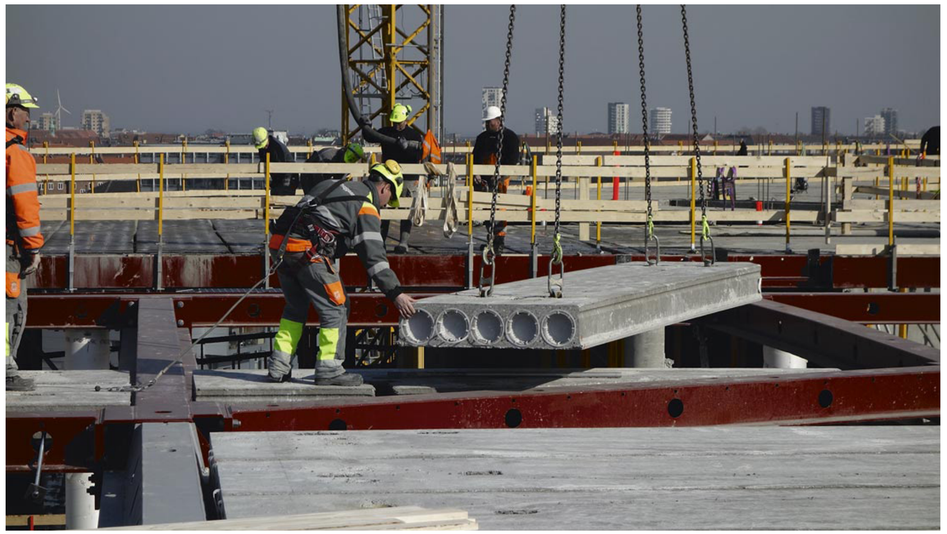


reusable components → *many other strategies!*

source:
7 Pomponi, F. & Moncaster, A. (2017), Circular Economy for the built environment: a research framework, *Journal of Cleaner Production* (143)
8 Jensen, K.G. & Sommer, J. (n.d.), *Building a Circular Future*, Retrieved from https://urbannext.net/building-a-circular-future/ on 13-01-19

Introduction

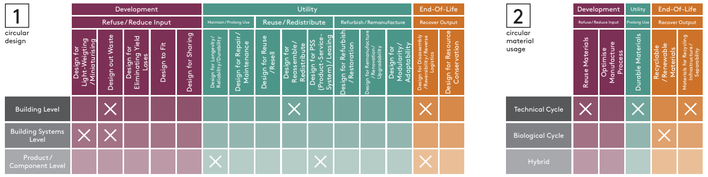
Graduation Project

Research: *"How can architects, non-expert to the CE, be stimulated and systematically guided towards circular design?"*

literature study

reference project analysis

Guidance Tool for Circular Building Design



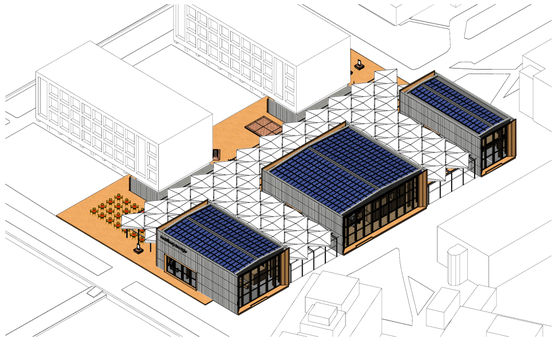
research paper


A GUIDANCE TOOL FOR CIRCULAR BUILDING DESIGN

Design: *"Can architects, non-expert to the CE, be stimulated and systematically guided towards circular design using the 'Guidance Tool for Circular Building Design'?"*

research by design

'Marinepassage'



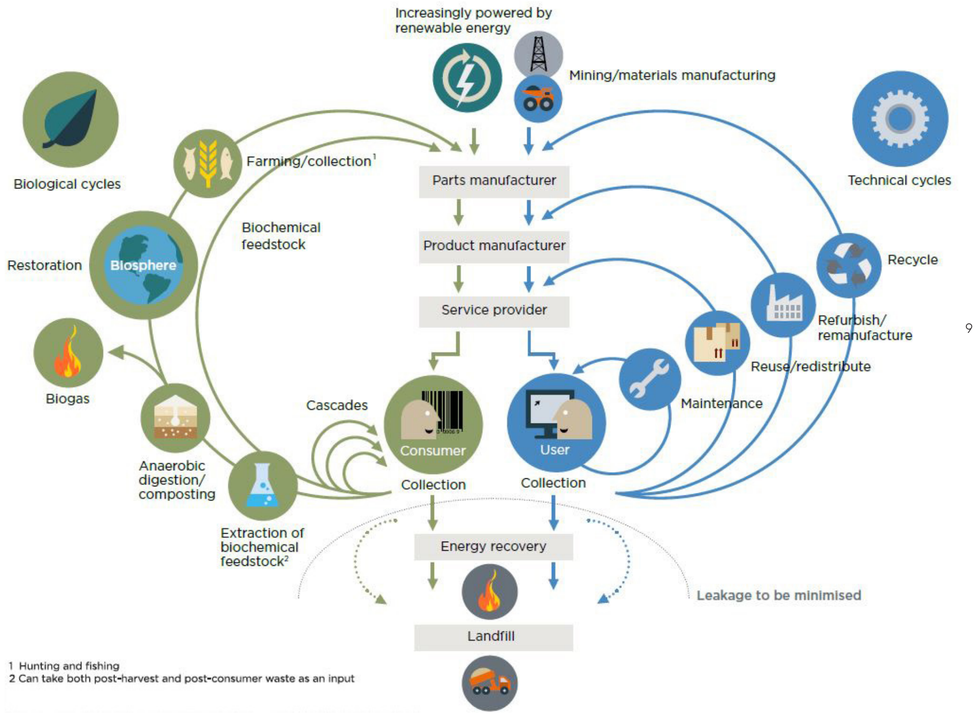
Research Circular Buildings

Key Principles
Guidance Tool

Research Circular Buildings

Key Principles

Circularity in diagrams:



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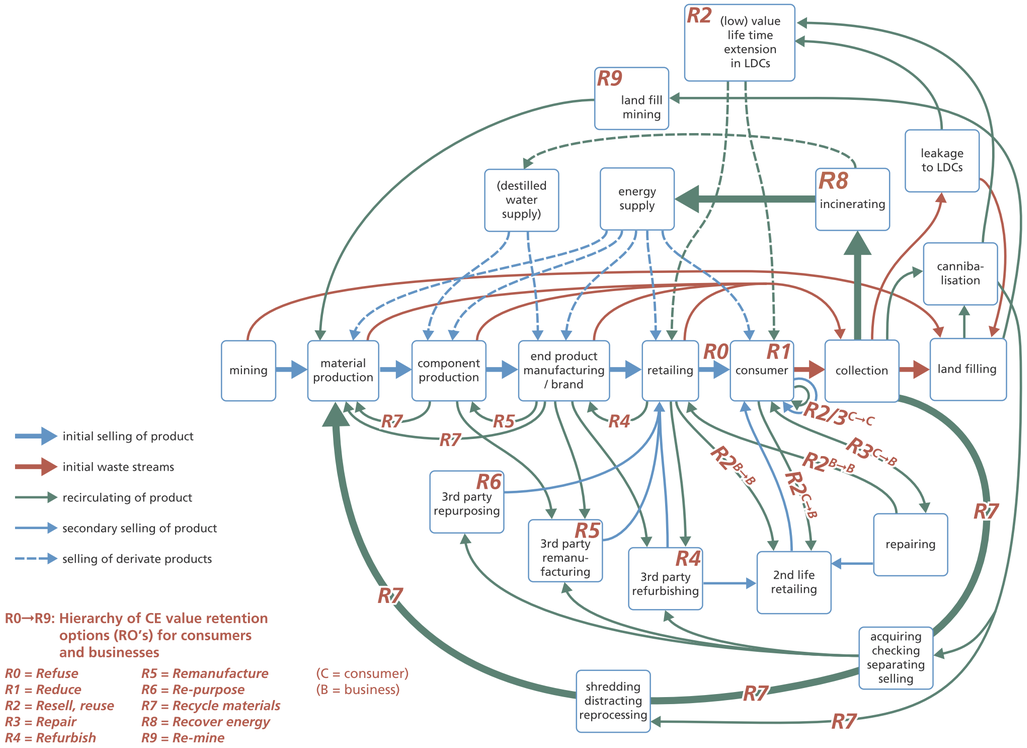

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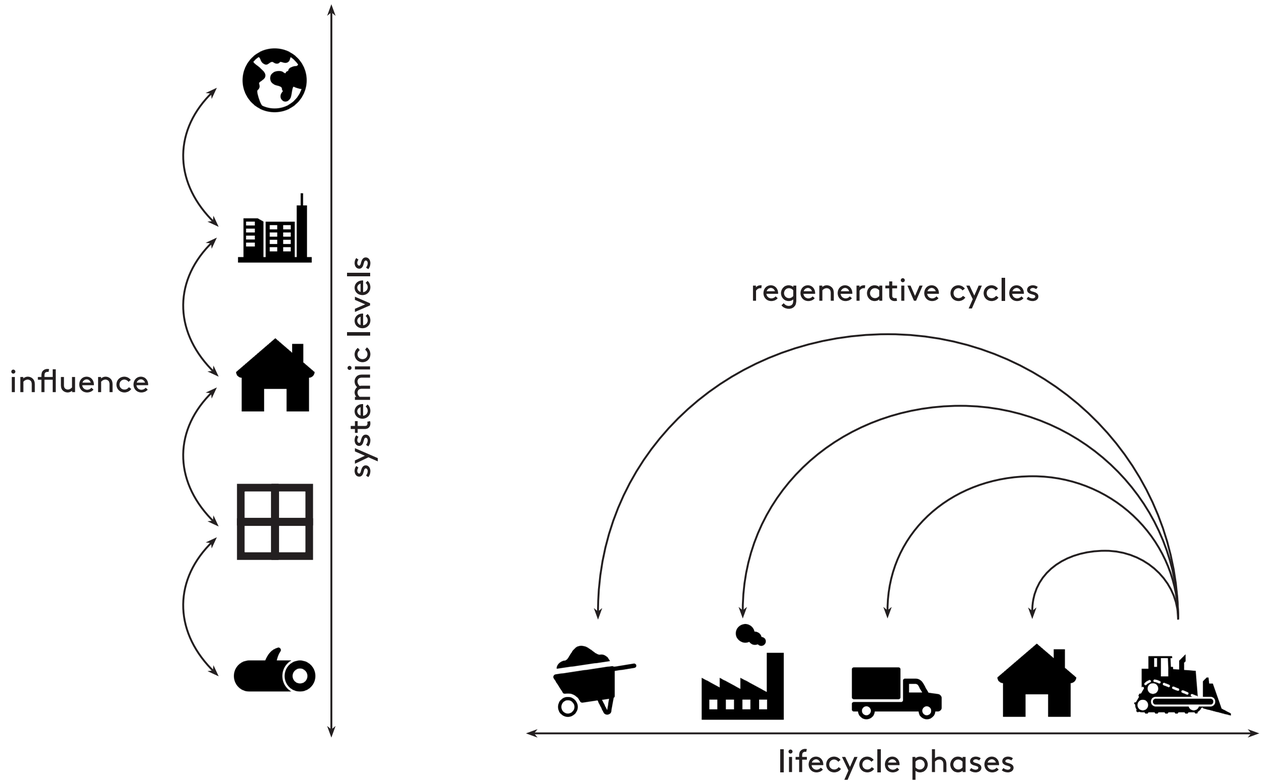
source: 9 Ellen MacArthur Foundation, Granta & LIFE (2015), *Circularity Indicators; An Approach to Measuring Circularity; Project Overview*
10 Reike, D., Vermeulen, W.J.V. & Witjes, S. (2017), The circular economy: New or Refurbished as CE 3.0? - Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options, *Resources, Conservation & Recycling* (135)

Research Circular Buildings

Key Principles

Circularity is a combination of:

lifecycle thinking *and* *system thinking* [11, 12]



source:
11 Balanay, R. & Halog, J. (2016), Charting Policy Directions for Mining's Sustainability with Circular Economy, *Recycling* (1, 2)
12 Saidani, M., Yannou, B., Leroy, Y. & Cluzel, F. (2017), How to Assess Product Performance in the Circular Economy? Proposed Requirements for the Design of a Circularity Measurement Framework, *Recycling* (2, 6), Paris

Research Circular Buildings

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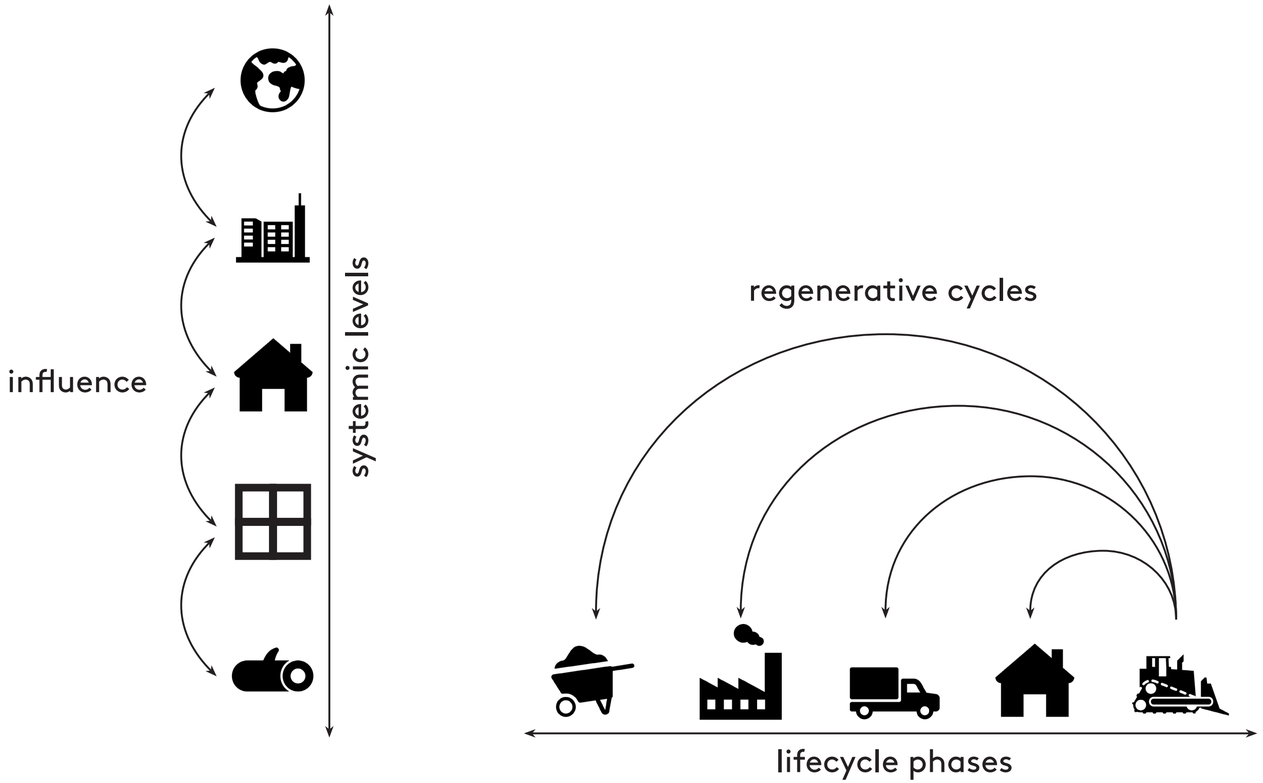
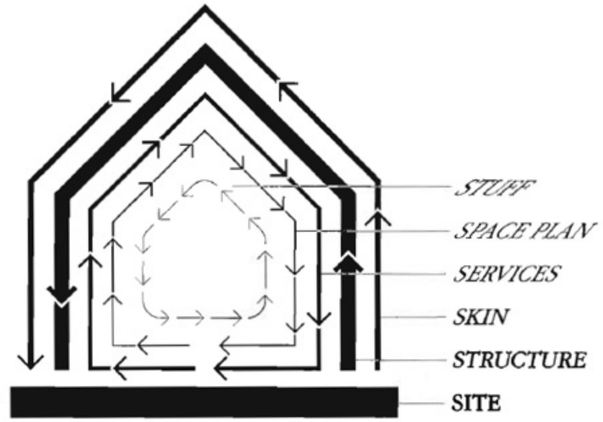


'Shearing Layers': [13]

Each building 'layer'
has its own lifespan



source:
11 Balanay, R. & Halog, J. (2016), Charting Policy Directions for Mining's Sustainability with Circular Economy, *Recycling* (1, 2)
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13 Brand, S. (1994), *How Buildings Learn - What Happens After They're Built*, Viking, New York

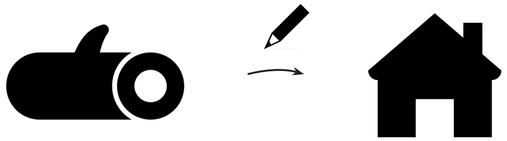
Research Circular Buildings

Key Principles

Circularity can be seen as a way of preserving value [14] **(of products, components and materials)**

System value consists of:

material value *and* *added value* [15]



Circularity is achieved through a combination of:

circular material usage *and* *circular design* [16, 17]

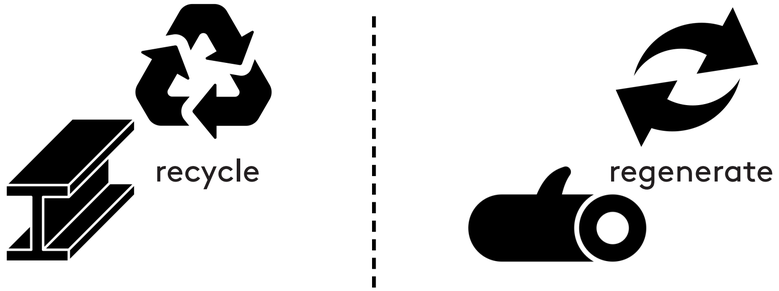
source:
14 Ellen MacArthur Foundation, Granta & LIFE (2015), *Circularity Indicators; An Approach to Measuring Circularity; Methodology*
15 Circulardesignguide (n.d.), *Understand Circular Flows*, Retrieved from https://www.circulardesignguide.com/post/loops on 12-03-18
16 Geldermans, R.J. (2016), Design for change and circularity - accommodating circular material & product flows in construction, *Energy Procedia* (96)
17 Loppies, W. (2015), *Bouwen aan de Circulaire Economie*, Technische Universiteit Delft, Delft

Research Circular Buildings

Key Principles

Circularity at material level makes a distinction between:

technical cycles *and* *biological cycles* [18]

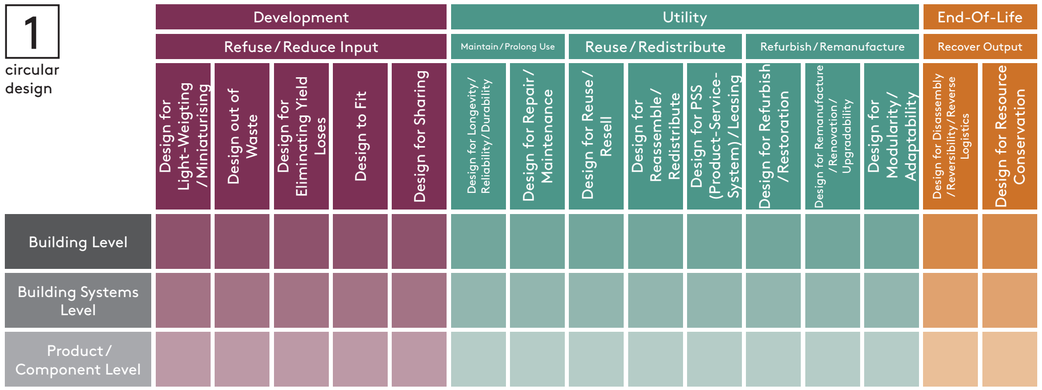


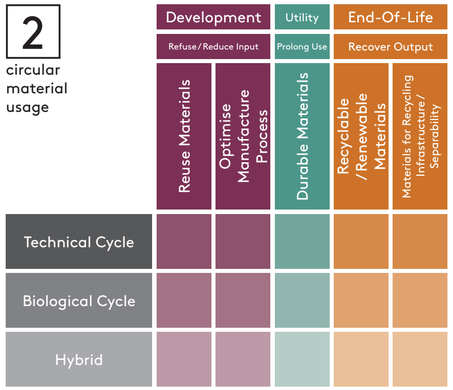
source: 18 Braungart, M. & McDonough, W. (2002), *Cradle to Cradle - Re-Making the Way We Make Things*, Vintage Books, London

Research Circular Buildings

Guidance Tool

The Guidance Tool is developed in accordance with these principles





Research Circular Buildings

Guidance Tool

It contains information and inspirational reference projects

1 circular design

	Development					Utility			End-Of-Life
	Refuse / Reduce Input								
	Design for Light-Weigting /Miniaturising		Design out Waste	Design for Eliminating Yield Loses	Design to Fit	Design for Sharing	Maintain / Prolong Use	Reuse / Redistribute	Refurbish / Remanufacture	Recover Output
Building Level		Refuse / Reduce Input *Design for Refuse and Design for Refuse and Reduce is aimed to reduce the resource use of buildings, systems, products and components, while maintaining performance. This can be achieved in design by using regenerated inputs, by efficient design and by the increase of utility, through sharing economy and collaborative consumption.*	X					X		X
Building Systems Level	□	Design for Light-Weigting /Miniaturising *Optimised design in order to save material through weight-saving strategies and size reduction strategies.*	X							
Product / Component Level		Building Systems Level Reference Project RAU - Lander Headquarters (office building renovation) *The resource input for the steel roof structure over the existing buildings was reduced through clever engineering by rollercoaster engineers (lightweight structure experts).*					X	X		X

2 circular material usage

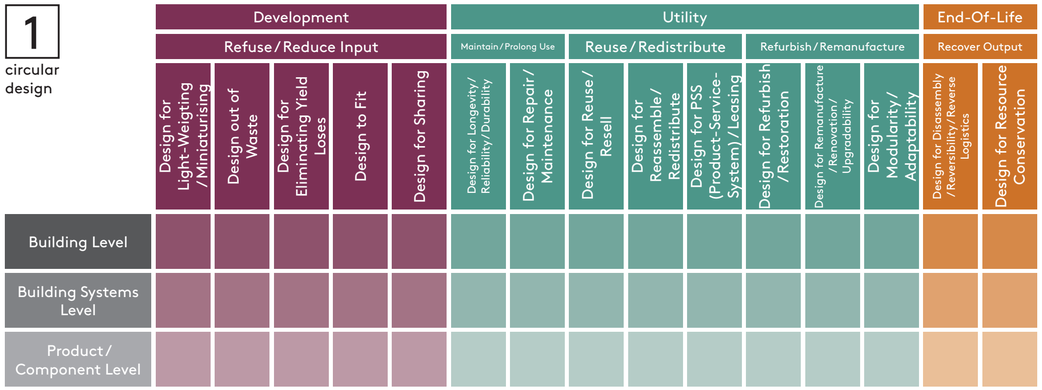
	Development			Utility	End-Of-Life
	Refuse / Reduce Input				
	Reuse Materials		Optimise Manufacture Process	Prolong Use	Recover Output
Technical Cycle	□	Refuse / Reduce Input *Refuse and reduce the virgin material input by substituting it with recycled materials. In some cases, remining (gathering feedstocks from landfills) can be considered as a material source, but for this process human health has to be considered (Reike et al., 2017).*		X	X
Biological Cycle		Reuse Materials *Refuse and reduce the virgin material input by substituting it with recycled mate-rials. In some cases, remining (gathering feedstocks from landfills) can be consid-ered as a material source, but for this process human health has to be considered.*			X
Hybrid		Technical Cycle Reference Project Dirk Vander Kooij - Endless Chair (furniture design) *Using a self-engineered 3D printer, design furniture is manufactured from 96% recycled plastics (coming from old refrigerators). As this feedstock comes in different colours, every piece is an industrially produced "one-of-a-kind" (dirkvanderkooij.com).*			

Research Circular Buildings

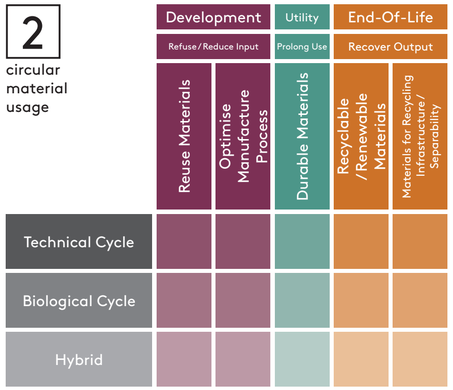
Guidance Tool

The selection of strategy is determined by the future prospects of the design:

1 circular design



2 circular material usage



business model
ownership model
actor group

→

products
design strategies
material usage strategies

Research Circular Buildings

Guidance Tool

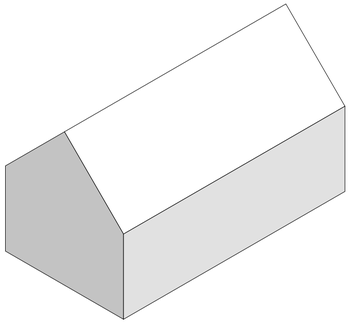
The selection of strategy is determined by the future prospects of the design:

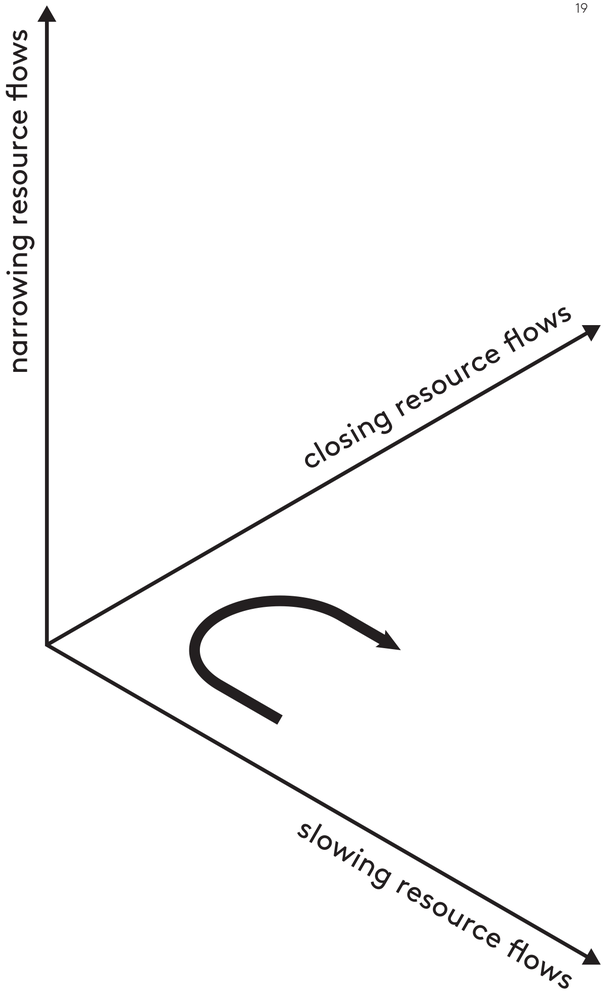
1 circular design

	Development					Utility								End-Of-Life	
	Refuse / Reduce Input					Maintain / Prolong Use		Reuse / Redistribute			Refurbish / Remanufacture			Recover Output	
	Design for Light-Weigting / Miniaturising	Design out of Waste	Design for Eliminating Yield Loses	Design to Fit	Design for Sharing	Design for Longevity / Reliability / Durability	Design for Repair / Maintenance	Design for Reuse / Resell	Design for Reassemble / Redistribute	Design for PSS (Product-Service-System) / Leasing	Design for Refurbish / Restoration	Design for Remanufacture / Renovation / Upgradability	Design for Modularity / Adaptability	Design for Disassembly / Reversibility / Reverse Logistics	Design for Resource Conservation
Building Level															
Building Systems Level															
Product / Component Level															

2 circular material usage

	Development		Utility	End-Of-Life	
	Refuse / Reduce Input		Prolong Use	Recover Output	
	Reuse Materials	Optimise Manufacture Process	Durable Materials	Recyclable / Renewable Materials	Materials for Recycling Infrastructure / Separability
Technical Cycle					
Biological Cycle					
Hybrid					





source: 19 Bocken, N.M.P., Pauw, I. de, Bakker, C. & Grinten, B. van (2016), Product design and business model strategies for a circular economy, *Journal of Industrial and Production Engineering* (33, 5)

Research Circular Buildings

Guidance Tool

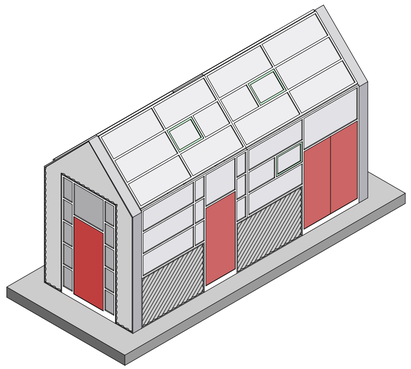
Focus on narrowing resource loops

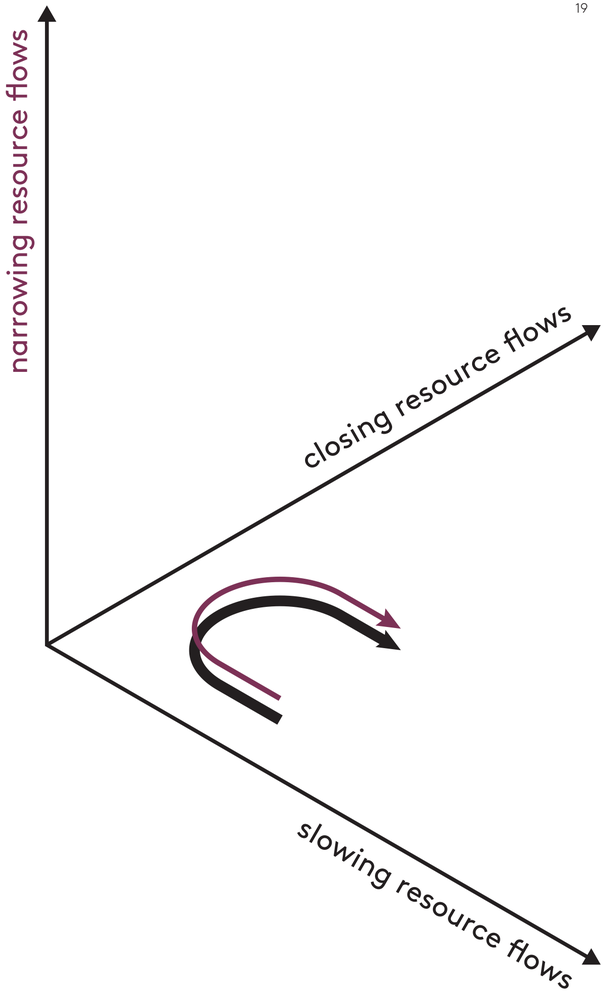
1 circular design

	Development					Utility									End-Of-Life	
	Refuse / Reduce Input					Maintain / Prolong Use		Reuse / Redistribute			Refurbish / Remanufacture				Recover Output	
	Design for Light-Weigting / Miniaturising	Design out of Waste	Design for Eliminating Yield Loses	Design to Fit	Design for Sharing	Design for Longevity / Reliability / Durability	Design for Repair / Maintenance	Design for Reuse / Resell	Design for Reassemble / Redistribute	Design for PSS (Product-Service-System) / Leasing	Design for Refurbish / Restoration	Design for Remanufacture / Renovation / Upgradability	Design for Modularity / Adaptability	Design for Disassembly / Reversibility / Reverse Logistics	Design for Resource Conservation
Building Level	■	■	■	■	■										
Building Systems Level	■	■	■	■	■										
Product / Component Level	■	■	■	■	■										

2 circular material usage

	Development		Utility	End-Of-Life	
	Refuse / Reduce Input		Prolong Use	Recover Output	
	Reuse Materials	Optimise Manufacture Process	Durable Materials	Recyclable / Renewable Materials	Materials for Recycling (Infrastructure / Separability)
Technical Cycle	■	■			
Biological Cycle	■	■			
Hybrid	■	■			





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Research Circular Buildings

Guidance Tool

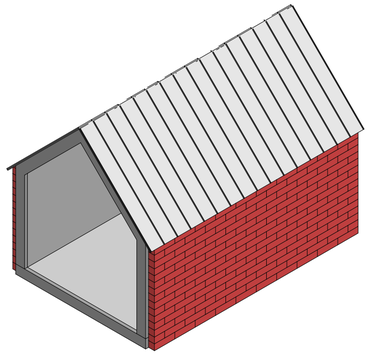
Focus on slowing resource loops

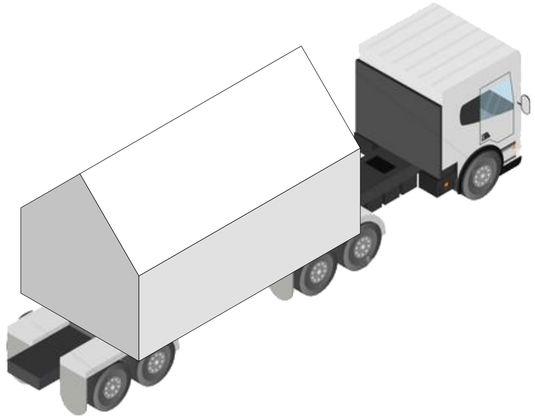
1 circular design

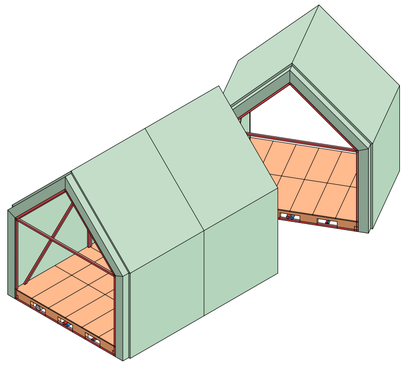
	Development					Utility								End-Of-Life	
	Refuse / Reduce Input					Maintain / Prolong Use		Reuse / Redistribute			Refurbish / Remanufacture			Recover Output	
	Design for Light-Weighting / Miniaturising	Design out of Waste	Design for Eliminating Yield Losses	Design to Fit	Design for Sharing	Design for Longevity / Reliability / Durability	Design for Repair / Maintenance	Design for Reuse / Resell	Design for Reassemble / Redistribute	Design for PSS (Product-Service-System) / Leasing	Design for Refurbish / Restoration	Design for Remanufacture / Renovation / Upgradability	Design for Modularity / Adaptability	Design for Disassembly / Reversibility / Reverse Logistics	Design for Resource Conservation
Building Level															
Building Systems Level															
Product / Component Level															

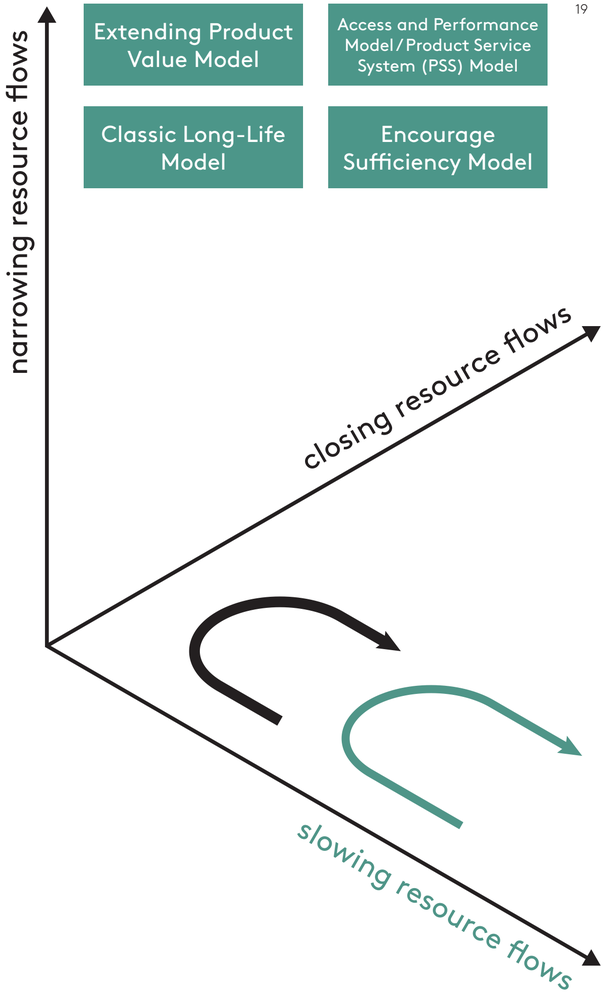
2 circular material usage

	Development	Utility	End-Of-Life	
	Refuse / Reduce Input	Prolong Use	Recover Output	
	Reuse Materials	Optimise Manufacture Process	Durable Materials	Recyclable / Renewable Materials	Materials for Recycling (Infrastructure / Separability
Technical Cycle					
Biological Cycle					
Hybrid					









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Research Circular Buildings

Guidance Tool

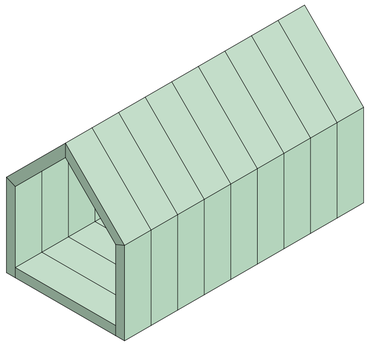
Focus on closing resource loops

1 circular design

	Development					Utility								End-Of-Life	
	Refuse / Reduce Input					Maintain / Prolong Use		Reuse / Redistribute			Refurbish / Remanufacture			Recover Output	
	Design for Light-Weighting / Miniaturising	Design out of Waste	Design for Eliminating Yield Losses	Design to Fit	Design for Sharing	Design for Longevity / Reliability / Durability	Design for Repair / Maintenance	Design for Reuse / Resell	Design for Reassemble / Redistribute	Design for PSS (Product-Service-System) / Leasing	Design for Refurbish / Restoration	Design for Remanufacture / Renovation / Upgradability	Design for Modularity / Adaptability	Design for Disassembly / Reversibility / Reverse Logistics	Design for Resource Conservation
Building Level															
Building Systems Level															
Product / Component Level															

2 circular material usage

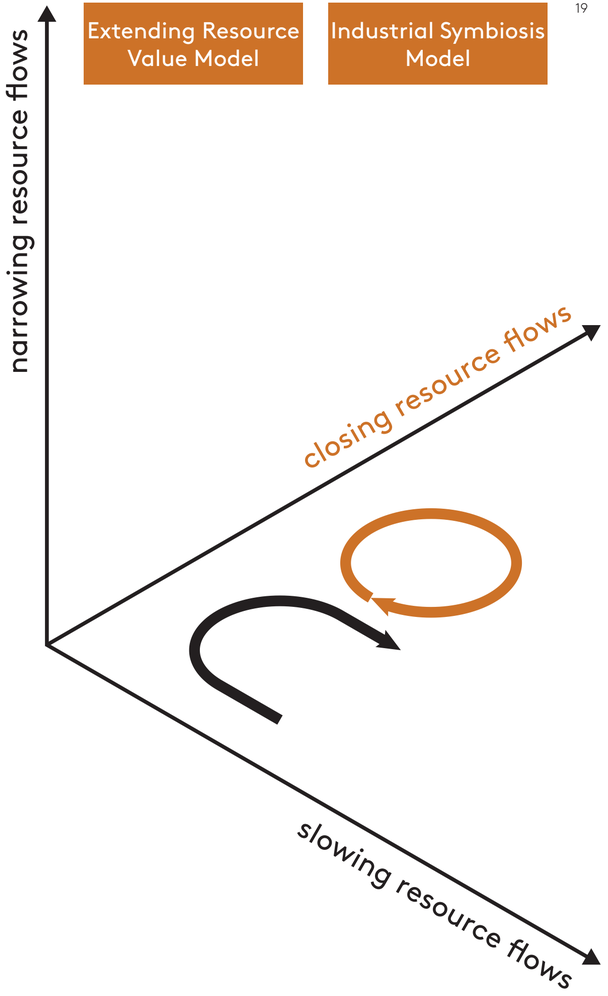
	Development	Utility	End-Of-Life	
	Refuse / Reduce Input	Prolong Use	Recover Output	
	Reuse Materials	Optimise Manufacture Process	Durable Materials	Recyclable / Renewable Materials	Materials for Recycling Infrastructure / Separability
Technical Cycle					
Biological Cycle					
Hybrid					



Extending Resource Value Model

Industrial Symbiosis Model

19



source: 19 Bocken, N.M.P., Pauw, I. de, Bakker, C. & Grinten, B. van (2016), Product design and business model strategies for a circular economy, *Journal of Industrial and Production Engineering* (33, 5)

Research Circular Buildings

Guidance Tool

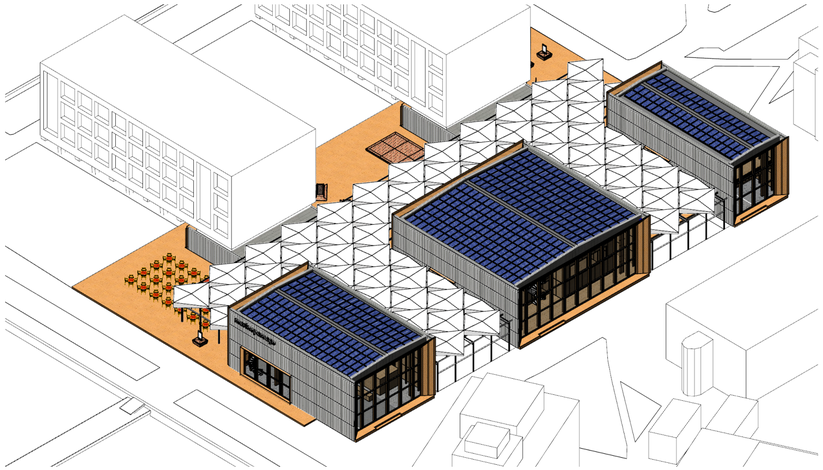
Possible to combine strategies

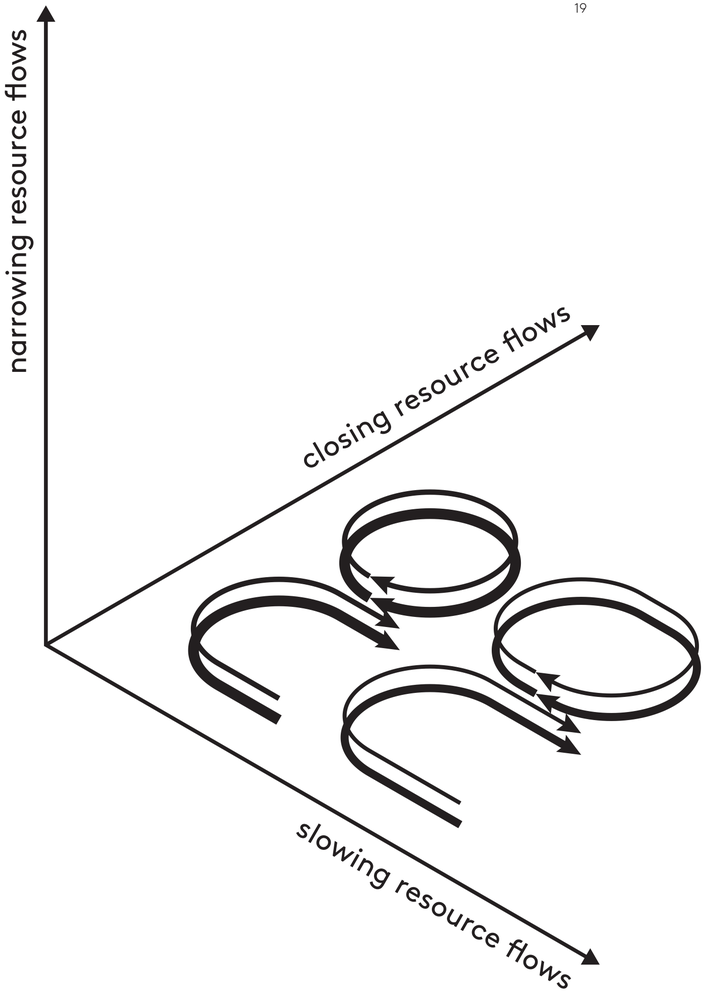
1 circular design

	Development					Utility								End-Of-Life	
	Refuse / Reduce Input					Maintain / Prolong Use		Reuse / Redistribute			Refurbish / Remanufacture			Recover Output	
	Design for Light-Weigting / Miniaturising	Design out of Waste	Design for Eliminating Yield Loses	Design to Fit	Design for Sharing	Design for Longevity / Reliability / Durability	Design for Repair / Maintenance	Design for Reuse / Resell	Design for Reassemble / Redistribute	Design for PSS (Product-Service-System) / Leasing	Design for Refurbish / Restoration	Design for Remanufacture / Renovation / Upgradability	Design for Modularity / Adaptability	Design for Disassembly / Reversibility / Reverse Logistics	Design for Resource Conservation
Building Level															
Building Systems Level															
Product / Component Level															

2 circular material usage

	Development		Utility	End-Of-Life	
	Refuse / Reduce Input		Prolong Use	Recover Output	
	Reuse Materials	Optimise Manufacture Process	Durable Materials	Recyclable / Renewable Materials	Materials for Recycling Infrastructure / Separability
Technical Cycle					
Biological Cycle					
Hybrid					





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Design

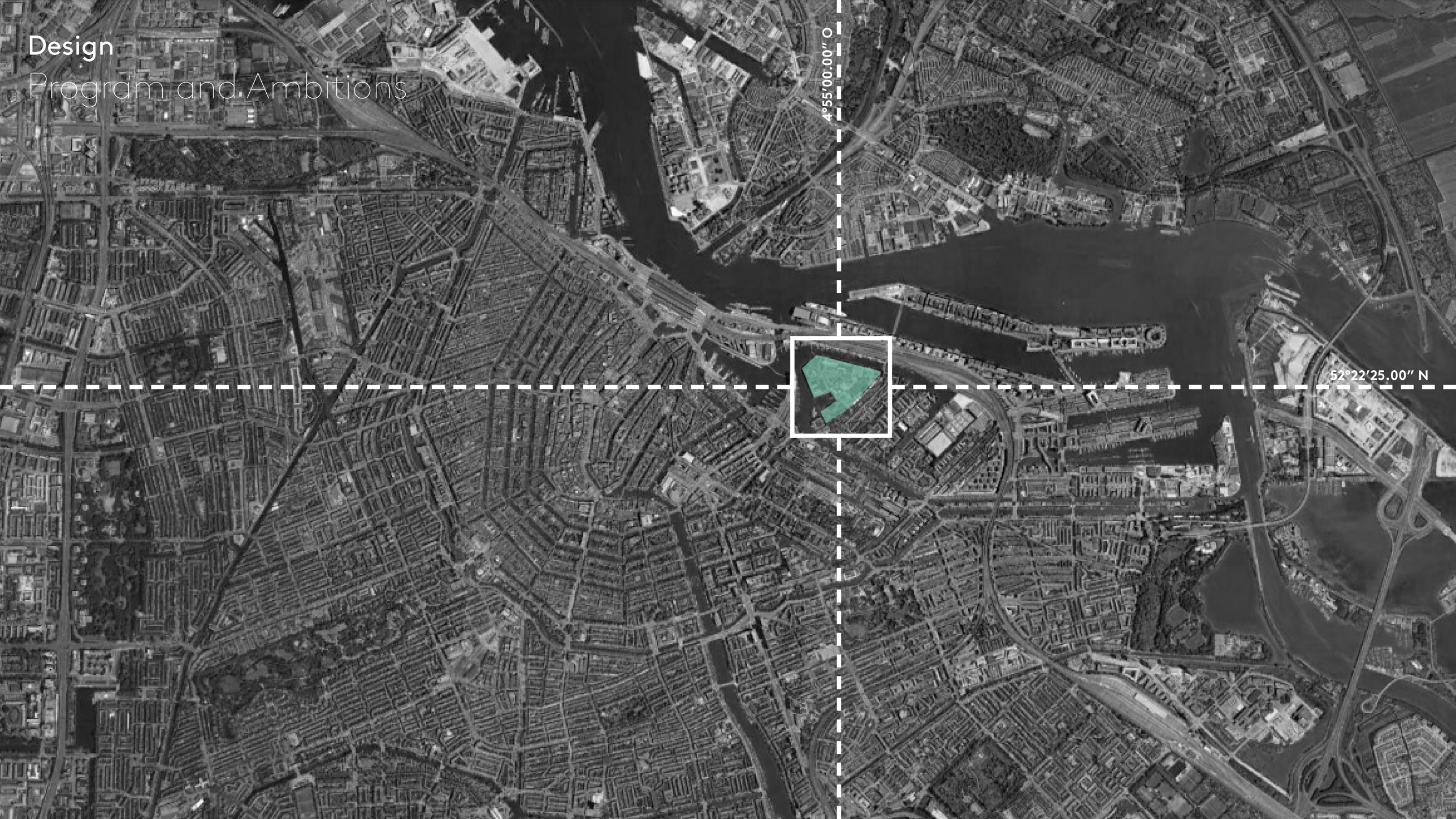
Program and Ambitions

Anchoring

Passage Canopy

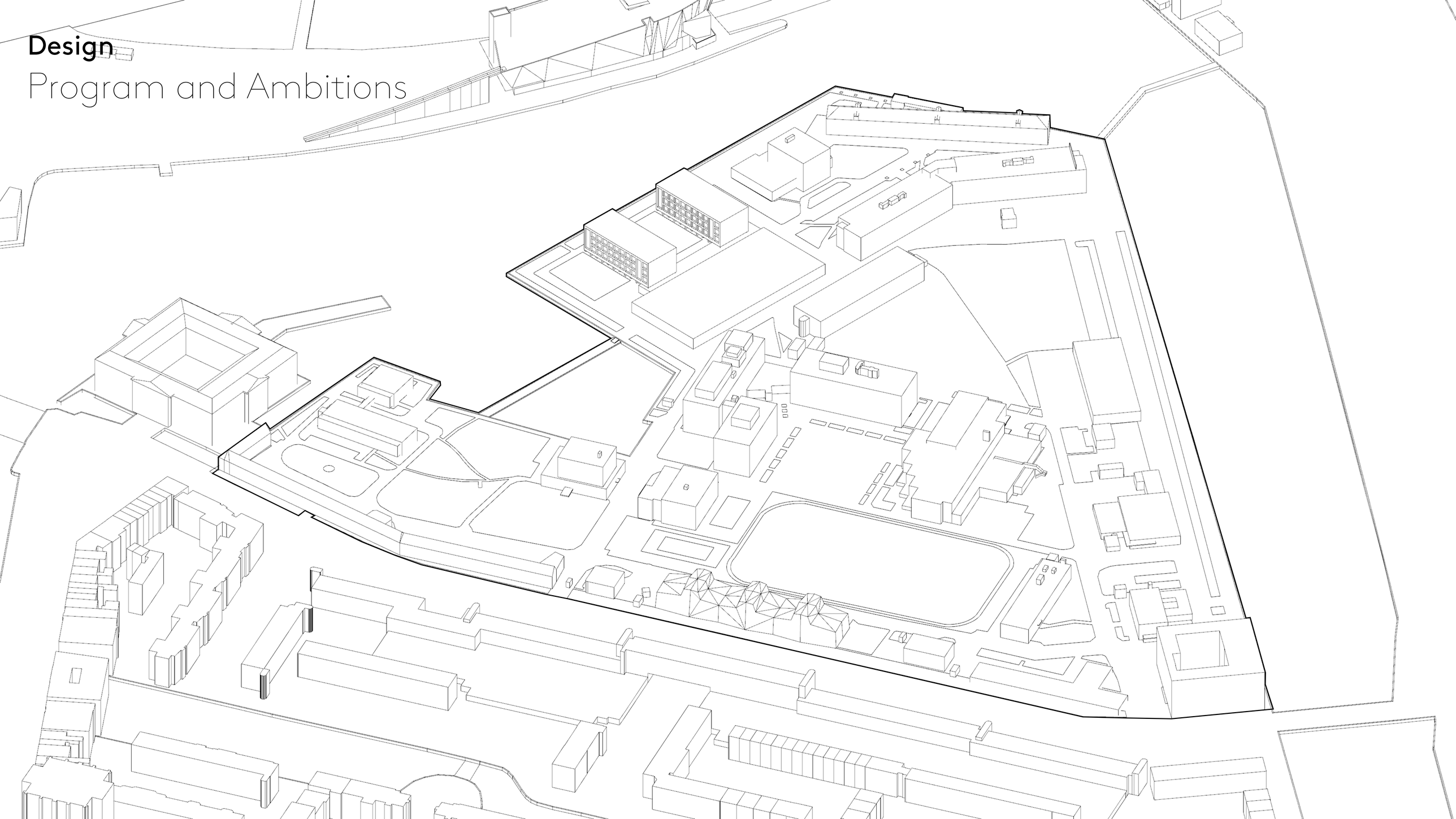
Building Volumes

Design
Program and Ambitions



Design

Program and Ambitions



Design

Program and Ambitions

Marineterrein again part of the city after 360 years...

nrc.nl› [20]

Marine weg, Van der Laan 'zo blij als een konijn'

Amsterdam heeft er een stuk stad bij. Het Marineterrein is (deels) opengegaan voor het publiek. Mét nieuwe brug.

source: [20] Remie, M. (2016), Marine weg, Van der Laan 'zo blij als een konijn', *NRC* (15-01-16), Retrieved from https://www.nrc.nl/nieuws/2016/01/15/marine-weg-van-der-laan-zo-blij-als-een-konijn-1576675-a695090 on 13-06-18

Design

Program and Ambitions

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Municipality ambitions:

frontrunner CE | car-free waterpark | innovation hub | 2021 Amsterdam Biennial[21, 22]

source:
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21 Gemeente Amsterdam (2013), *Strategienota Het Marineterrein*
22 Gemeente Amsterdam (2017), *Principenota Marineterrein Amsterdam*

Design

Program and Ambitions

Marineterrein again part of the city after 360 years…

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Marine weg, Van der Laan 'zo blij als een konijn'

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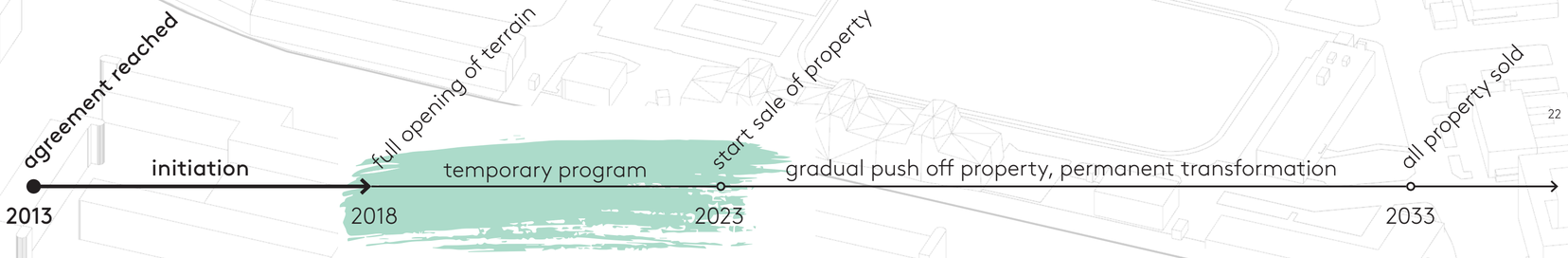
Municipality ambitions:

frontrunner CE | car-free waterpark | innovation hub | 2021 Amsterdam Biennial [21, 22]

Ideal location for case study Circular Building



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Design

Program and Ambitions

Marineterrein **car-free waterpark**

Design

Program and Ambitions

Marineterrein **car-free waterpark**

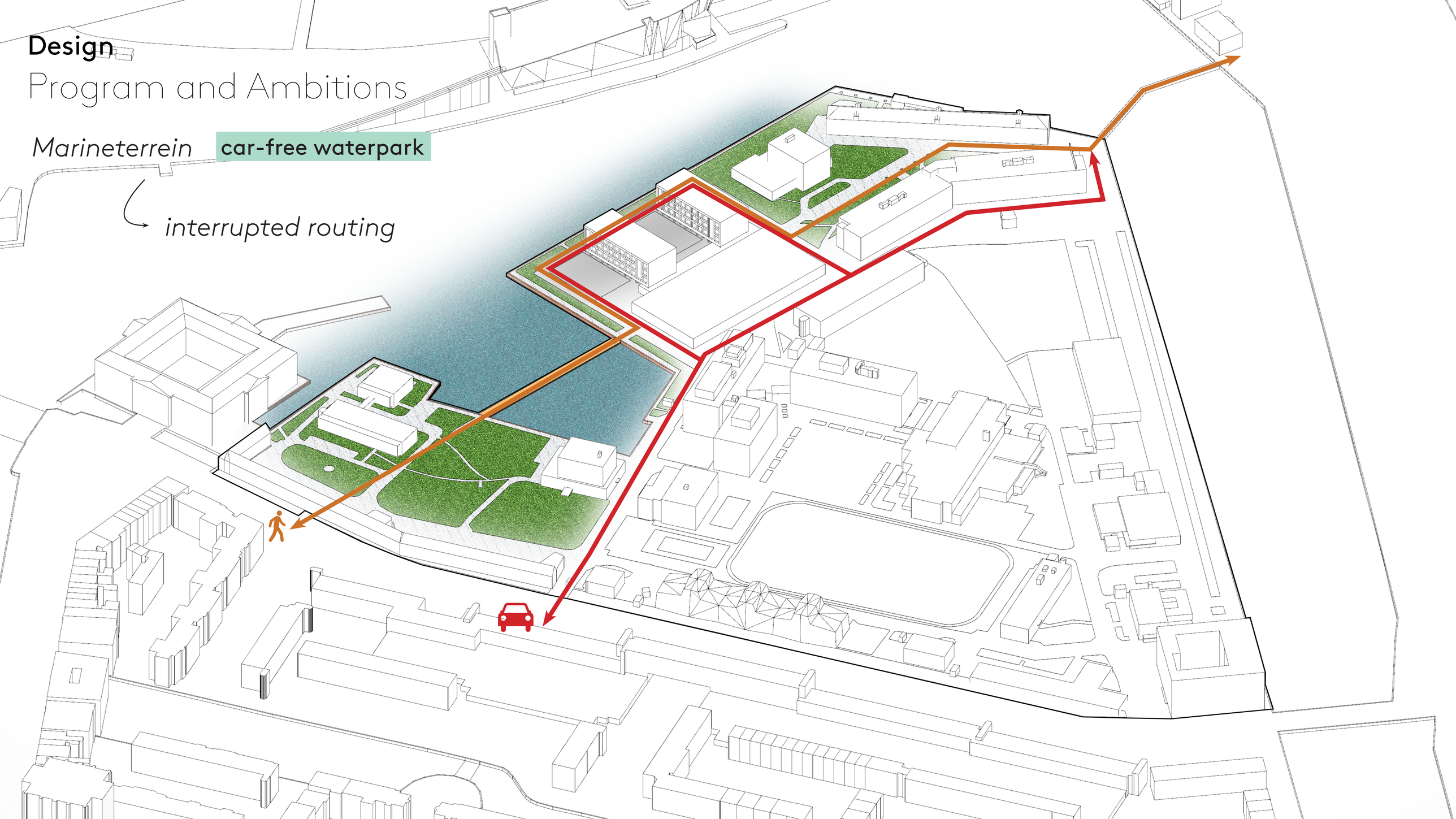
parking space

Design

Program and Ambitions

Marineterrein **car-free waterpark**

interrupted routing



Design

Program and Ambitions

Marineterrein **car-free waterpark**

building volume between parks

Design

Program and Ambitions

Marineterrein **car-free waterpark**

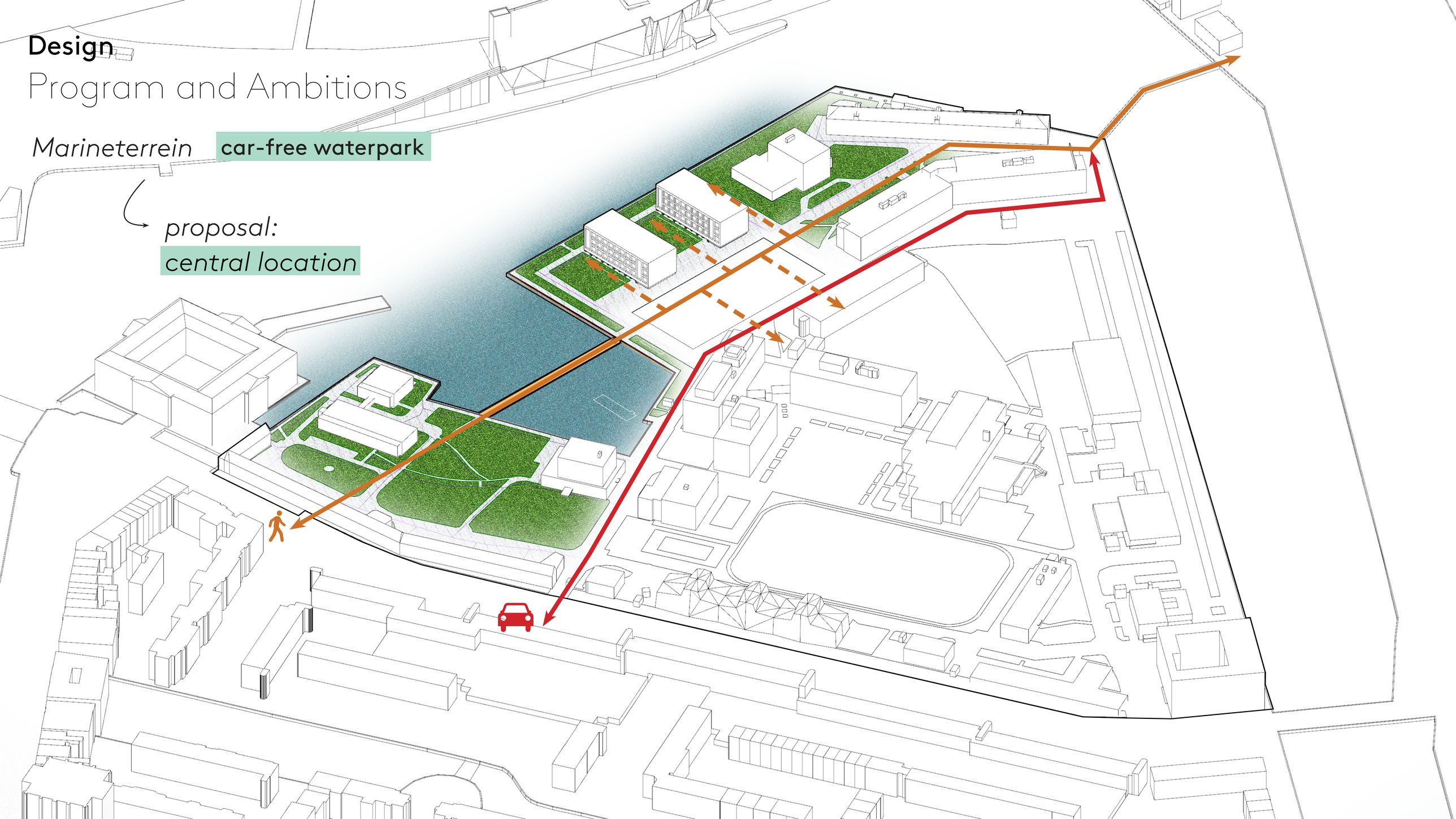
proposal:
continous park and routing

Design

Program and Ambitions

Marineterrein **car-free waterpark**

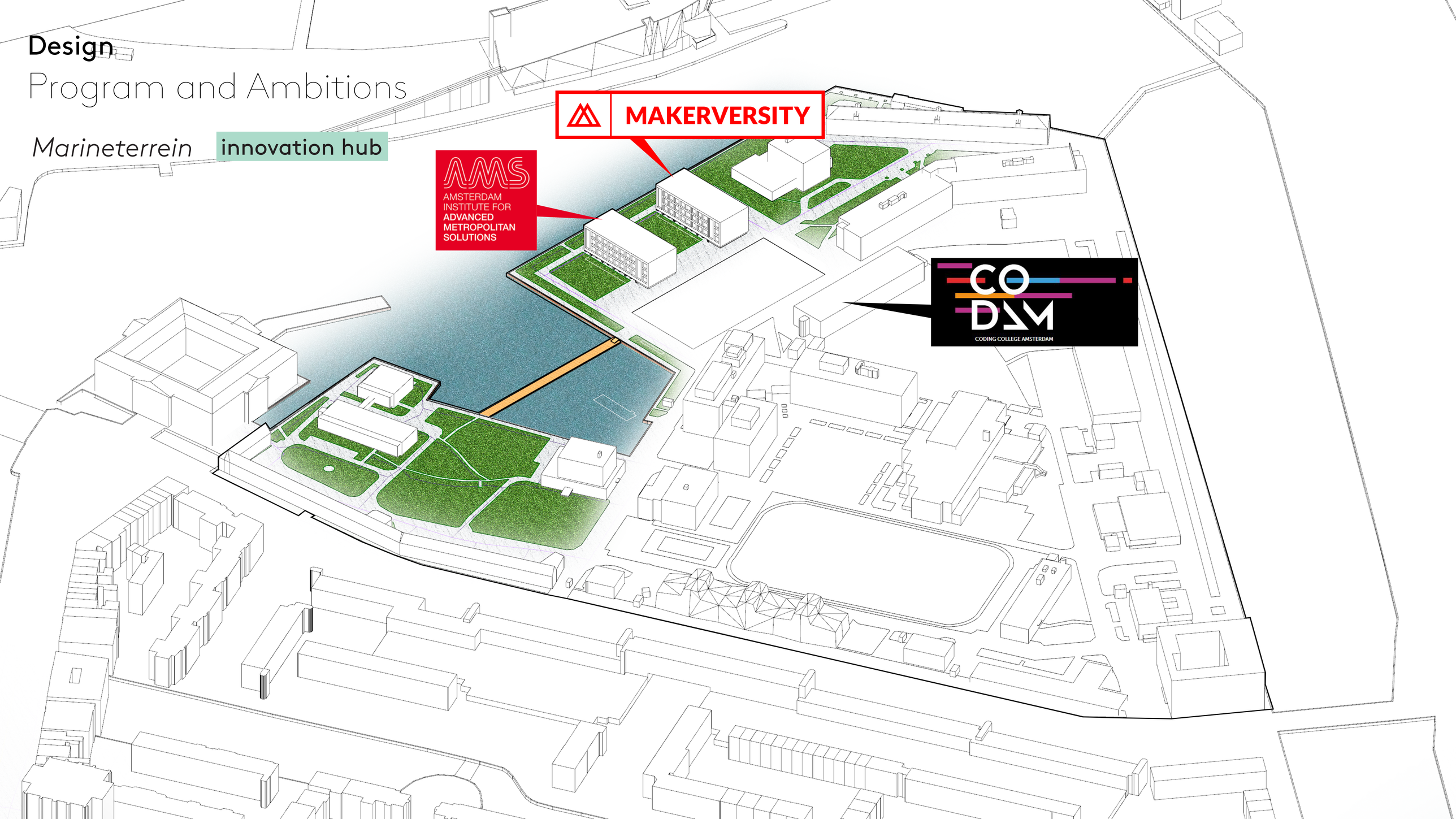
proposal:
central location



Design

Program and Ambitions

Marineterrein **innovation hub**

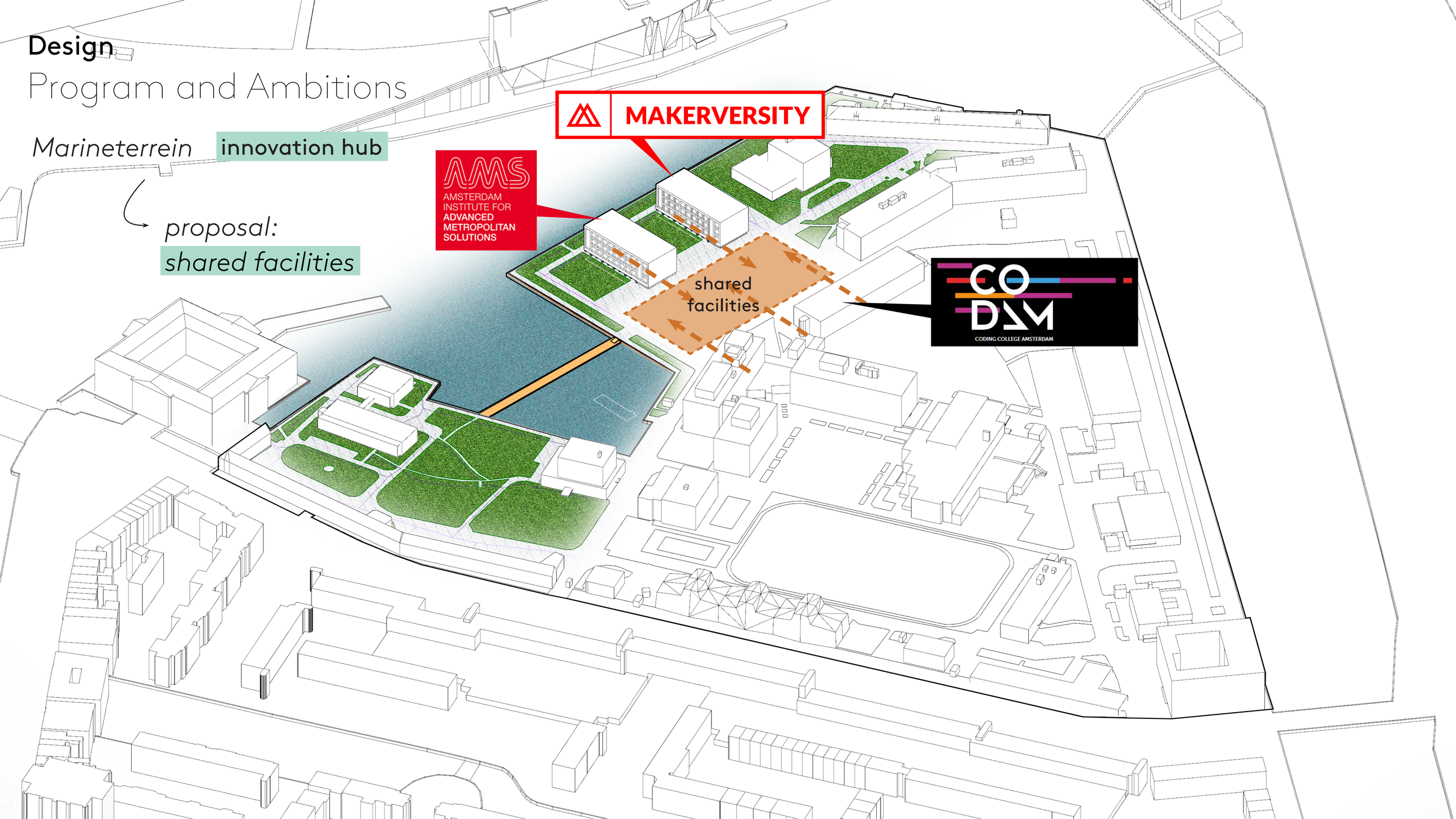


Design

Program and Ambitions

Marineterrein **innovation hub**

proposal:
shared facilities



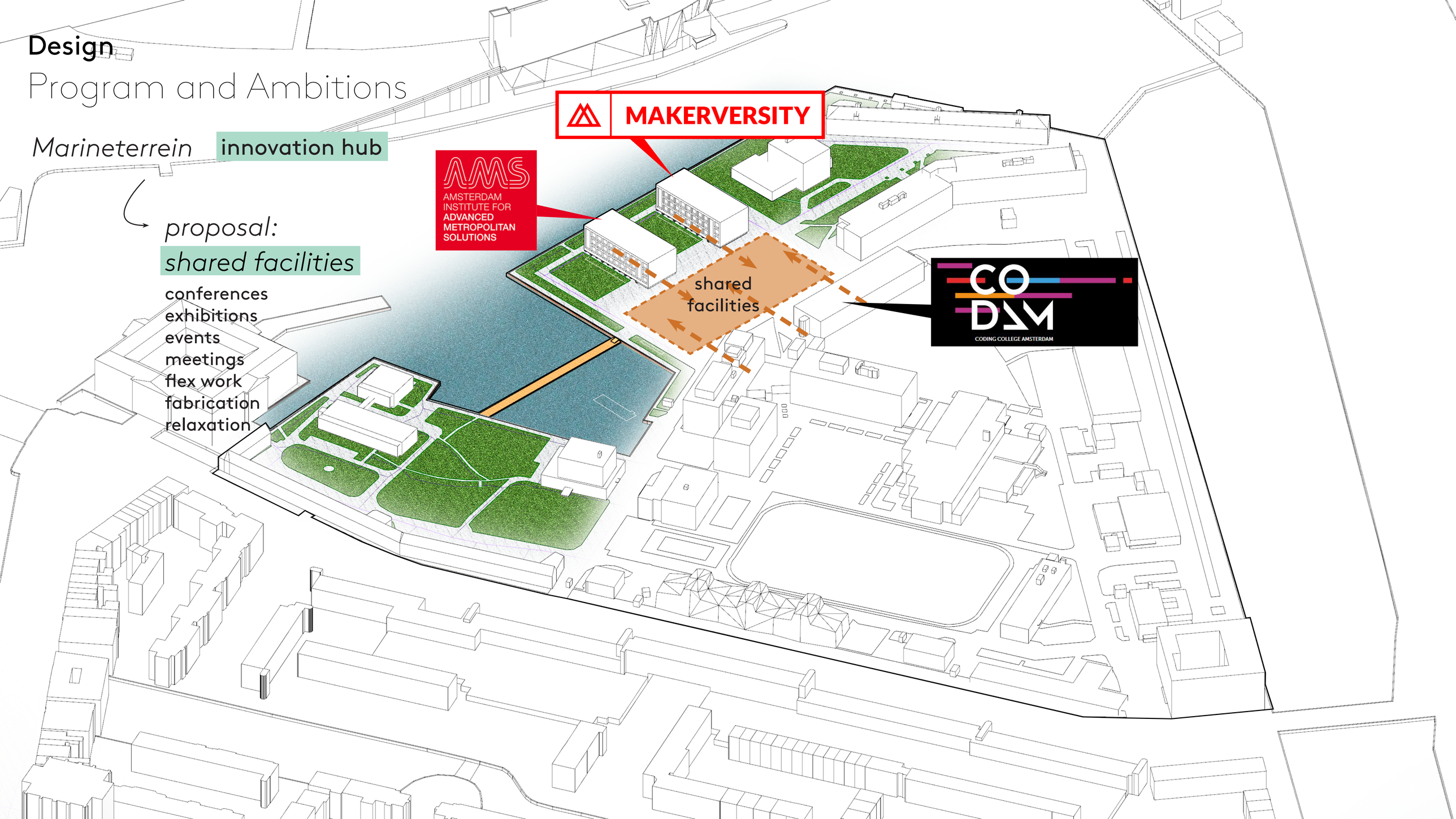
Design

Program and Ambitions

Marineterrein **innovation hub**

proposal:
shared facilities

conferences
exhibitions
events
meetings
flex work
fabrication
relaxation

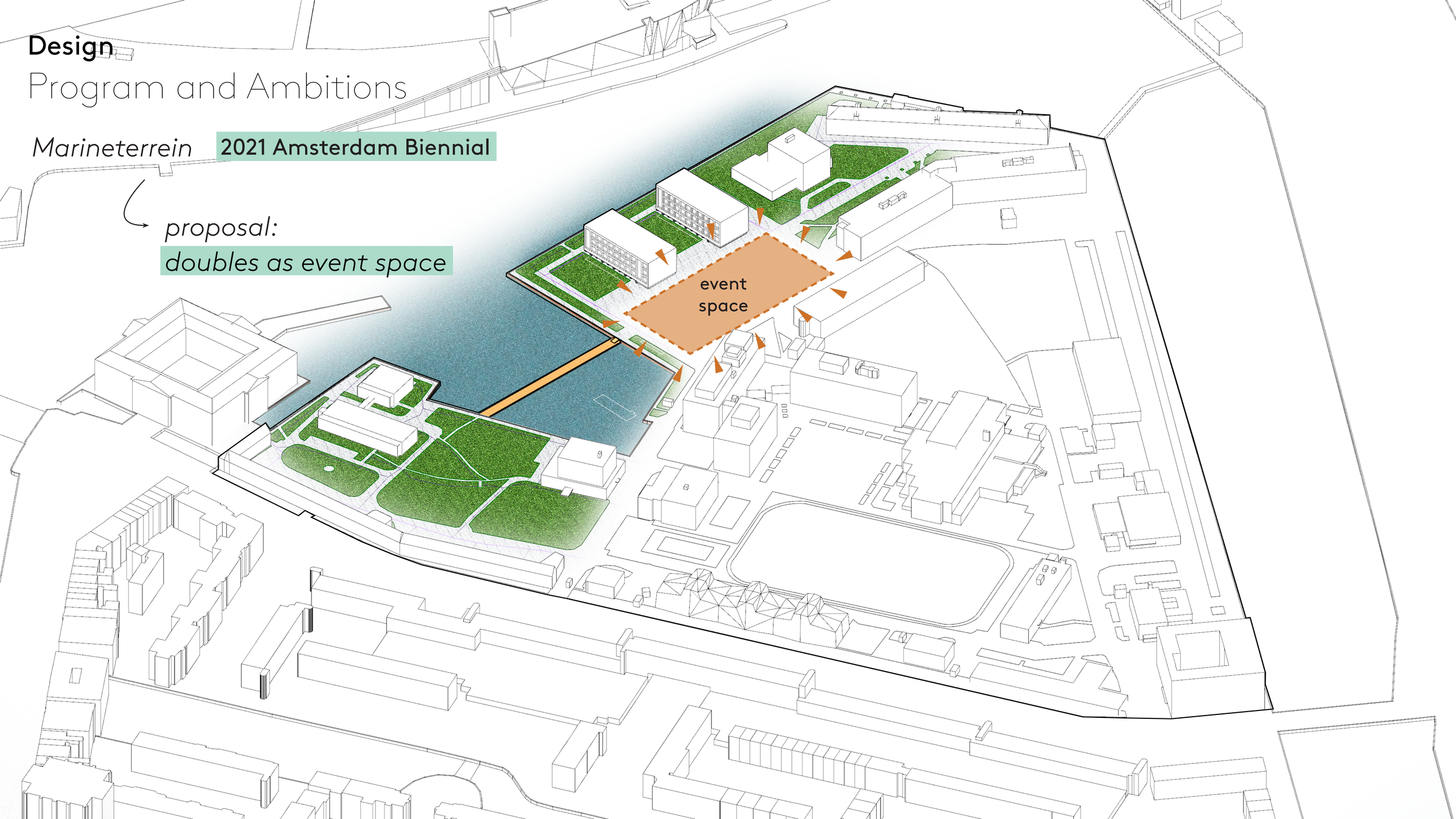


Design

Program and Ambitions

Marineterrein **2021 Amsterdam Biennial**

proposal:
doubles as event space



Design

Program and Ambitions

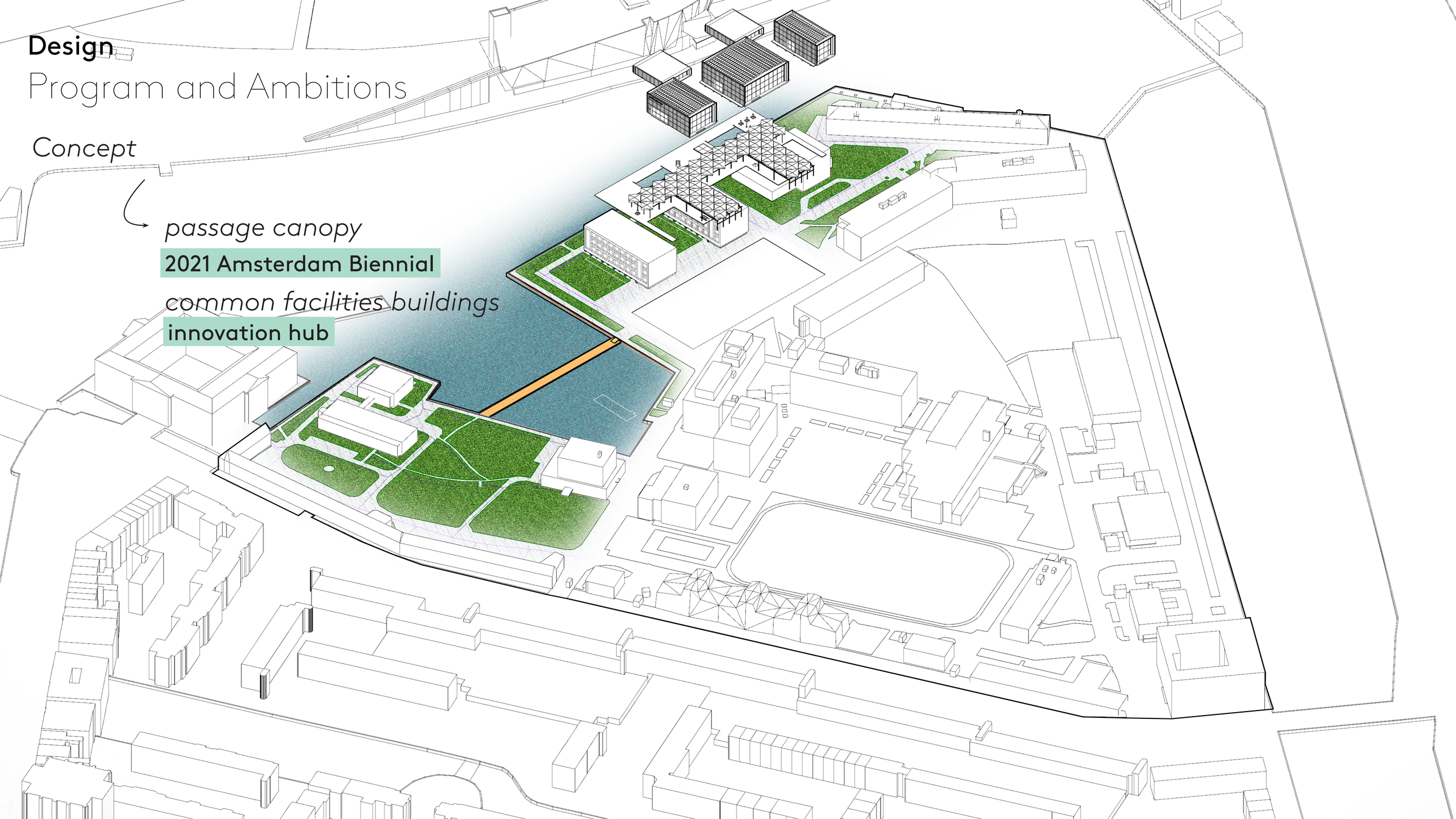
Concept

passage canopy

2021 Amsterdam Biennial

common facilities buildings

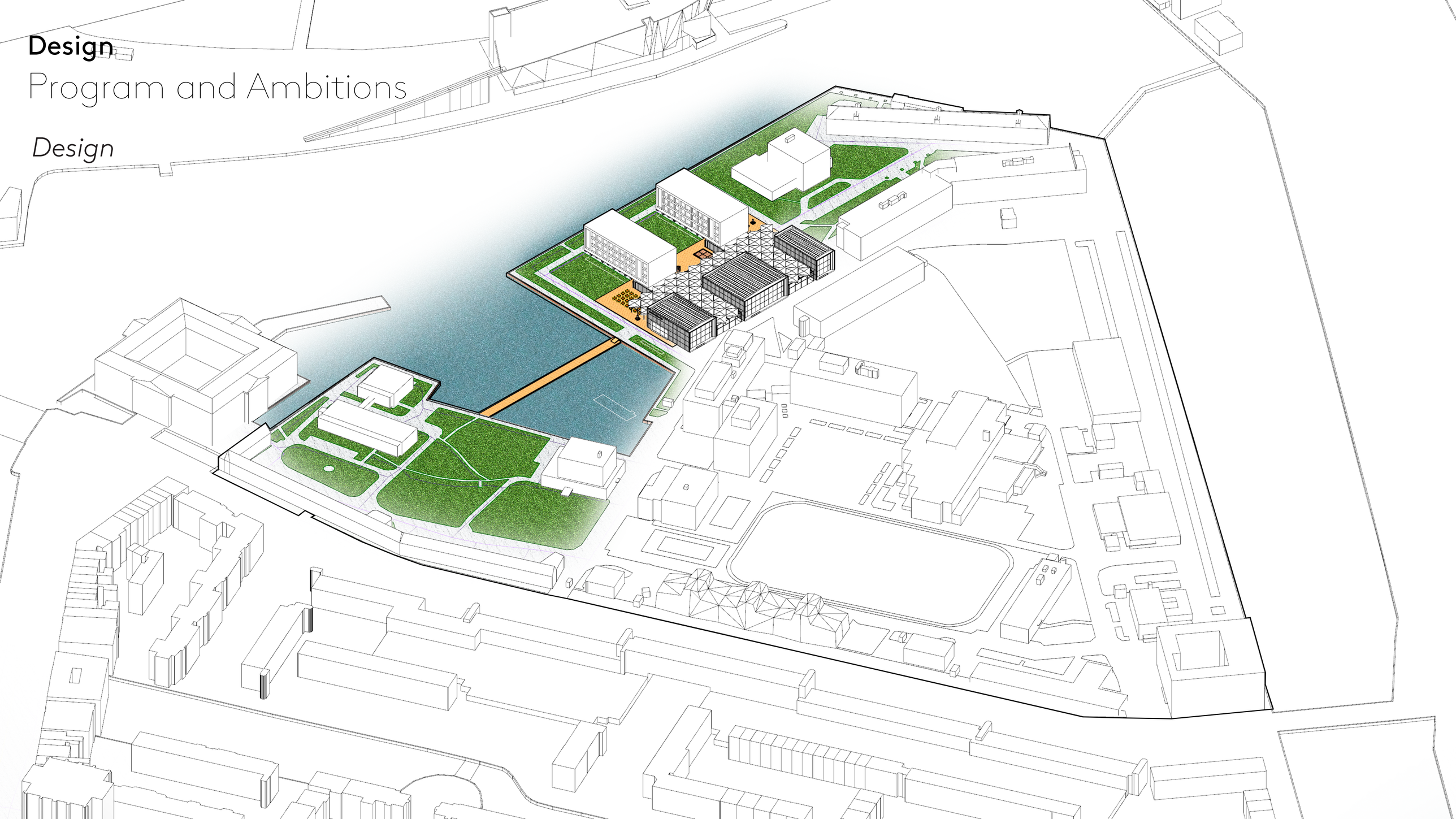
innovation hub



Design

Program and Ambitions

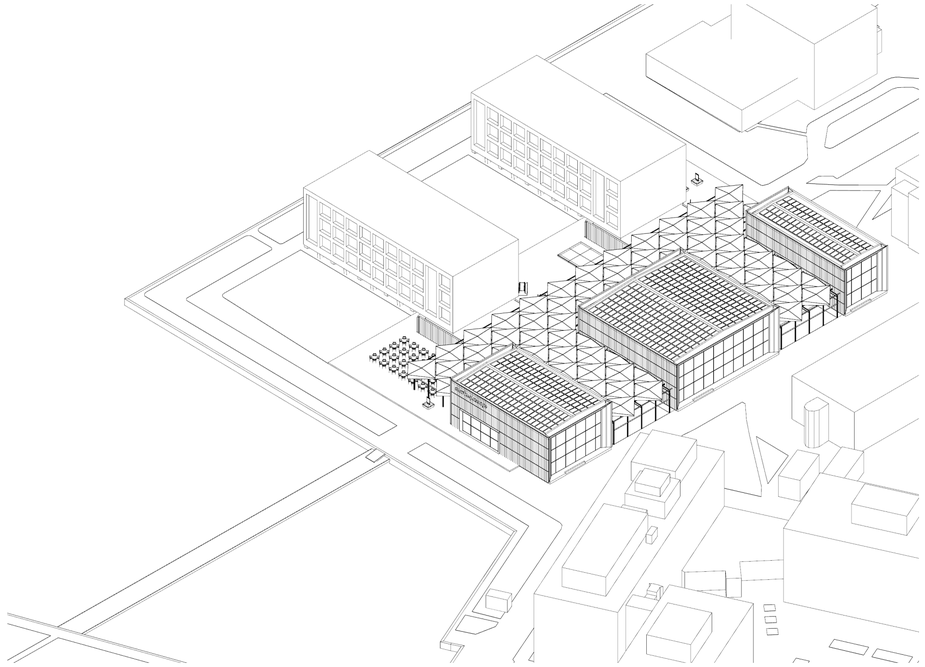
Design

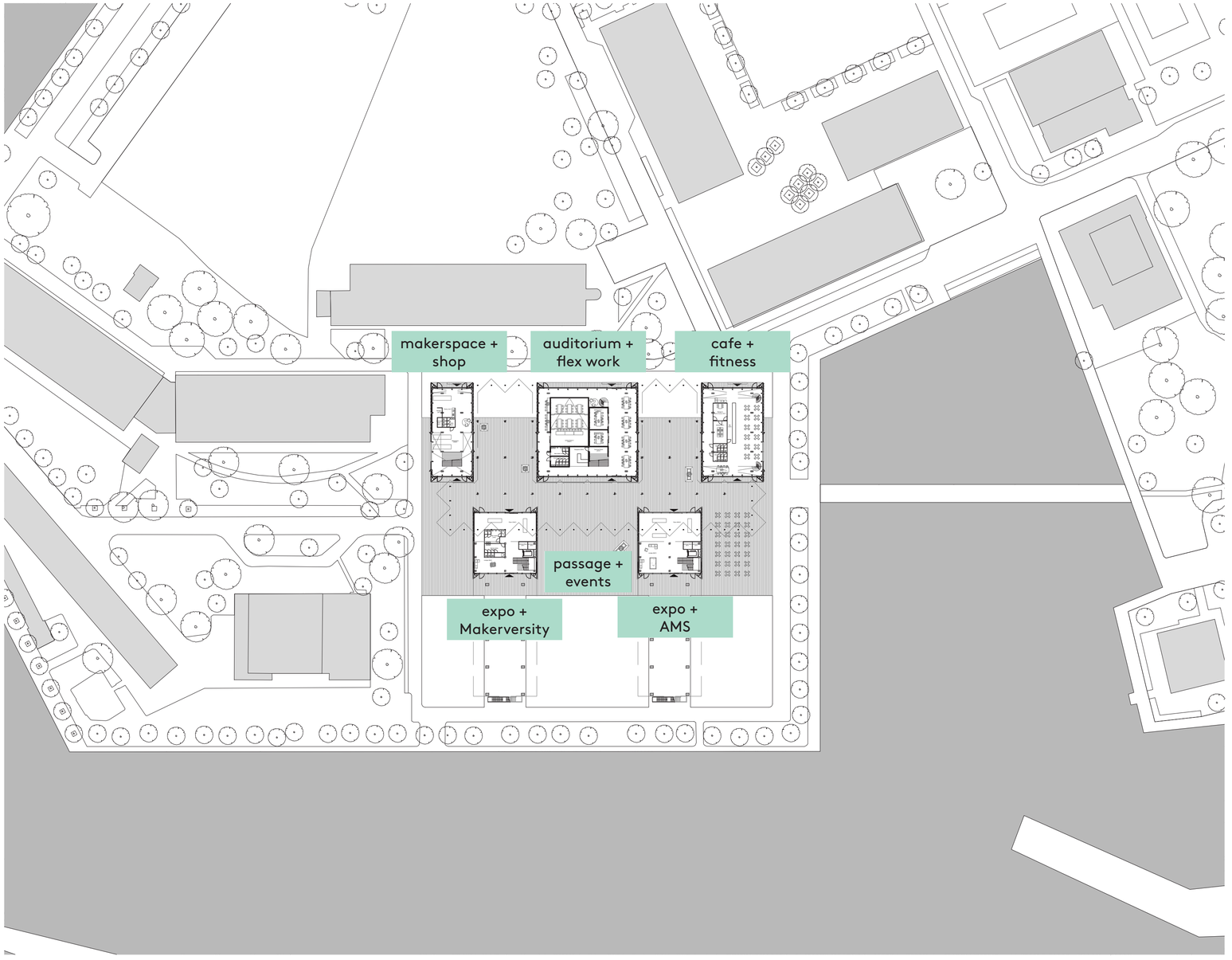


Design

Anchoring

Shared facilities

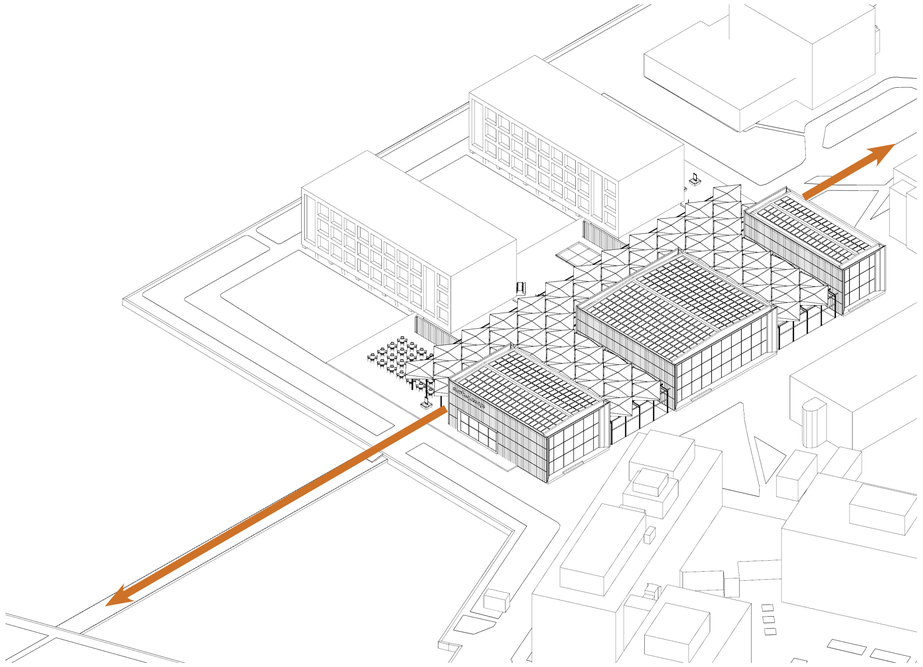


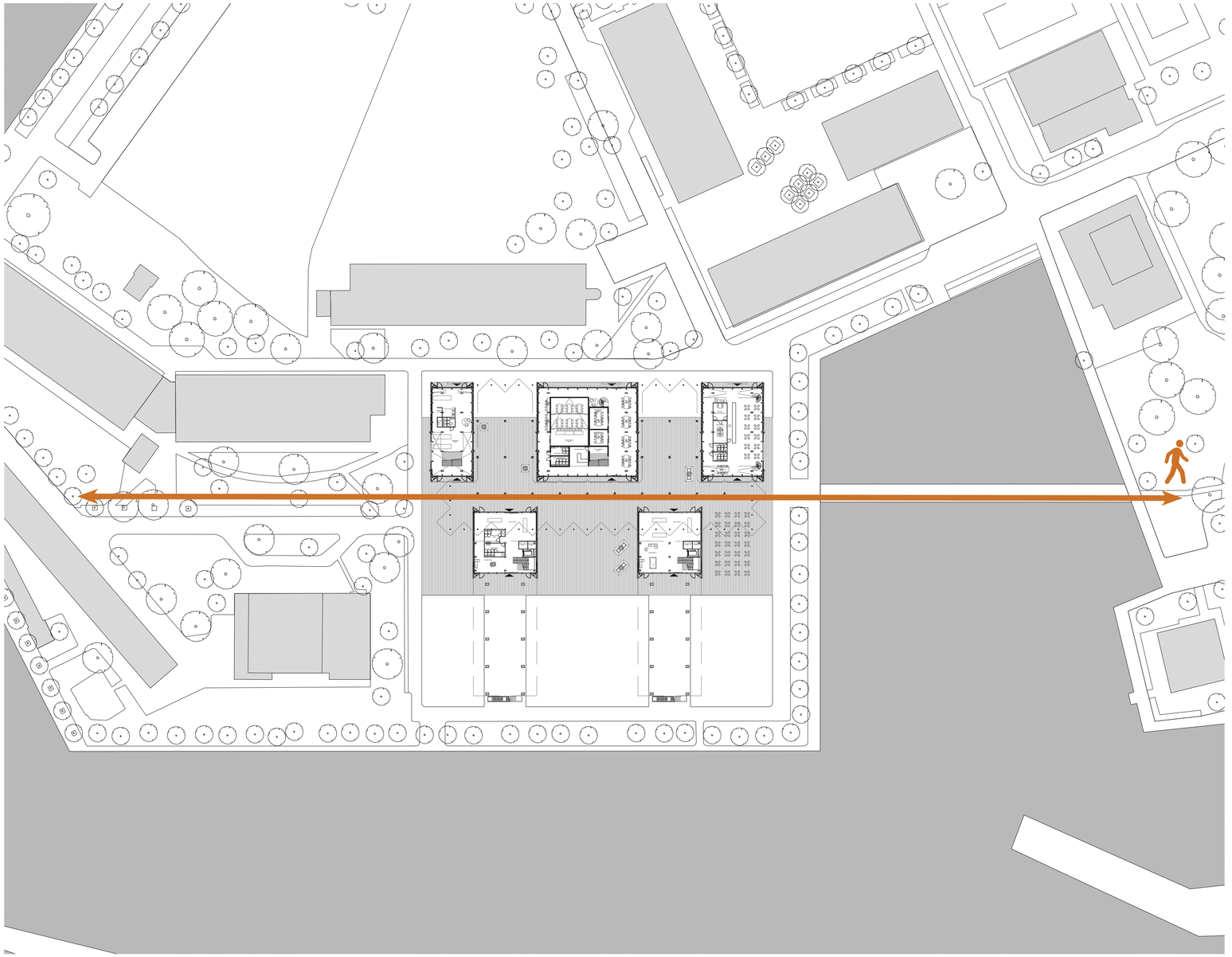


Design

Anchoring

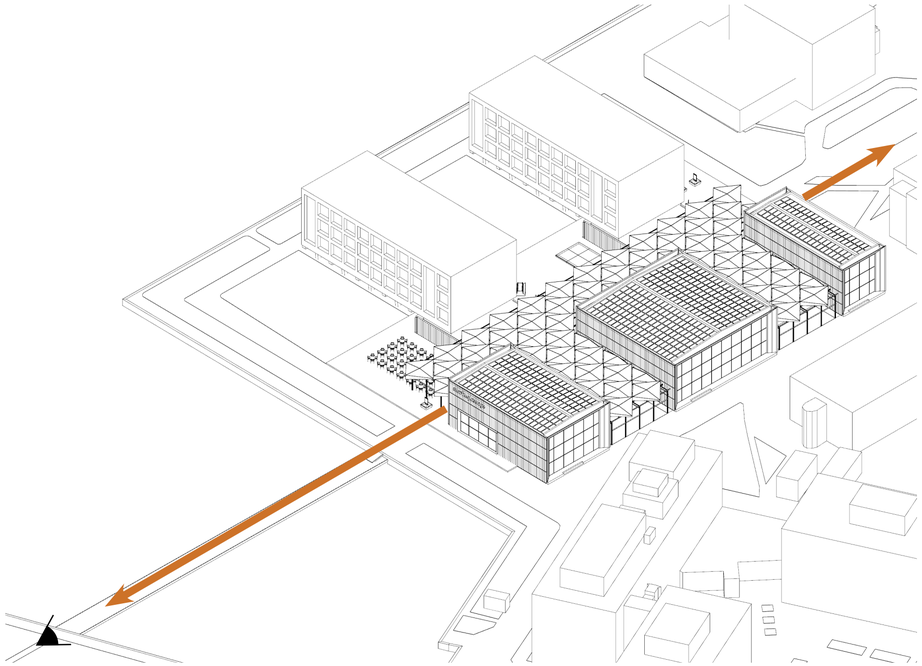
Main routing through passage





Design
Anchoring

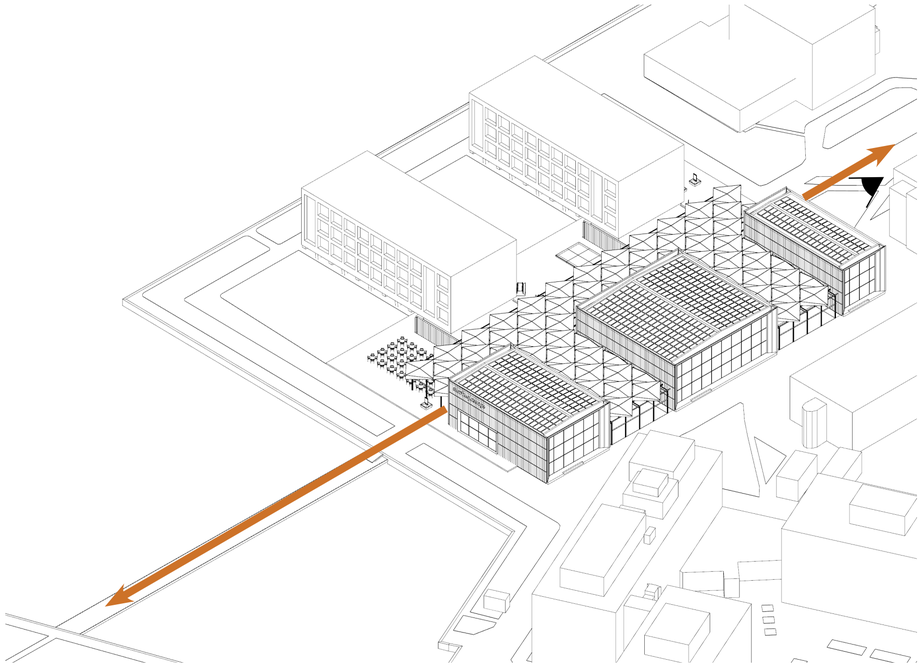
Main routing through passage



Design

Program and Ambitions

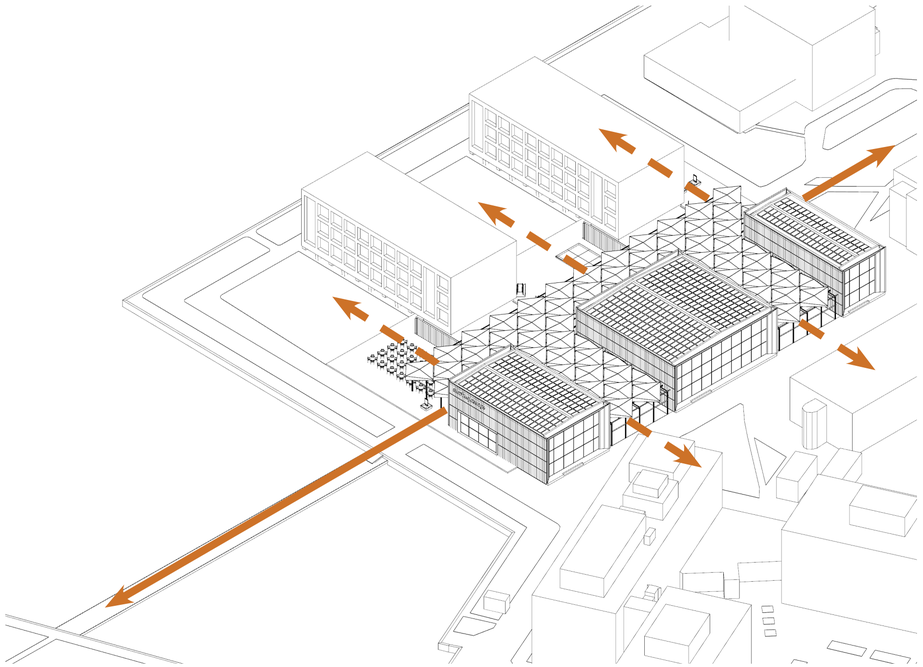
Main routing through passage

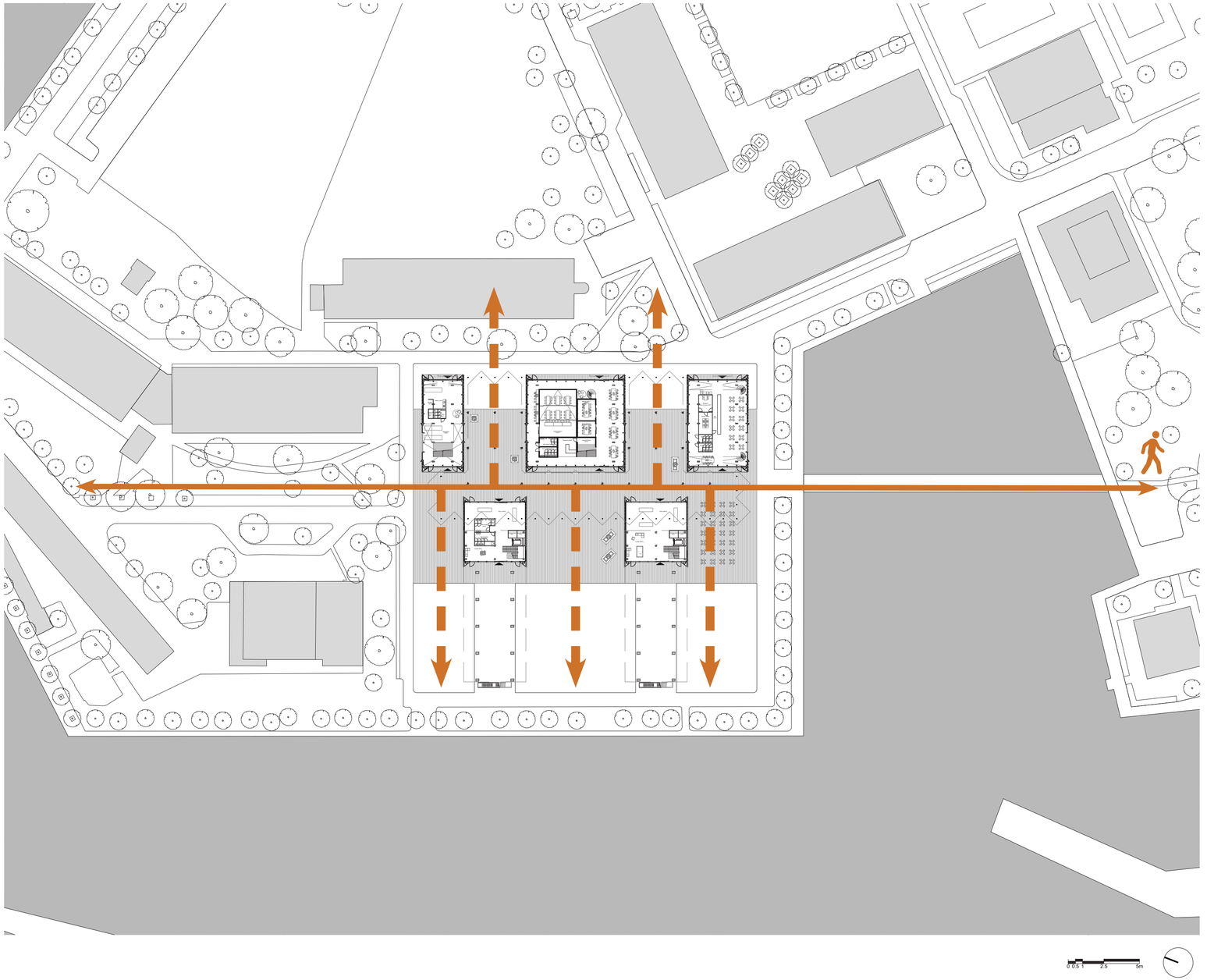


Design

Program and Ambitions

Alternating open 'pockets'

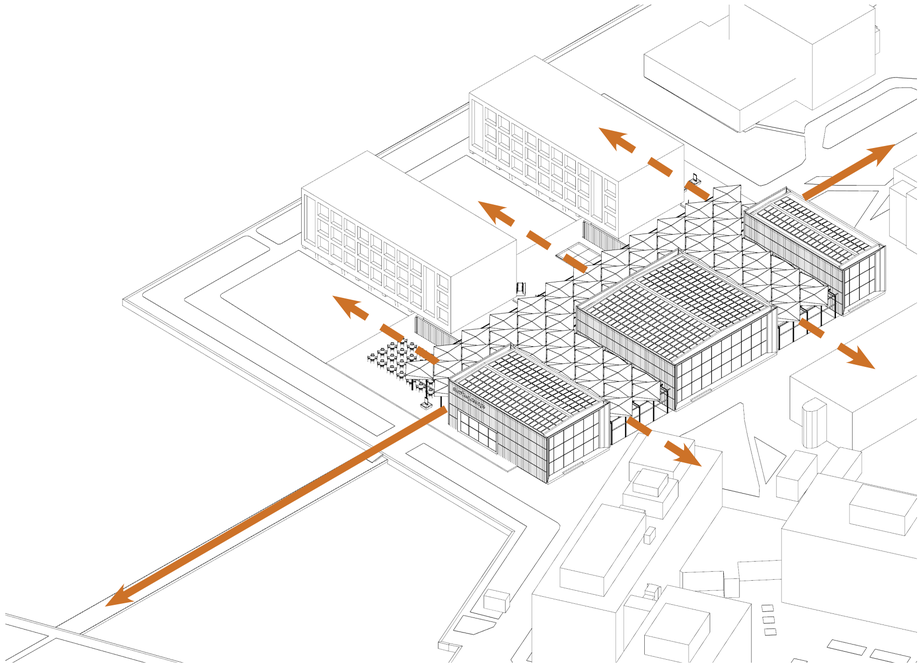


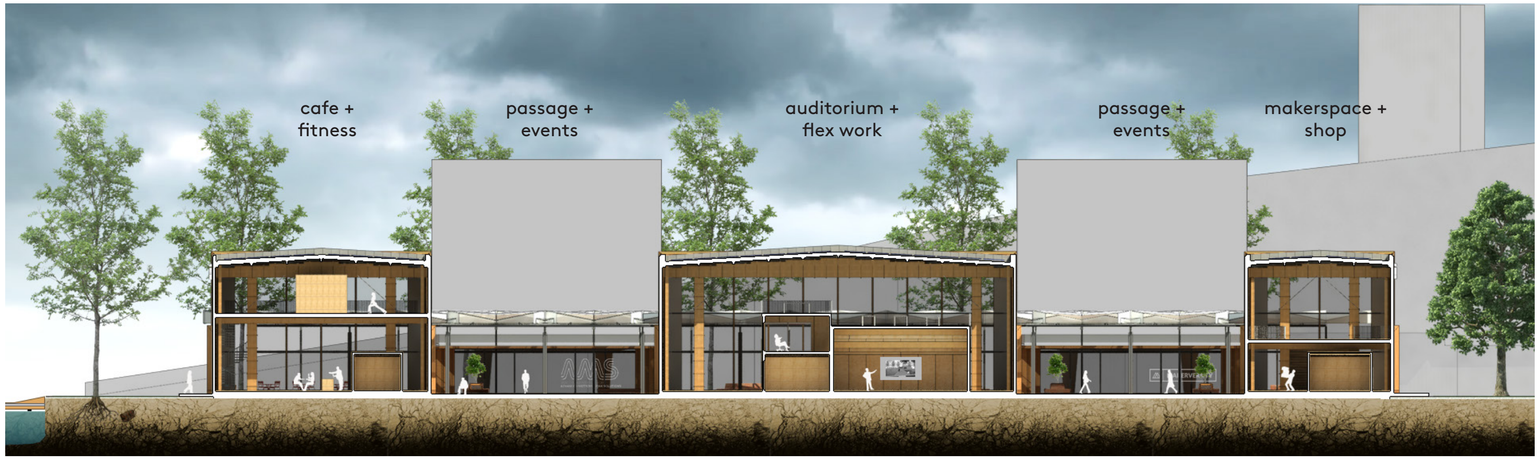


Design

Program and Ambitions

Alternating open 'pockets'

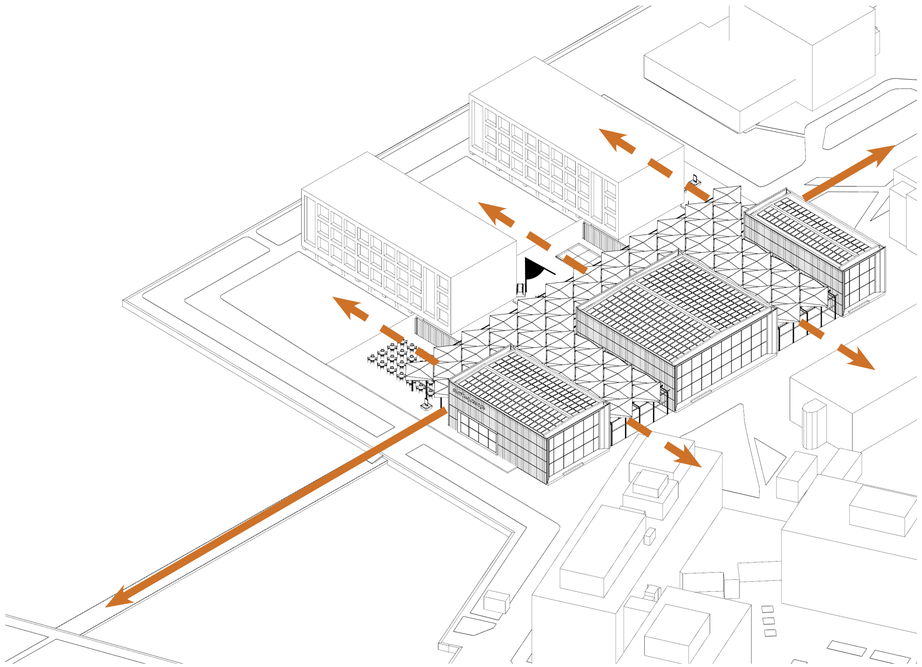


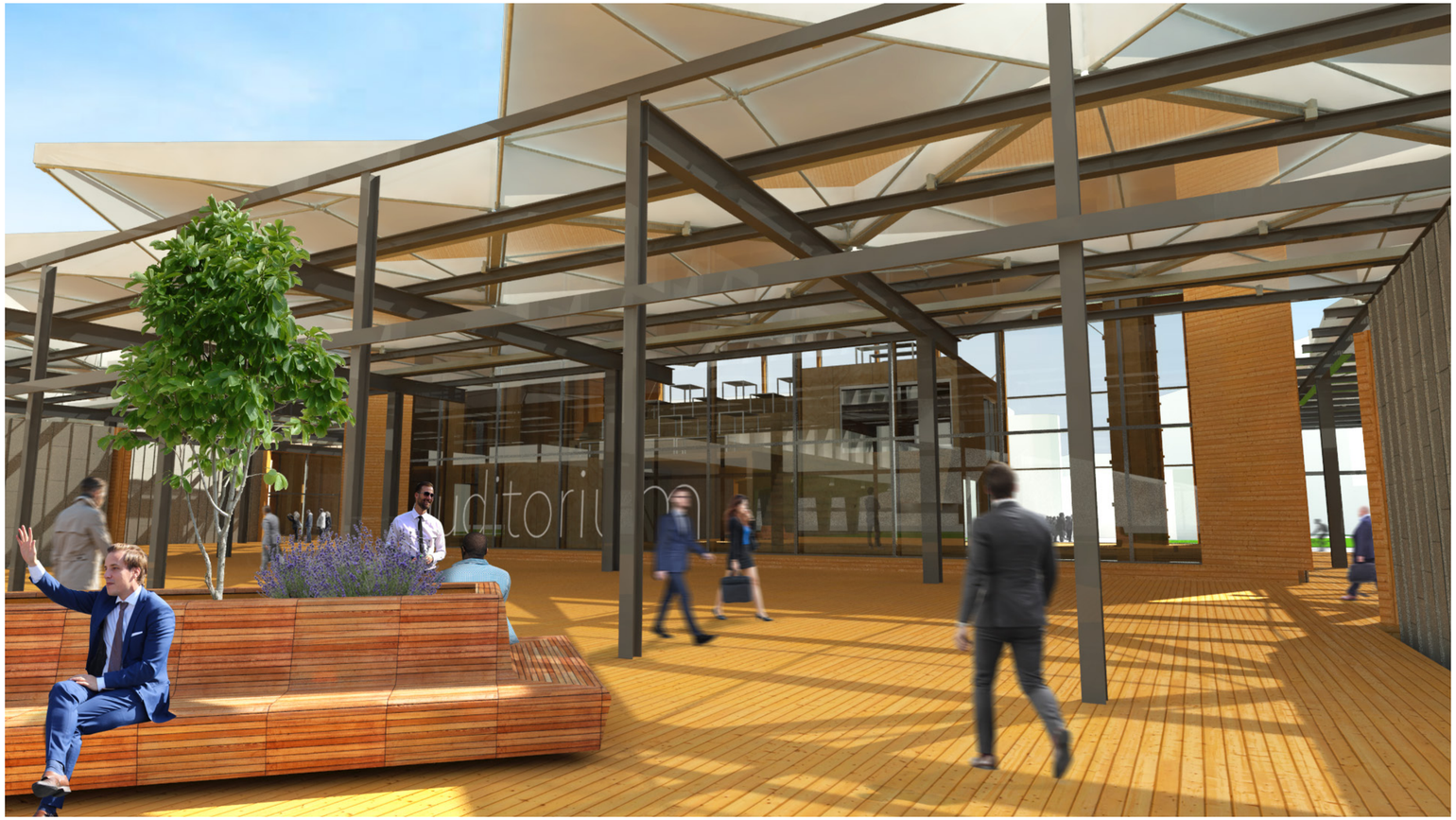


Design

Program and Ambitions

Alternating open ‘pockets’

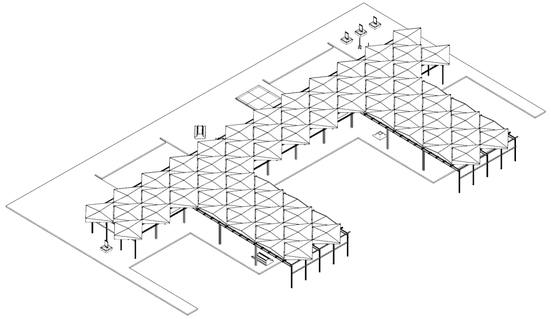


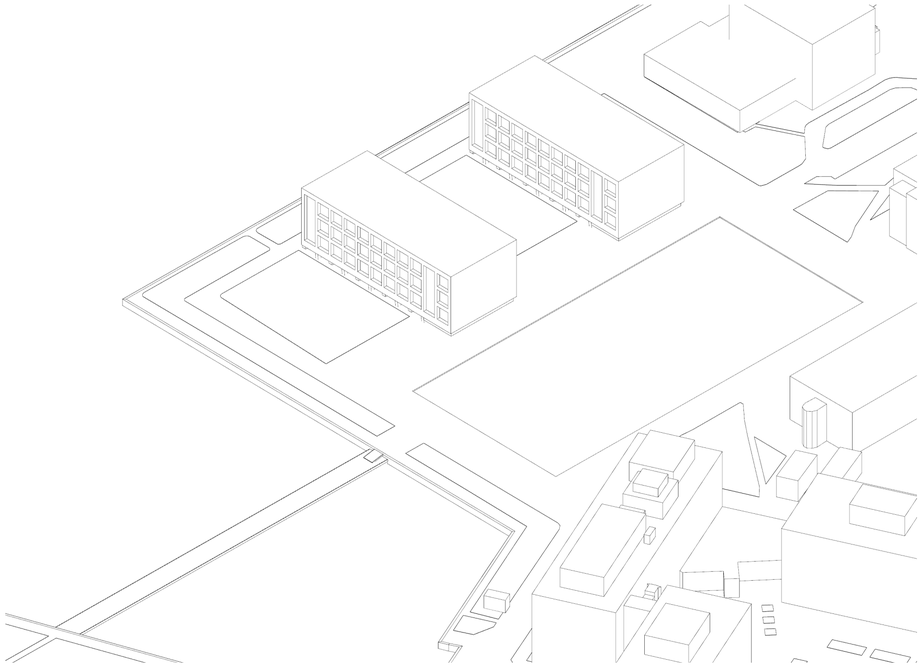


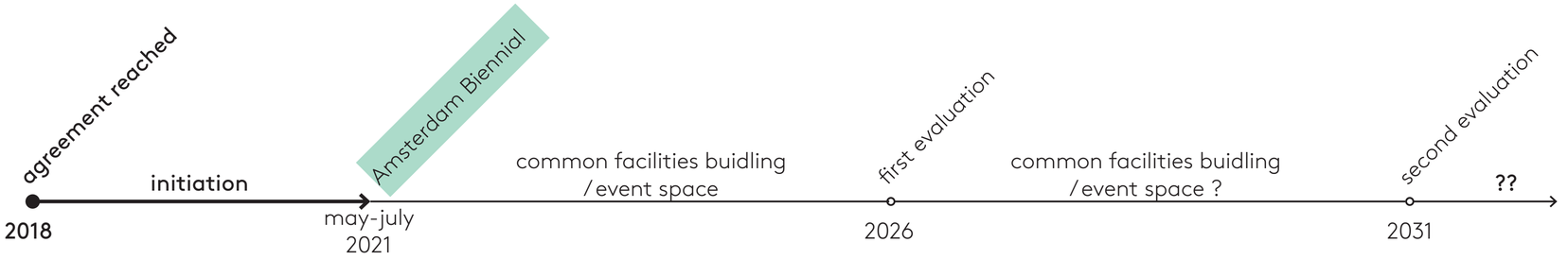
Design

Passage Canopy

Circularity strategy







1
circular
design

	Development					Utility								End-Of-Life	
	Refuse / Reduce Input					Maintain / Prolong Use		Reuse / Redistribute			Refurbish / Remanufacture			Recover Output	
	Design for Light-Weigting / Miniaturising	Design out of Waste	Design for Eliminating Yield Loses	Design to Fit	Design for Sharing	Design for Longevity / Reliability / Durability	Design for Repair / Maintenance	Design for Reuse / Resell	Design for Reassemble / Redistribute	Design for PSS (Product-Service-System) / Leasing	Design for Refurbish / Restoration	Design for Remanufacture / Renovation / Upgradability	Design for Modularity / Adaptability	Design for Disassembly / Reversibility / Reverse Logistics	Design for Resource Conservation
Building Level															
Building Systems Level															
Product / Component Level															

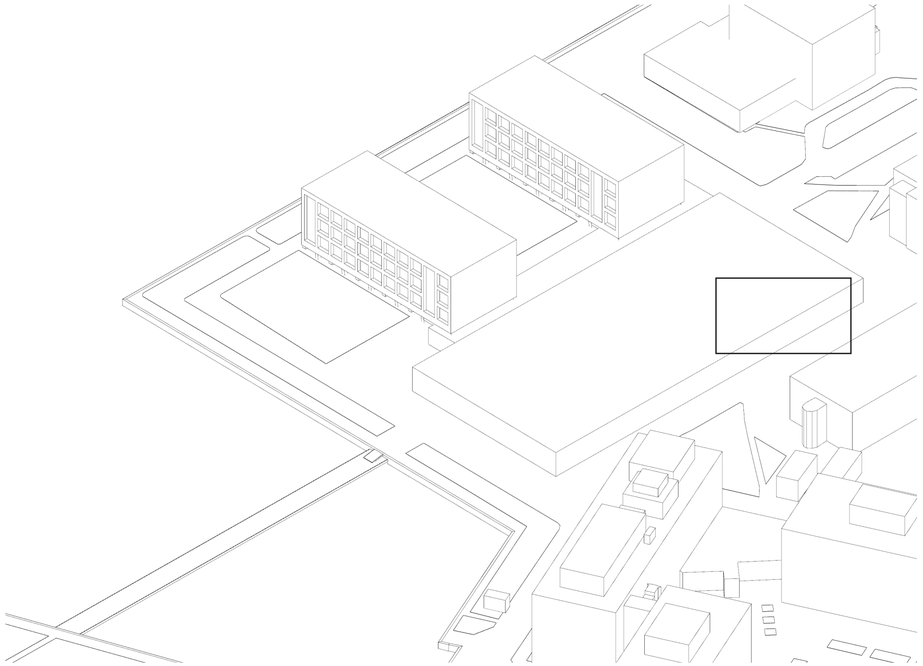
2
circular
material
usage

	Development		Utility	End-Of-Life	
	Refuse / Reduce Input		Prolong Use	Recover Output	
	Reuse Materials	Optimise Manufacture Process	Durable Materials	Recyclable / Renewable Materials	Materials for Recycling Infrastructure / Separability
Technical Cycle					
Biological Cycle					
Hybrid					

Design

Passage Canopy

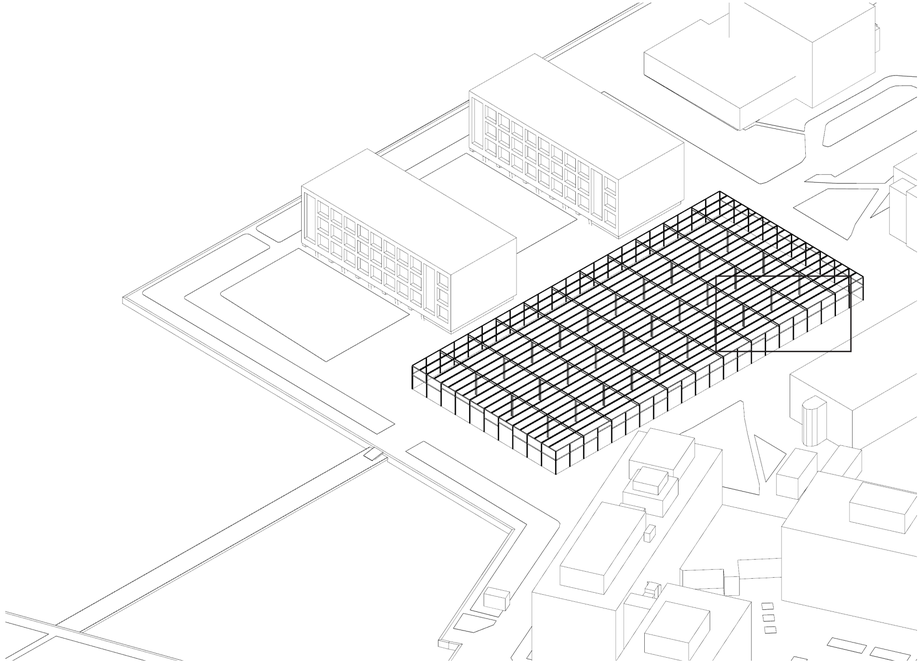
Starting point

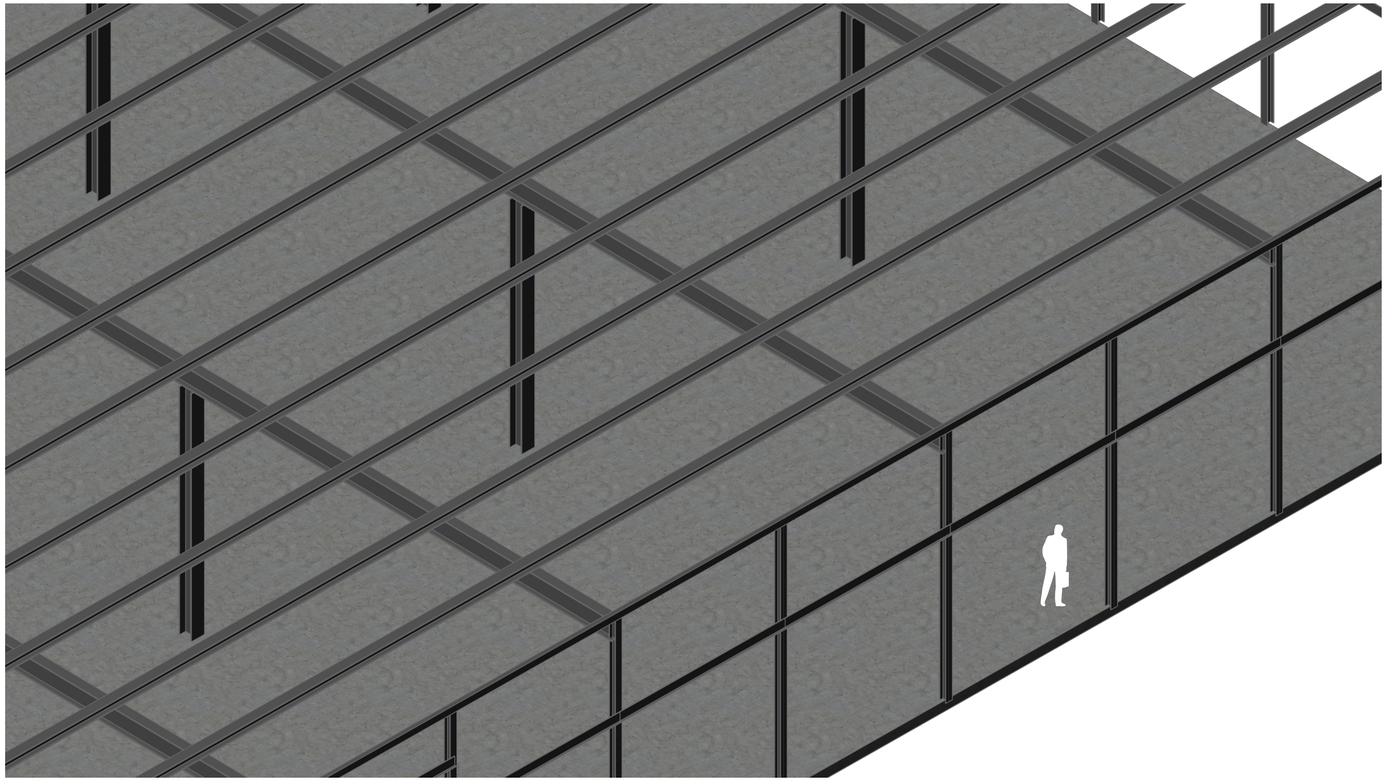


Design

Passage Canopy

Reuse existing structure

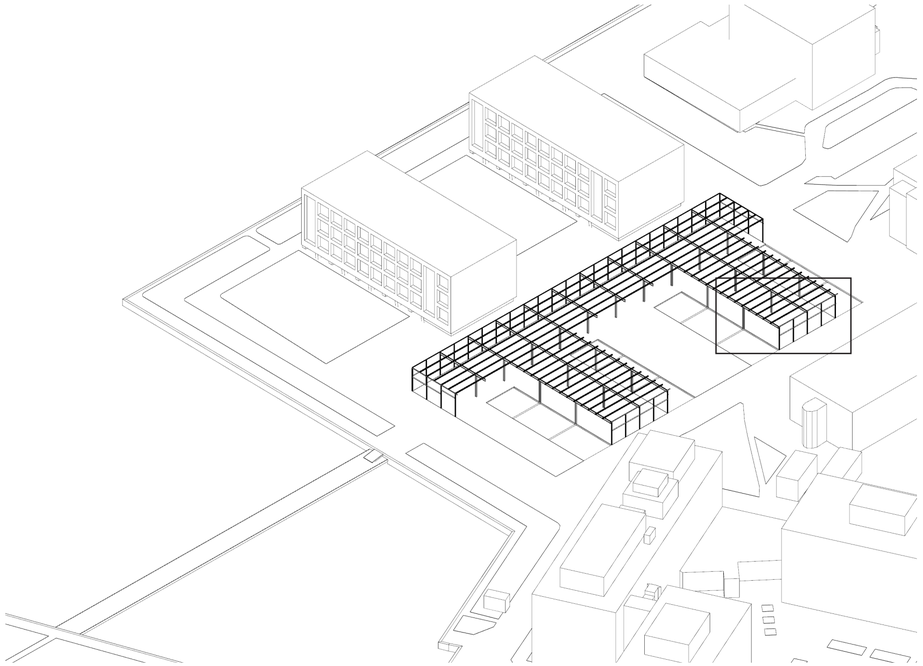


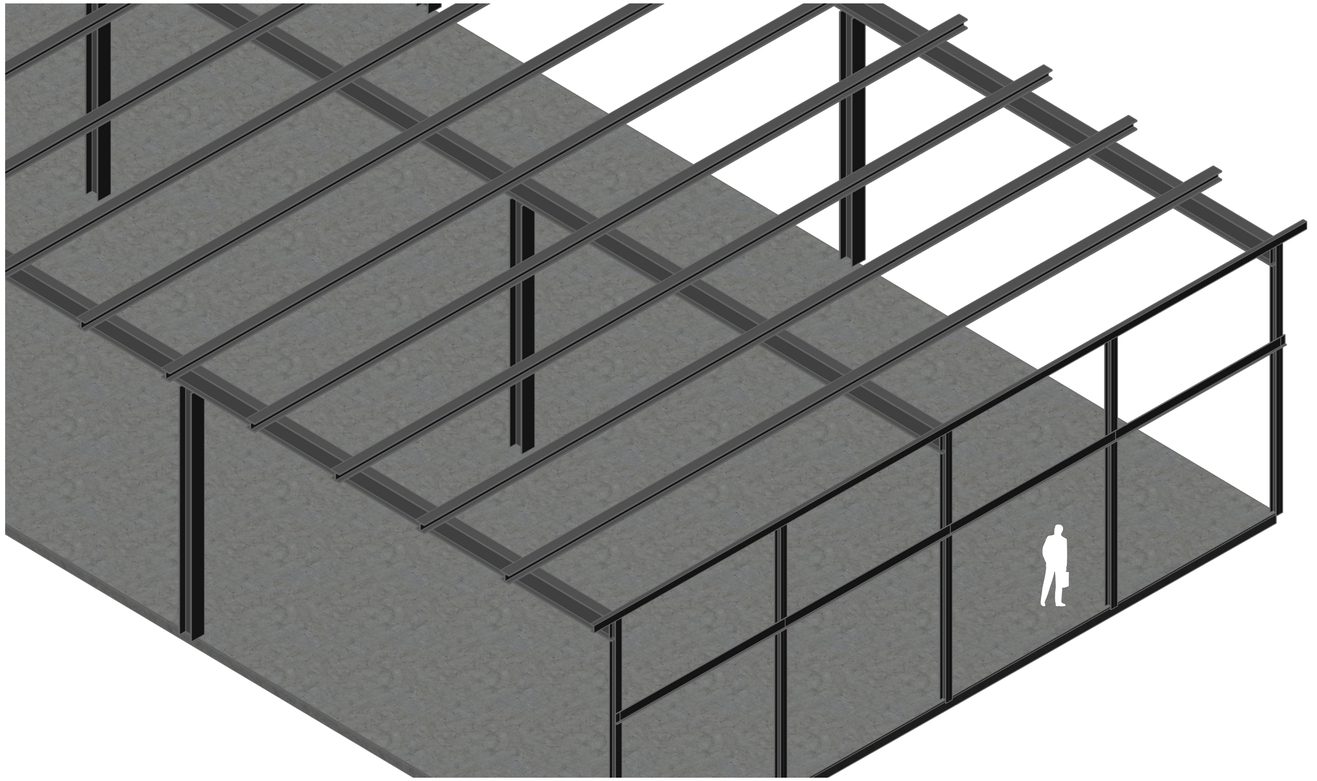


Design

Passage Canopy

Cut-outs

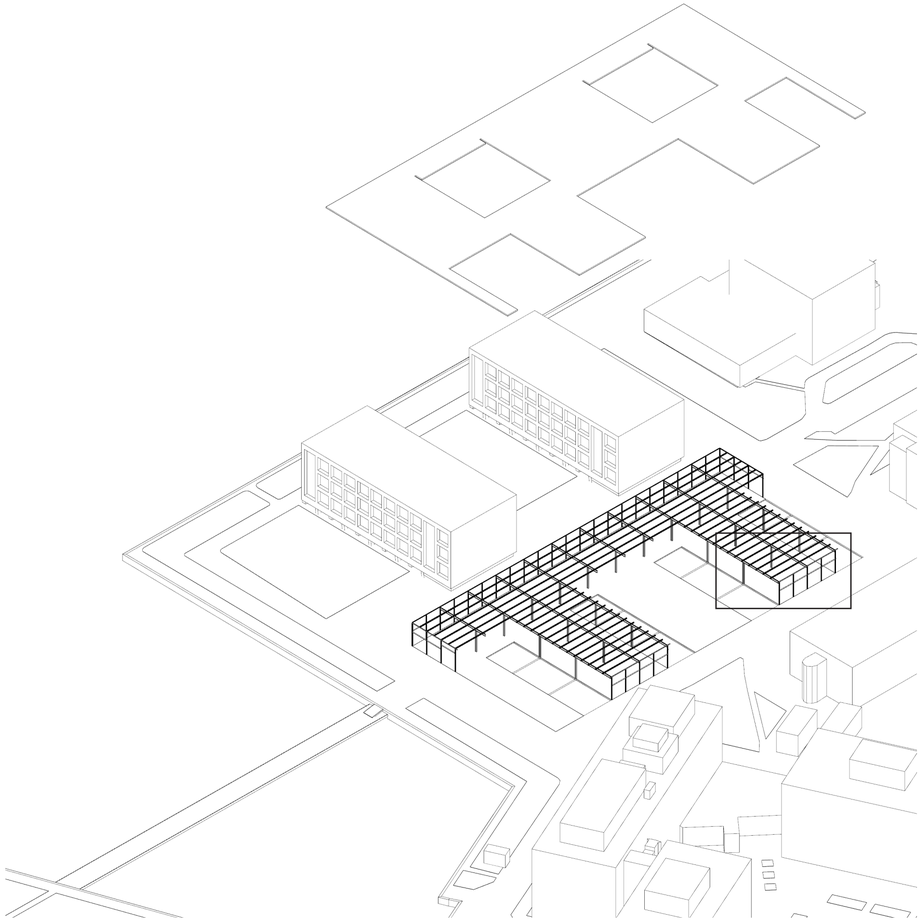


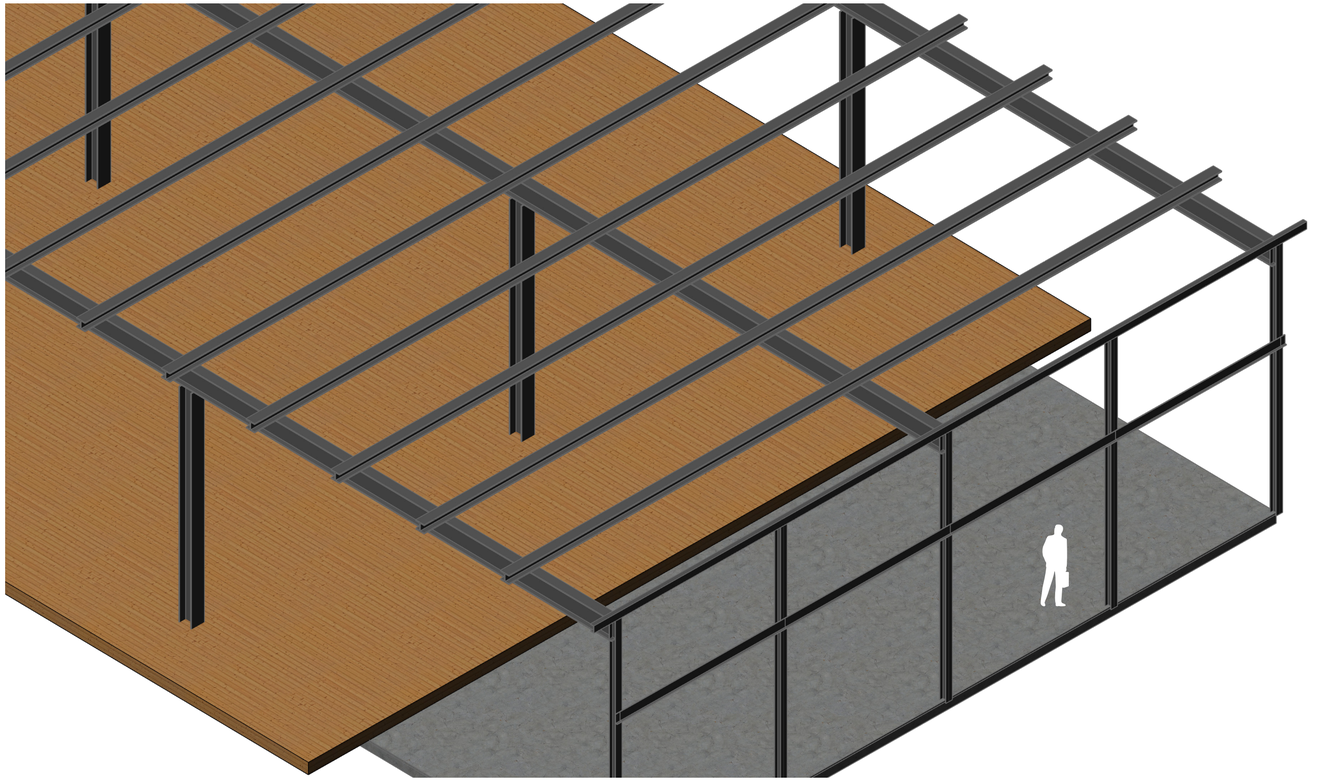


Design

Passage Canopy

Raised plateau for placemaking

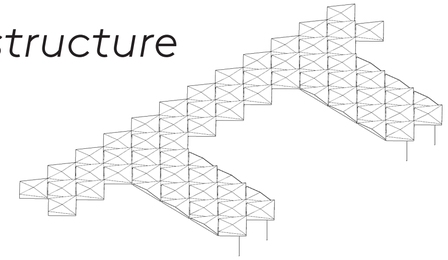


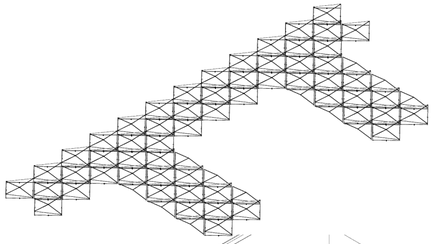


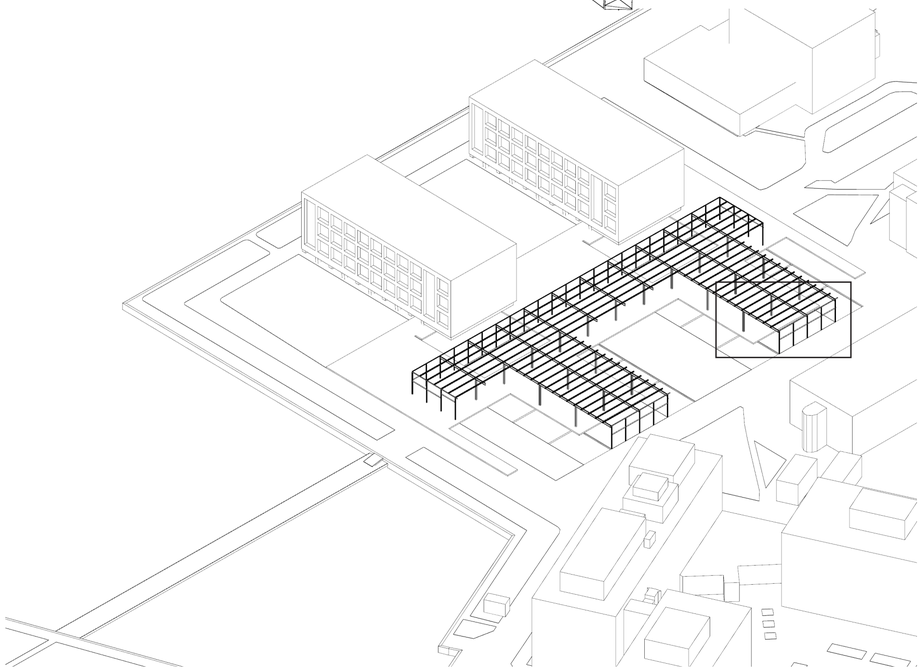
Design

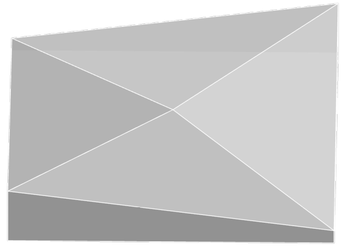
Passage Canopy

Lightweight roofstructure

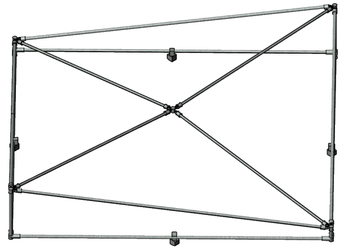




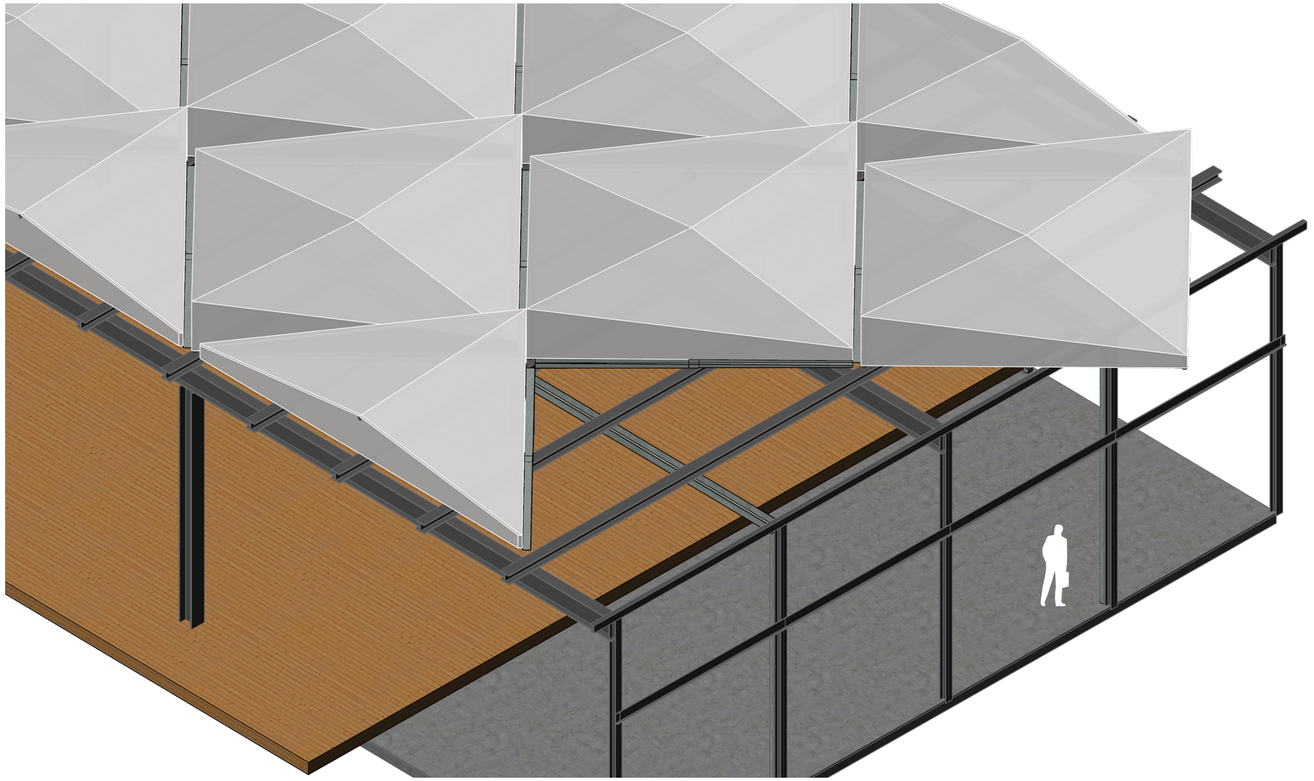




transluscent ETFE



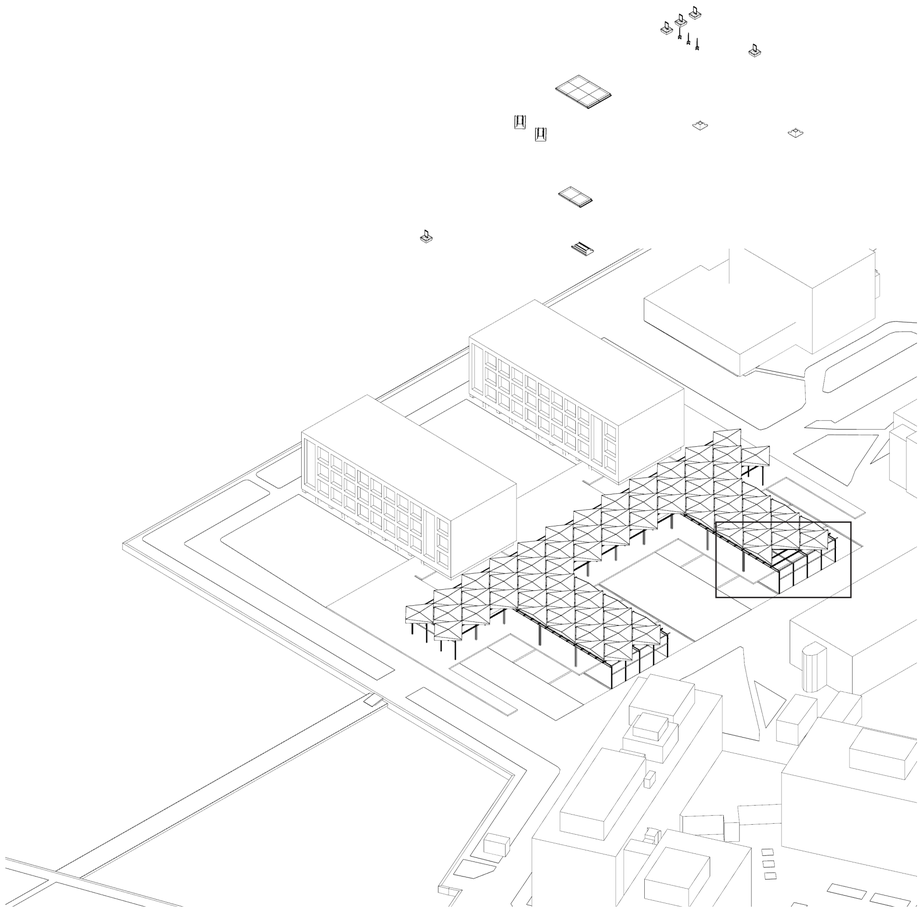
scaffolding structure

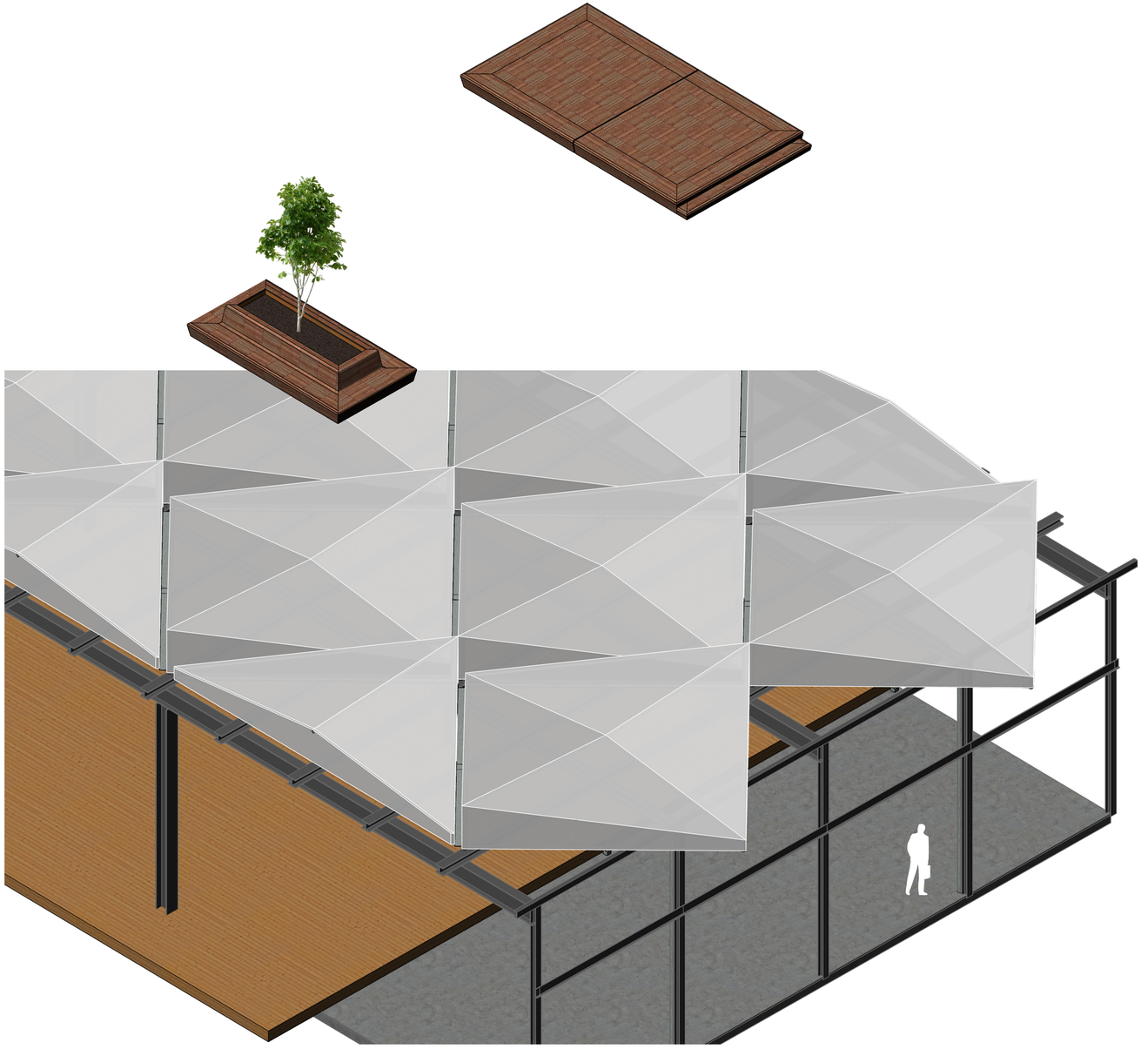


Design

Passage Canopy

Mobile furniture

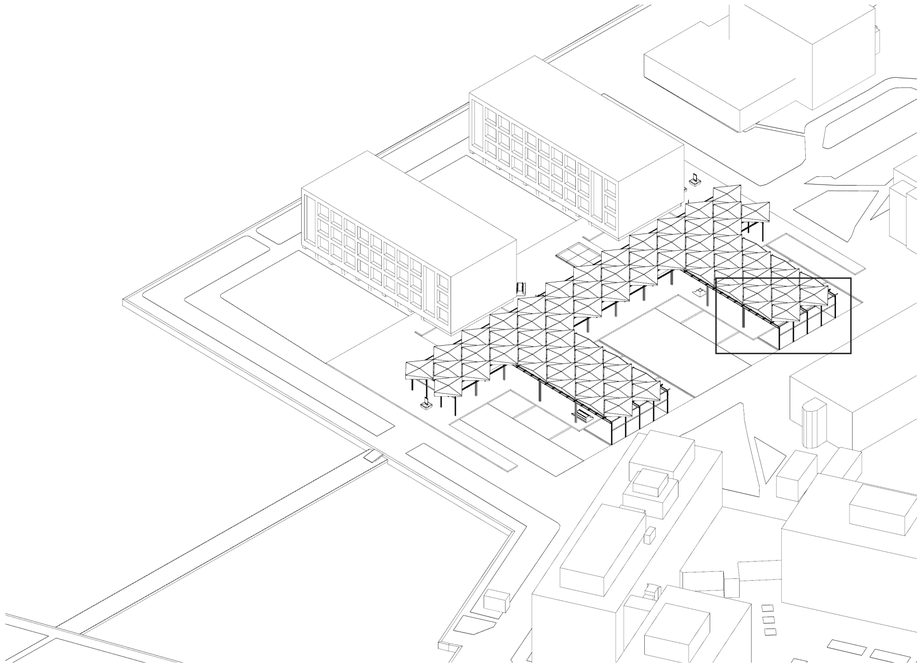


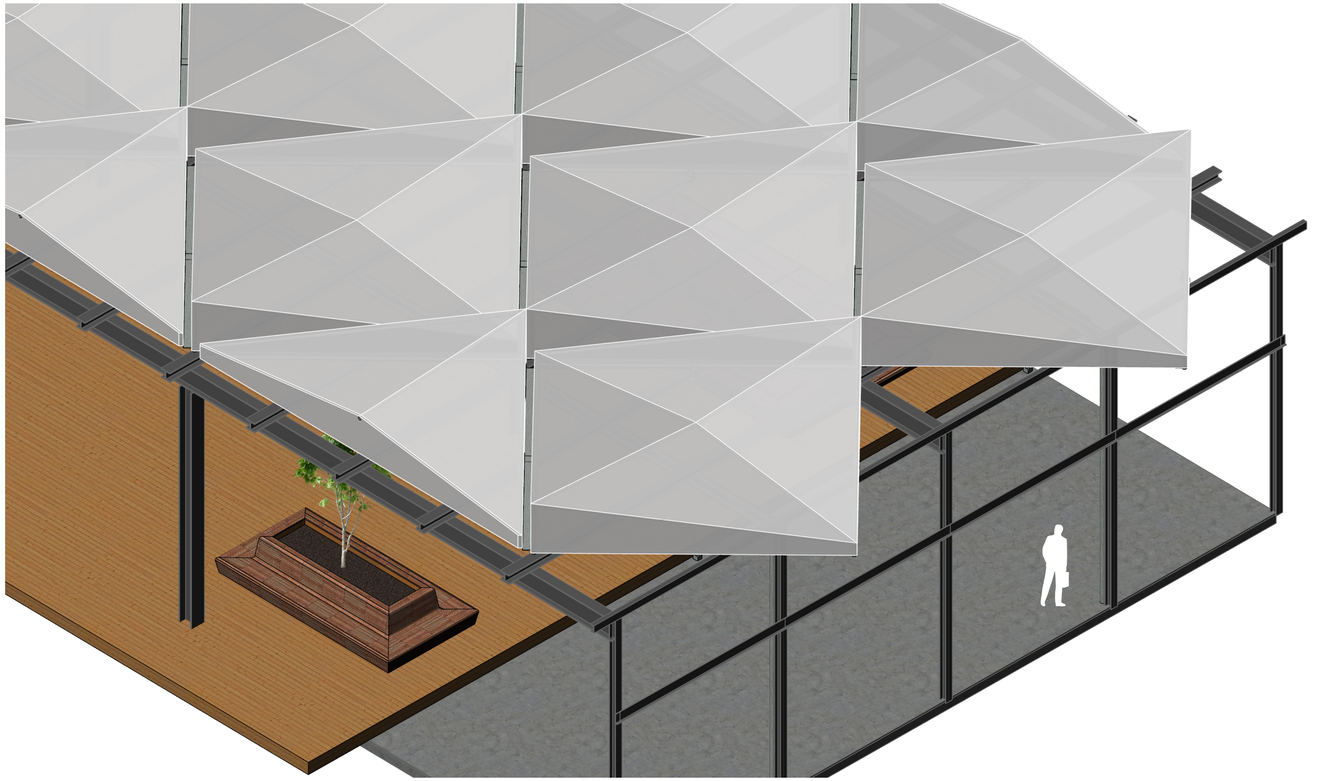


Design

Passage Canopy

Design

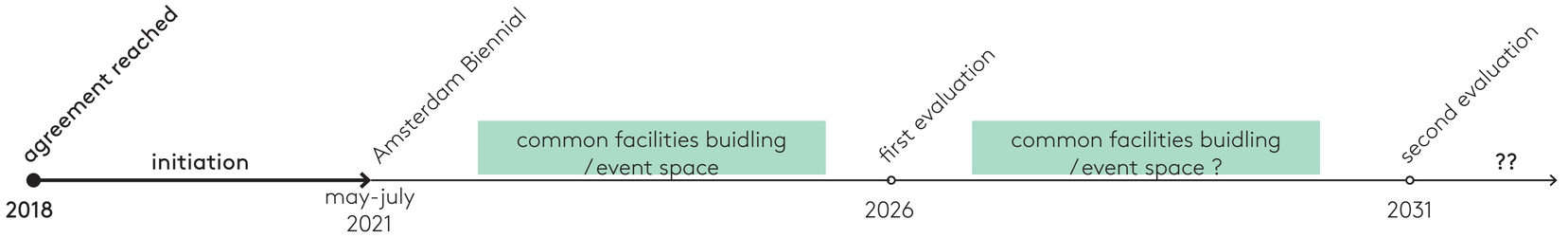


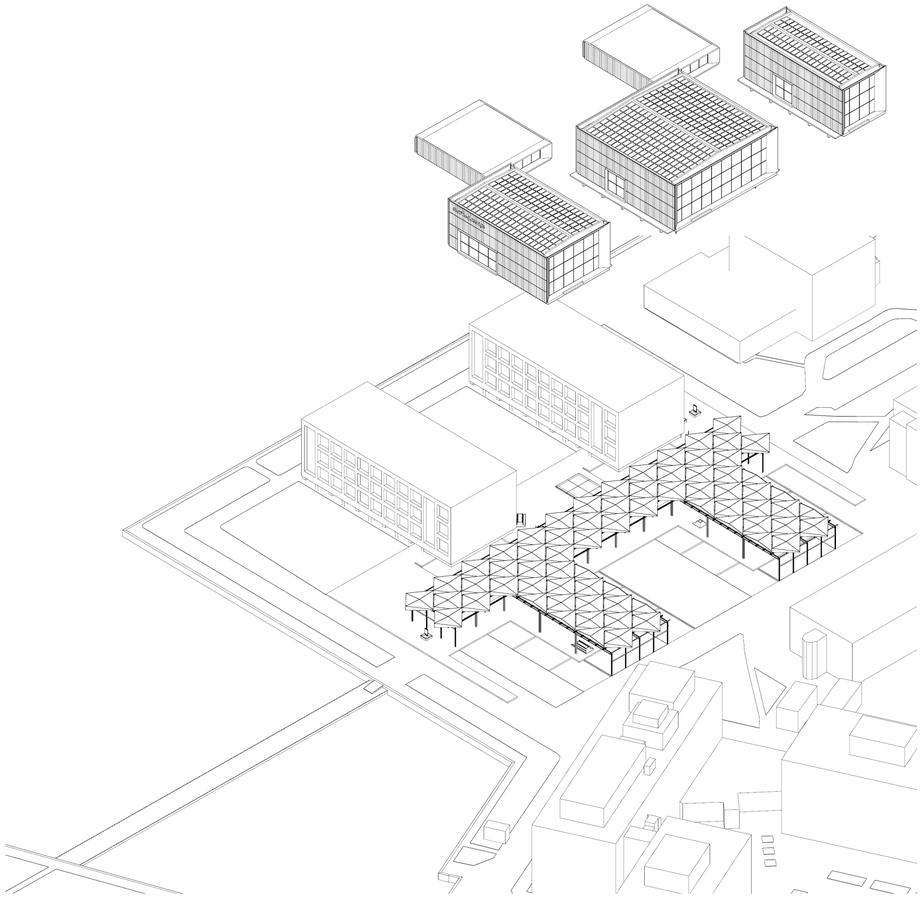


Design

Common Facilities Buildings

Circularity strategy





1 circular design

	Development					Utility								End-Of-Life	
	Refuse / Reduce Input					Maintain / Prolong Use		Reuse / Redistribute			Refurbish / Remanufacture			Recover Output	
	Design for Light-Weigting / Miniaturising	Design out of Waste	Design for Eliminating Yield Loses	Design to Fit	Design for Sharing	Design for Longevity / Reliability / Durability	Design for Repair / Maintenance	Design for Reuse / Resell	Design for Reassemble / Redistribute	Design for PSS (Product-Service-System) / Leasing	Design for Refurbish / Restoration	Design for Remanufacture / Renovation / Upgradability	Design for Modularity / Adaptability	Design for Disassembly / Reversibility / Reverse Logistics	Design for Resource Conservation
Building Level															
Building Systems Level															
Product / Component Level															

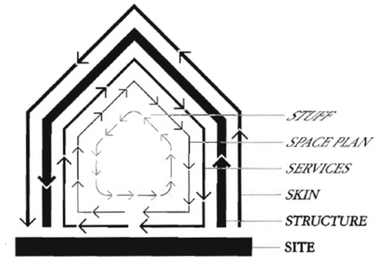
2 circular material usage

	Development		Utility	End-Of-Life	
	Refuse / Reduce Input		Prolong Use	Recover Output	
	Reuse Materials	Optimise Manufacture Process	Durable Materials	Recyclable / Renewable Materials	Materials for Recycling Infrastructure / Separability
Technical Cycle					
Biological Cycle					
Hybrid					

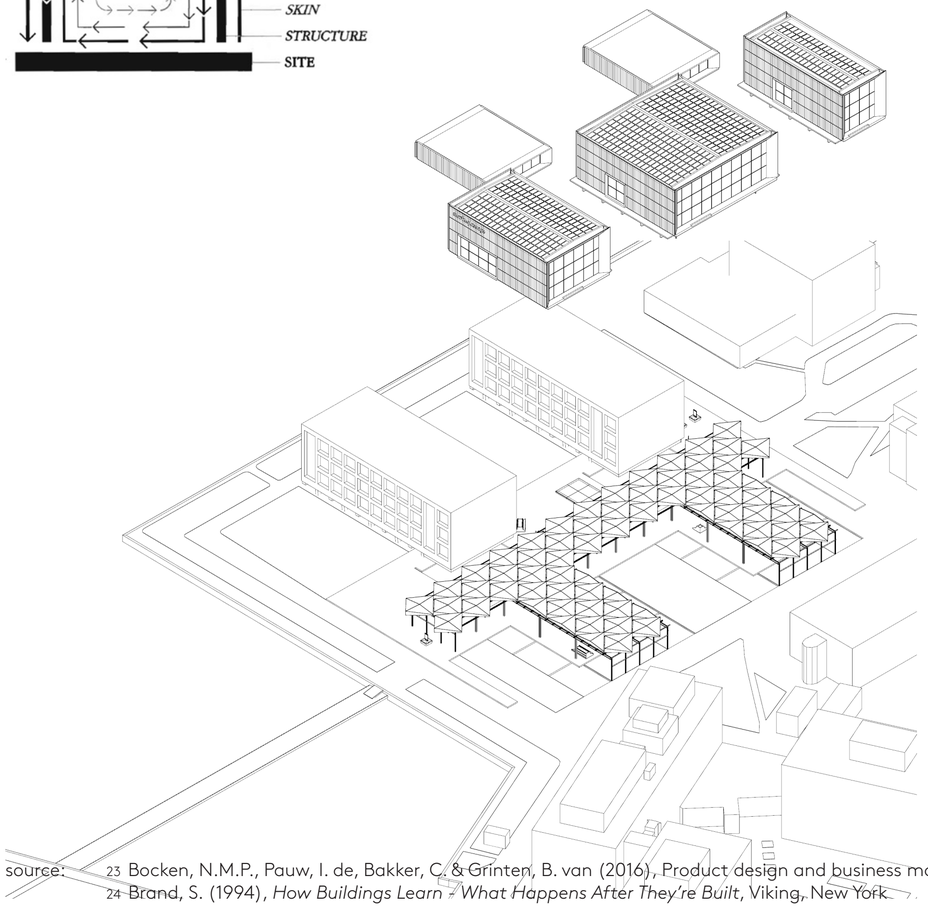
Design

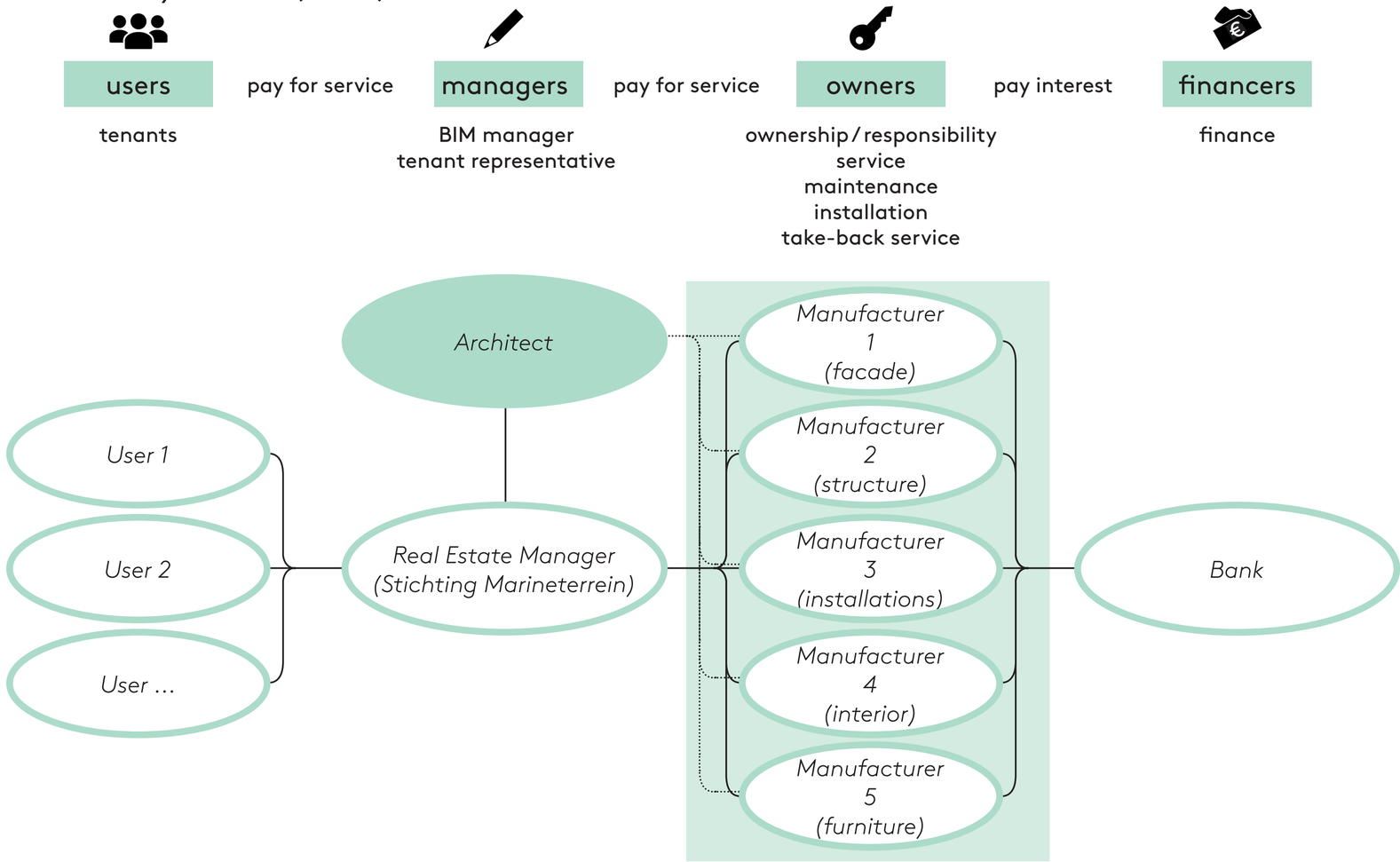
Common Facilities Buildings

Access and Performance Model / Product Service System (PSS): [23]



[24]

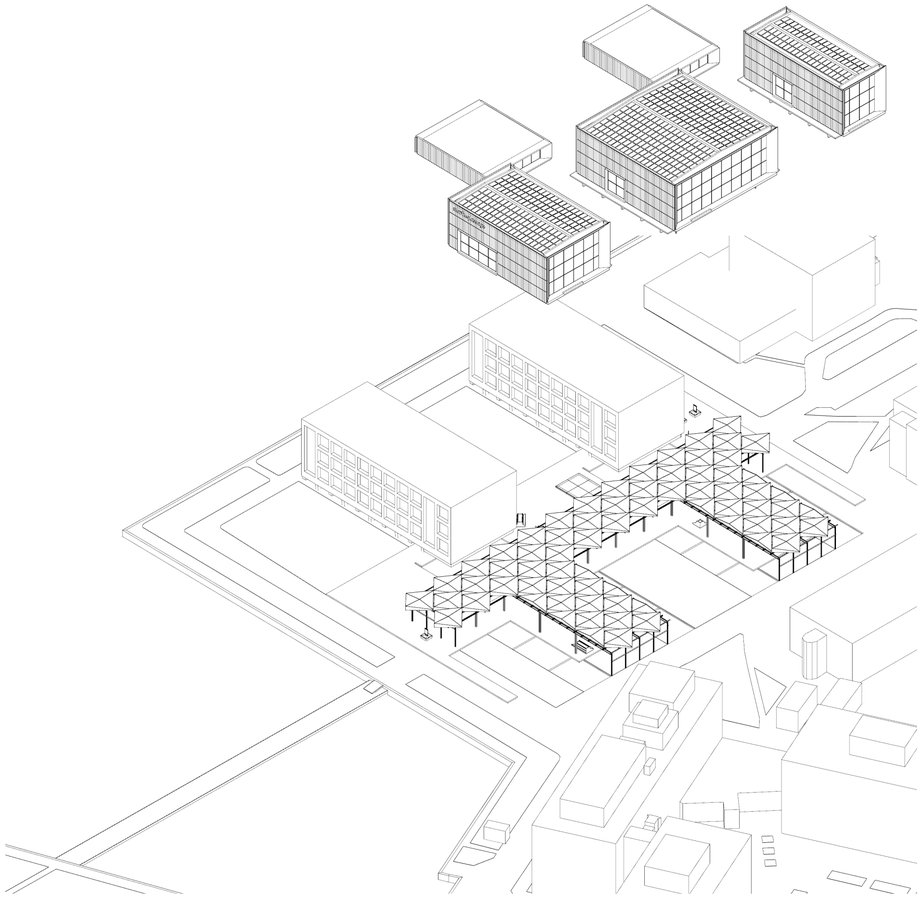


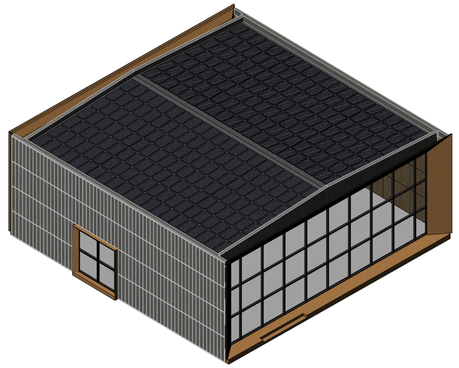


source:
23 Bocken, N.M.P., Pauw, I. de, Bakker, C. & Grinten, B. van (2016), Product design and business model strategies for a circular economy, *Journal of Industrial and Production Engineering* (33, 5)
24 Brand, S. (1994), *How Buildings Learn - What Happens After They're Built*, Viking, New York

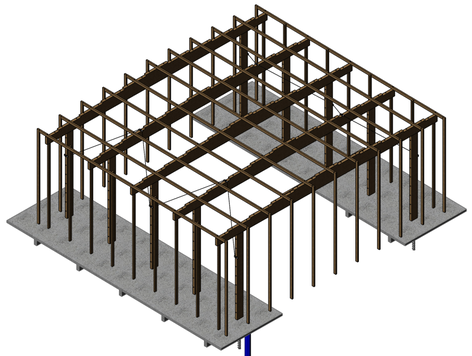
Design

Common Facilities Buildings

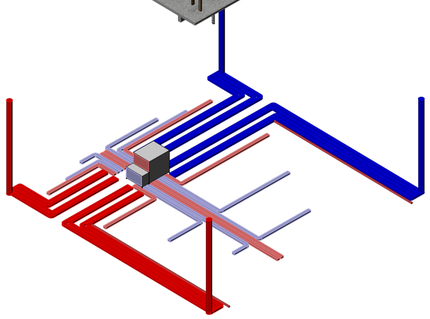




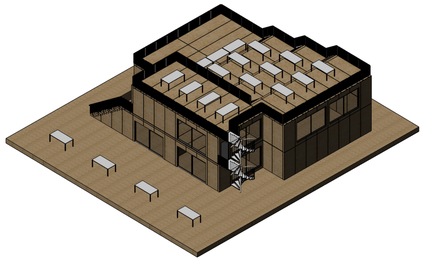
Manufacturer 1 (facade)



Manufacturer 2 (structure)



Manufacturer 3 (installations)

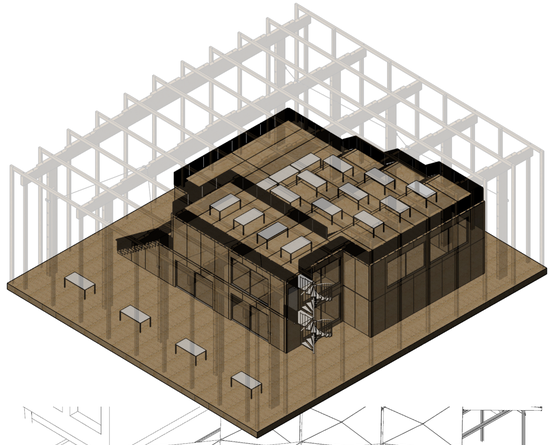


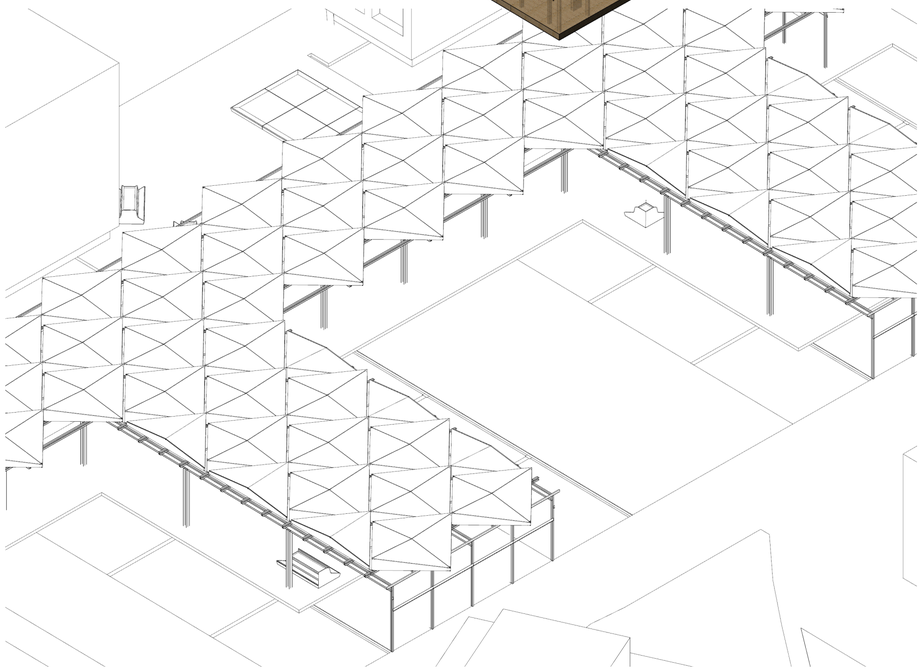
Manufacturer 4 (interior)

Design

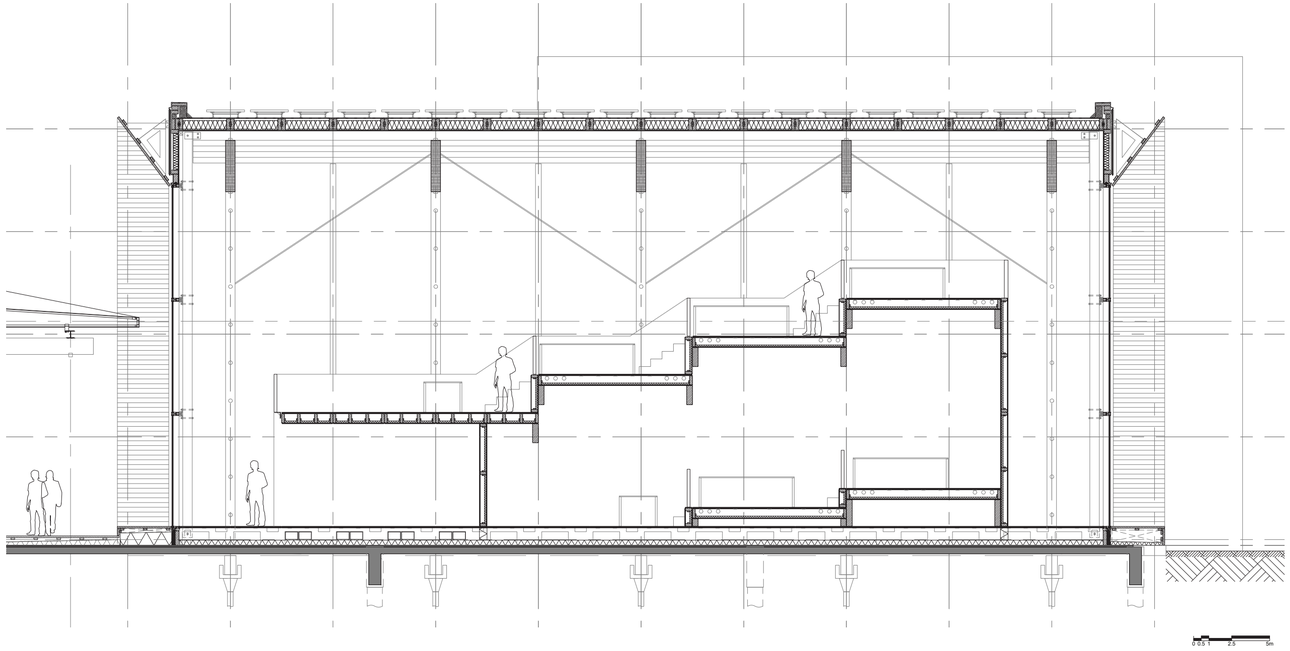
Common Facilities Buildings

Space Plan: Design for Sharing





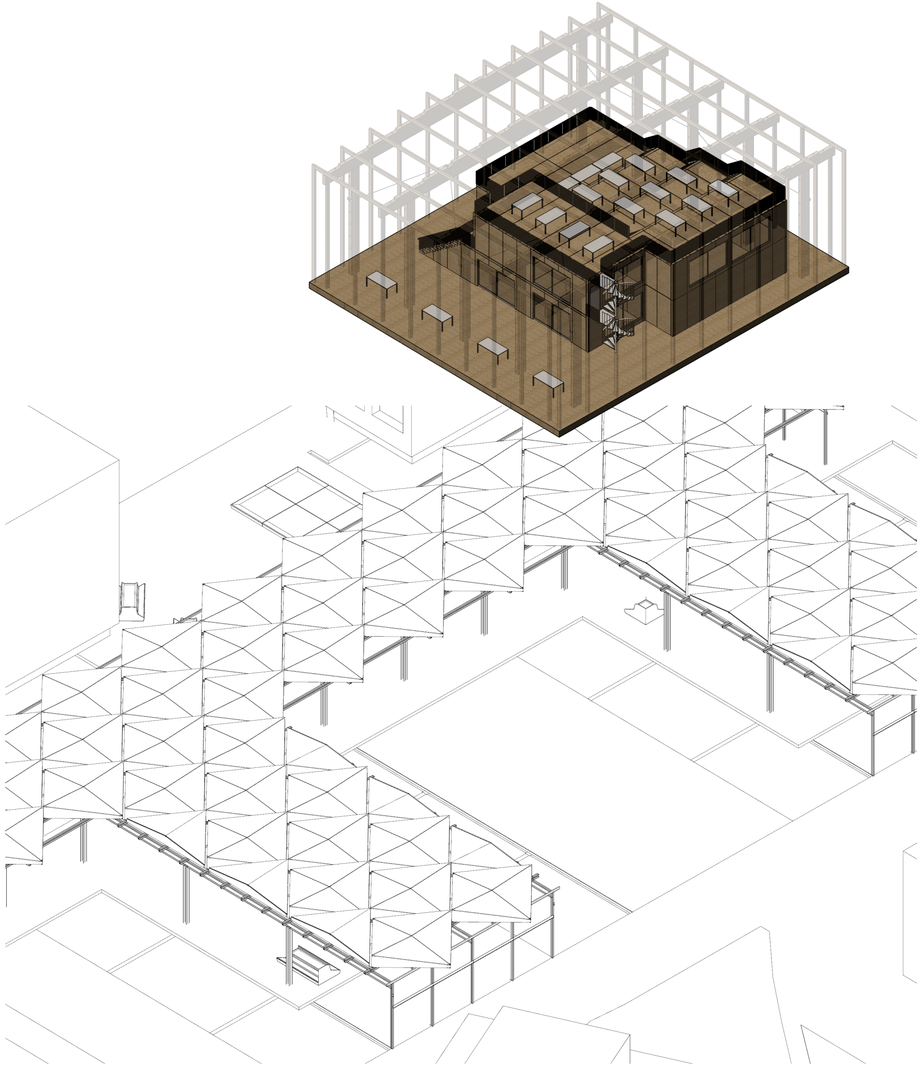
auditorium +
flex work

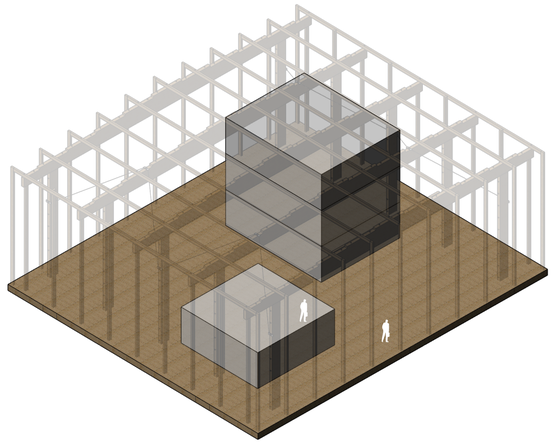


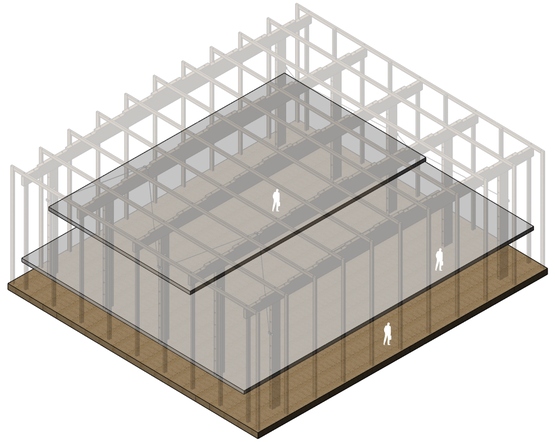
Design

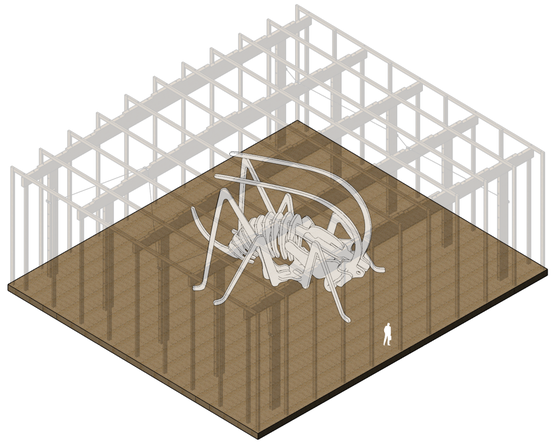
Common Facilities Buildings

Space Plan: Design for Modularity / Adaptability





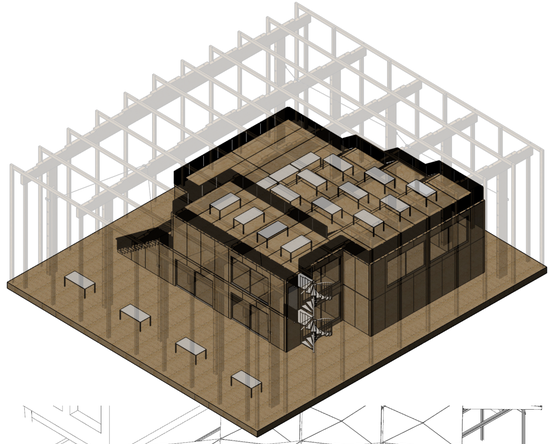


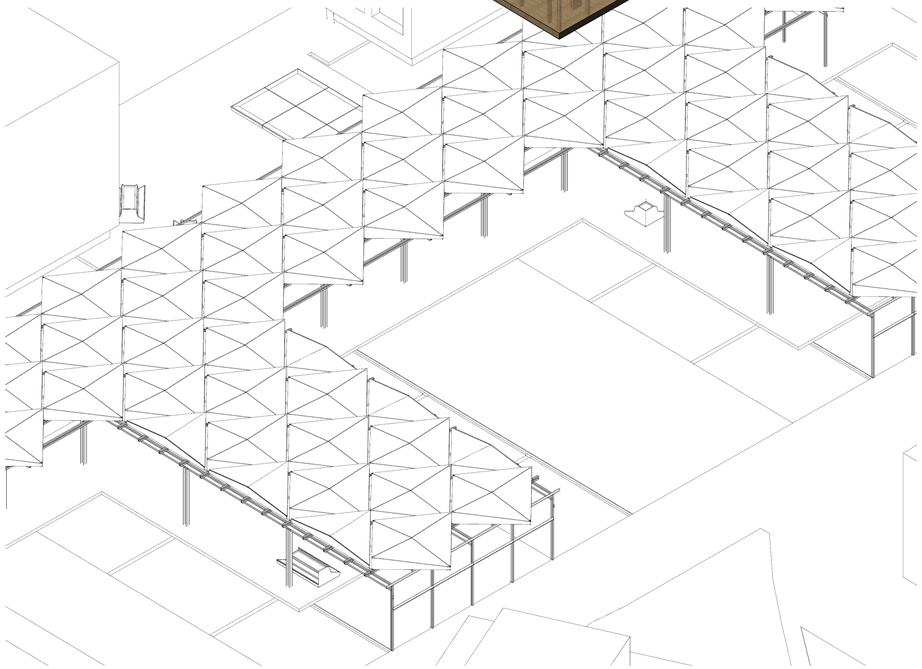


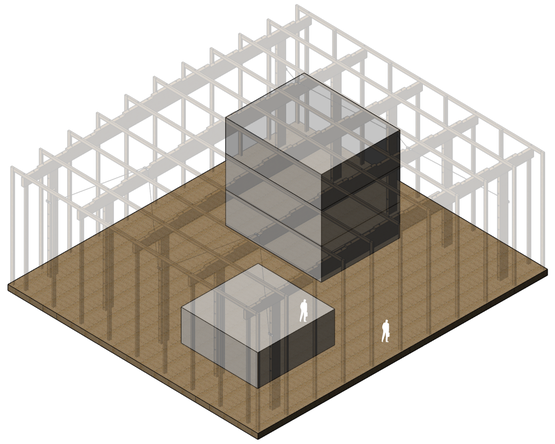
Design

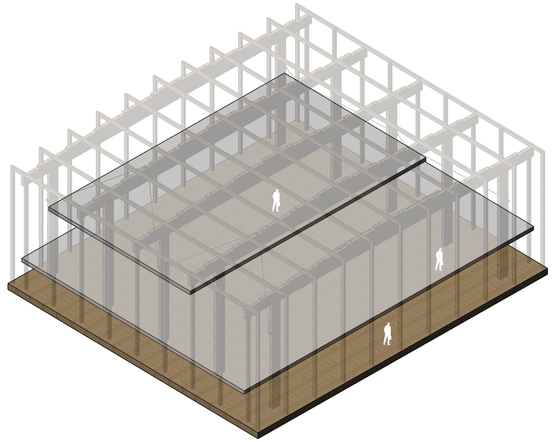
Common Facilities Buildings

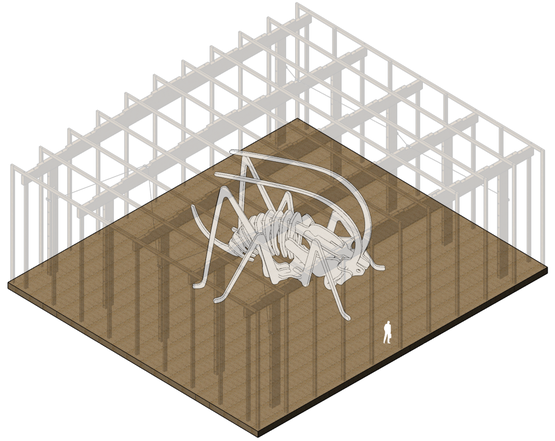
Space Plan: Design for Modularity / Adaptability

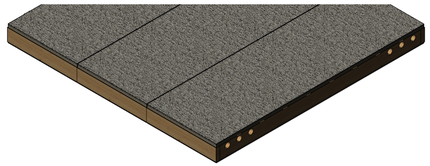


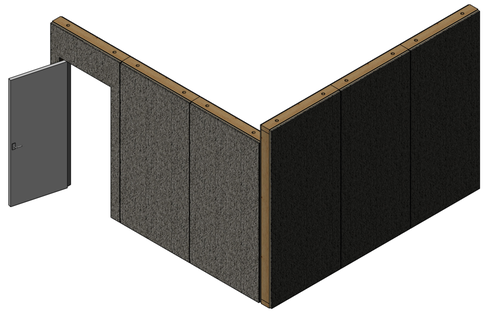


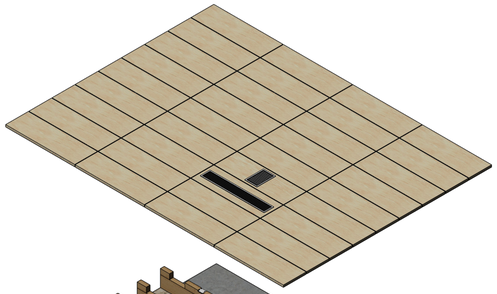


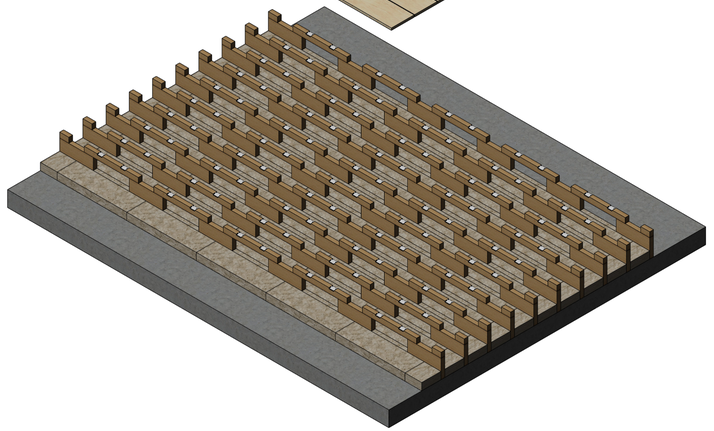










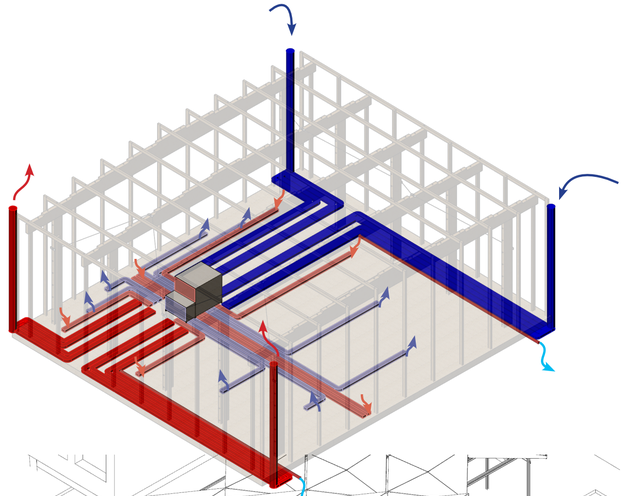


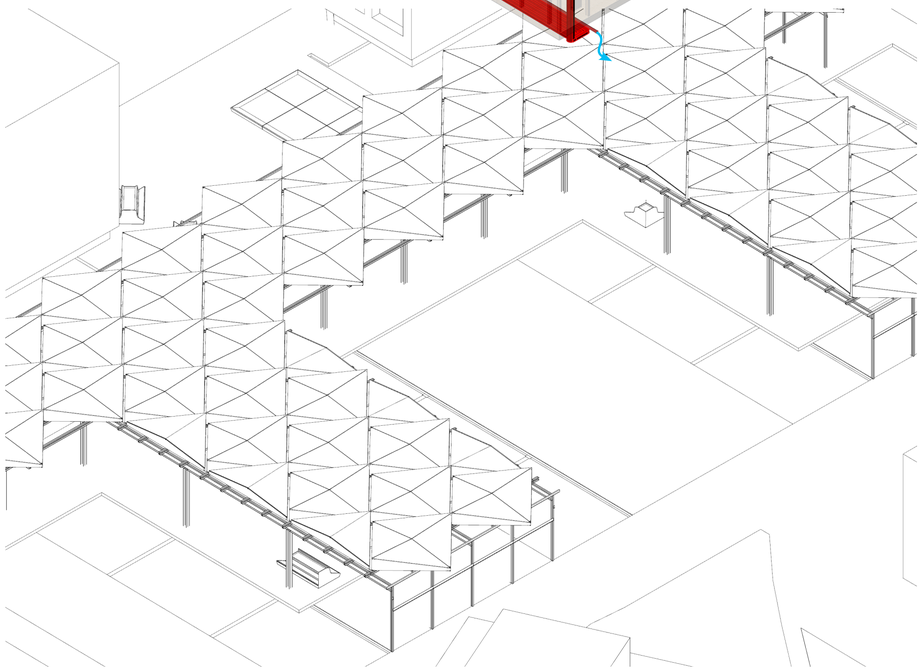
Design

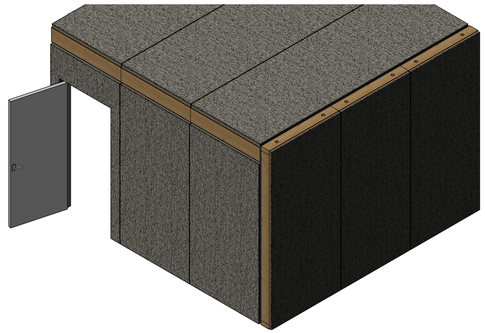
Common Facilities Buildings

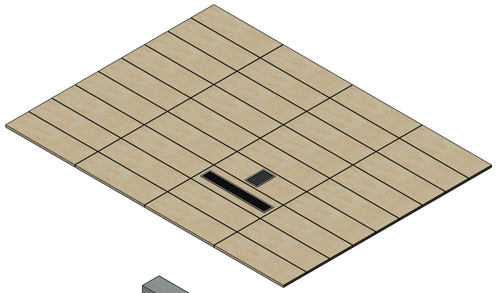
Services:

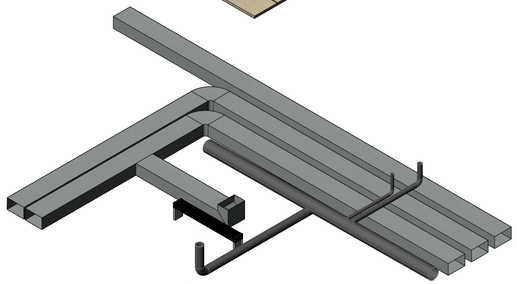
Design for Modularity/Adaptability



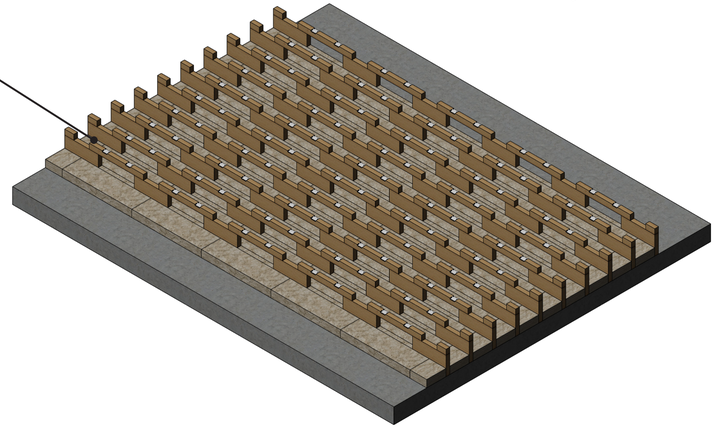








raised floor system (500mm):
220mm existing in situ concrete floor
270mm prefab concrete floorslab patches
460x75mm slotted wooden beams (450mm grid)
130mm hemp insulation boards (Rc=3,5)
440mm air cavity
2x 20mm PureGlue plywood flooring (1350x450mm grid)
aluminium spacers

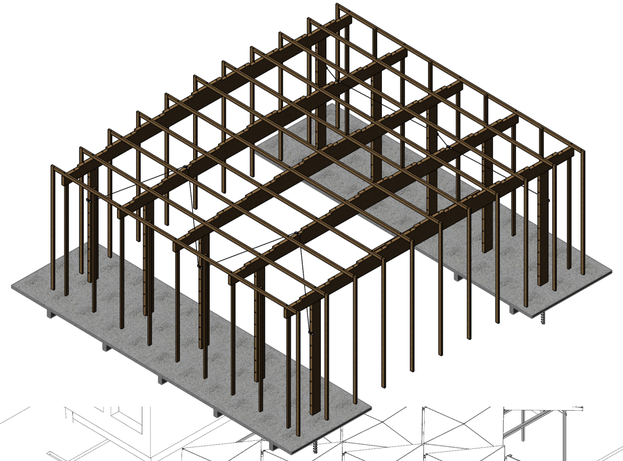


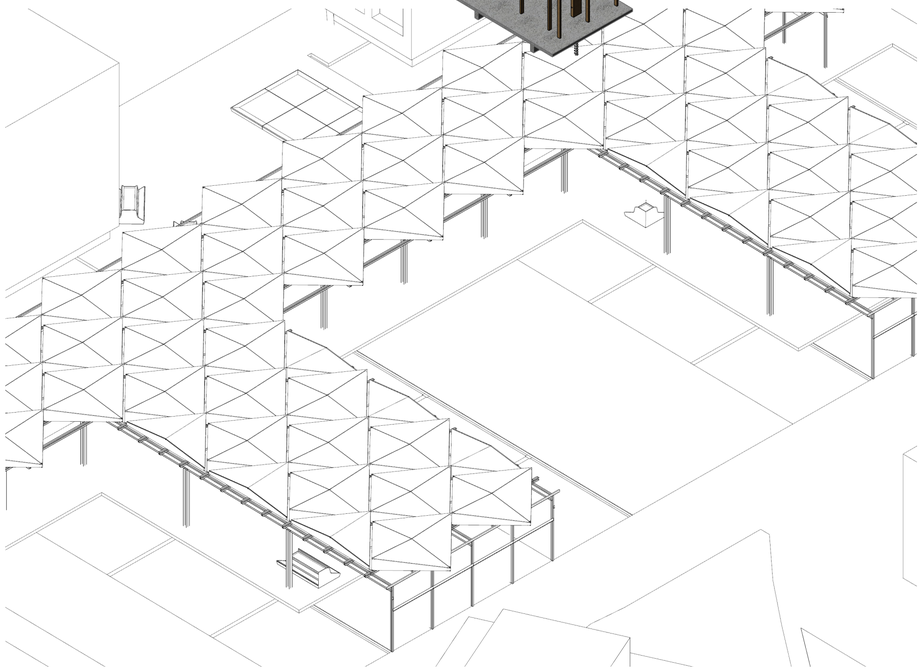
Design

Common Facilities Buildings

Structure:

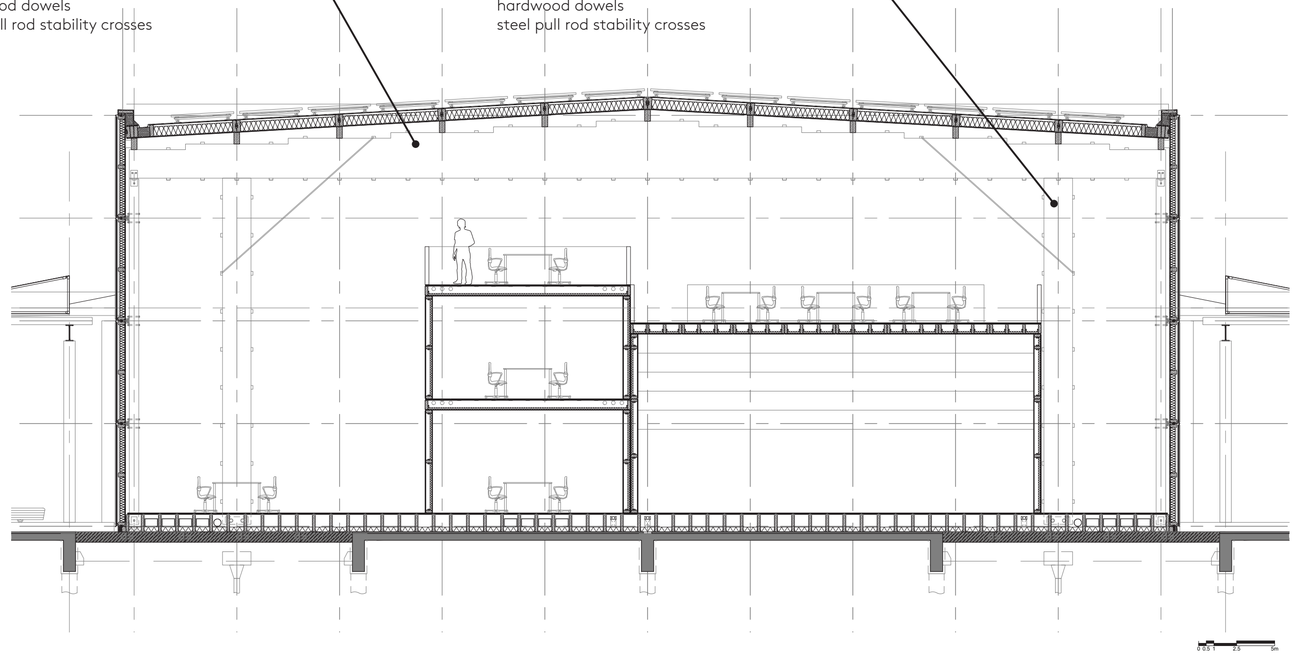
Materials for Recycling Infrastructure / Separability





structural beam (27m; 5400mm grid):
750-1500x250mm dowel laminated timber (DLT)
hardwood dowels
steel pull rod stability crosses

structural column (9m; 5400mm grid):
750x250mm dowel laminated timber (DLT)
hardwood dowels
steel pull rod stability crosses

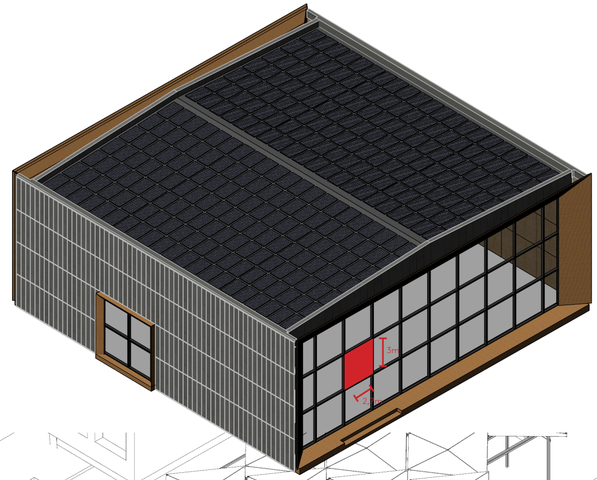


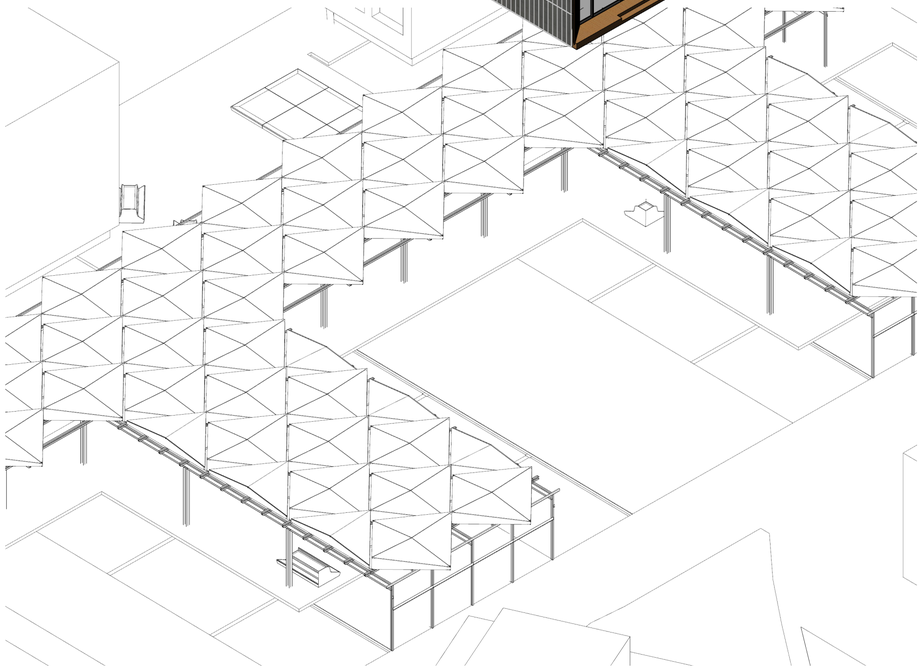
Design

Common Facilities Buildings

Skin:

Design for Standardisation and Compatibility

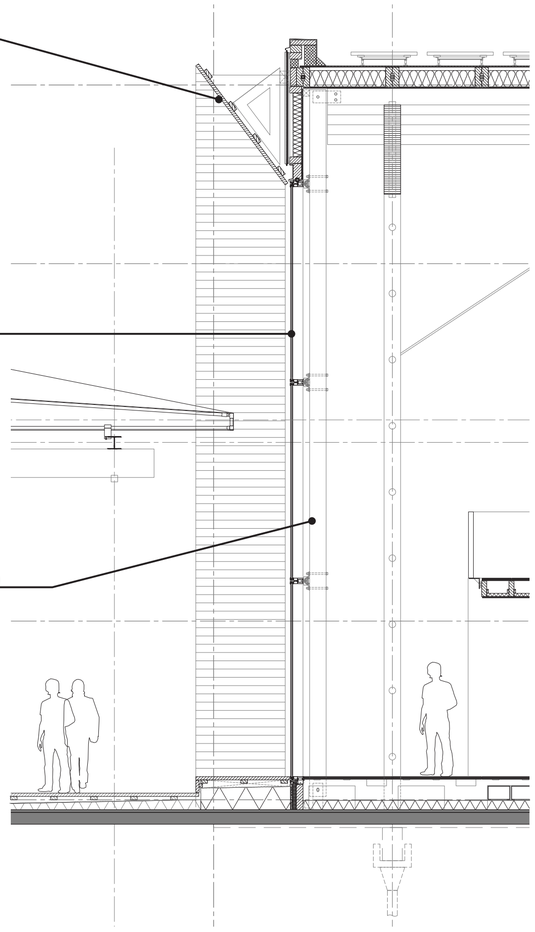


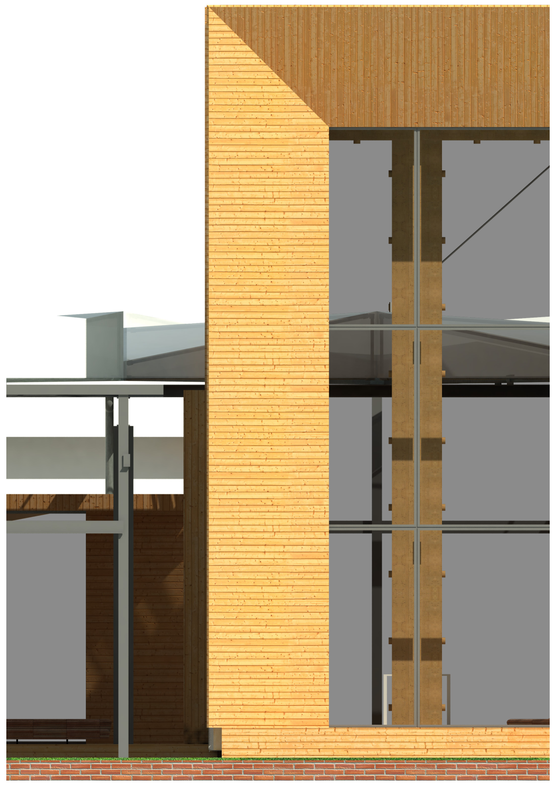


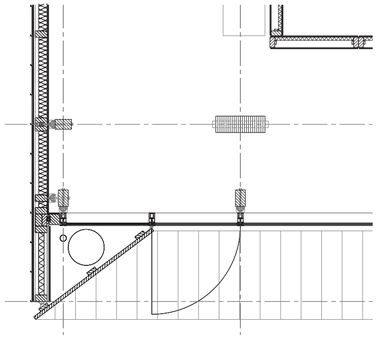
rooftop finish:
50mm ThermoWood timber cladding
50mm ThermoWood slats
stainless steel brackets

curtain wall panels (3000x2700mm):
195x85mm insulated aluminium
mullions
HR++ glazing

suspended facade column (9m; 270mm grid)
300x150 wooden beam
bolted stainless steel facade connections





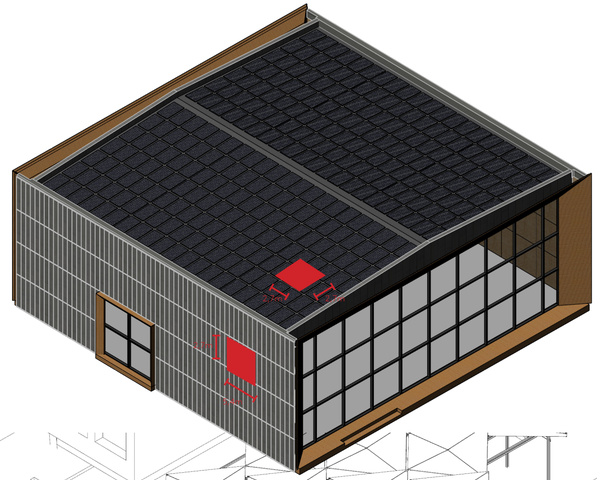


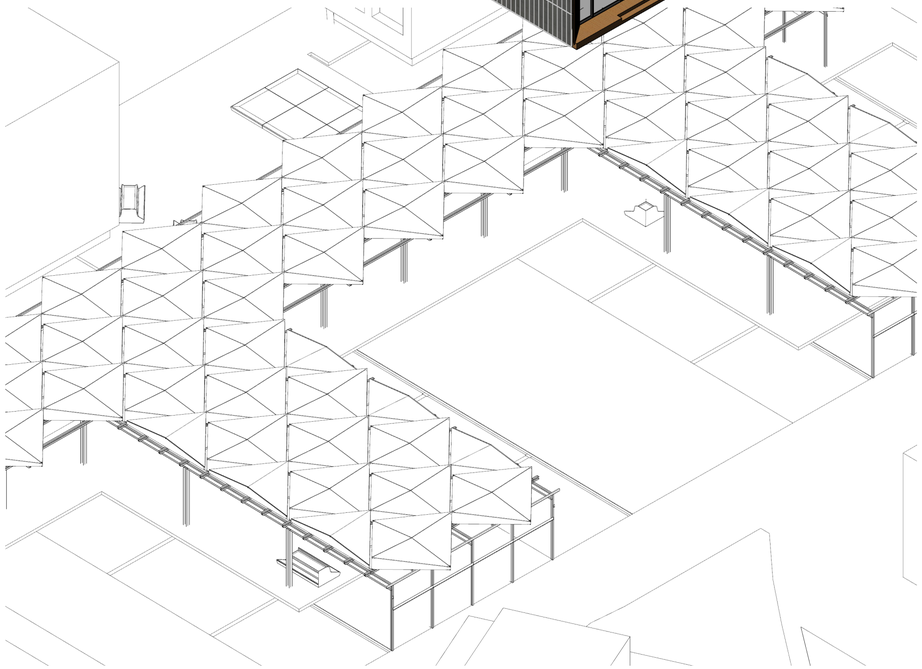
Design

Common Facilities Buildings

Skin:

Design for Standardisation and Compatibility

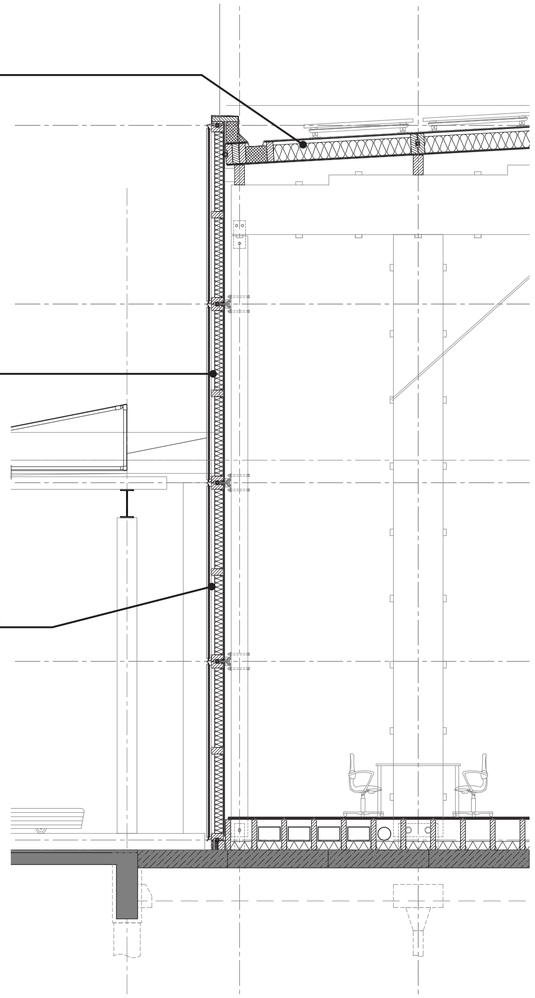




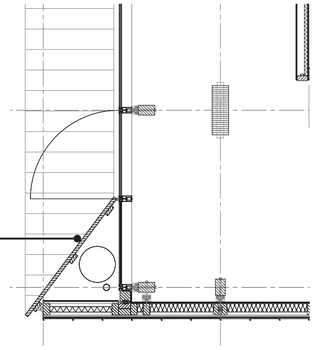
roof component (2700x2700mm):
water barrier
20mm PureGlue plywood
air cavity
water barrier
250mm sheep wool (Rc=6,0)
300x100mm 'vuren' wooden beams
vapour barrier
20mm PureGlue plywood

facade component (5400x2700mm):
0,8mm zinc cladding
20mm PureGlue plywood
air cavity
water barrier
130mm sheep wool (Rc=4,5)
180x100mm 'vuren' wooden beams
vapour barrier
20mm PureGlue plywood

suspended facade column (9m; 270mm grid)
300x150 wooden beam
bolted stainless steel facade connections



facade corner element:
50mm ThermoWood timber cladding
50mm ThermoWood slats
stainless steel hinges



Modelmaking

Modelmaking for Modularity/Adaptability

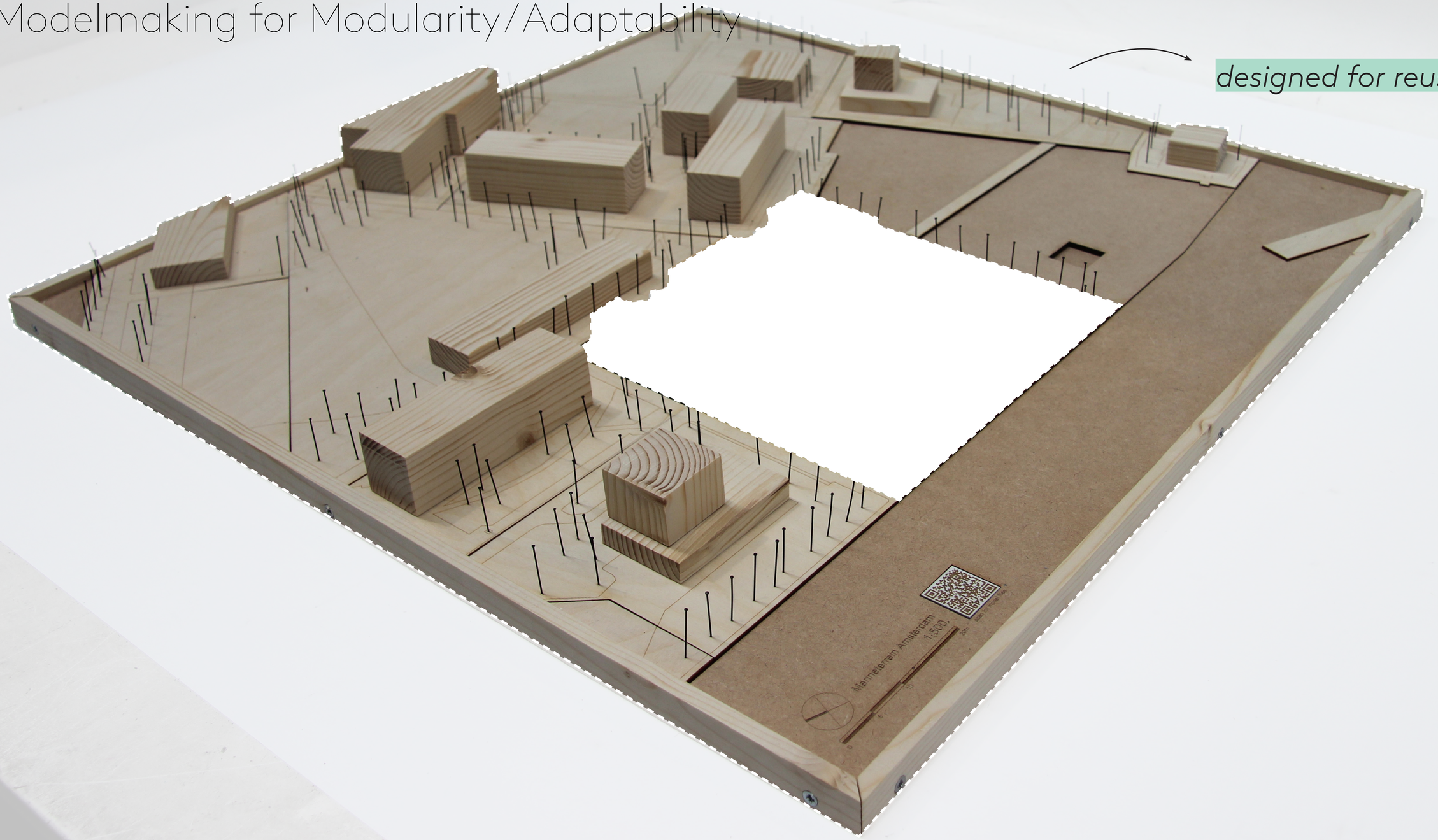
Modelmaking for Recycling Infrastructure

Modelmaking

Modelmaking for Modularity/Adaptability

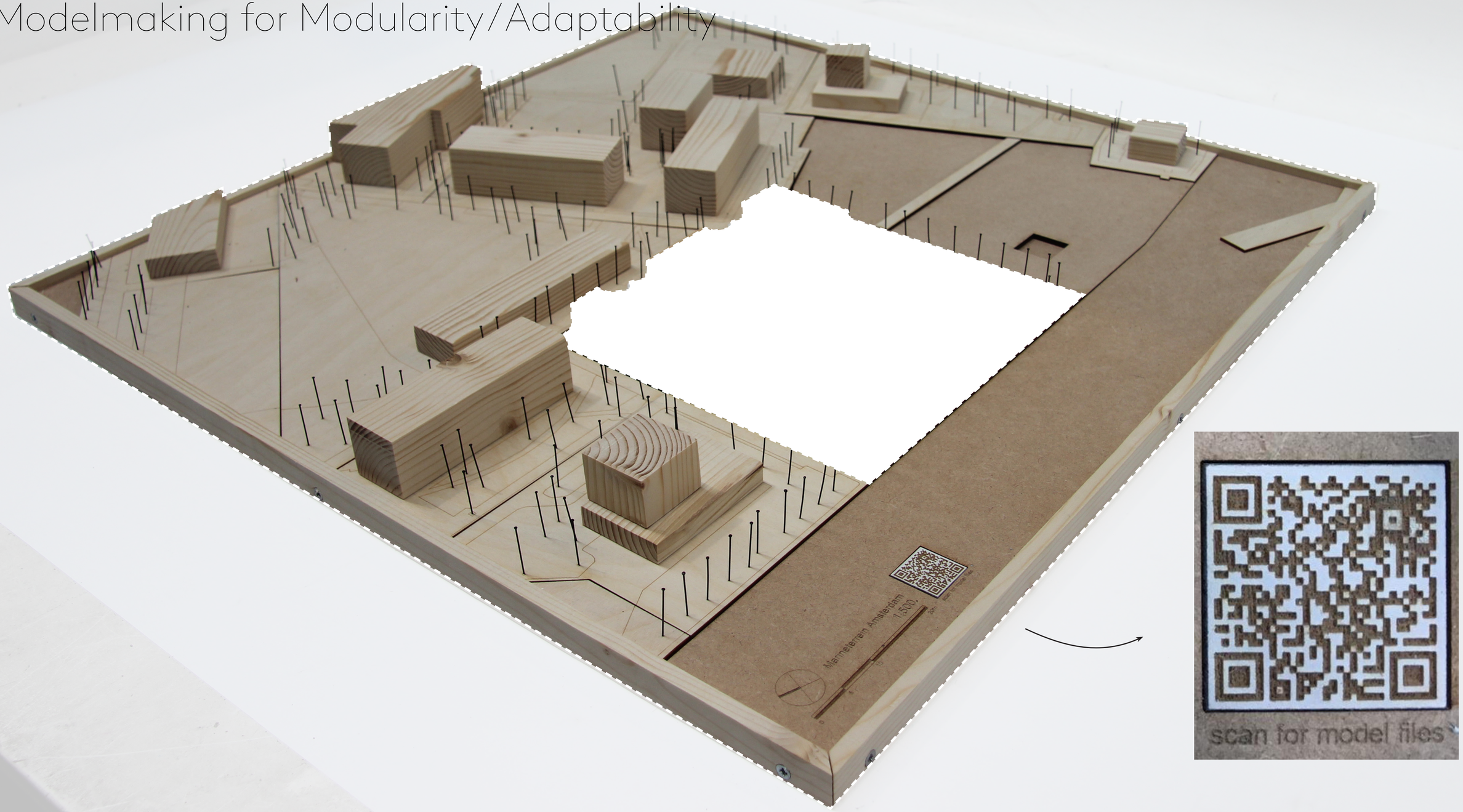
Modelmaking

Modelmaking for Modularity/Adaptability



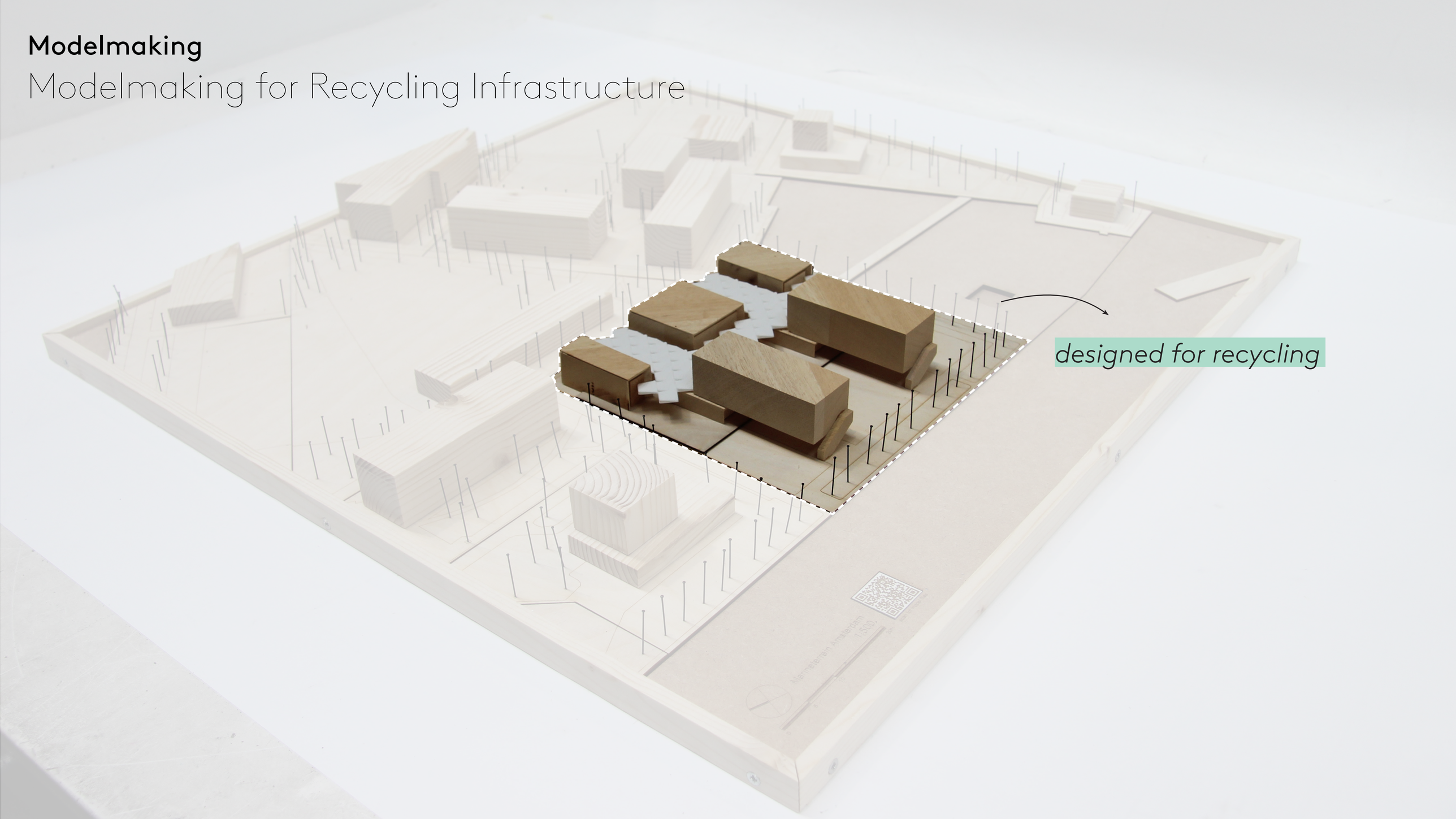
Modelmaking

Modelmaking for Modularity/Adaptability



Modelmaking

Modelmaking for Recycling Infrastructure

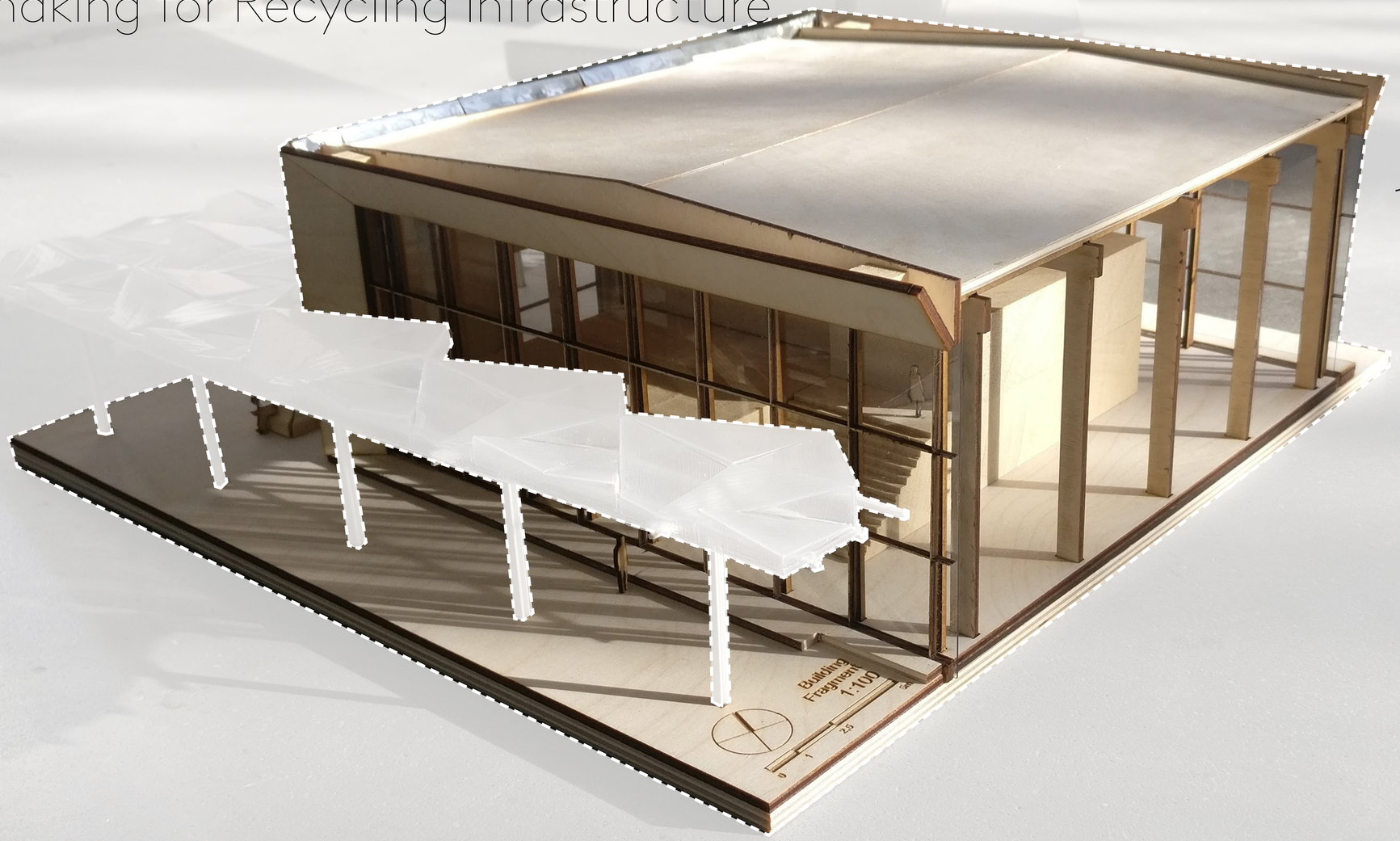


Modelmaking

Modelmaking for Recycling Infrastructure

Modelmaking

Modelmaking for Recycling Infrastructure



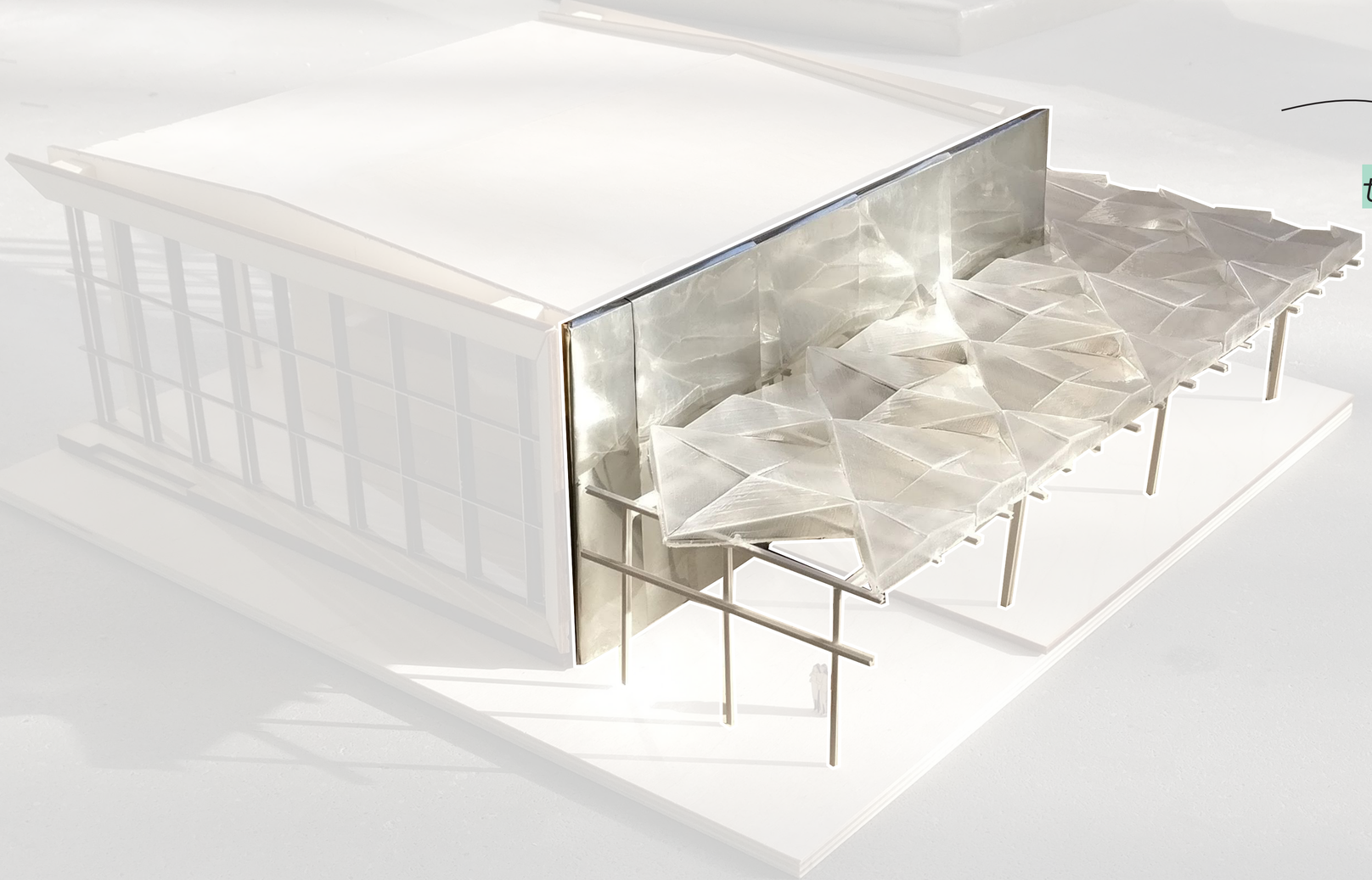
biological materials

Modelmaking

Modelmaking for Recycling Infrastructure

Modelmaking

Modelmaking for Recycling Infrastructure



technical materials

Conclusions and Reflection

Reflection Circular Design by Guidance Tool

Conclusions

Conclusions and Reflection

Reflection Circular Design by Guidance Tool

Graduation design project as a test case for the guidance tool:

Positives:

+ *overview of strategies*
+ *reminder of the essentials*
+ *inspirational*

Improvement:

- *overlap within strategies*
- *lack of definitive selection criteria*
- *limited scale levels*

Conclusions and Reflection

Conclusions

Question:

"Can architects, non-expert to the CE, be stimulated and systematically guided towards circular design using the 'Guidance Tool for Circular Building Design'?"

Conclusions and Reflection

Conclusions

Question:

"Can architects, non-expert to the CE, be stimulated and systematically guided towards circular design using the 'Guidance Tool for Circular Building Design'?"

stimulated:

→ *yes!*

Conclusions and Reflection

Conclusions

Question:

"Can architects, non-expert to the CE, be stimulated and systematically guided towards circular design using the 'Guidance Tool for Circular Building Design'?"

stimulated:

→ *yes!*

systematically guided:

→ *to an extent...*

...additional input required in:

- *future scenario*
- *larger scale levels*

Conclusions and Reflection

Conclusions

Question: *"Can architects, non-expert to the CE, be stimulated and systematically guided towards circular design using the 'Guidance Tool for Circular Building Design'?"*

stimulated:

→ *yes!*

systematically guided:

→ *to an extent...*

...additional input required in:

- *future scenario*
- *larger scale levels*

Advise: *Use the framework for inspiration and as an overview of circular strategies*

Thank you!

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Architectural Engineering Graduation | P5

01-02-2019

Roel van de Pas | architecture tutor
Pieter Stoutjesdijk | research tutor
Engbert van der Zaag | building technology tutor
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