TU Delft | aE Intecture Studio | P2 Presentation
Tutors: ir. A. Snijders & dr. ir. M. Stellingwerf

popUP SUPERstructure

Manuella Borges | 4521463

Content

01
Introduction

02
Research

03
Design

04
Next Steps

Content

01
Introduction
- Fascination
- Temporary Architecture
- Design Goal
- Design Question
- Thechnical Question

02
Research
- Methodology
- Problem statement
- Materials
- Sizes
- Connections
- Research x Design

03
Design
- Context
- Project Phasing
- Program
- Possible Locations
- Vision

04
Next Steps
- Strategy
- Planning
- Questions

01 Introduction | Fascination

In nature...

Keukenhof, the Netherlands

Images: online source

01 Introduction | Fascination

In architecture...

Modern Pentathlon Park, Toronto

Images: by author

Some causes that drive temporary architecture

Cause:	Natural Disaster	Large scale International Events	
Purpose:	Shelter	Expo, Exhibit	Games, Concerts
Typology:	Housing	Folly, Pavillion →	Arena

Types of temporary architecture

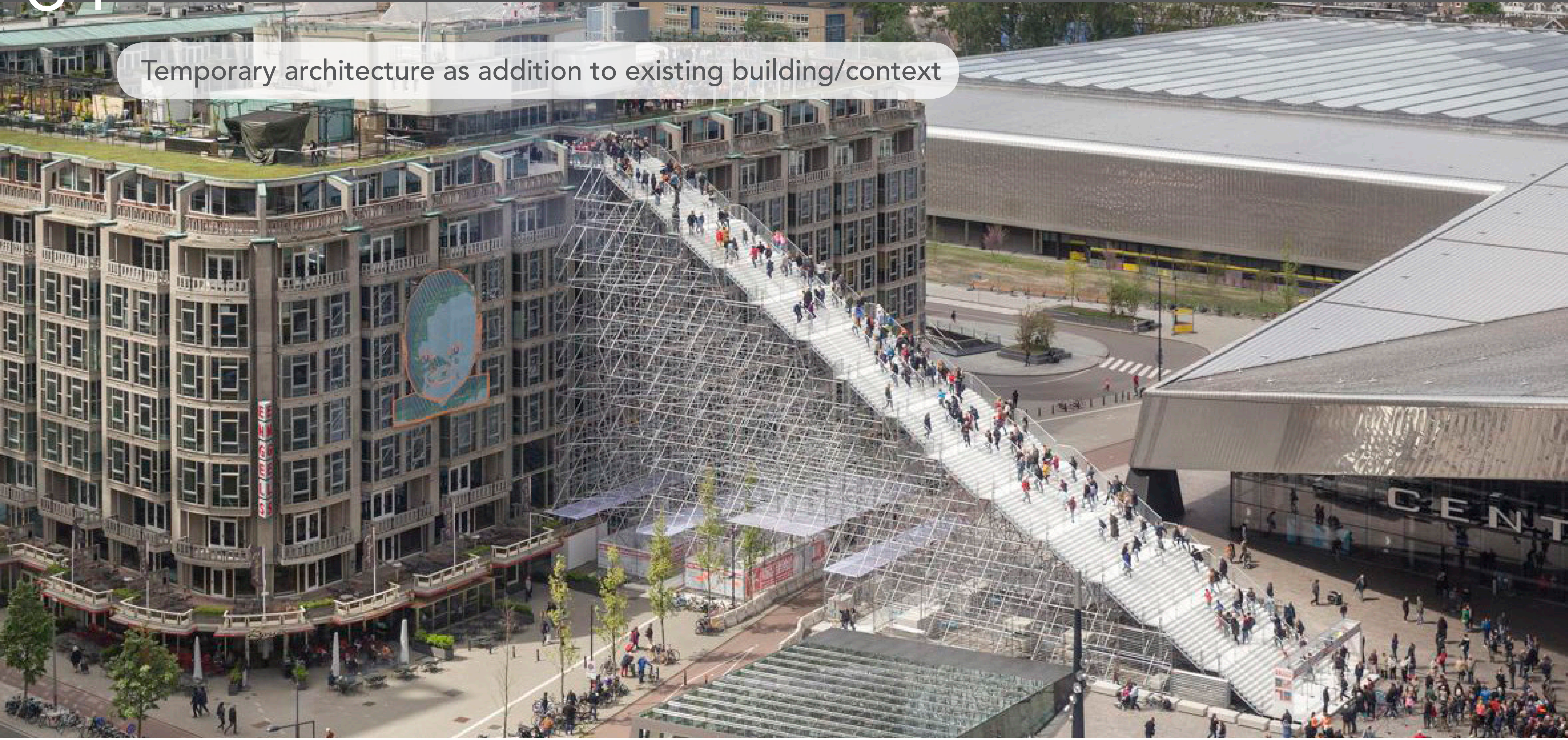
According to Robert Kronenburg, mobile and temporary building systems can be divided into three specific types:

1) Portable buildings

2) Relocatable buildings

3) Demountable buildings

Temporary architecture as addition to existing building/context



The stairs to Kriterion by MVRDV, Rotterdam
Images: online source

Temporary architecture as building

London 2012 Basketball Arena by Sinclair Knight Merz

Images: online source

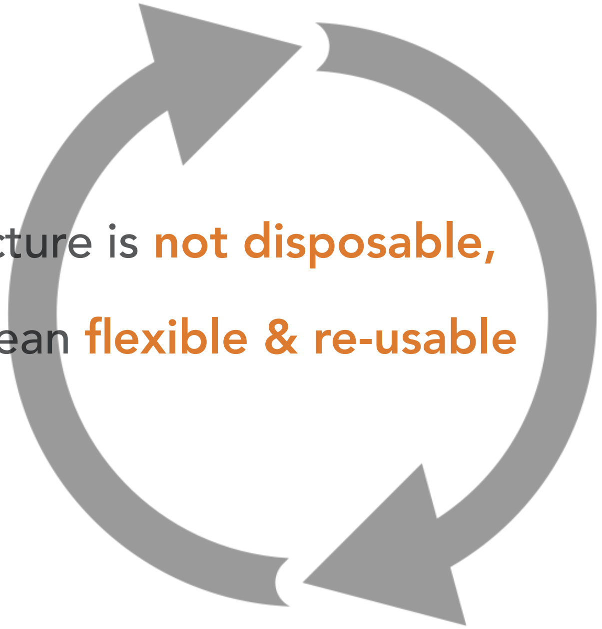
01 **Introduction** | Design Goal

> *"However, portable (moveable) buildings, though temporary in location, are not temporary in use. Their portability is precisely what makes them not disposable. The fact that they can be re-used means that they can represent an efficient use of materials and resources, and should therefore be designed with care. They are high-quality products tuned to a specific need if not a specific location."*

Kronenburg, Robert. Architecture in Motion. : Taylor and Francis, 2013. ProQuest Ebook Central. Web. 24 October 2016.

Design Goal: Folly/ Pavillion → Arena

FLEXIBILITY



Temporary architecture is **not disposable,**

but rather it can mean **flexible & re-usable**

Overall Design Question

How can temporary architecture for large scale international events be designed to be easily assembled and disassembled in order to adapt to different programmatic needs and project scales, or re-used in a different setting when its temporary need has ceased to exist?

01 Introduction | Technical Question

Main Thematic Research Question

Which technologies and techniques will allow for the creation of eco-friendly temporary and flexible architecture?

Sub-questions

- What materials will be most suitable for the creation of lightweight and demountable structures that have low environmental impact?
- What would be the optimal sizes for ease of handling and transportation?
- What assembly/disassembly methods and connections will be most suitable?

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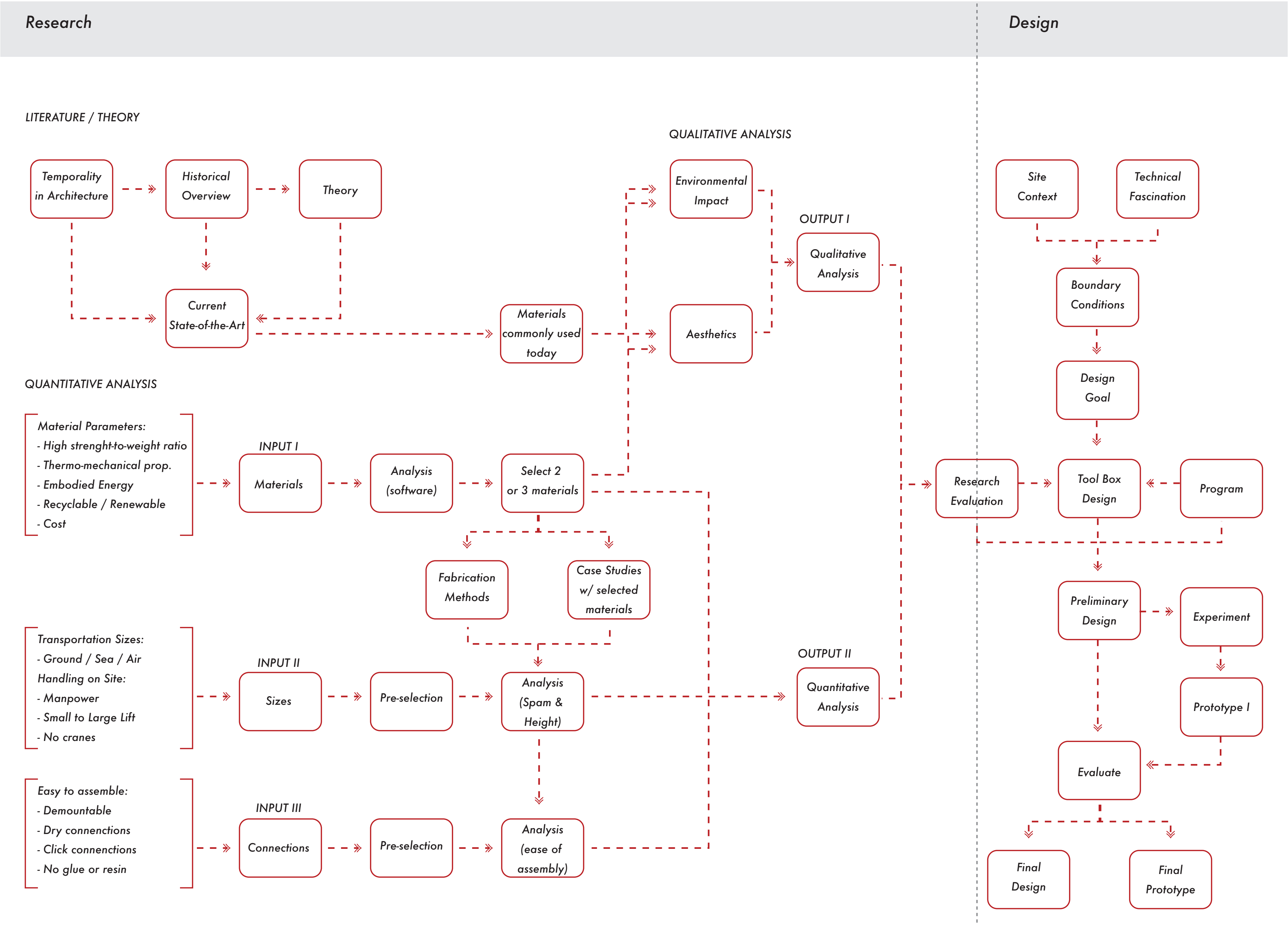
02 Research | Methodology



Research

Design

LITERATURE / THEORY

Temporality in Architecture

Historical Overview

Theory

Current State-of-the-Art

Materials commonly used today

QUALITATIVE ANALYSIS

Environmental Impact

Aesthetics

OUTPUT I

Qualitative Analysis

QUANTITATIVE ANALYSIS

Material Parameters:
- *High strenght-to-weight ratio*
- *Thermo-mechanical prop.*
- *Embodied Energy*
- *Recyclable / Renewable*
- *Cost*

INPUT I

Materials

Analysis (software)

Select 2 or 3 materials

Fabrication Methods

Case Studies w/ selected materials

Transportation Sizes:
- *Ground / Sea / Air*

Handling on Site:
- *Manpower*
- *Small to Large Lift*
- *No cranes*

INPUT II

Sizes

Pre-selection

Analysis (Spam & Height)

OUTPUT II

Quantitative Analysis

Easy to assemble:
- *Demountable*
- *Dry connections*
- *Click connections*
- *No glue or resin*

INPUT III

Connections

Pre-selection

Analysis (ease of assembly)

Site Context

Technical Fascination

Boundary Conditions

Design Goal

Research Evaluation

Tool Box Design

Program

Preliminary Design

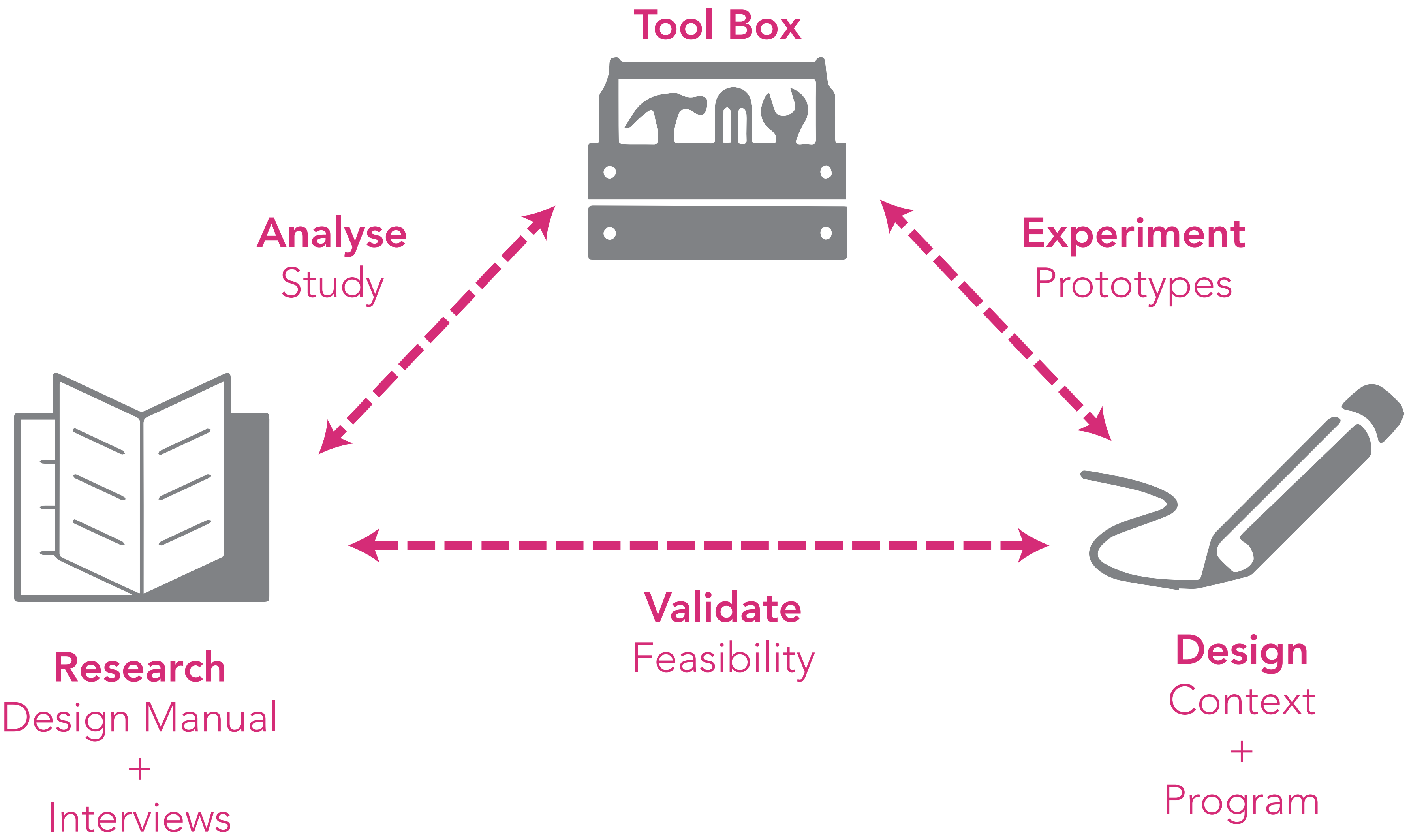
Experiment

Prototype I

Evaluate

Final Design

Final Prototype



Tool Box

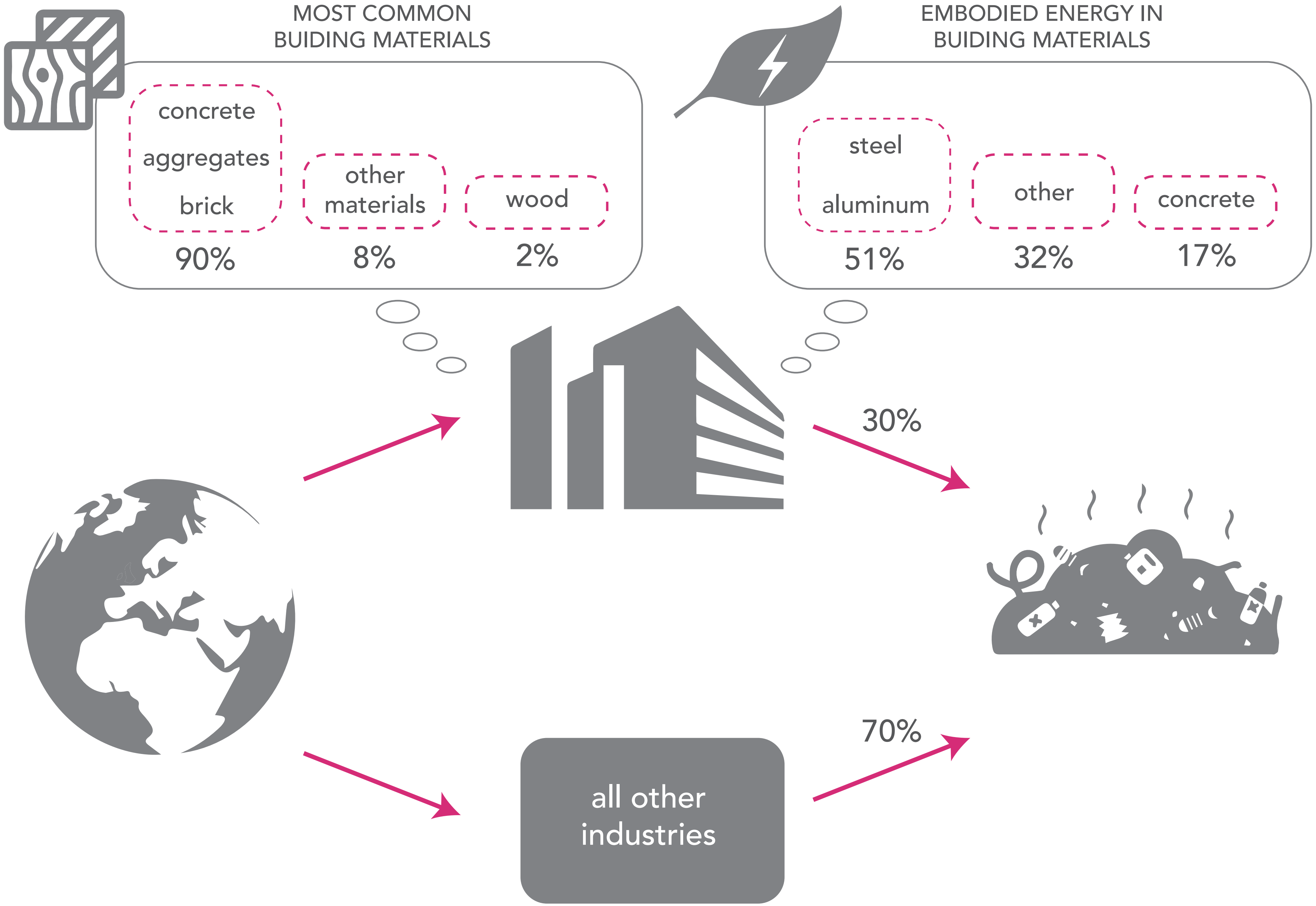
Analyse
Study

Experiment
Prototypes

Research
Design Manual
+
Interviews

Validate
Feasibility

Design
Context
+
Program



MOST COMMON
BUIDING MATERIALS

concrete aggregates brick	other materials	wood
90%	8%	2%

EMBODIED ENERGY IN
BUIDING MATERIALS

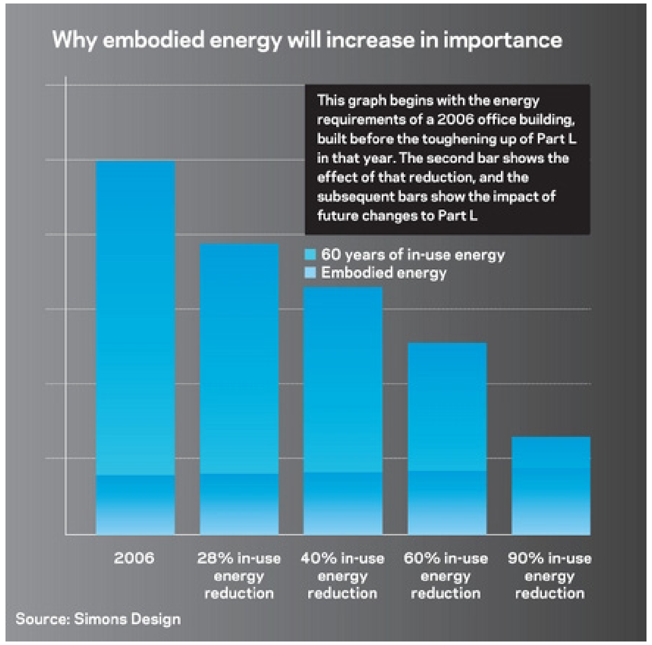
steel aluminum	other	concrete
51%	32%	17%

30%

all other industries

70%

Embodied Energy of Materials as a Rising Issue



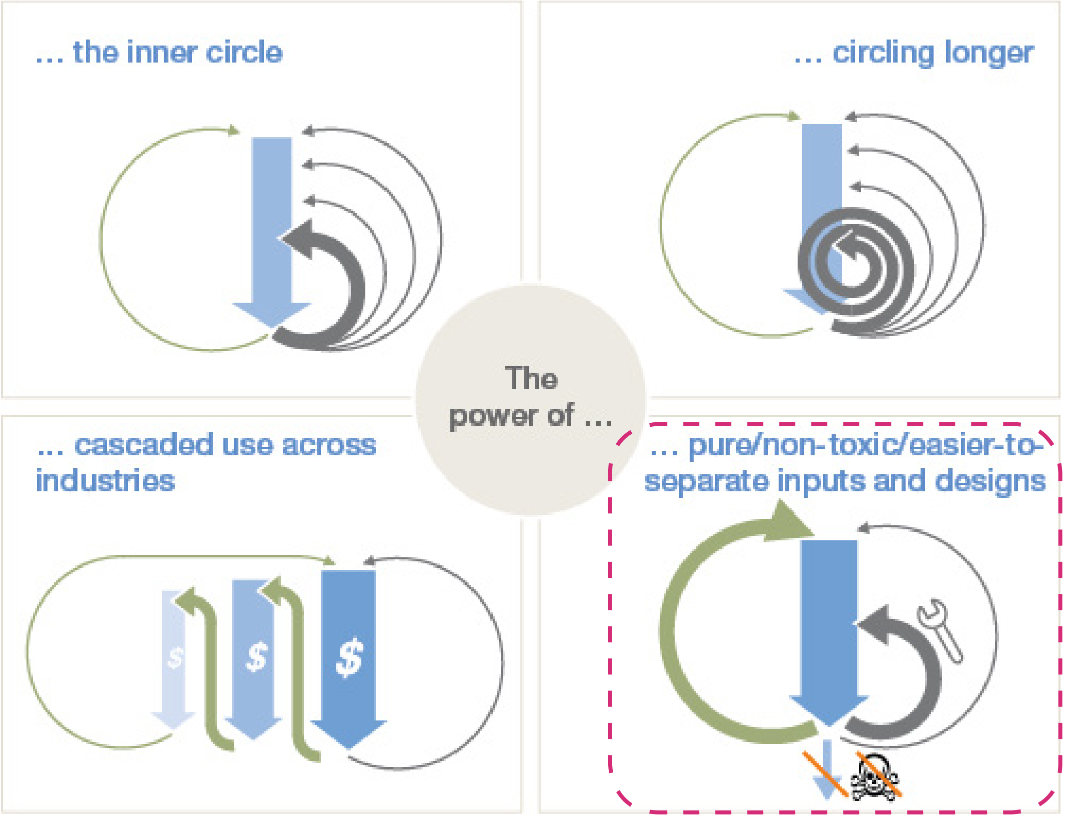
This graph begins with the energy requirements of a 2006 office building, built before the toughening up of Part L in that year. The second bar shows the effect of that reduction, and the subsequent bars show the impact of future changes to Part L

Source: Simons Design

Embodied Energy Analysis.

Source: http://www.bdonline.co.uk/

The Pure Cicle as the Key for Material Re-use & Less Embodied Energy



Design for Disassembly

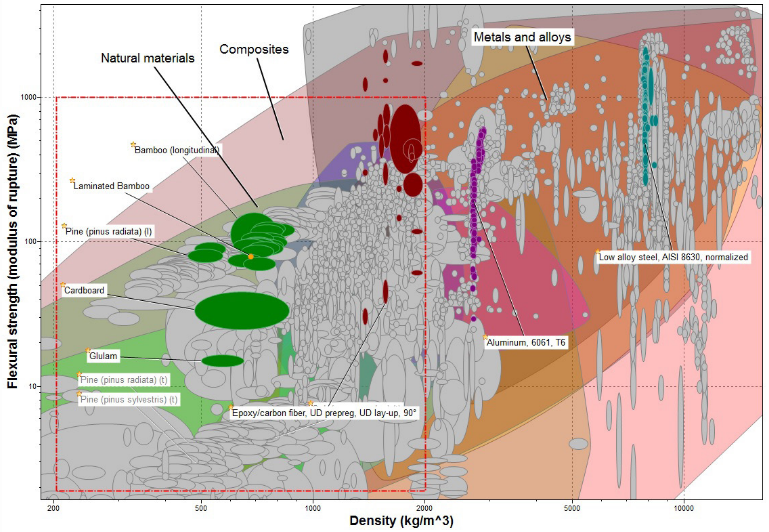
Modular

Lightweight

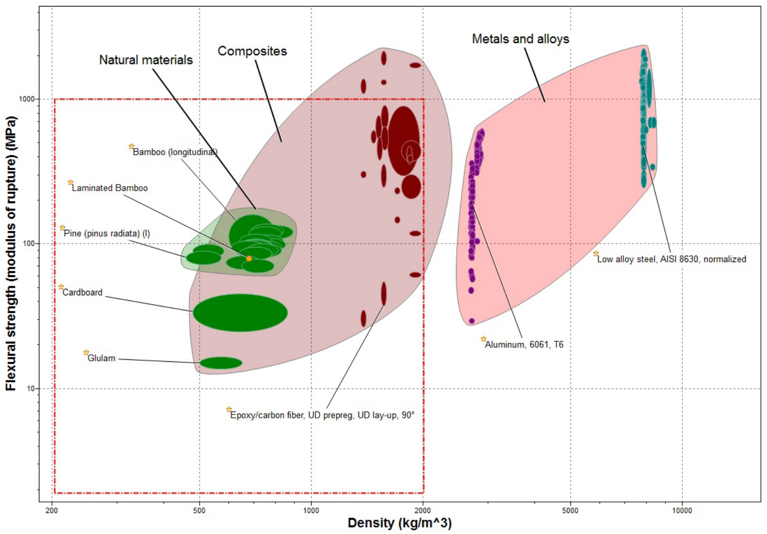
Temporary

Four Principles for Circular Economy

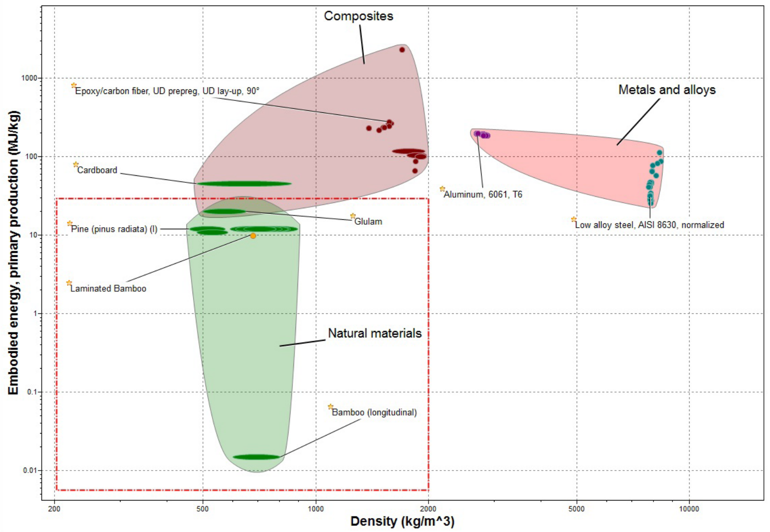
Source: Ellen MacArthur Foundation



Material Universe before boundary conditions
Source: CES Edupack (author’s analysis)



Density x Flexural Strength boundary conditions
Source: CES Edupack (author’s analysis)



Density x Embodied energy boundary conditions
Source: CES Edupack (author’s analysis)

02 Research | Materials

CATEGORY 1: METALS & ALLOYS

CATEGORY 2: COMPOSITES

CATEGORY 3: NATURAL MATERIALS

CATEGORY 4: ENGINEERED MATERIALS

Materials Pre-Selection Choice

Most Used Materials	Alternative Materials
1) Metals & Alloys - Steel (AISI 8630) - Aluminum (Al 6061)	**2) Composites** - Fiber Reinforced Composite (EP-CF70) - Cardboard (CES Edupack standard)
	3) Natural Materials - Wood (Radiata Pine) - Bamboo (CES Edupack standard)
	4) Engineered Materials - Laminated Wood (acetylated Radiata Pine) - Laminated Bamboo (Moso)

Criteria I

Material Performance
Density (kg/m3)
Flexural Strength - MoR (Mpa)
Strength-to-weight ratio (MoR/density)
Young's Modulus – MoE (GPa)
Compressive Strength (Mpa)
Tensile Strength (Mpa)
Thermal Conductivity (W/m.oC)

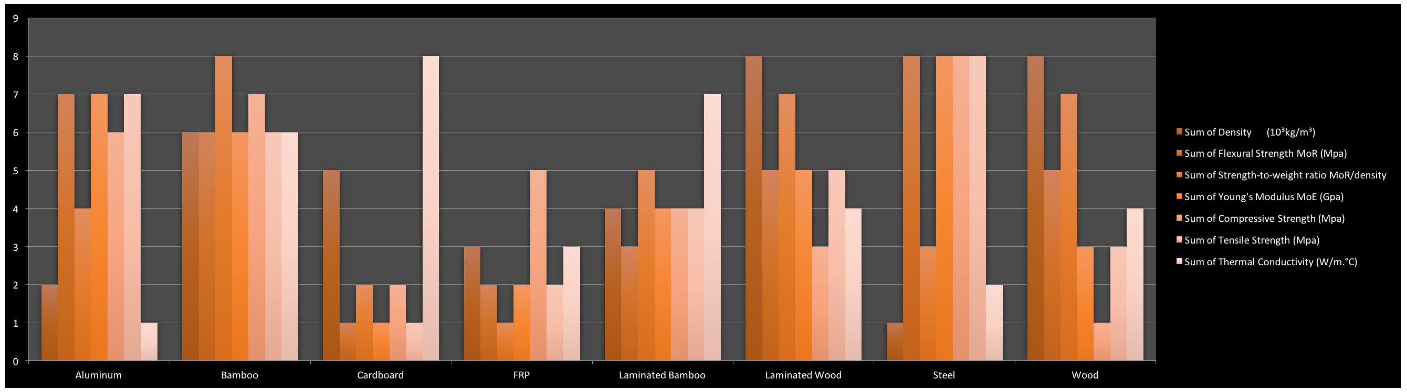
Criteria II

Material Health
Embodied Energy (MJ/kg)
CO2 footprint (kg/kg)
Water Usage (l/kg)
Recycle fraction current supply (%)
Combust for Energy Recovery (yes/no)
Biodegradable (yes/no)
Renewable Content (%)

Criteria III

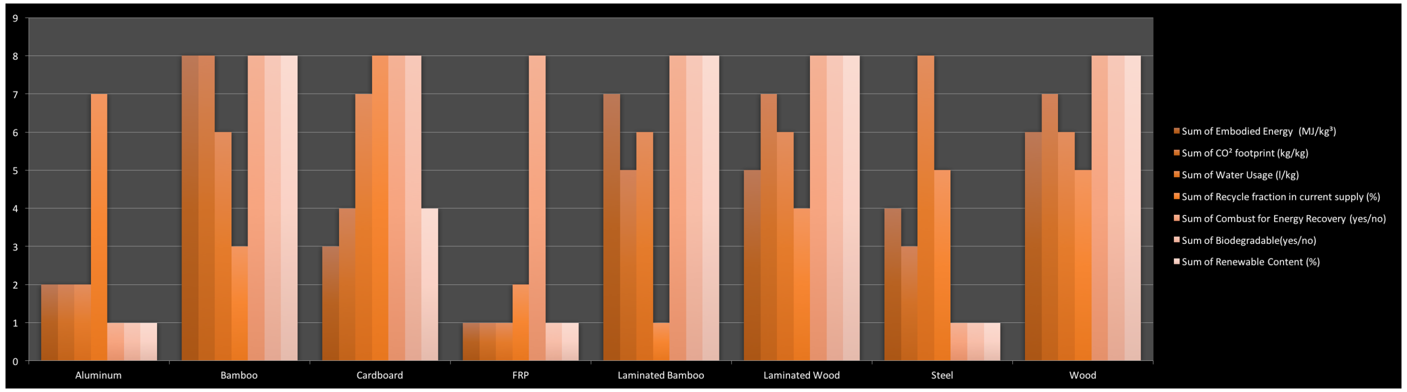
Cost

Criteria I: Material Performance



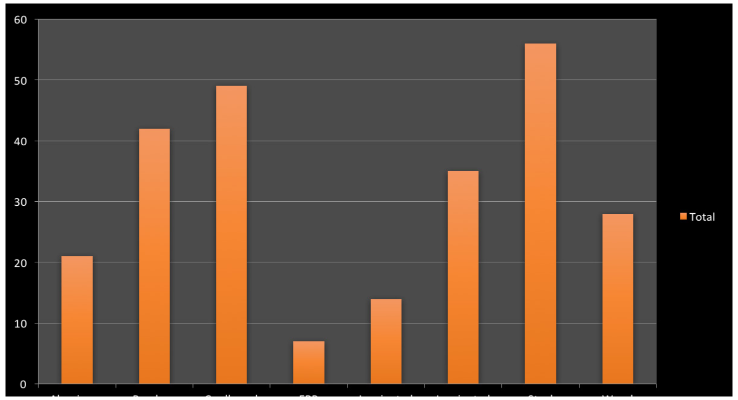
by author

Criteria II: Material Health



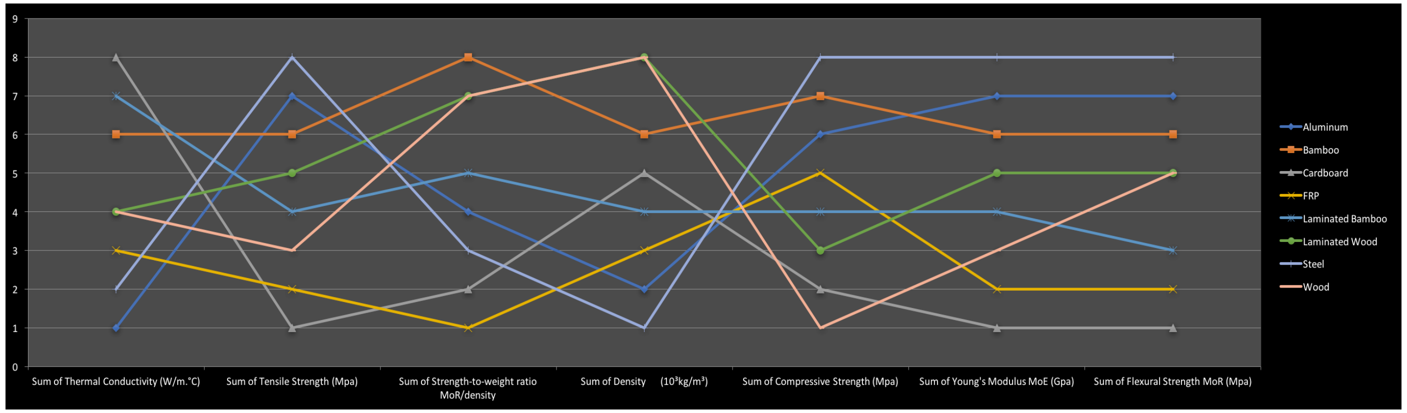
by author

Criteria III: Cost



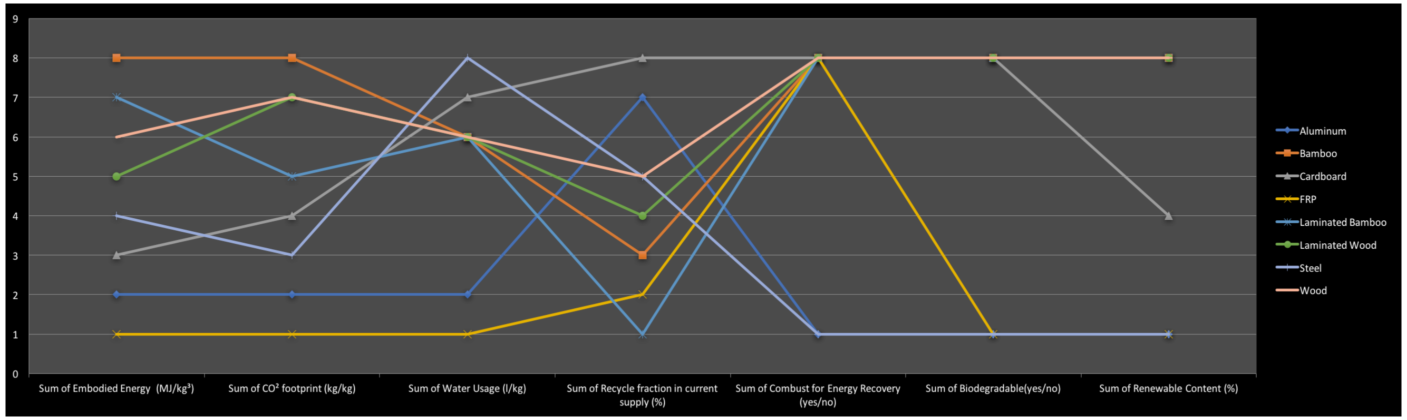
by author

Criteria I: Material Performance



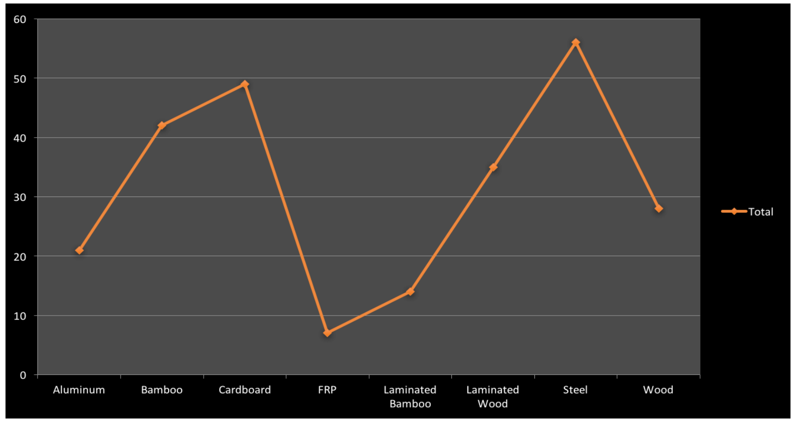
by author

Criteria II: Material Health



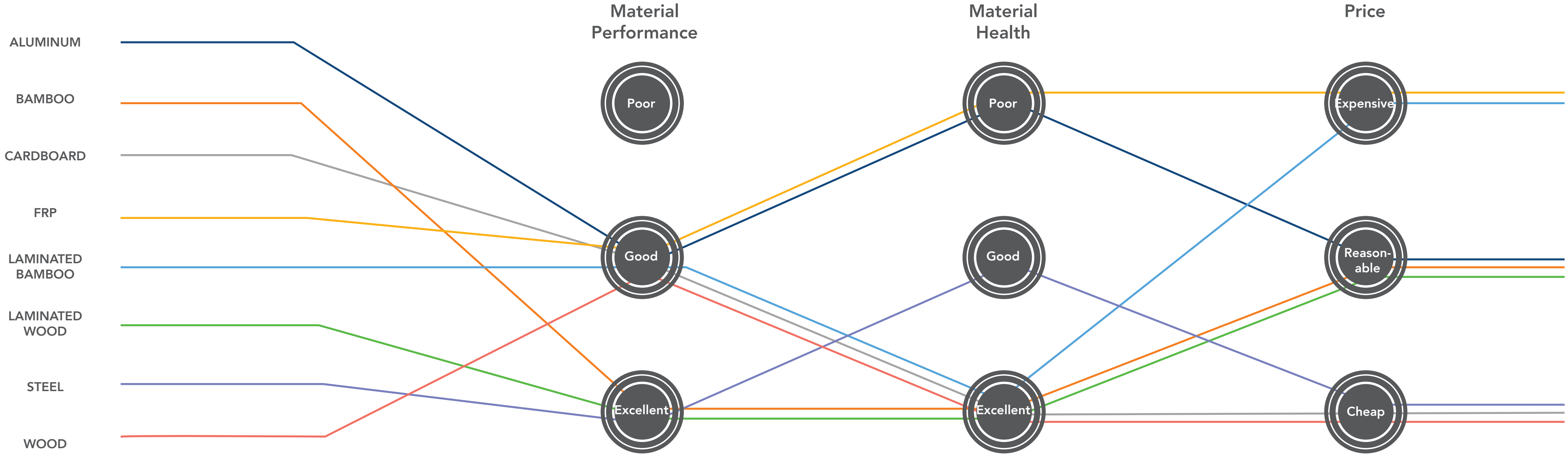
by author

Criteria III: Cost



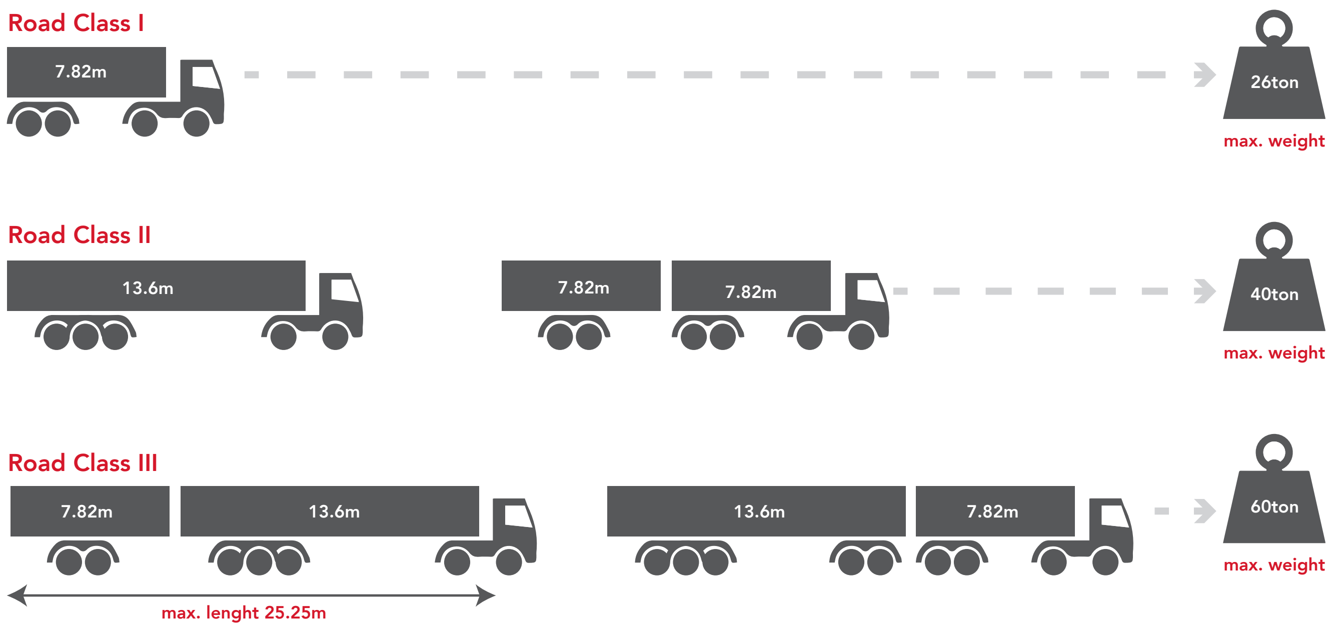
by author

Final results per material & possible scenarios



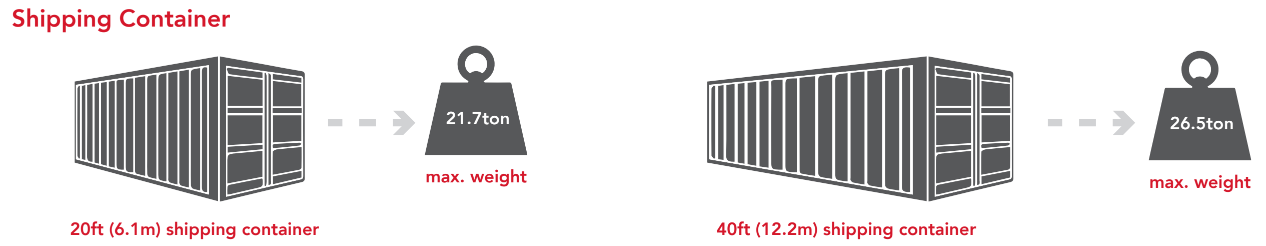
Criteria I: Material Performance	Criteria II: Material Health	Criteria III: Cost
Poor: 1 – 18 points	Poor: 1 – 18 points	Expensive: 1 – 18 points
Good: 19 – 36 points	Good: 19 – 36 points	Reasonable: 19–36 points
Excellent: 37 – 56 points	Excellent: 37 – 56 points	Cheap: 37 – 56 points

GROUND TRANSPORTATION



Source: Information based on the EMS (European Modular System) by ACEA. Diagrams by author

SEA TRANSPORTATION



Source: Mainfreight, Global Supply Chain Logistics. Diagrams by author

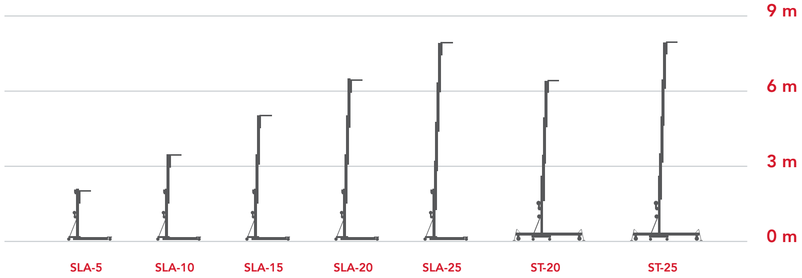
by author

HANDLING ON SITE

Category A

46kg
max. weight

Category B

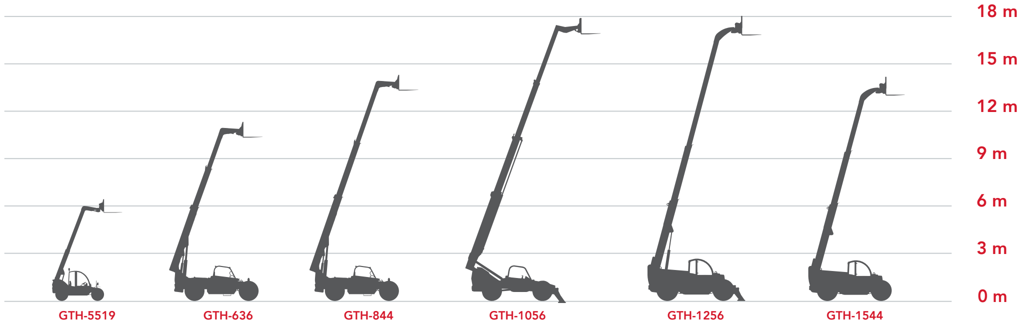


Source: Material Lifts by Genie

363kg
max. weight

Genie Material Lift

Category C



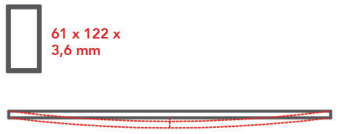
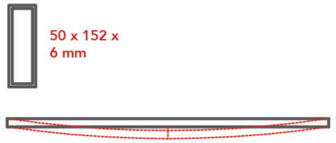
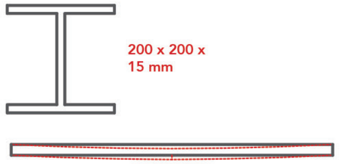
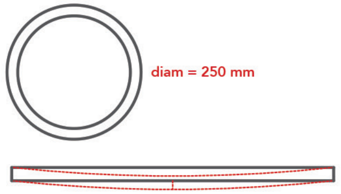
Source: Telehandlers by Genie

16600kg
max. weight

by author

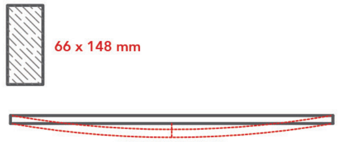
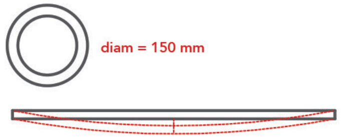
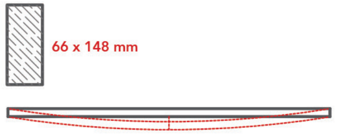
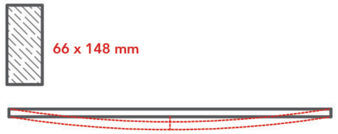
Genie Telehandler

02 Research | Sizes - up to 6m span

		Profile	Deflection	Weight	Cost
CATEGORY 1: METALS & ALLOYS	 Steel	 61 x 122 x 3,6 mm	δ = 190 mm	30 kg	€€ 20 €
	 Aluminum	 50 x 152 x 6 mm	δ = 220 mm	28 kg	€€€ €€€ 62 €
CATEGORY 2: COMPOSITES	 FRP	 200 x 200 x 15 mm	δ = 80 mm	82 kg	€€€€€€€ €€€€€€€ €€€€€€€ €€€€€€€ €€€€€€€ x8,5 2975 €
	 Cardboard	 diam = 250 mm	δ = 160 mm	30 kg	€€€ 29 €

NOTE: Beam scale is 1/10 of sectional profile size

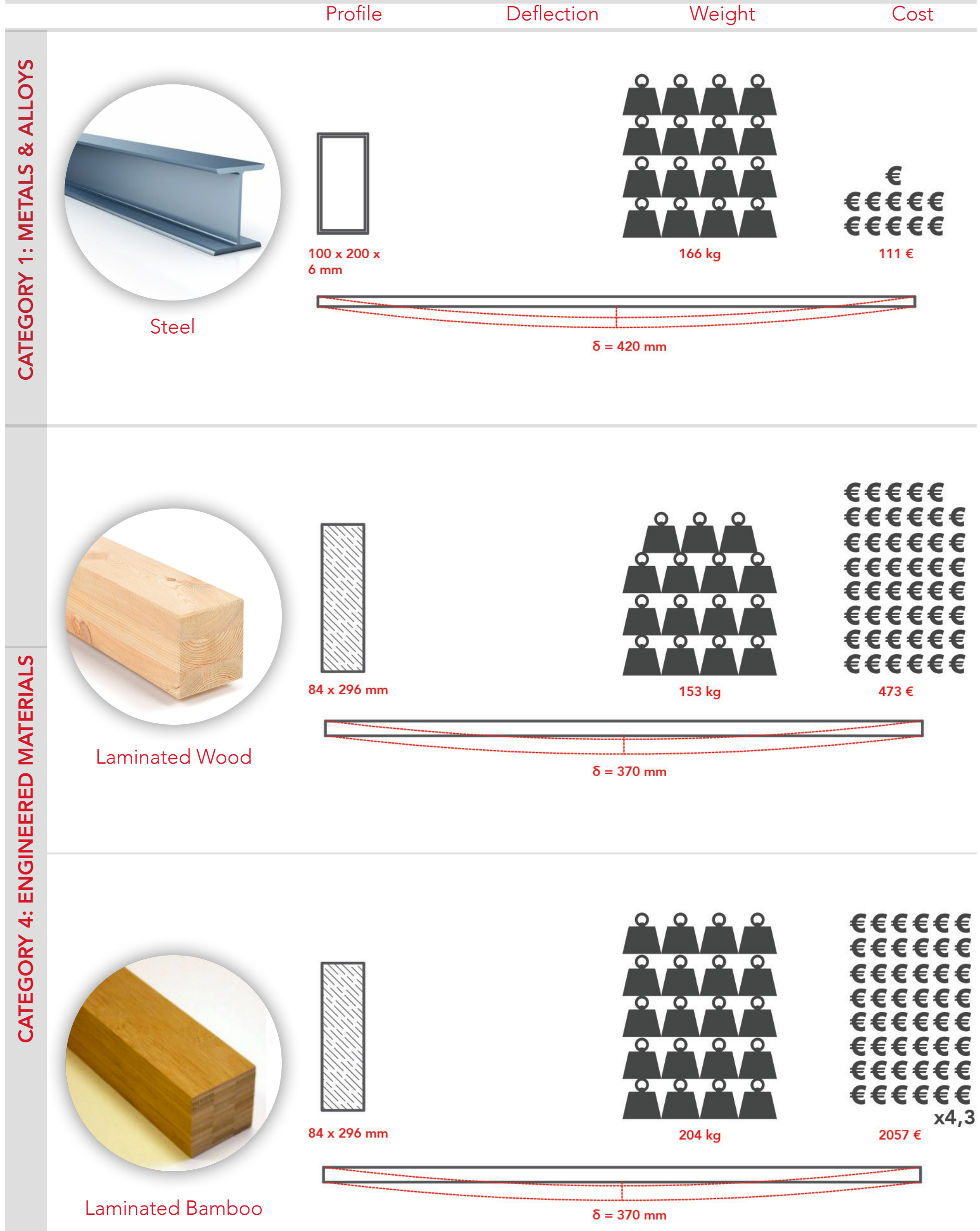
by author

		Profile	Deflection	Weight	Cost
CATEGORY 3: NATURAL MATERIALS	 Wood	 66 x 148 mm	δ = 260 mm	30 kg	€€ €€€ 46 €
	 Bamboo	 diam = 150 mm	δ = 280 mm	17 kg	€ €€€ 43 €
CATEGORY 4: ENGINEERED MATERIALS	 Laminated Wood	 66 x 148 mm	δ = 240 mm	30 kg	€€€ €€€ €€€ 93 €
	 Laminated Bamboo	 66 x 148 mm	δ = 240 mm	40 kg	€€€€€ €€€€€€€ €€€€€€€ €€€€€€€ €€€€€€€ €€€€€€€ 404 €

NOTE: Beam scale is 1/10 of sectional profile size

by author

02 Research | Sizes - up to 12m span



NOTE: Beam scale is 1/10 of sectional profile size

by author

Calculations Methodology

GOAL: find lightest and safest choice for a 3KN/m load for a determined span

W = 3KN/m for Class C5 (areas where people may congregate). Source: Formichi, P. (2008). *EUROCODE 1, Actions on Building Structures*

FORMULAS:

1) Beam designed for maximum moment:
$M_{max} = W*L^2/8$ (KN.m)

2) Required Section Modulus
S_x required = M_{max}/MoR $(10^{-3}\ m^3)$

3) MoR is the Modulus of Rupture or bending strength
and it depends on the material

4) Compute Section Modulus to check if member passes
or fails the required Section Modulus
Square/Rectangular beams: $S_x = b*d^2/6$ $(10^{-3}\ m^3)$
Other shapes: $S_x = I_{xx}/y$ $(10^{-3}\ m^3)$
I_{xx} = Moment of Inertia $(10^{-3}\ m^4)$
y= distance to neutral axis (m)

5) Compare allowed deflections with the deflections of each member
Deflection $_{max}$ = $5W*L^4/384*E*I_{xx}$
E= Young's Modulus (Gpa)
$I_{xx} = b*h^3/12$ $(10^{-3}\ m^4)$

Allowed deflection = L/200 for roof beams = 0.30m (for span up to 6m)
= 0.60m (for span up to 12m)

Source: BSI Standards Publication

6) Find the weight in *kg* of each member
Mass = area profile * lenght * density

7) Find the final price in Euros
Final price = price/kg * mass

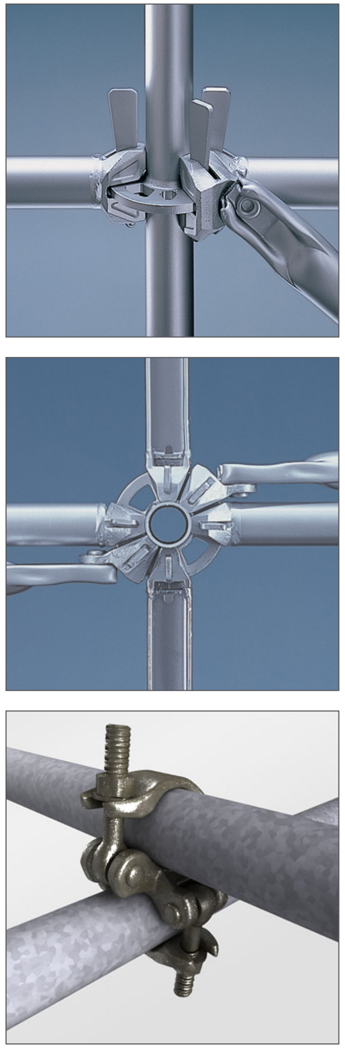
Units Reference:
GPa= 10^9 N/m^2
MPa= 10^6 N/m^2
MPa= 10^3 KN/m^2
KPa= 10^3 N/m^2
Pa= N/m^2

02 Research | Connections

CONNECTIONS USING THE SAME MATERIAL AS STRUCTURE

Clamped Connections

Connections that use a clamp or ring as a means to attatch multiple elements.



Slotted Connections

Connections that allow elements to fit into each other my means of a slot or tenon.

Fitting Connections

Connections that allow elements to fit into each other my means laps that are similar in size and shape.

CONNECTIONS USING DIFFERENT MATERIAL FROM STRUCTURE

Fastened Connections

Connections that allow different elements to be fastened to each other by the use of fittings, ties or rope.

Inserted Connections

Connections that link different elemts by inserting them into it.

Bolted Connections

Connections that have different elemts such as steel plates that are bolted to the members.

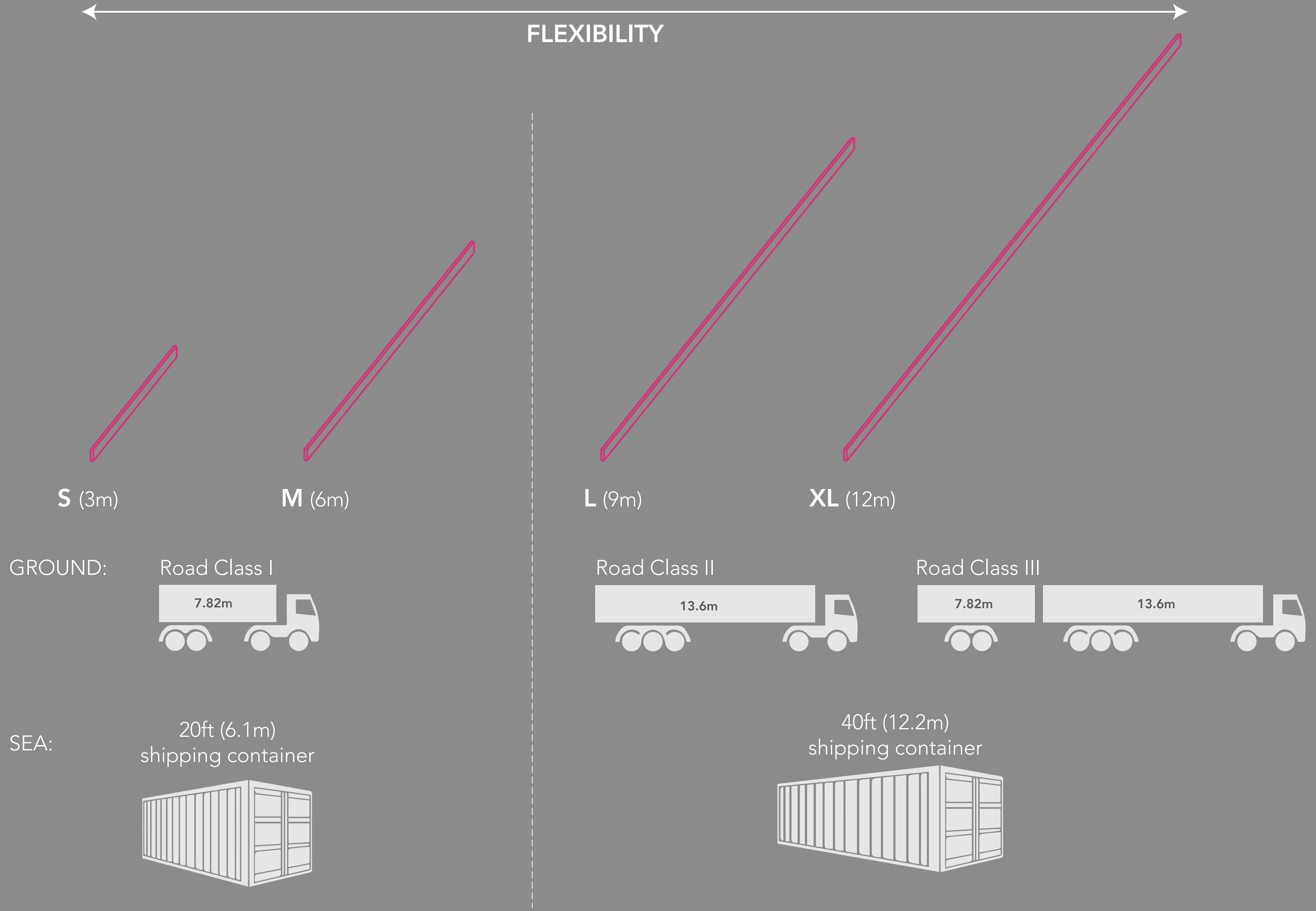
NOTE: All figure references can be found on the appendix of the Design Manual (Research Paper).

Design Principles

FLEXIBLE AND
REUSABLE
TEMPORARY
STRUCTURES

01	02	03
Flexible	Lightweight	Easy to Assemble
Modular	Durable	Easy to Disassemble
Easy to transport	Sustainable	Few parts
Easy to handle on site	Affordable	Simplified design

Span sizes informed by transportation methods



FLEXIBILITY

S (3m)

M (6m)

L (9m)

XL (12m)

GROUND:

Road Class I

7.82m

Road Class II

13.6m

Road Class III

7.82m

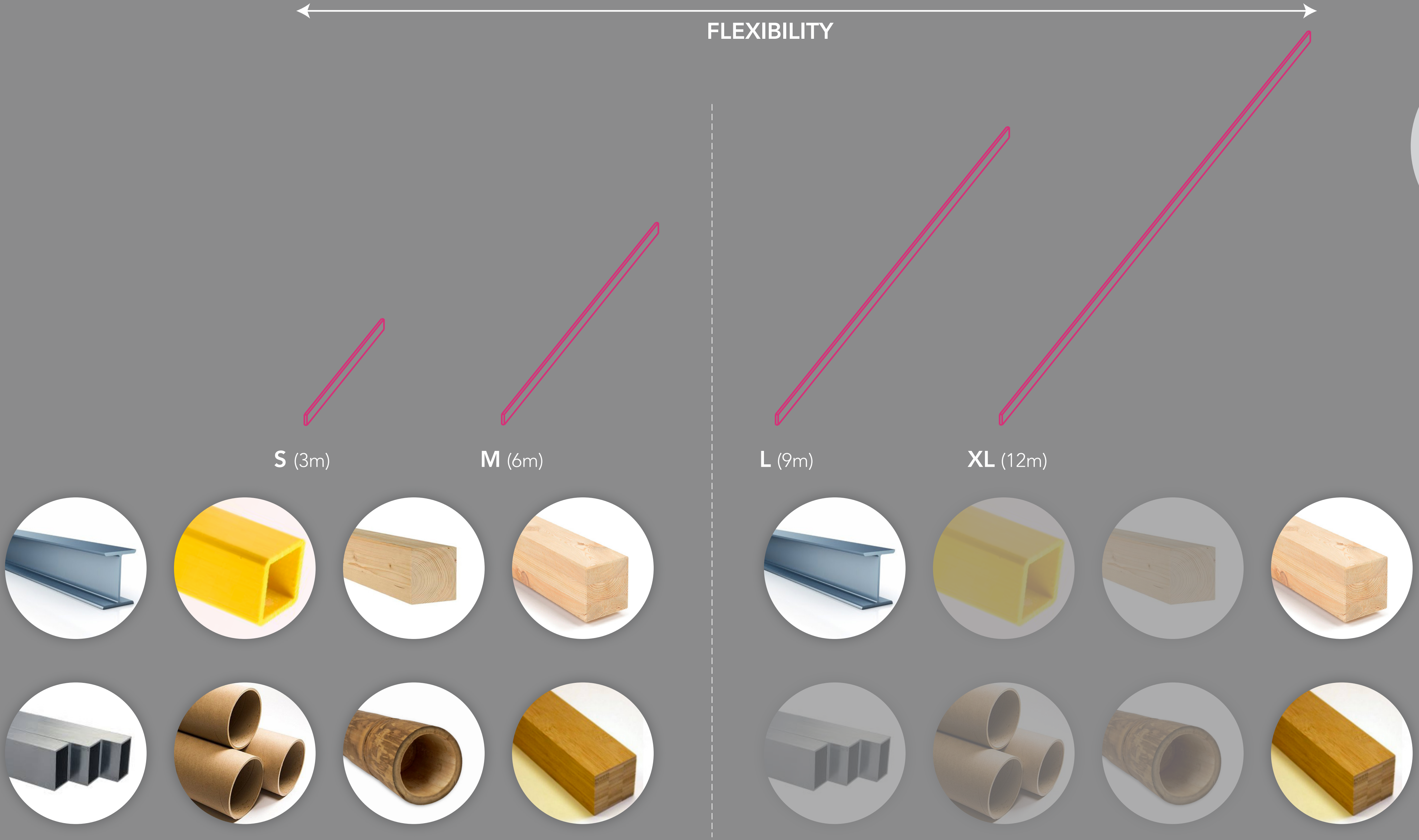
13.6m

SEA:

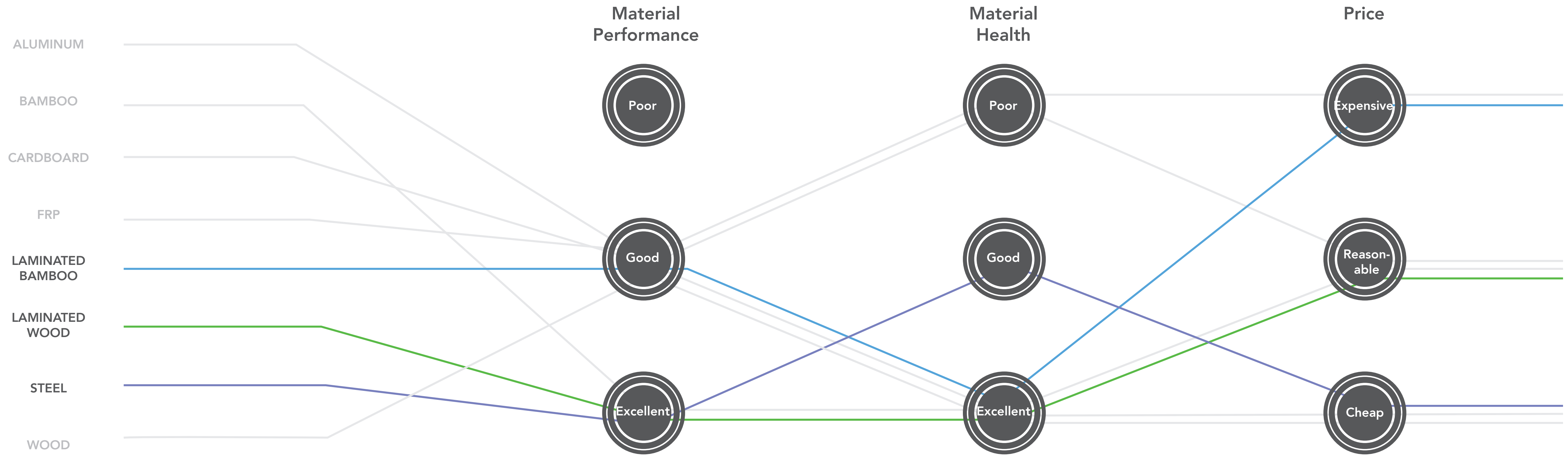
20ft (6.1m)
shipping container

40ft (12.2m)
shipping container

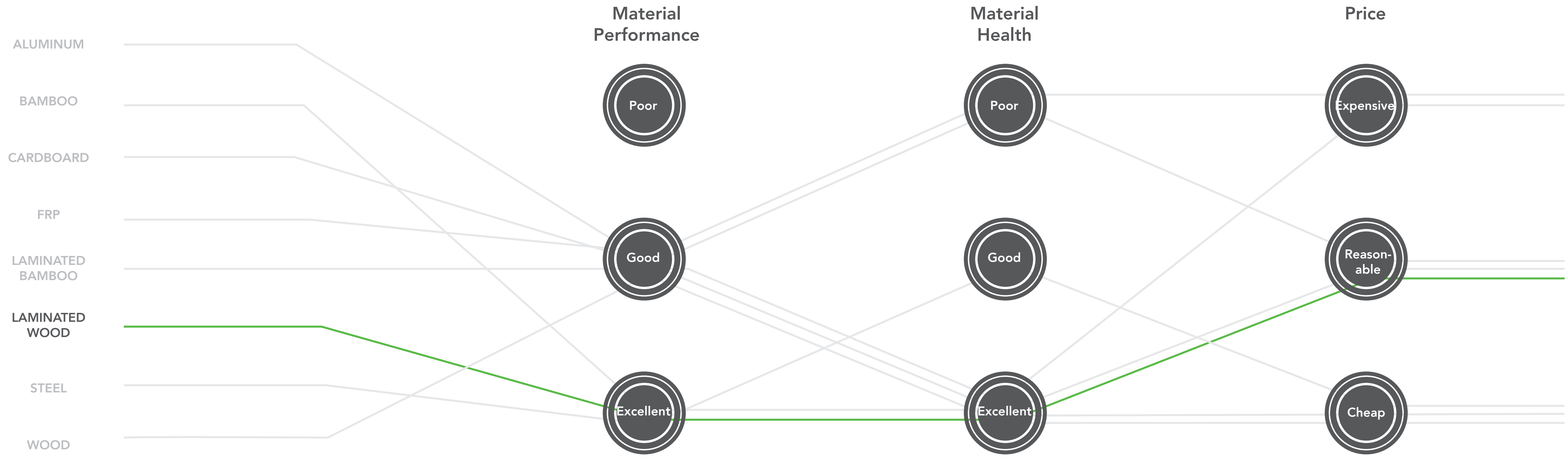
Span sizes influence in material choice



Shortlisted materials



Chosen scenario



ALUMINUM
BAMBOO
CARDBOARD
FRP
LAMINATED BAMBOO
LAMINATED WOOD
STEEL
WOOD

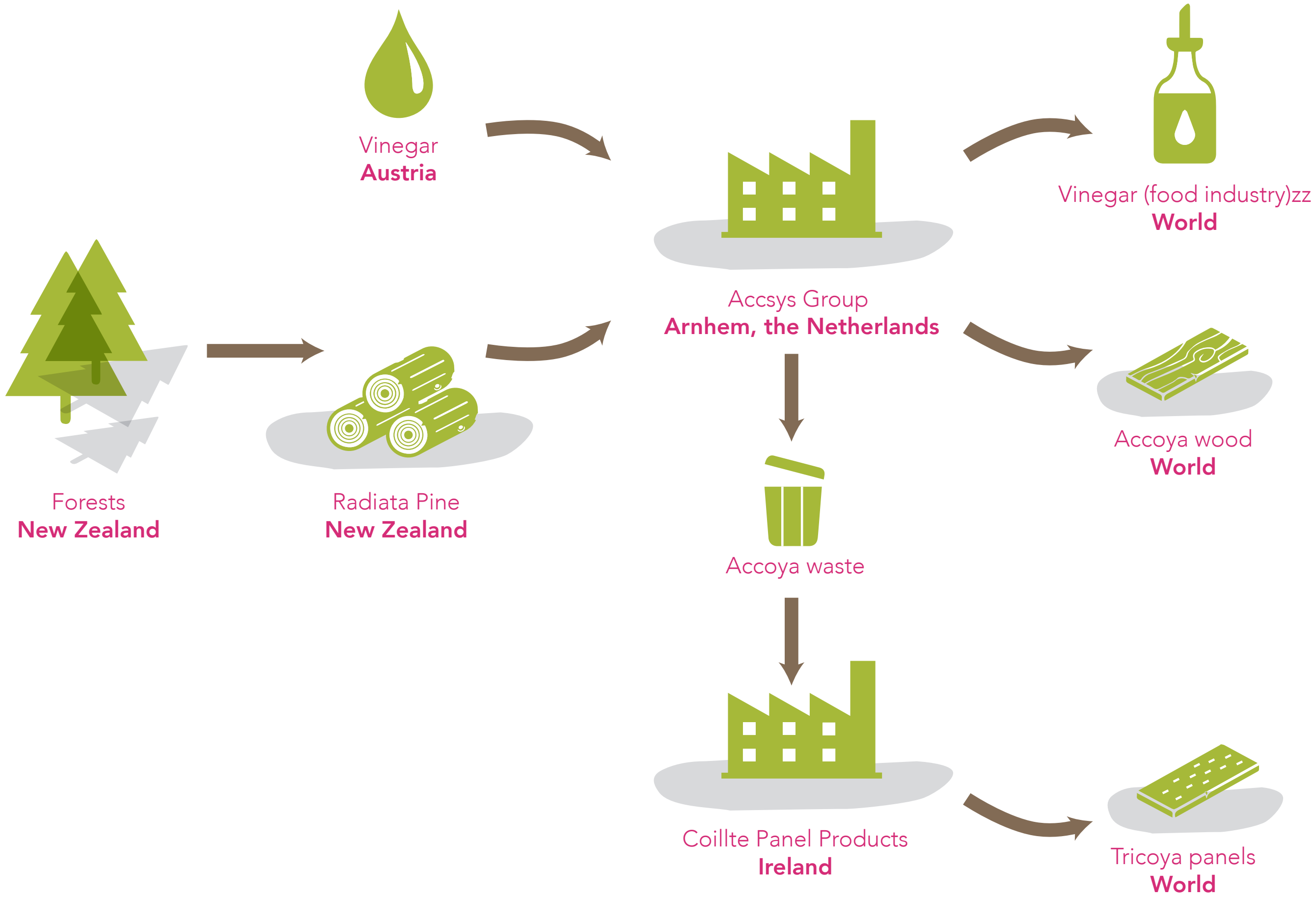
Material Performance
Poor
Good
Excellent

Material Health
Poor
Good
Excellent

Price
Expensive
Reason-able
Cheap

Qualitative Analysis Chosen Material

Production of Acetylated Wood



Vinegar
Austria

Forests
New Zealand

Radiata Pine
New Zealand

Accsys Group
Arnhem, the Netherlands

Vinegar (food industry)zz
World

Accoya wood
World

Accoya waste

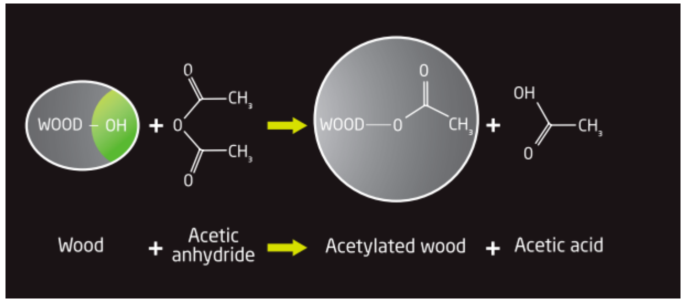
Coillte Panel Products
Ireland

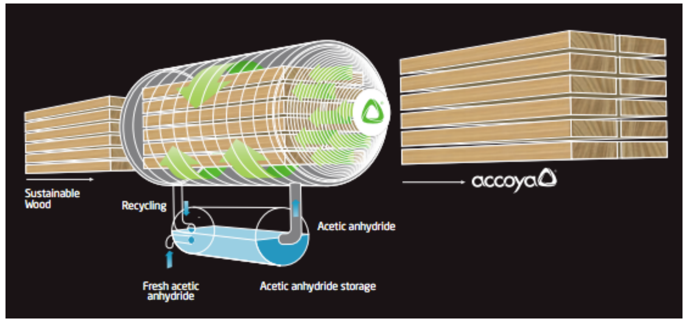
Tricoya panels
World

Diagram showing products and by-products of the acetlylation process.

Source: by author based on interview

Acetylation Process





Images by Accoya Wood

Qualitative Analysis Chosen Material

Structural Performance Enhancement

Performance	untreated wood	acetylated wood	acetylated & laminated wood	
Durability	Class 4	Class 1	Class 1	*
Quality	variable	consistent	consistent	
Density	100%	110%	110%	**
Flexural Strength (MoR)	100%	120%	120%	***
Strength-to-weight ratio	100%	108%	108%	
Young's Modulus (MoE)	100%	90%	105%	****
Compressive Strength	100%	100%	114%	*****
Tensile Strength	100%	100%	137%	*****

by author

* Classification presented in BS-EN 350-2
Class 1 - very durable
Class 2 - durable
Class 3 - moderately durable
Class 4 - slightly durable
Class 5 - not durable

** some sources say that density increases during acetylation process due to vinegar, while others consider density increase irrelevant.

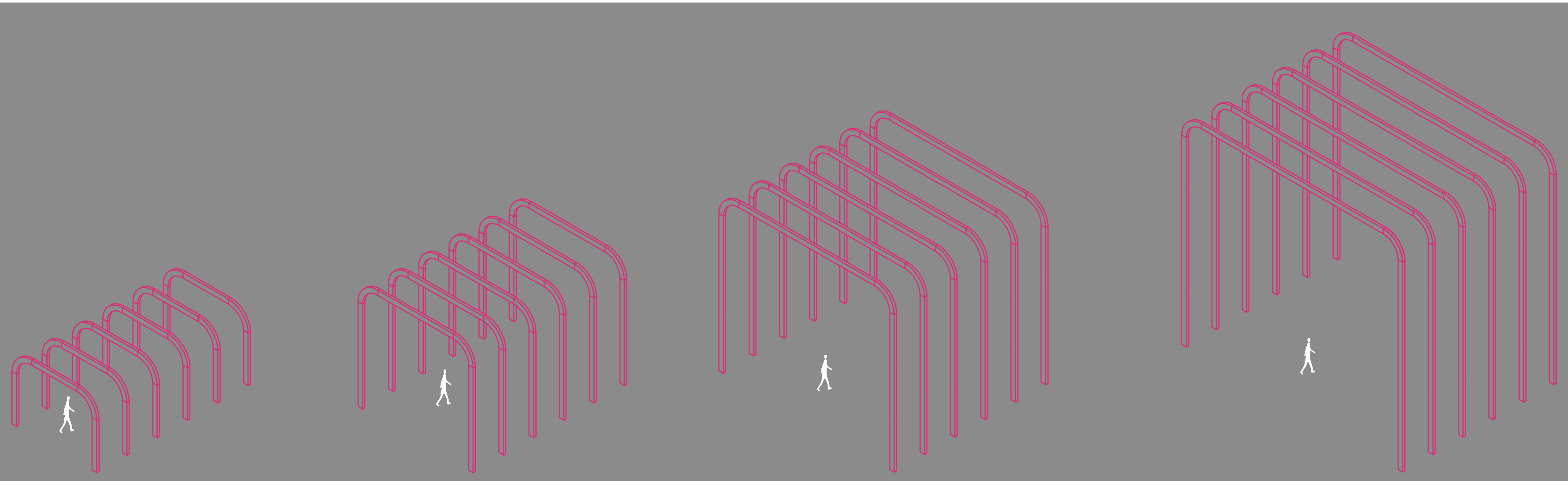
*** 20% increase between untreated wood and acetylated wood based on Accoya performance report. Source: Accoya, 2016c

Laminated Accoya wood is stronger in bending than solid Accoya wood but structural report shows same numbers. Source: Accoya, 2016b

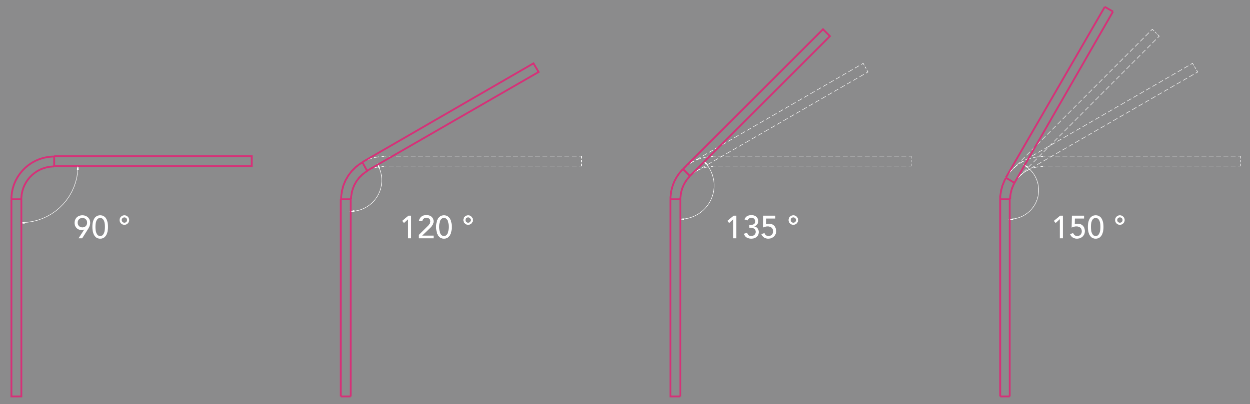
**** 10% decrease between untreated wood and acetylated wood based on Accoya performance report. Source: Accoya, 2016c

***** Information based on Accoya structural report. Source: Accoya, 2016b

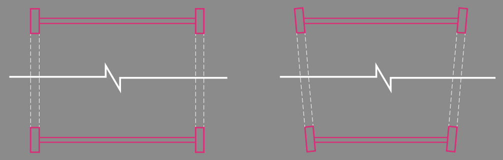
Flexibility



Modular Sizes

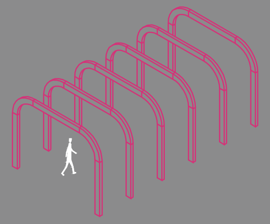


Angular Connections



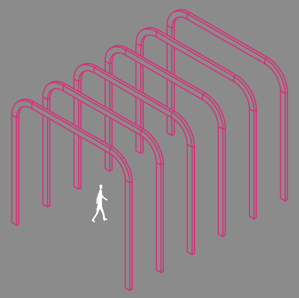
Bracing for Radial Variation

Analysis of a Pavilion Design using Laminated Wood



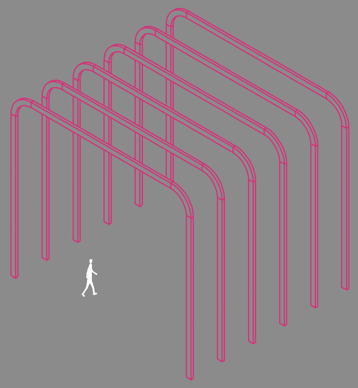
S (3m members)

W 3m x H 3m x D 10m



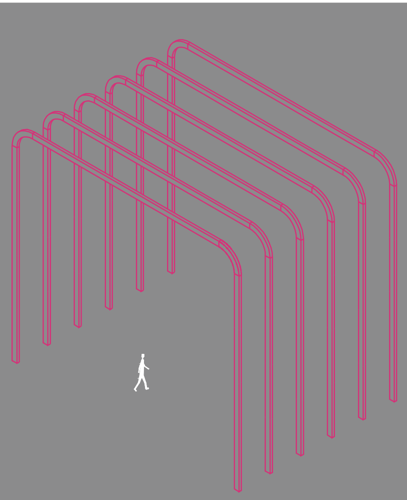
M (6m members)

W 6m x H 6m x D 10m



L (9m members)

W 9m x H 9m x D 10m



XL (12m mem-

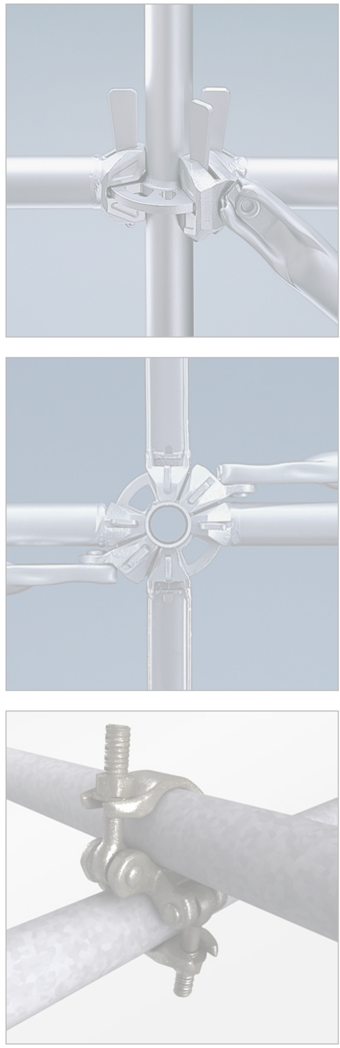
W 12m x H 12m x D 10m

270 kg	540 kg	2065 kg	2754 kg
837 €	1674 €	6385 €	8514 €
3294 MJ	6588 MJ	25200 MJ	33600 MJ
	+	+	+
or	or	or	or

Chosen connection category

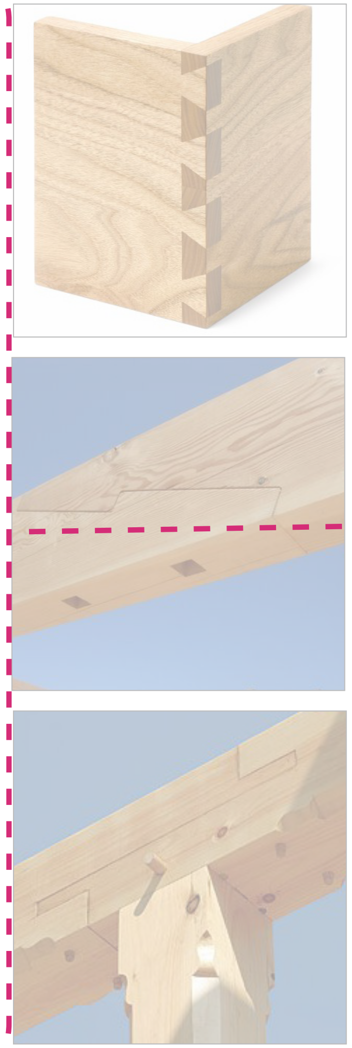
CONNECTIONS USING THE SAME MATERIAL AS STRUCTURE

Clamped Connections



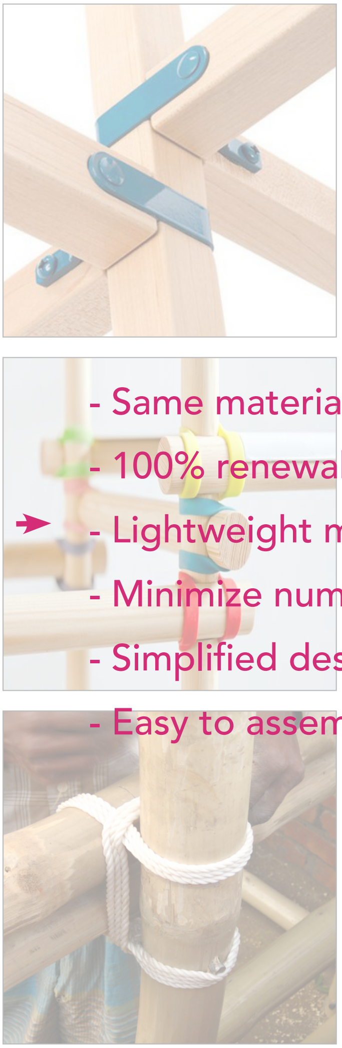
Slotted Connections

Fitting Connections



CONNECTIONS USING DIFFERENT MATERIAL FROM STRUCTURE

Fastened Connections

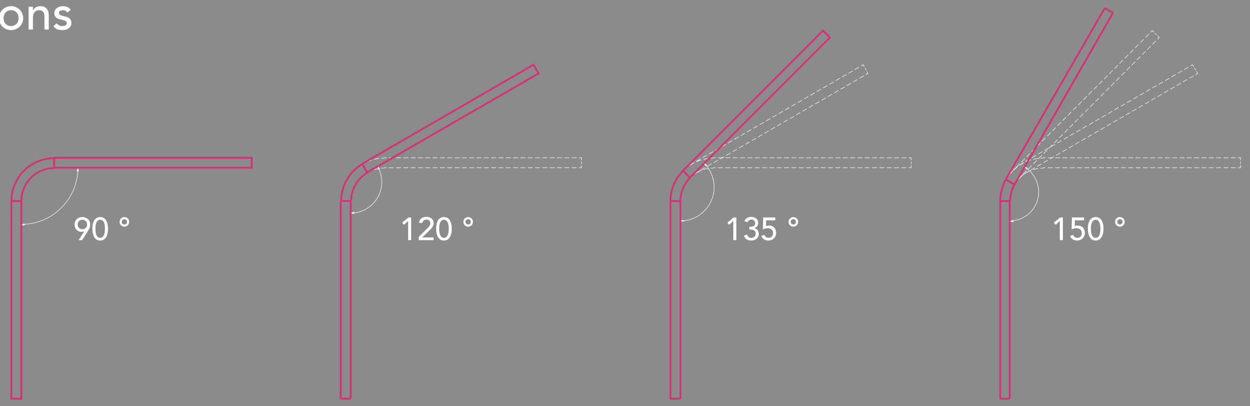


Inserted Connections

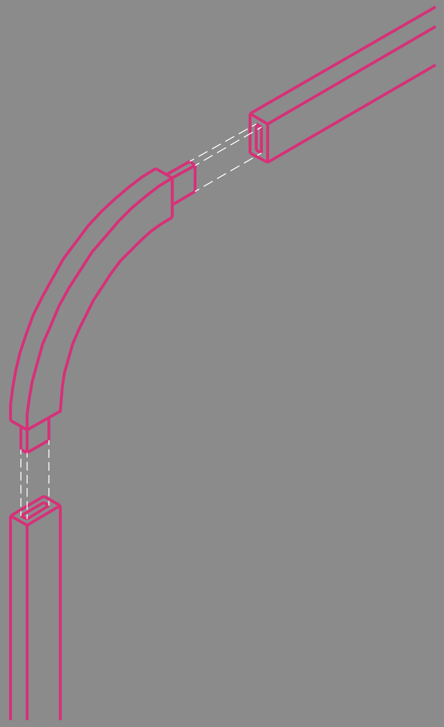
Bolted Connections

- Same material as structure
- 100% renewable materials
- Lightweight material
- Minimize number of parts
- Simplified design
- Easy to assemble

Angular Connections

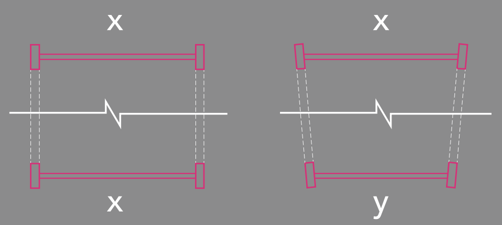


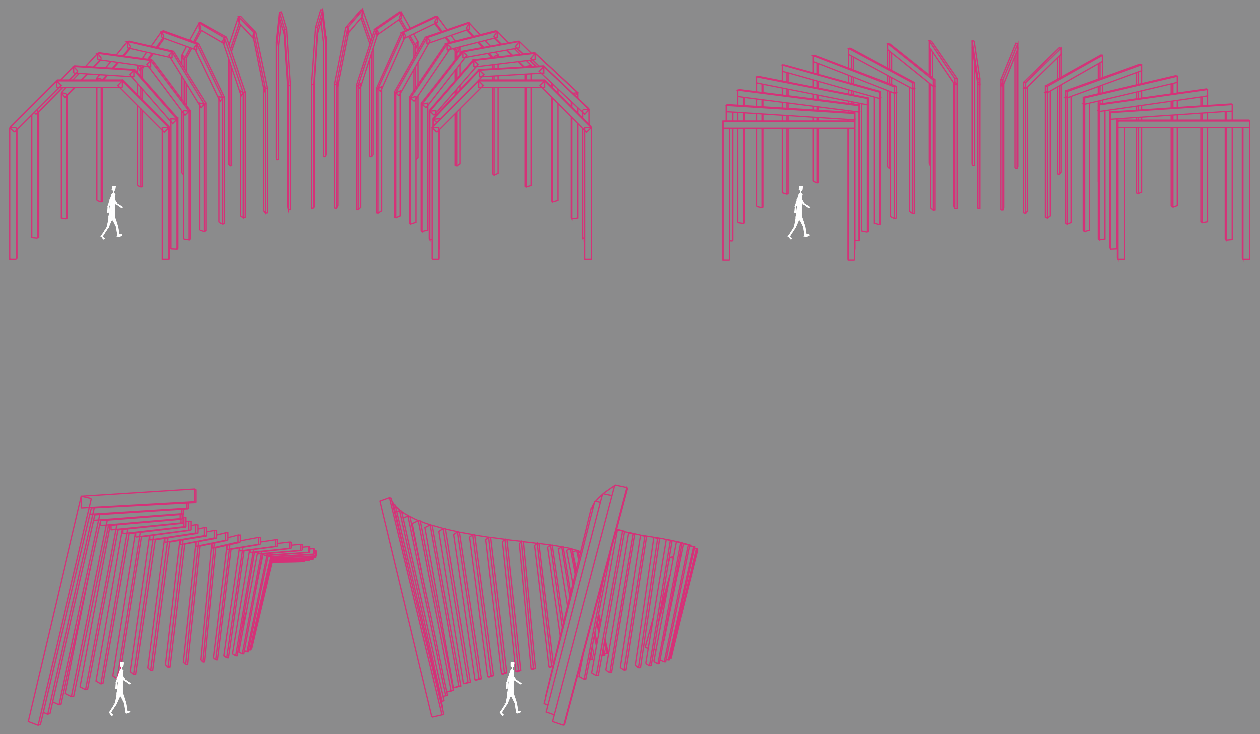
Combination of different connection angles and modular sizes



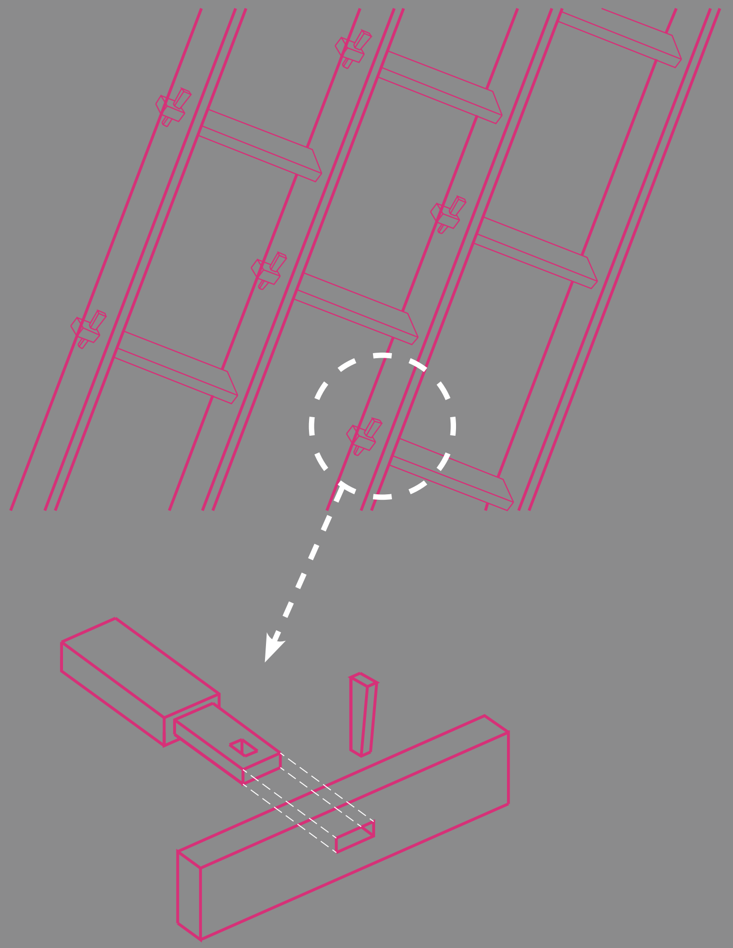
Tenon and Mortise joint @ corners

Bracing for Radial Variation





Bracing of different sizes allow for radial variation



Tusk Tenon and Mortise joint

Content

01
Introduction

Fascination
Temporary Architecture
Design Goal
Design Question
Thechnical Question

02
Research

Methodology
Problem statement
Materials
Sizes
Connections
Research x Design

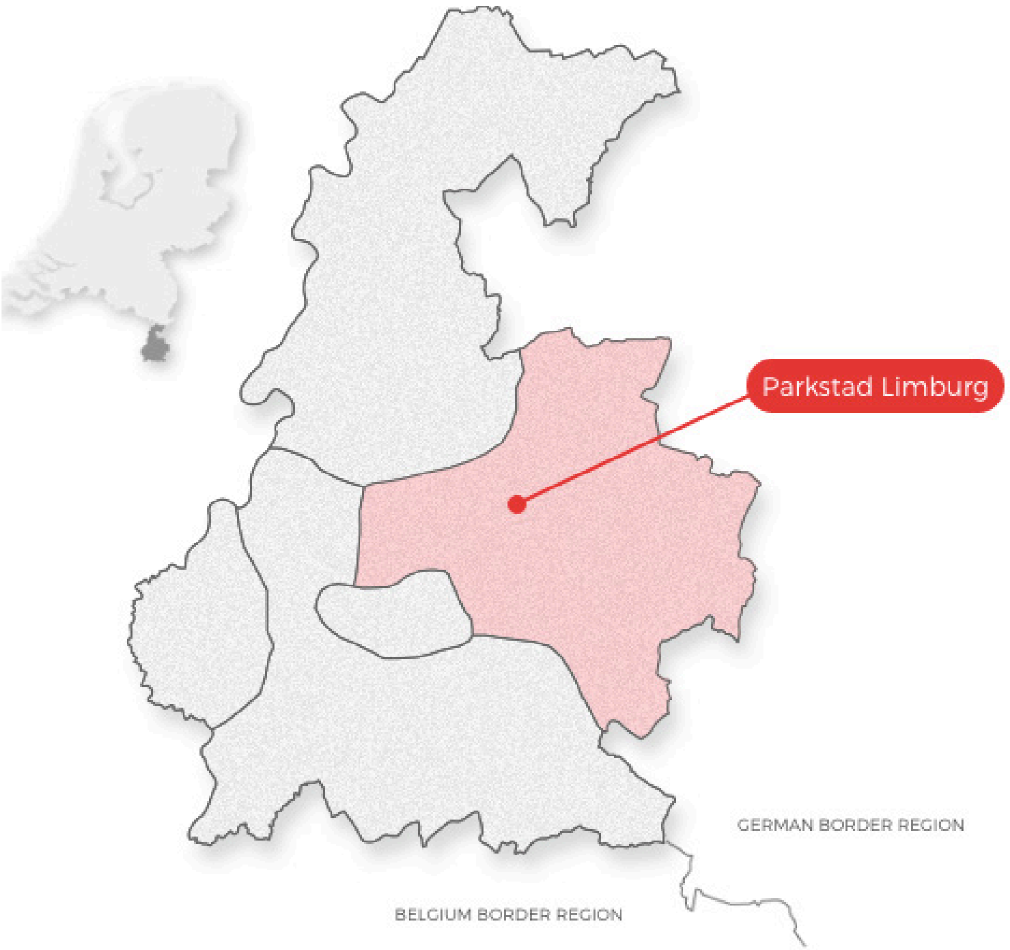
03
Design

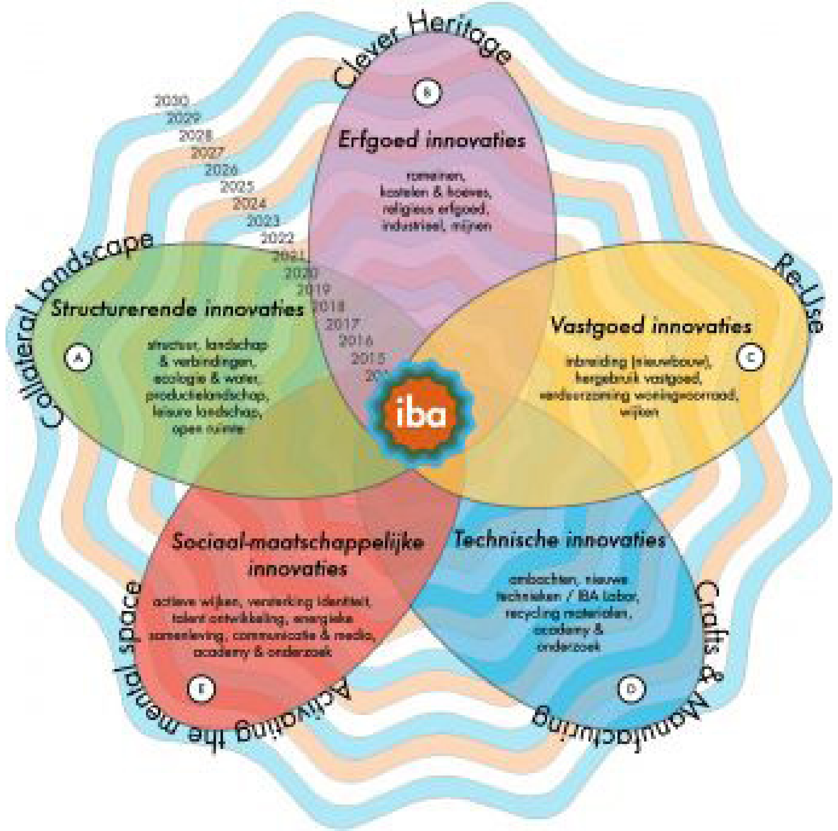
Context
Project Phasing
Program
Possible Locations
Vision

04
Next Steps

Strategy
Planning
Questions

Why IBA Parkstad?

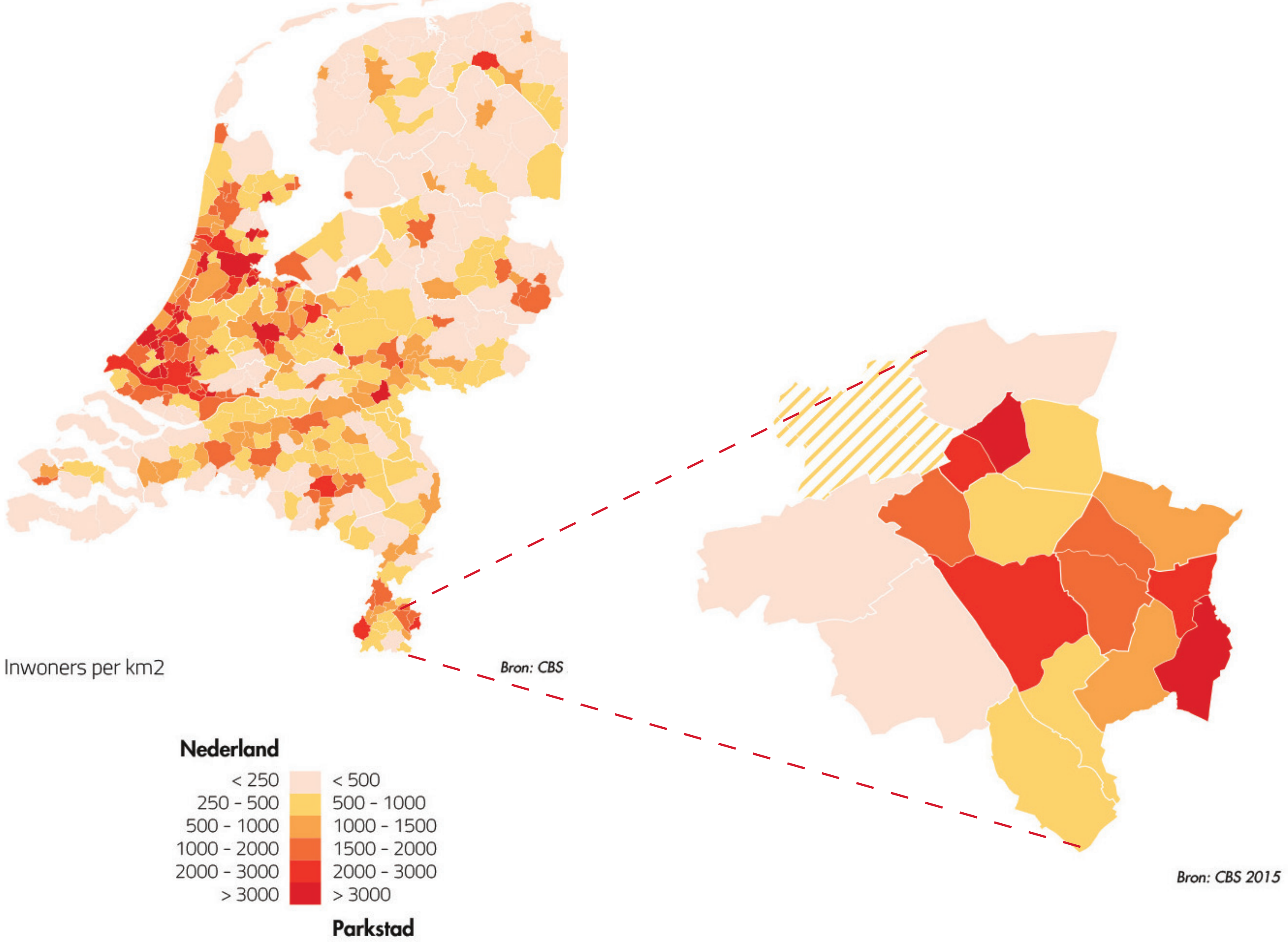




International Event/Expo to be held in 2020 in order to showcase future-proof, innovative and experimental projects that will draw attention to the region and help boost its economy and restore the pride of its citizens.

The Parkstad Region Challenge

Population Density



-875
birth surplus in 2013

9%
unemployment

2,05
average household size

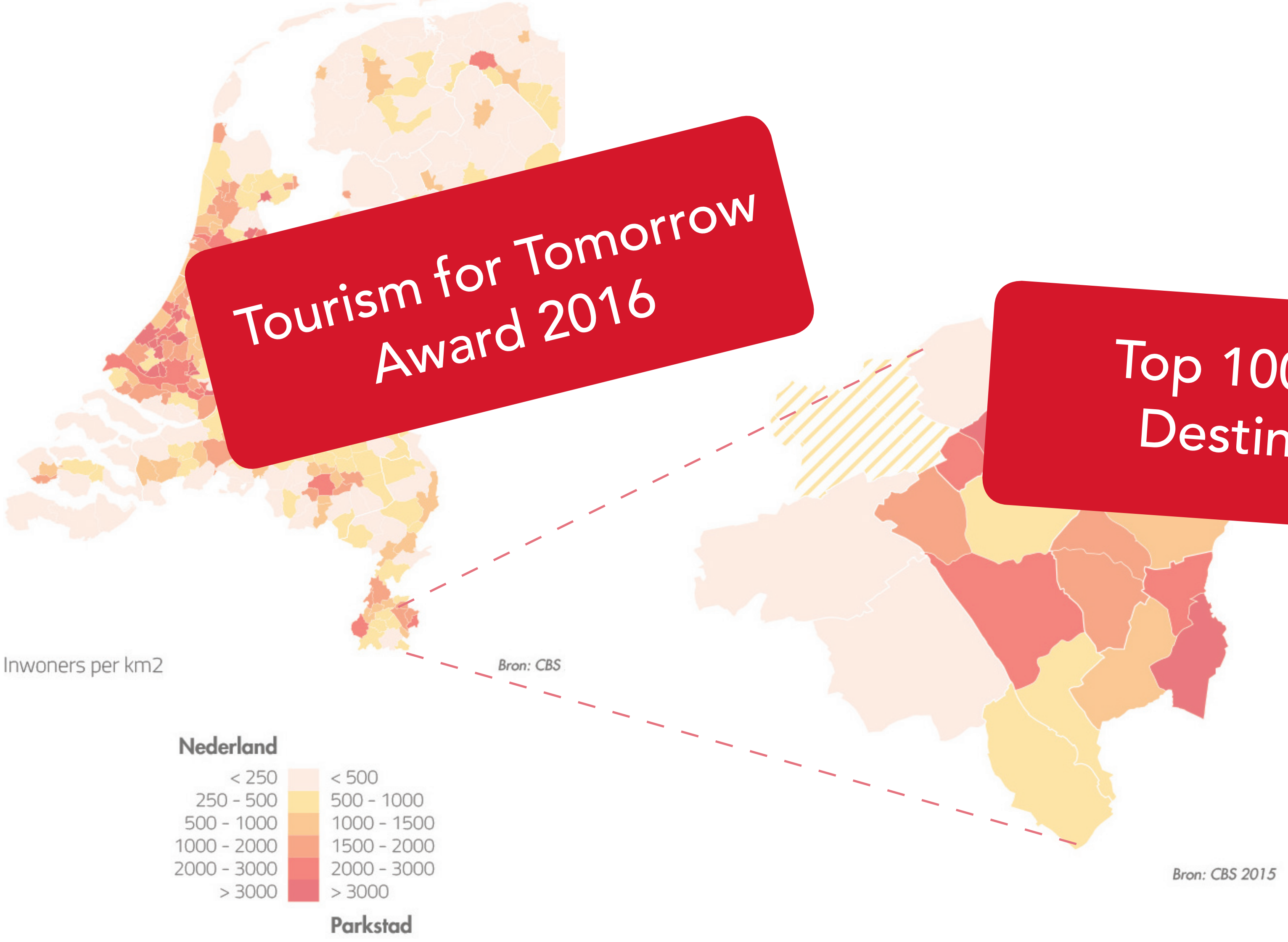
1.180
population density inhabitant per km^2

Shrinking Region

Data Source: Handboek IBA Zomer2015

The Parkstad Region Challenge

Population Density



Tourism for Tomorrow Award 2016

Top 100 Green Destinations

-875
birth surplus in 2013

9%
unemployment

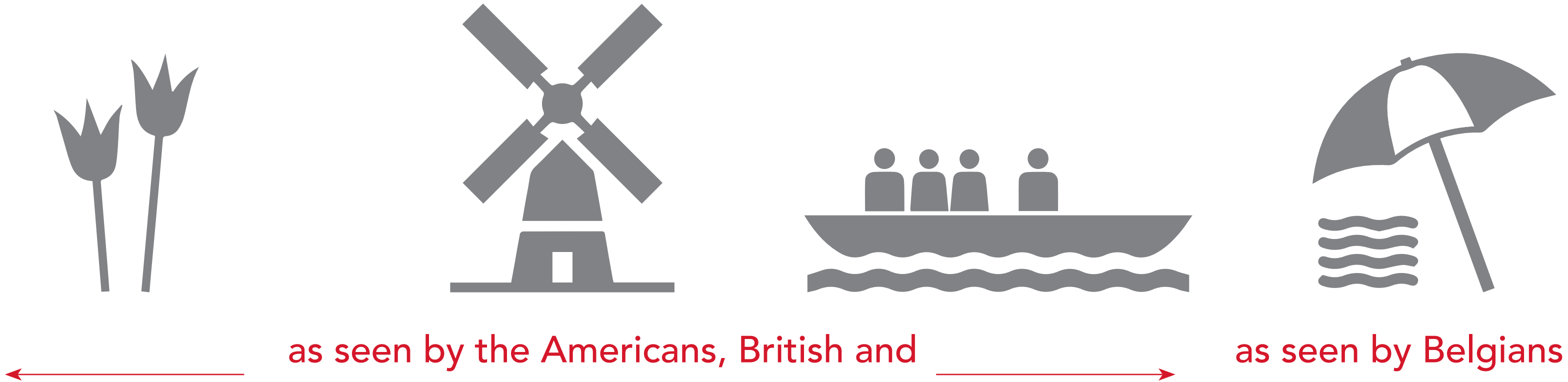
2,05
household size

1.180
population density inhabitant per km^2

Shrinking Region

Dutch nature as seen by Tourists

Data Source:
(source: https://www.mooistenatuurgebied.nl/over-de-natuur)
Images: online source

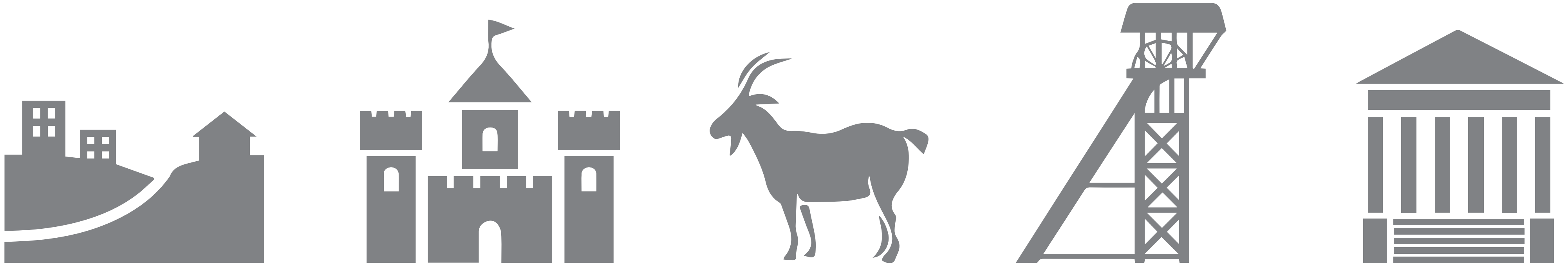


as seen by the Americans, British and Chinese

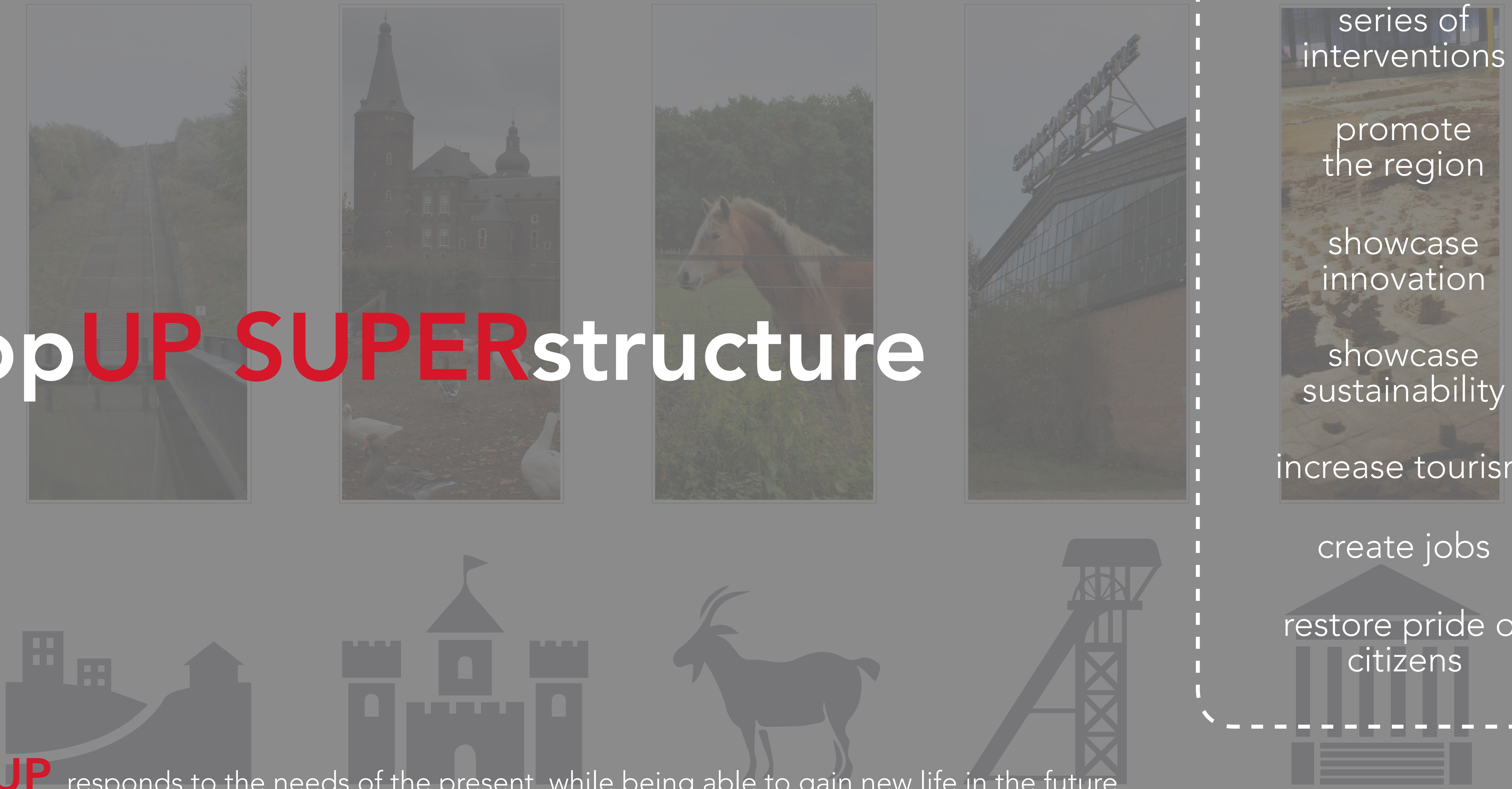
as seen by Belgians and Germans

What makes the Parkstad Region unique?

Images: by author



The cultural and historic heritage of the Parkstad Region



popUP SUPERstructure

- series of interventions
- promote the region
- showcase innovation
- showcase sustainability
- increase tourism
- create jobs
- restore pride of citizens

popUP responds to the needs of the present, while being able to gain new life in the future

SUPERstructure: capacity of structure to be flexible and adapt to various scales and programs

Project Phasing

PHASE 1

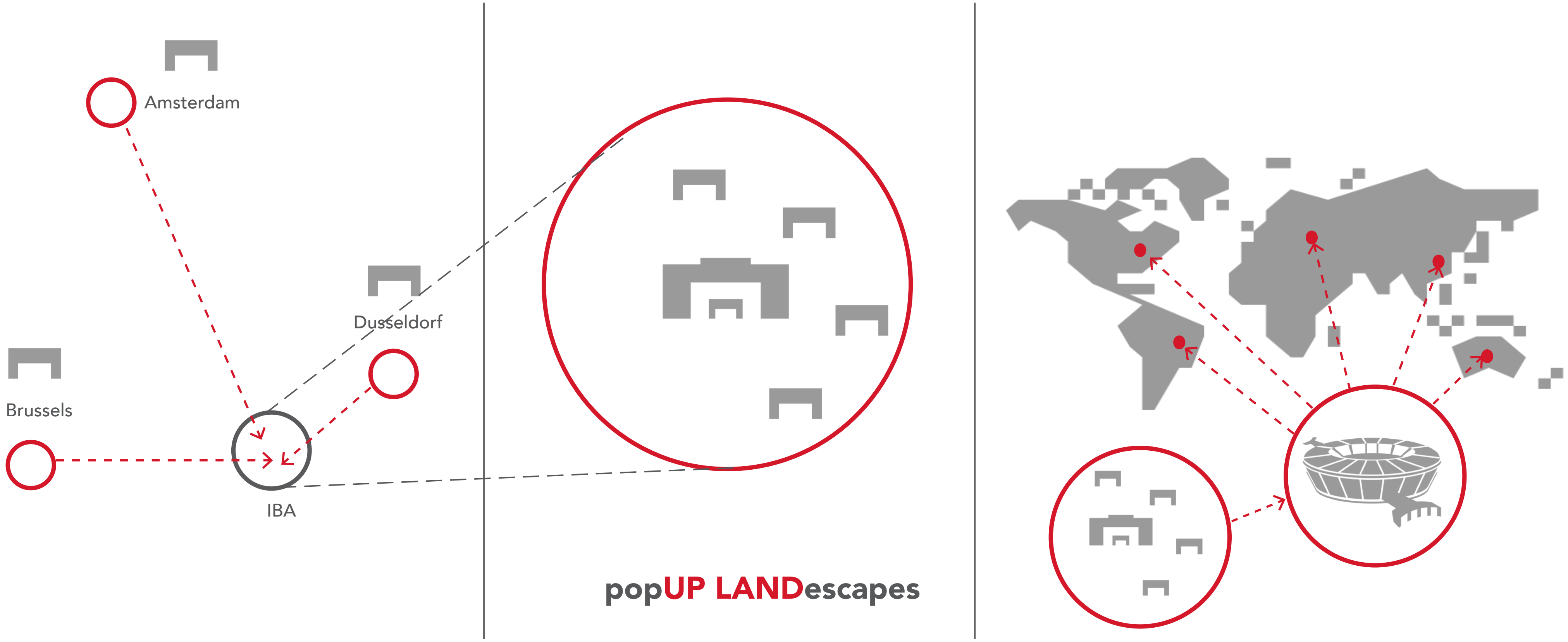
Before IBA 2020

PHASE 2

IBA 2020

PHASE 3 (future vision)

After IBA 2020



popUP LANDescapes

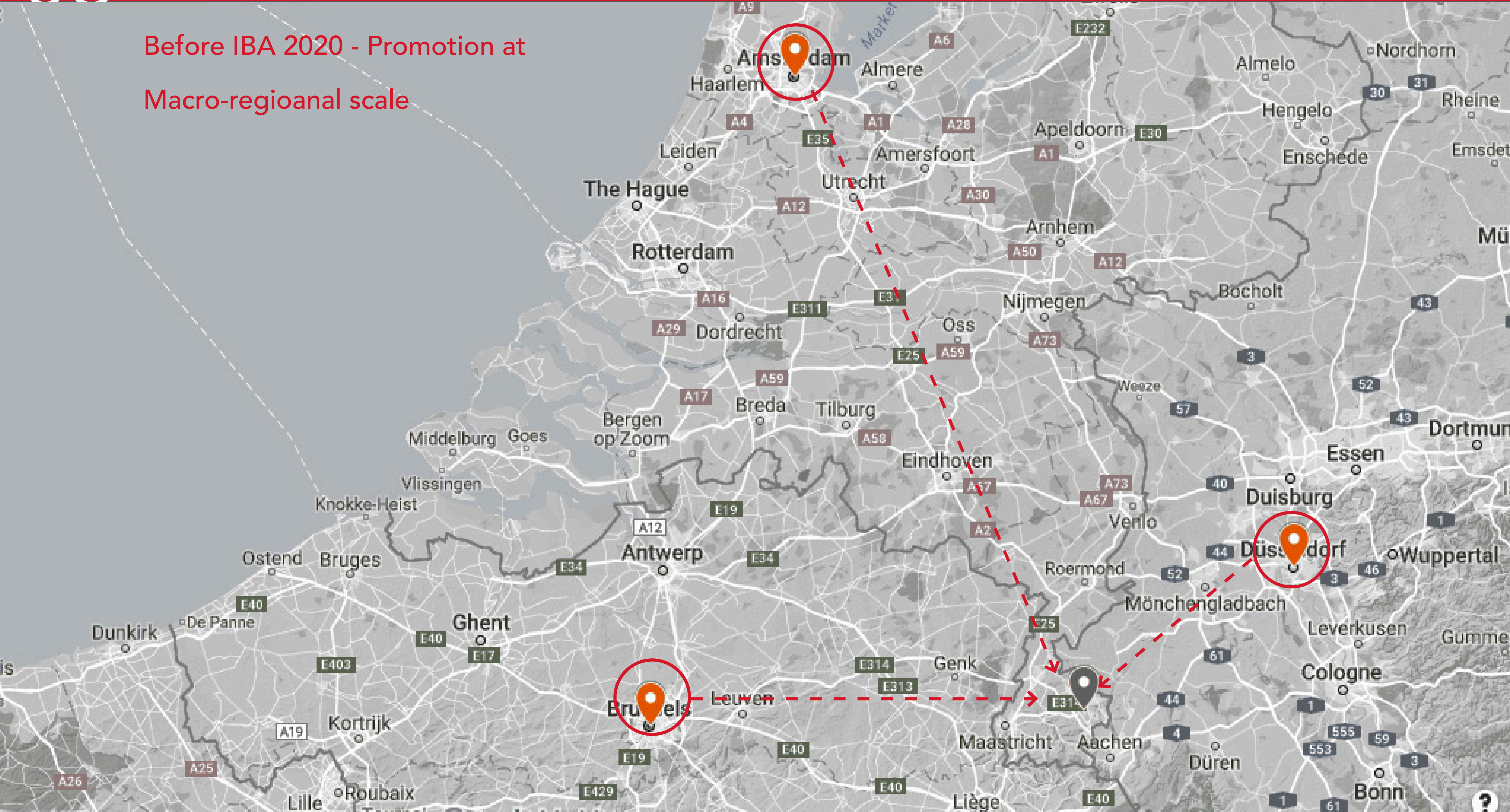
popUP URBANescapes

popUP URBANescapes

Folly/ Pavillion → Arena

FLEXIBILITY

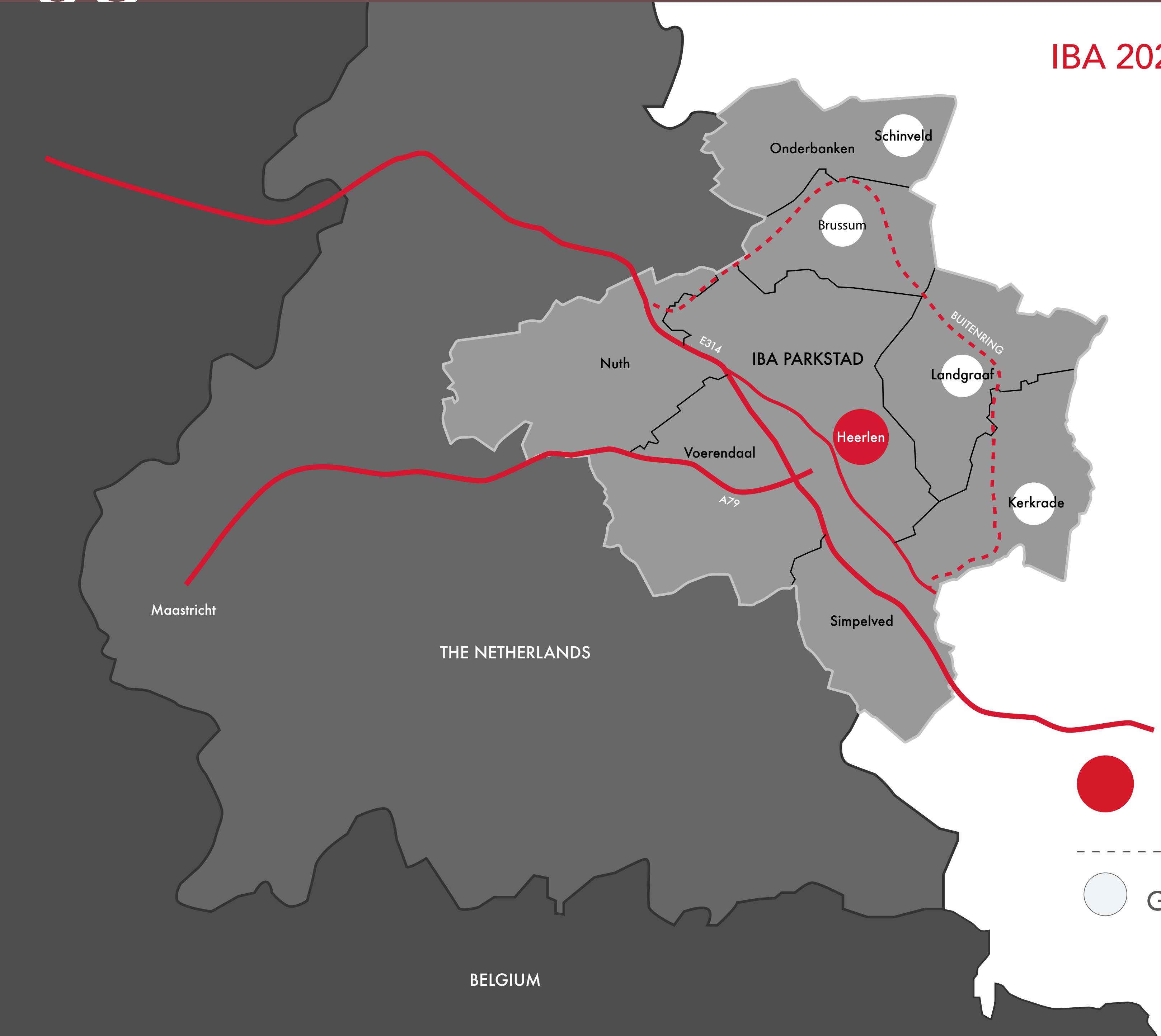
Before IBA 2020 - Promotion at Macro-regioanal scale



03 Design | Project Phasing

IBA 2020 - Meet IBA & Get Connected

IBA 2020 - Meet IBA & Get Connected



●	Meet IBA	**popUP URBANescapes** Exhibition & Cultural Centre
○	Get connected	**popUP LANDescapes** Follies to attract people to certain regions

Typologyical Comparison - Leisure & Cultural precedents

SCALE

Folly/ Pavillion → Arena

Follies / Installation

Pavillion / Exhibition

Museum / Exhibition

Theatre / Presentations

Concert Hall / Performances

Arenas / Sports

PERMANENT

Parc de La Villette
Bernard Tuschumi

Montreal Biosphere
Buckminster Fuller

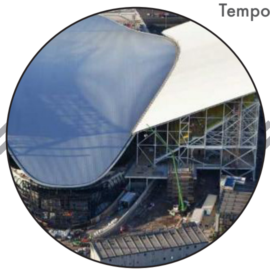
MuséoParc Alésia
by Bernard Tschumi

Limoges Hall
Bernard Tschumi

Zenith Amien Music Hall by
Bernard Tschumi

London 2012 Velodrome
Capacity: 6000

London 2012 Aquatic Centre
Zaha Hadid
Permanent Capacity: 2500
Temporray Capacity: 17500



TEMPORARY

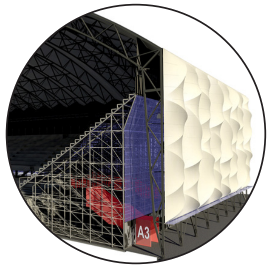
Paper Bridge
Shigery Ban

Hannover Expo Japan
Pavillion
Shigery Ban

Nomadic Museum
Shigery Ban

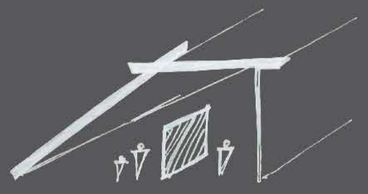
TED Theatre
Rockwell Group

Tomorrowland Festival

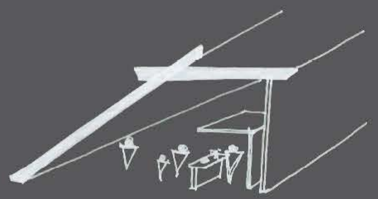


London 2012 Basketball Arena
Capacity: +/- 5000

FLEXIBLE INDOOR SPACES

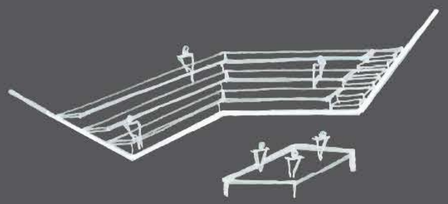


Cultural
Mining & Industrial Heritage
EXHIBITIONS

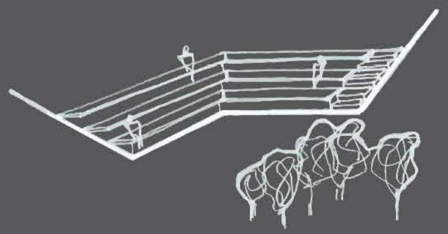


Social & Sustainable
Local Produce
MARKET

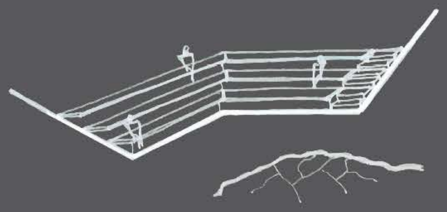
FLEXIBLE OUTDOOR SPACES



Leisure
Recreational Gatherings
FESTIVAL & CONCERT



Nature
Interaction with Landscape
BARE NATURE



Historic
Interaction with Site History
INSTALLATION

03 **Design** | Possible Locations

Grunsvenplein - Exhibition & Cultural Centre

Heerlen

popUP URBANescapes

Heerlen is considered the Heart of the Parkstad Region. Rich Roman heritage at Via Belgica.
City is situated strategically betweem main roads leading to Belgium and Germany.

Image: Google Earth

Schinveldse Bossen - Folly (Observatory)

Schinveld

Clay pits excavated during Roman times for production of pottery.
Elevated pond location is a viewing point for surrounding landscape.

Image: Image: online

Schutterspark - Folly (Bridge)

“From Black to Green”: project at the intersection between the Park and the waste left behind by the mining industry now aims to bring back to surface the Rode Beek stream and create a green corridor.

Image: by author

03 Design | Possible Locations

Wilhelminaberg hill - Folly

Landgraaf

A former waste hill from the Wilhelmina state mine.
Located close to some leisure attractions such as SnowWorld and Mondo Verde

Image: online source

03 Design | Possible Locations

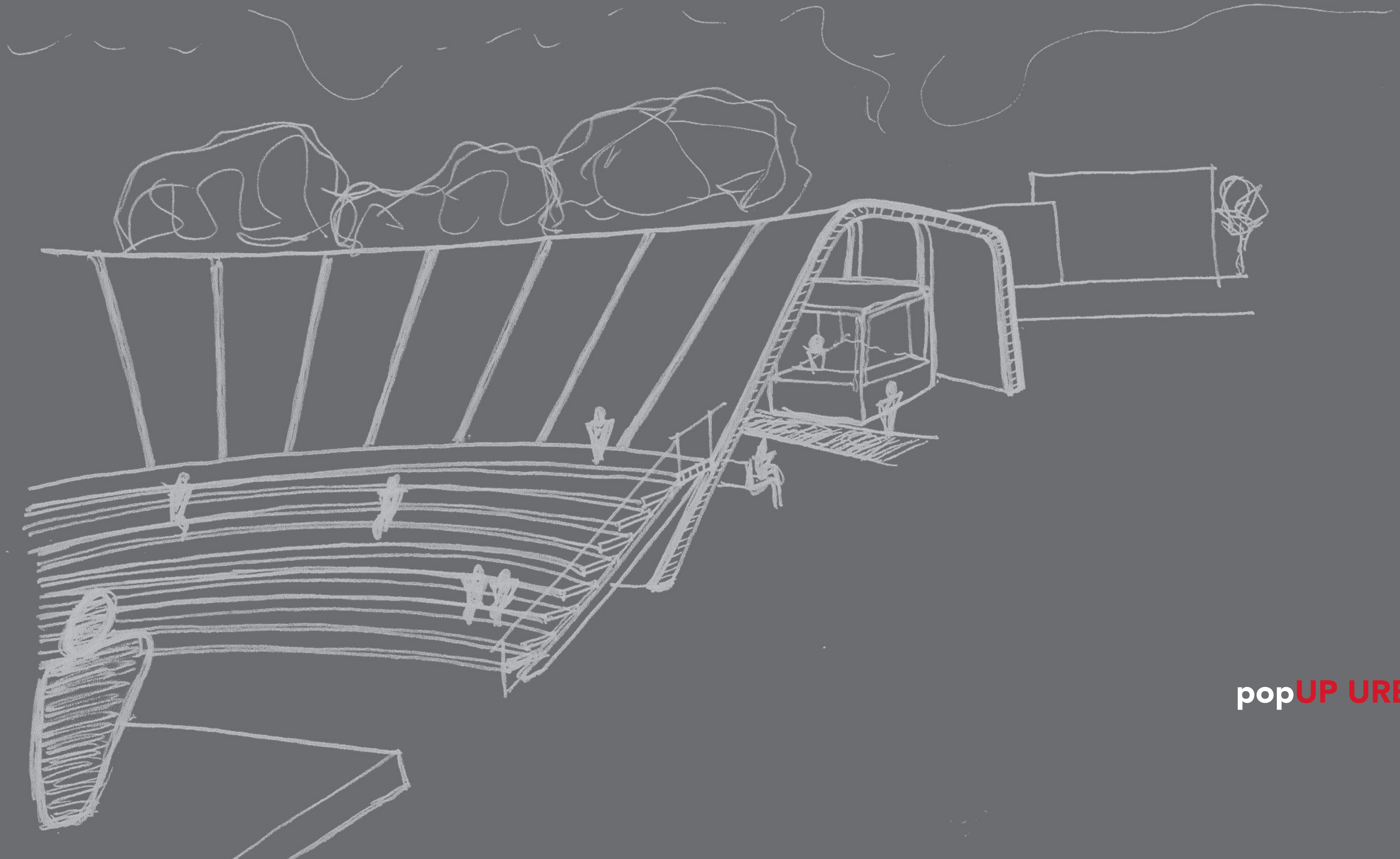
Rolduc Abbey - Pavillion

One of the top 100 UNESCO monuments of The Netherlands.
Rich Cultural, religious and architectural heritage. Today has hotel, restaurant, vineyards.

Image: online source

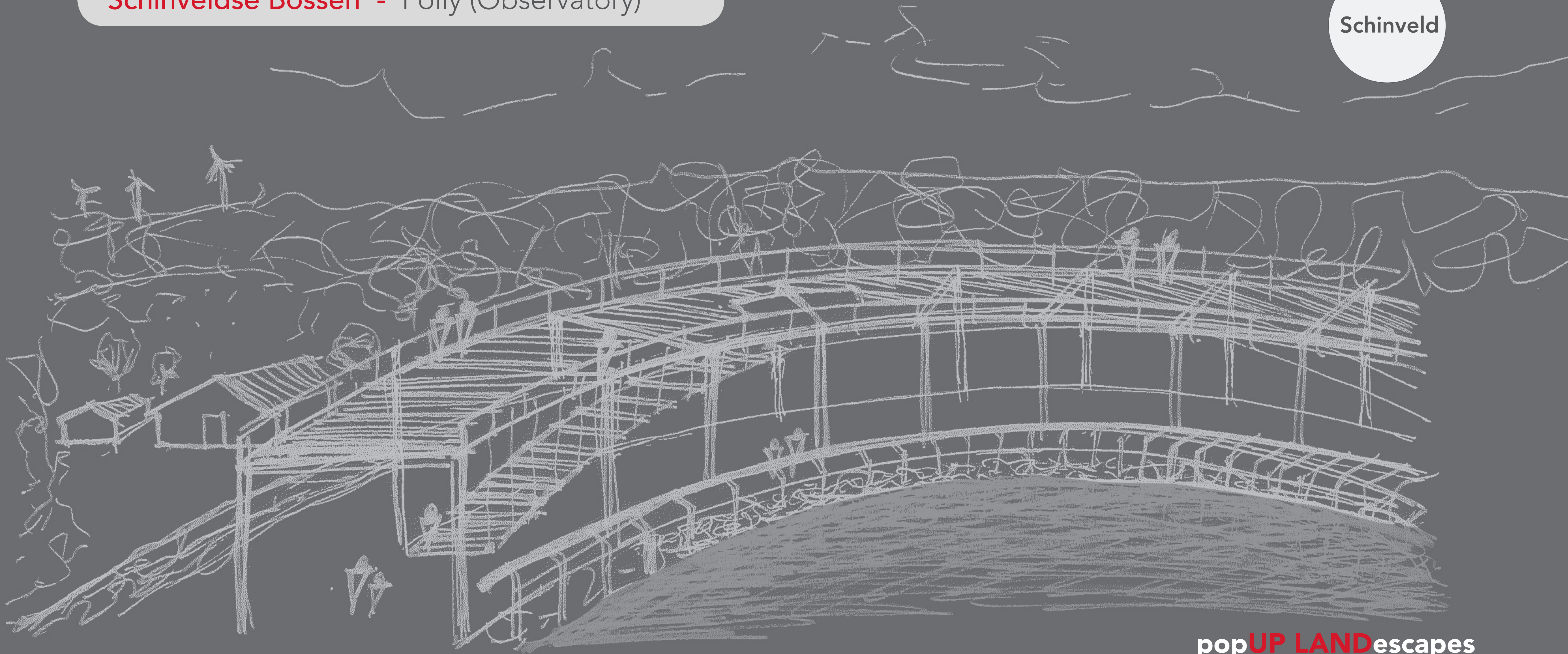
Grunsvenplein - Exhibition & Cultural Centre

Heerlen



Schinveldse Bossen - Folly (Observatory)

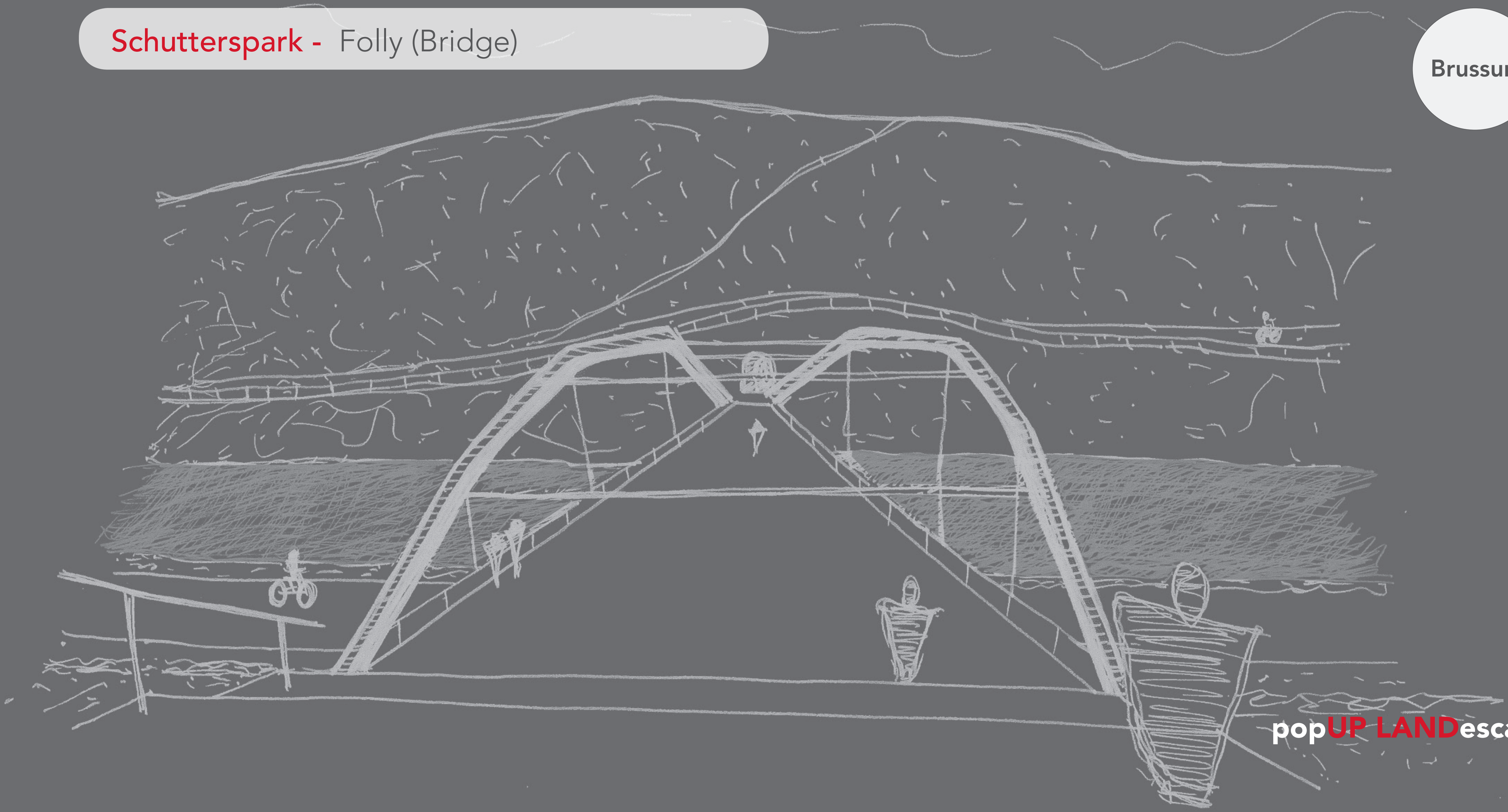
Schinveld



popUP LANDescapes

Schutterspark - Folly (Bridge)

Brussum



Content

01 **Introduction**
- Fascination
- Temporary Architecture
- Design Goal
- Design Question
- Thechnical Question

02 **Research**
- Methodology
- Problem statement
- Materials
- Sizes
- Connections
- Research x Design

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- Program
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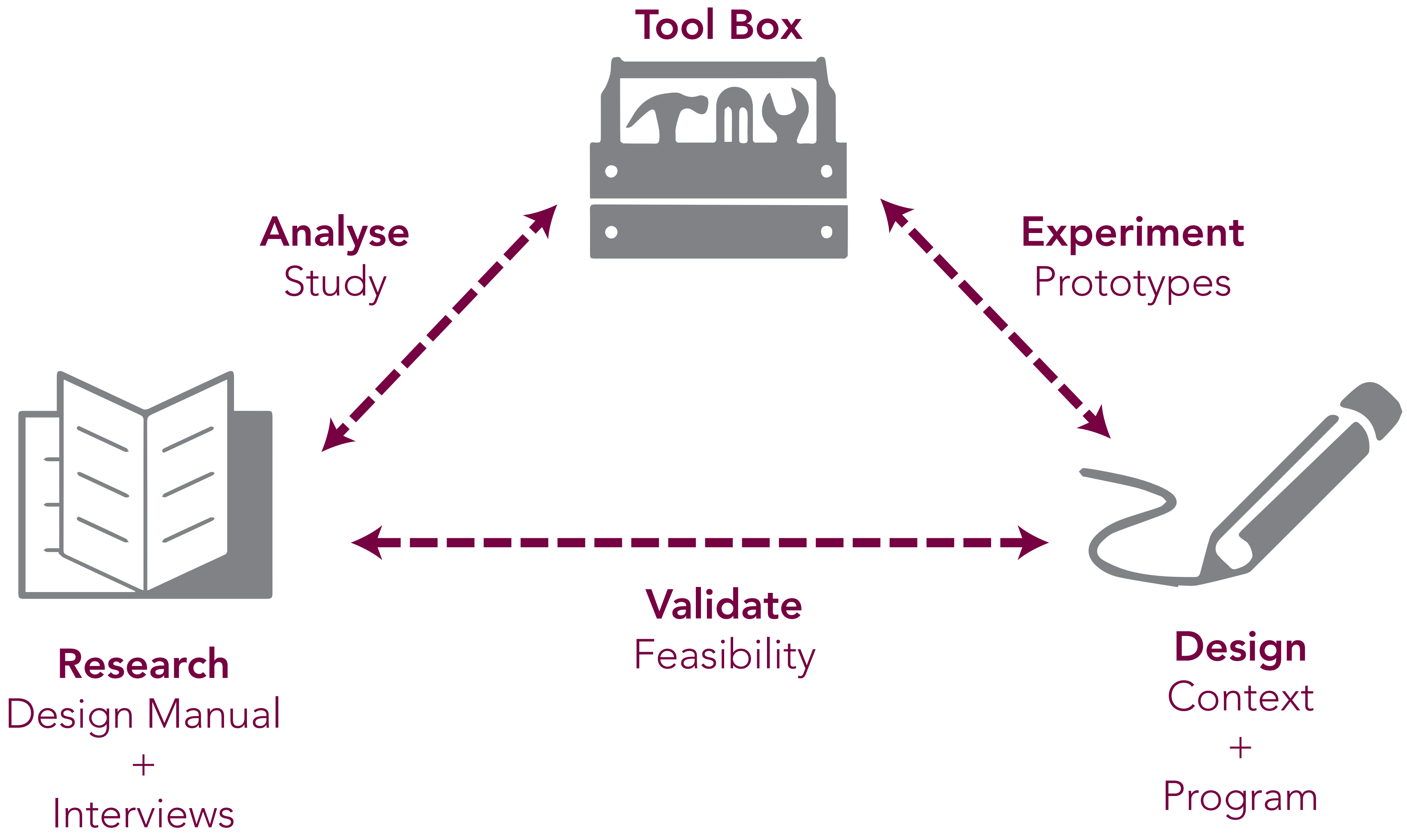
- Vision

04 **Next Steps**
- Strategy
- Planning
- Questions

04 Next Steps | Strategy



Tool Box

Analyse
Study

Experiment
Prototypes

Validate
Feasibility

Research
Design Manual
+
Interviews

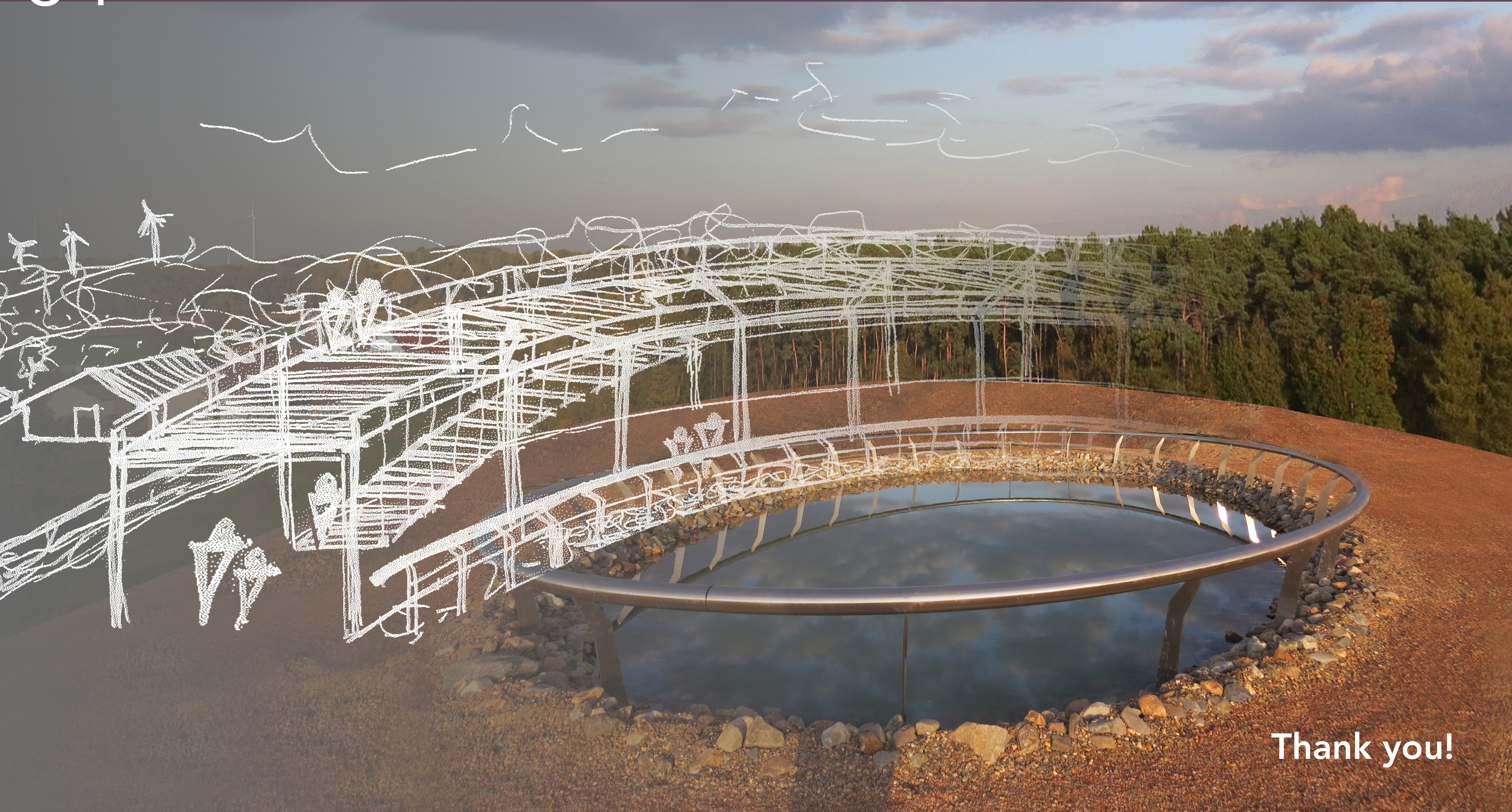
Design
Context
+
Program

04 Next Steps | Planning

MSc3		SEPTEMBER				OCTOBER					NOVEMBER				DECEMBER				JANUARY				
		05-Sep	12-Sep	19-Sep	26-Sep	03-Oct	10-Oct	17-Oct	24-Oct	31-Oct	07-Nov	14-Nov	21-Nov	28-Nov	05-Dec	12-Dec	19-Dec	26-Dec	02-Jan	09-Jan	16-Jan	23-Jan	30-Jan
Others:	Research Methods	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	Paper 03/11	🟧	🟧	Paper 24/11	🟧	🟧	Paper 15/12		▨	▨		▨		
	TiSD											TiSD	TiSD	TiSD	TiSD	TiSD	TiSD	▨	▨		TiSD		
	Holiday																??	Christmas	Christmas				
																		▨	▨		▨		
Studio:	Graduation Plan	Pavillion	Poster	Grad Plan	Grad Plan				Grad Plan									▨	▨	Grad Paper	▨		
	Research				🟧	🟧	🟧	🟧		🟧	🟧	🟧	🟧	🟧				▨	▨		▨		
	Case Studies					🟧	🟧			🟧	🟧							▨	▨		▨		
	Site Visits								Amsterdam?			IBA Site						▨	▨		▨		
	Design					🟧	🟧	🟧			🟧	🟧	🟧	🟧	🟧			▨	▨		▨		
	Presentation Preparation						🟧	🟧							🟧	🟧		▨	▨	🟧	▨		
	Presentation								P1									▨	▨		▨	P2	
	Presentation Reflection									🟧								▨	▨		▨		🟧
	Modeling												🟧	🟧				▨	▨		▨		
	Analysis														🟧			▨	▨		▨		

MSc4		FEBRUARY				MARCH				APRIL				MAY					JUNE				
		06-Feb	13-Feb	20-Feb	27-Feb	06-Mar	13-Mar	20-Mar	27-Mar	03-Mar	10-Mar	17-Mar	24-Mar	01-May	08-May	15-May	22-May	29-May	05-Jun	12-Jun	19-Jun	26-Jun	03-Jul
Others:		▨																					
	TiSD	▨																					
	Holiday	Break																					
		▨																					
Studio:	Building Technology	▨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧								
	Research	▨	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧												
	Case Studies	▨																					
	Site Visits	▨																					
	Design	▨			🟧	🟧	🟧	🟧				🟧	🟧	🟧	🟧								
	Presentation Preparation	▨					🟧	🟧					🟧	🟧	🟧				🟧	🟧	🟧	🟧	
	Presentation	▨							P3							P4							P5
	Presentation Reflection	▨								🟧							🟧						
	Modeling	▨									🟧	🟧						🟧	🟧				
	Analysis	▨											🟧										

04 Questions



Thank you!