

# SymbioSys

A Low-tech, Three-dimensional, Circular, Façade  
Cladding System which Utilises Waste Materials  
and Fosters Local Urban Biodiversity

P5 Final Presentation | Building Technology Graduation

Marilse Nouws | 31/10/2023

# Introduction

# Global climate change



***Rising temperature***



***Excessive GHG emissions***



# Global climate change



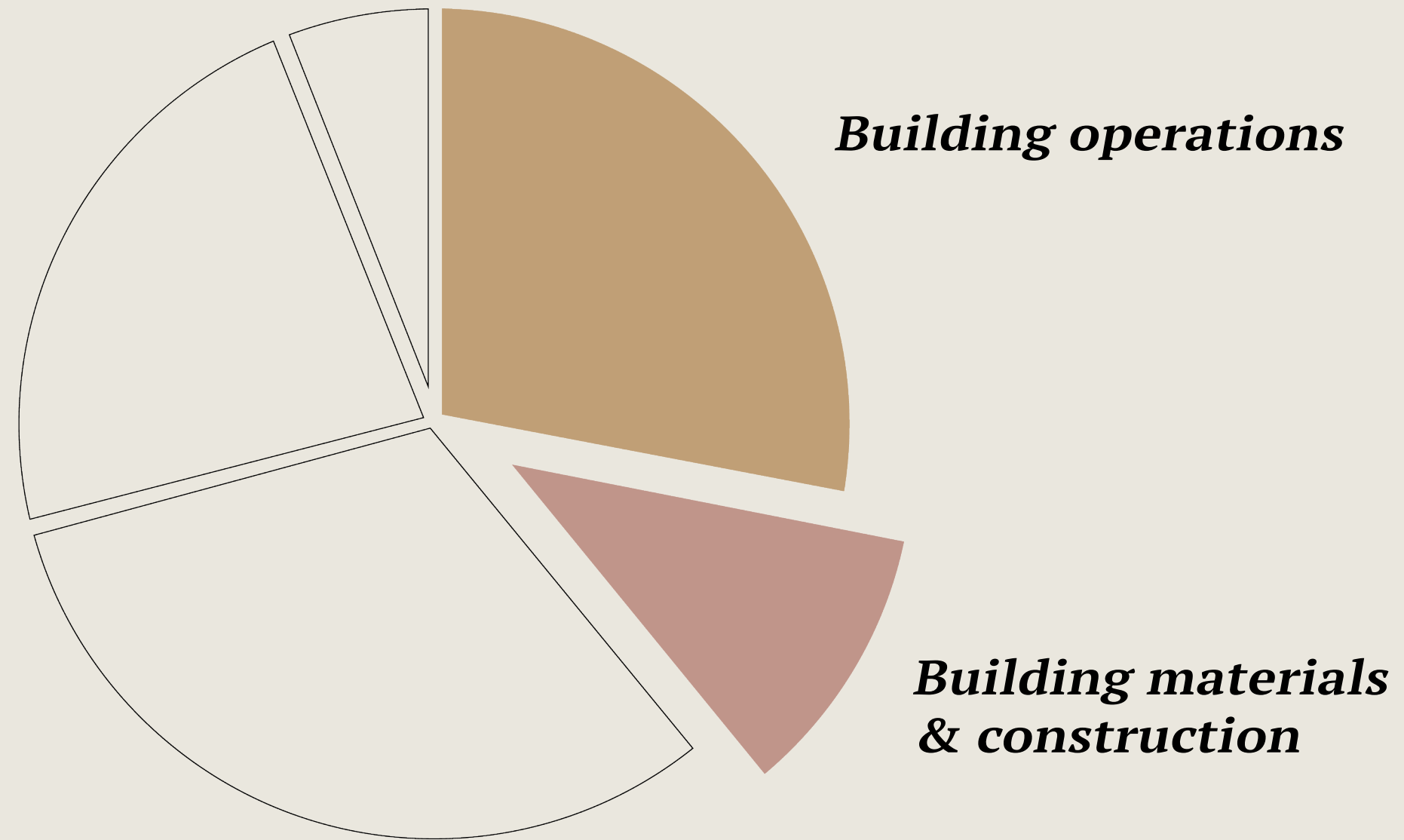
*Rising temperature*



***Excessive GHG  
emissions***



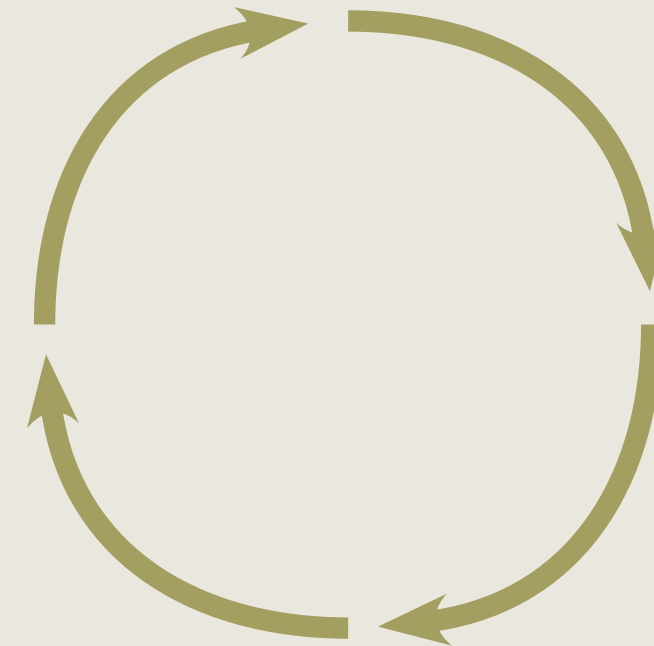
# Global emissions



# Shifting towards circular design strategies



***From linear***



***To circular***

Introduction



# Global climate change



***Rising temperature***

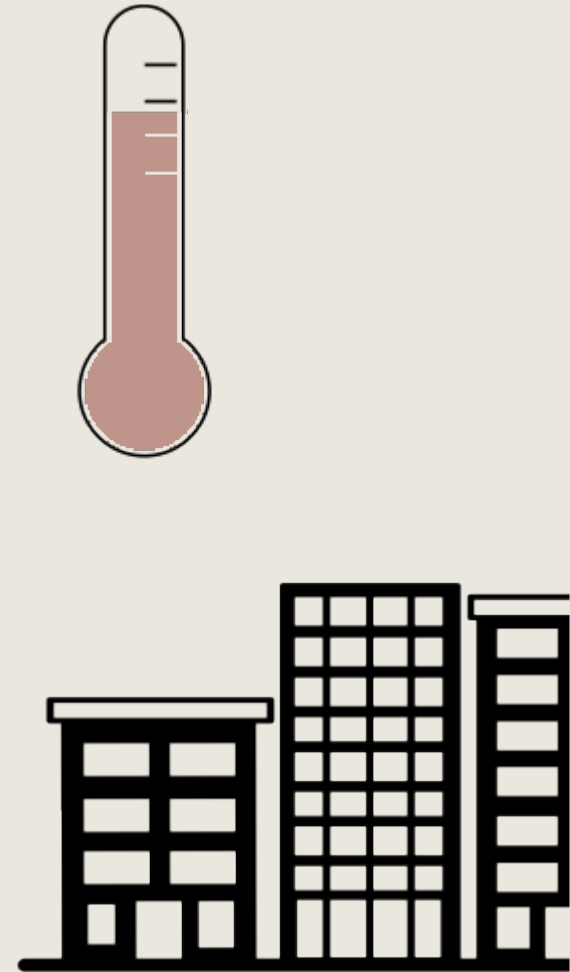


***Excessive GHG  
emissions***

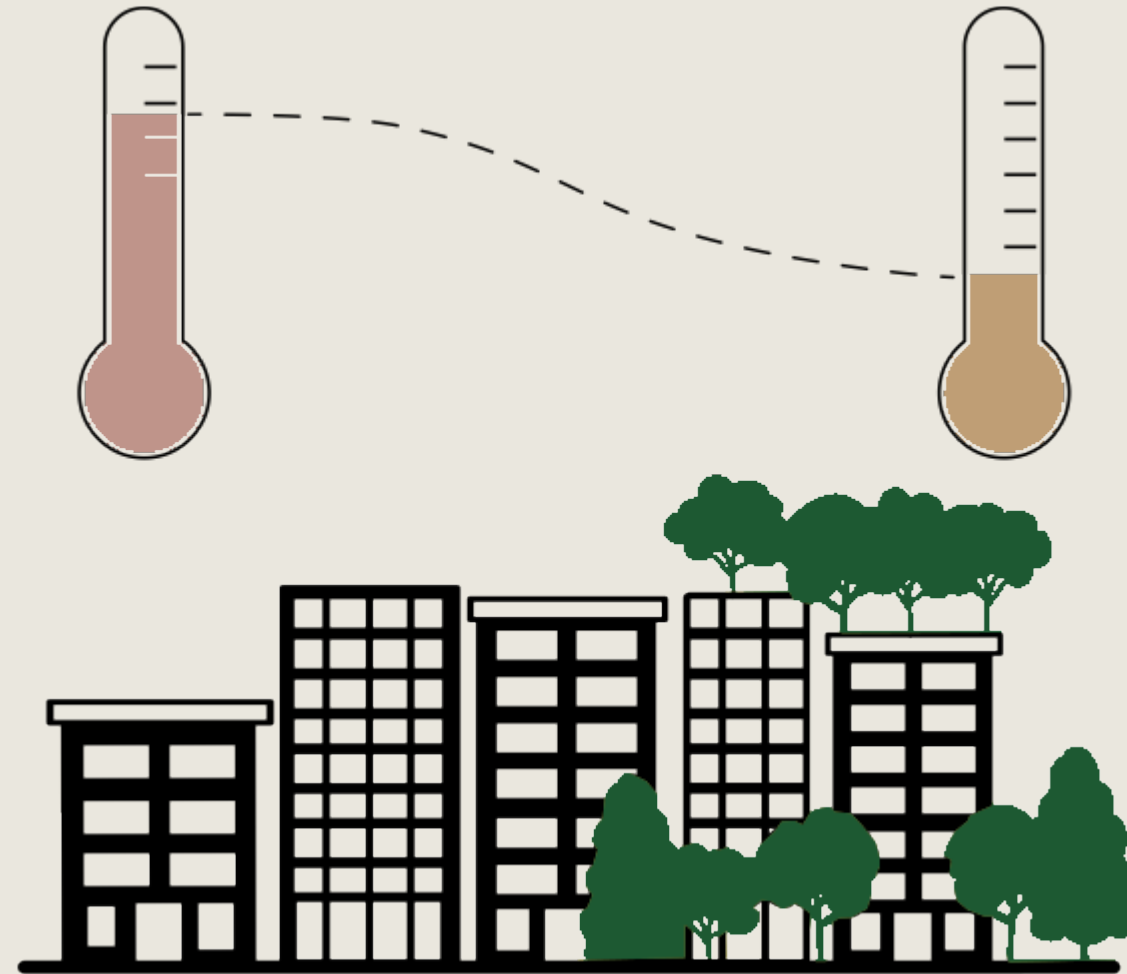
Introduction



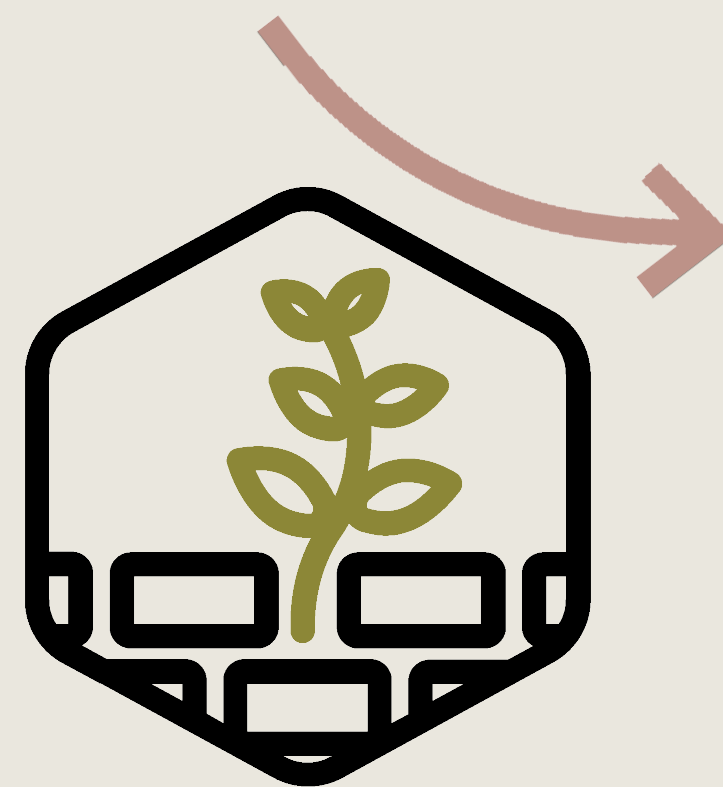
# Urban heat island effect



# Mitigated by urban nature



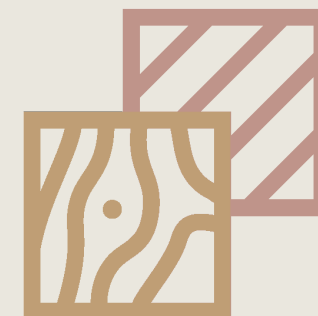
# Urbanisation



Introduction

# Main objective

*Design a **low-tech**, three-dimensional, **circular** façade cladding system (product) utilising **waste materials** and which fosters **biodiversity** in urban environments in the Netherlands*

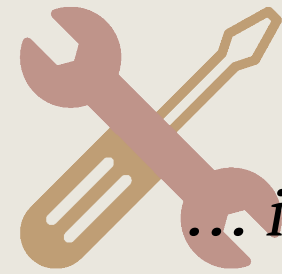


Introduction





# A low-tech system ...



... increases its **approachability**

... creates **awareness** by involving people

... has **educational potential** for children



# Research question

***“How can a low-tech, three-dimensional, circular façade cladding system be made *utilising waste materials* and *fostering biodiversity* in urban areas in the Netherlands?”***

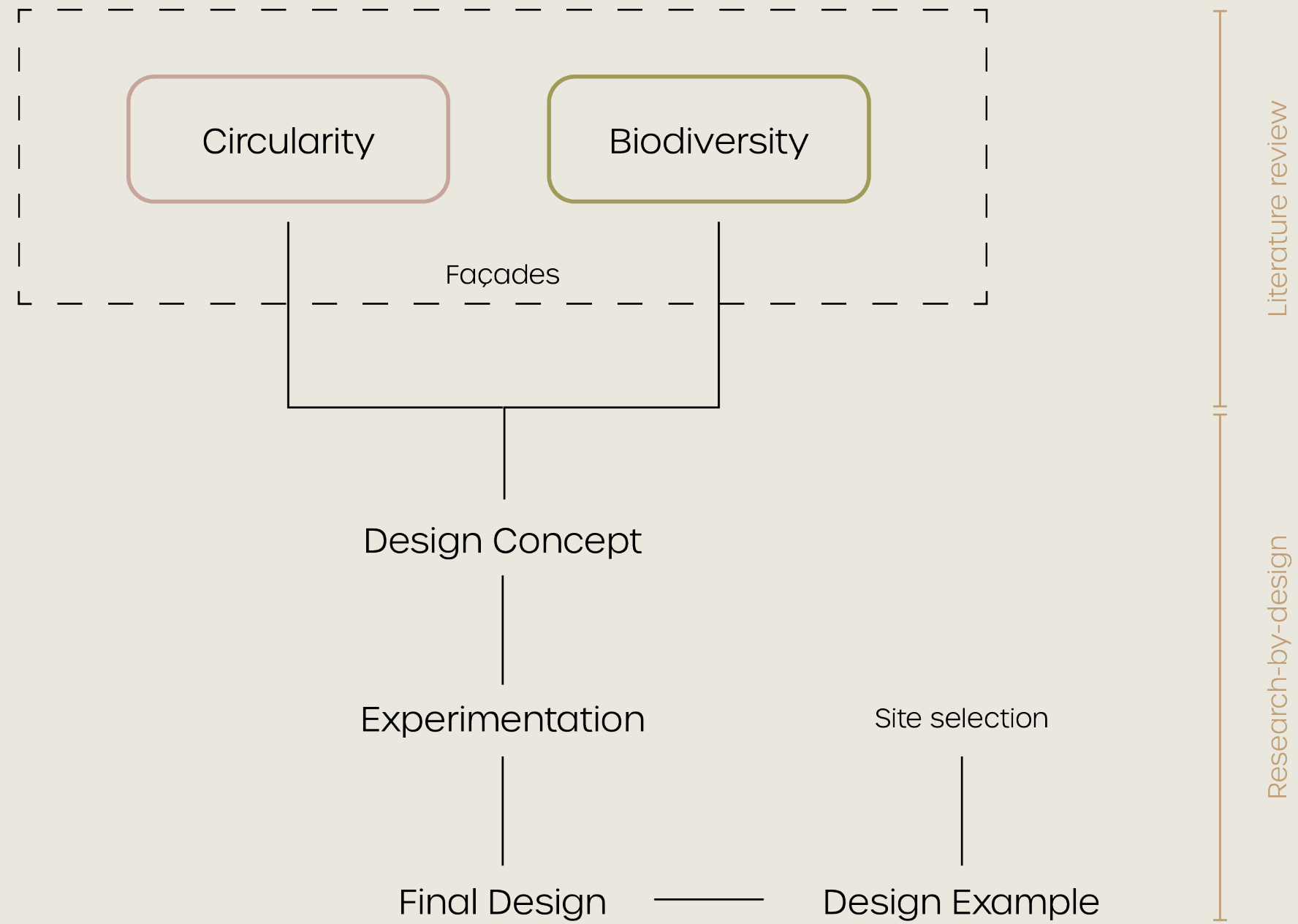


# Design question

*“How can various **biodiversity fostering functions** be implemented in a three-dimensional, circular façade cladding system, designed according to **low-tech design principles**, aiming to foster local biodiversity in urban areas in the Netherlands?”*



# Methodology



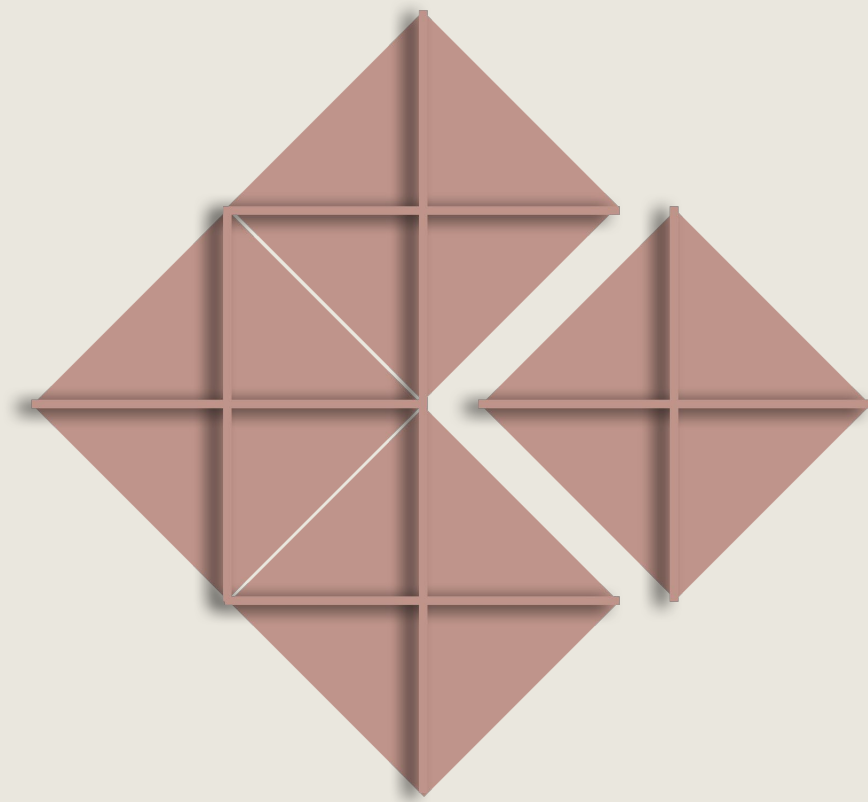
Introduction



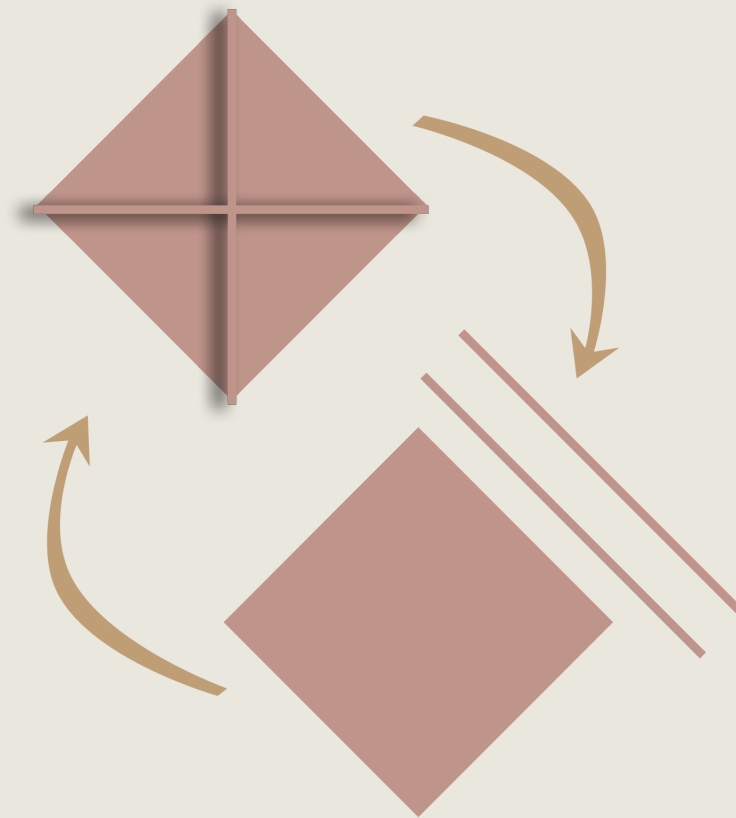


# Design Concept

# Circular design approaches



***Modularity***

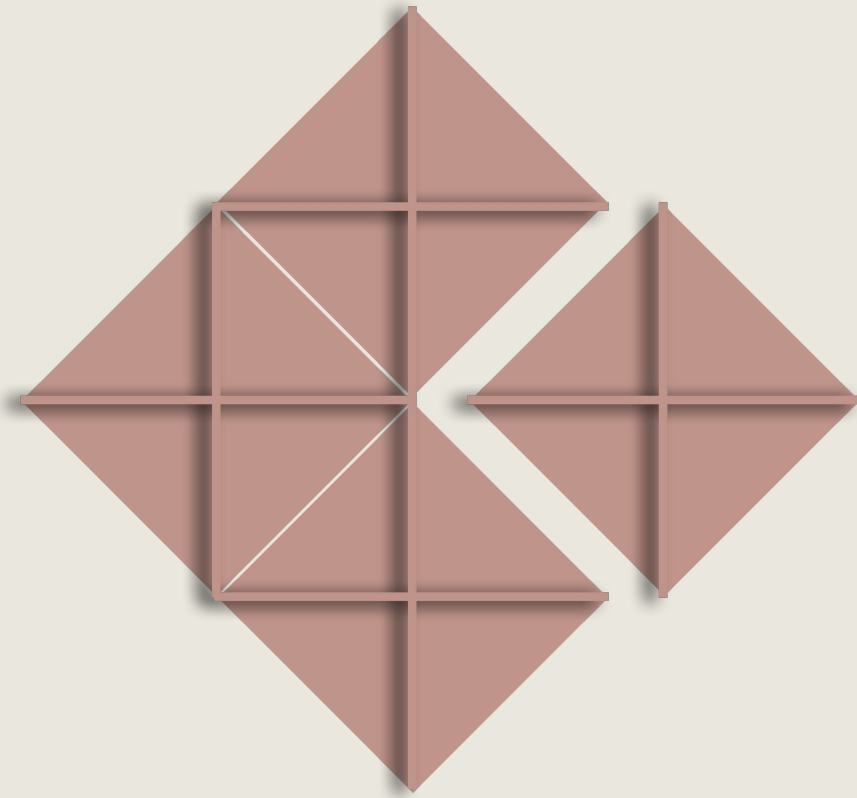


***Design for Disassembly***

Design Concept



# Circular design approaches



***Modularity***

***Standardisation***

***Replace and repair  
single modules***

***Various configurations***

Design Concept



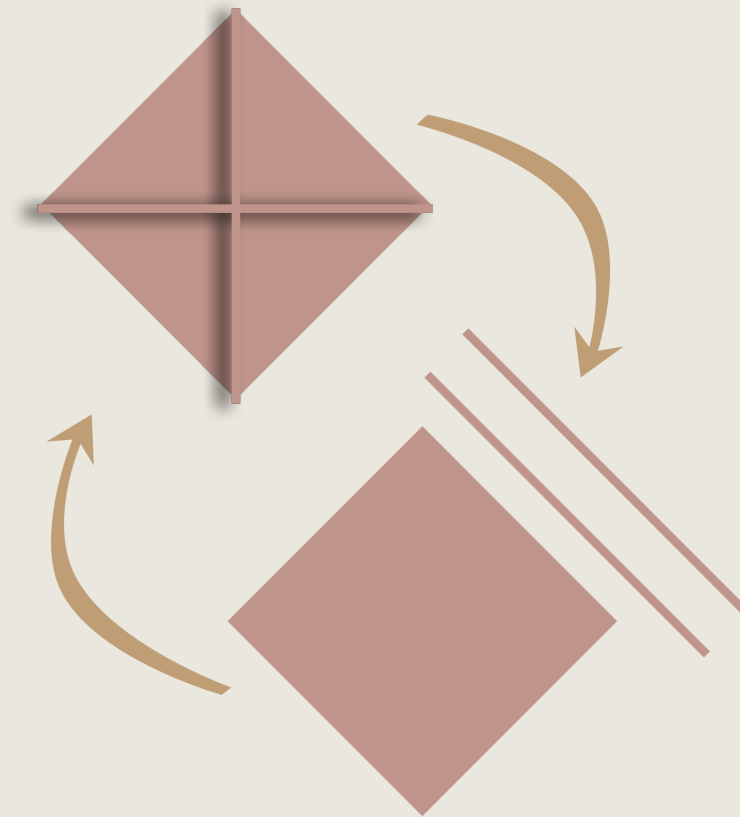


# Circular design approaches

*Facilitate change and  
dismantlement*

*Recover components  
and materials*

*Reuse, reassemble and  
recycle*

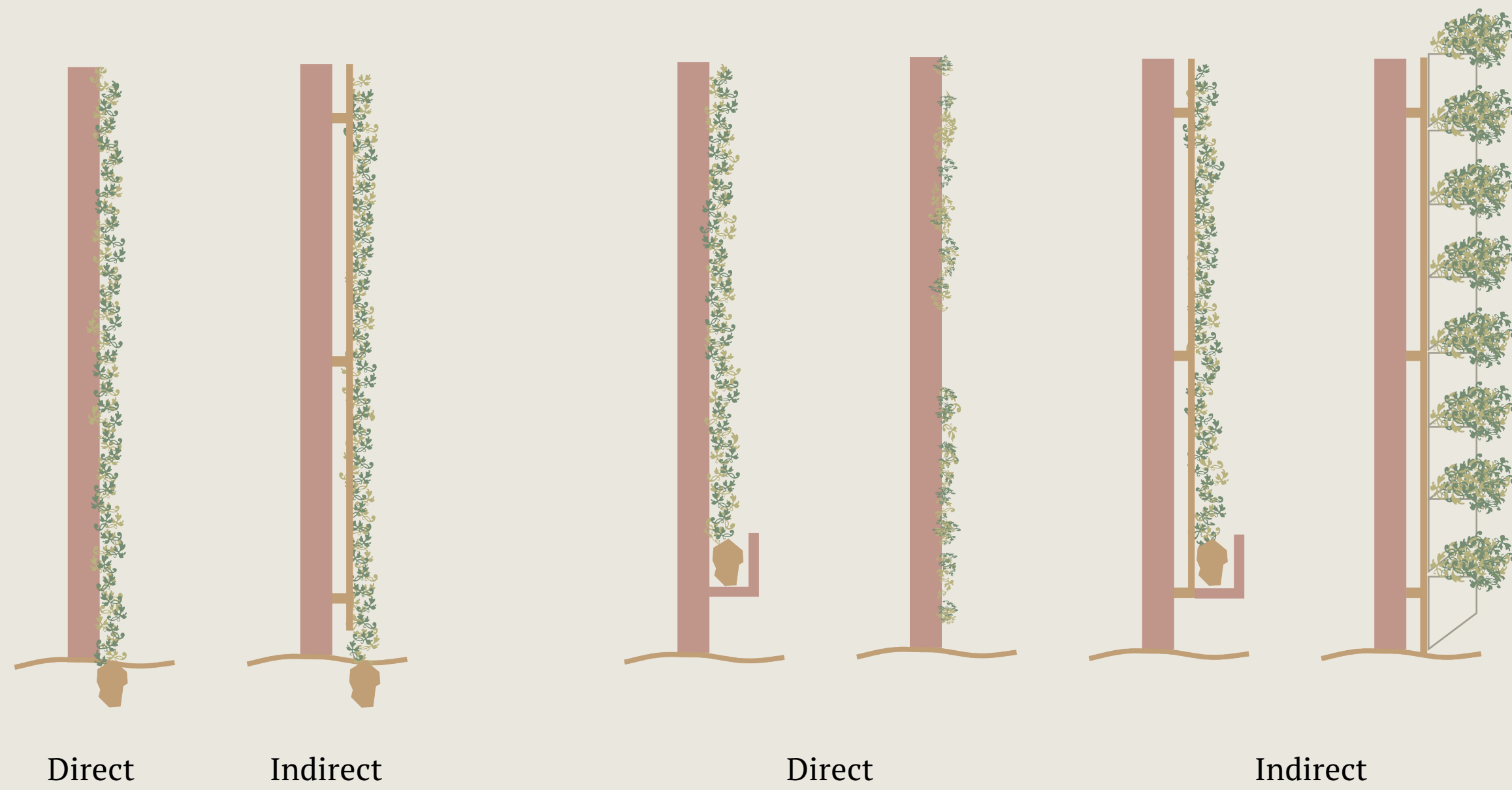


*Design for Disassembly*

Design Concept



# Green wall typologies



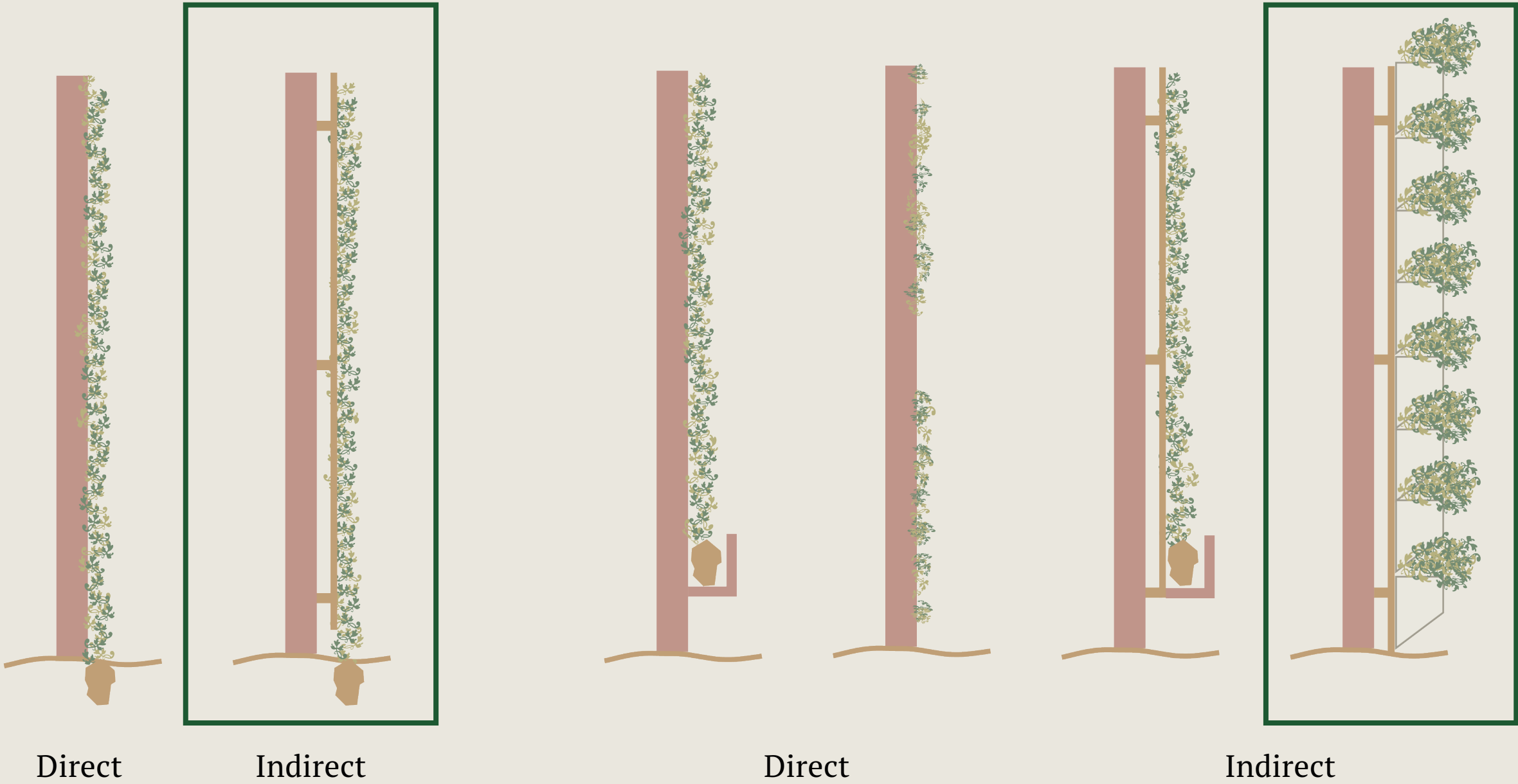
*Green facades*

*Living walls*

Design Concept



# Green wall typologies

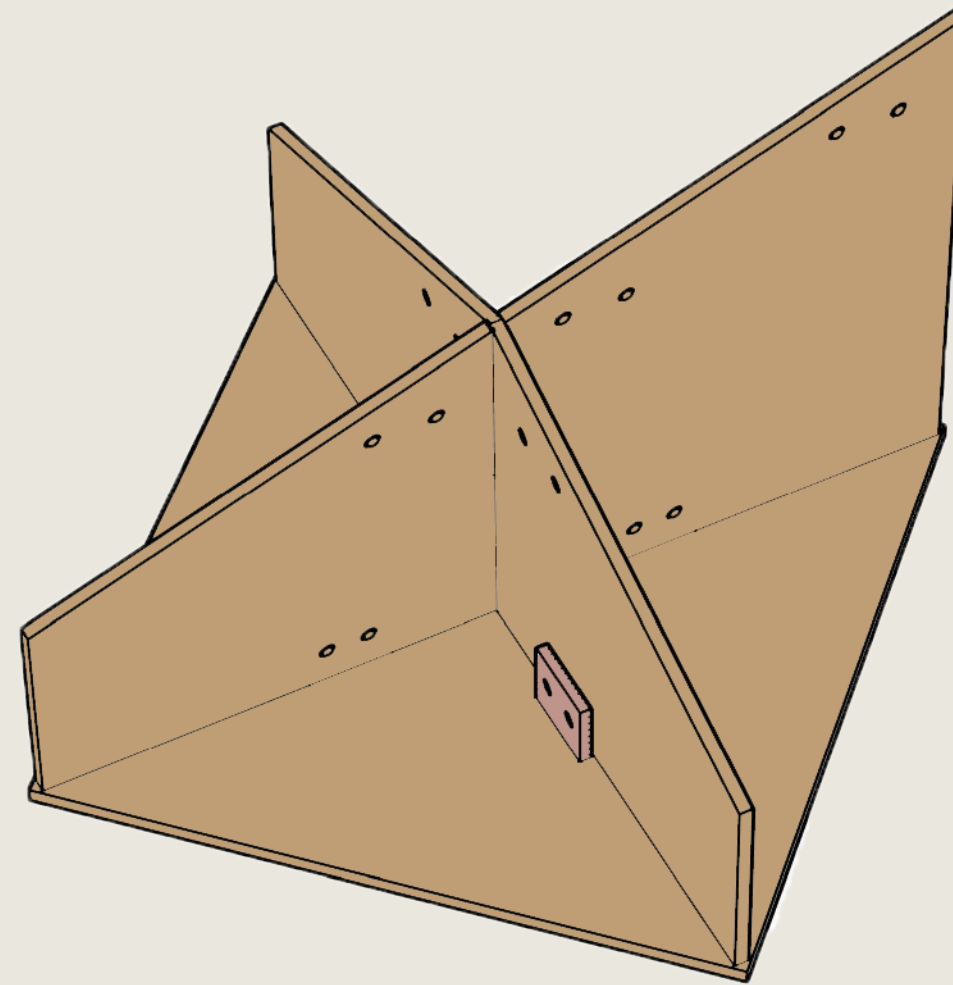


*Green facades*

*Living walls*

Design Concept

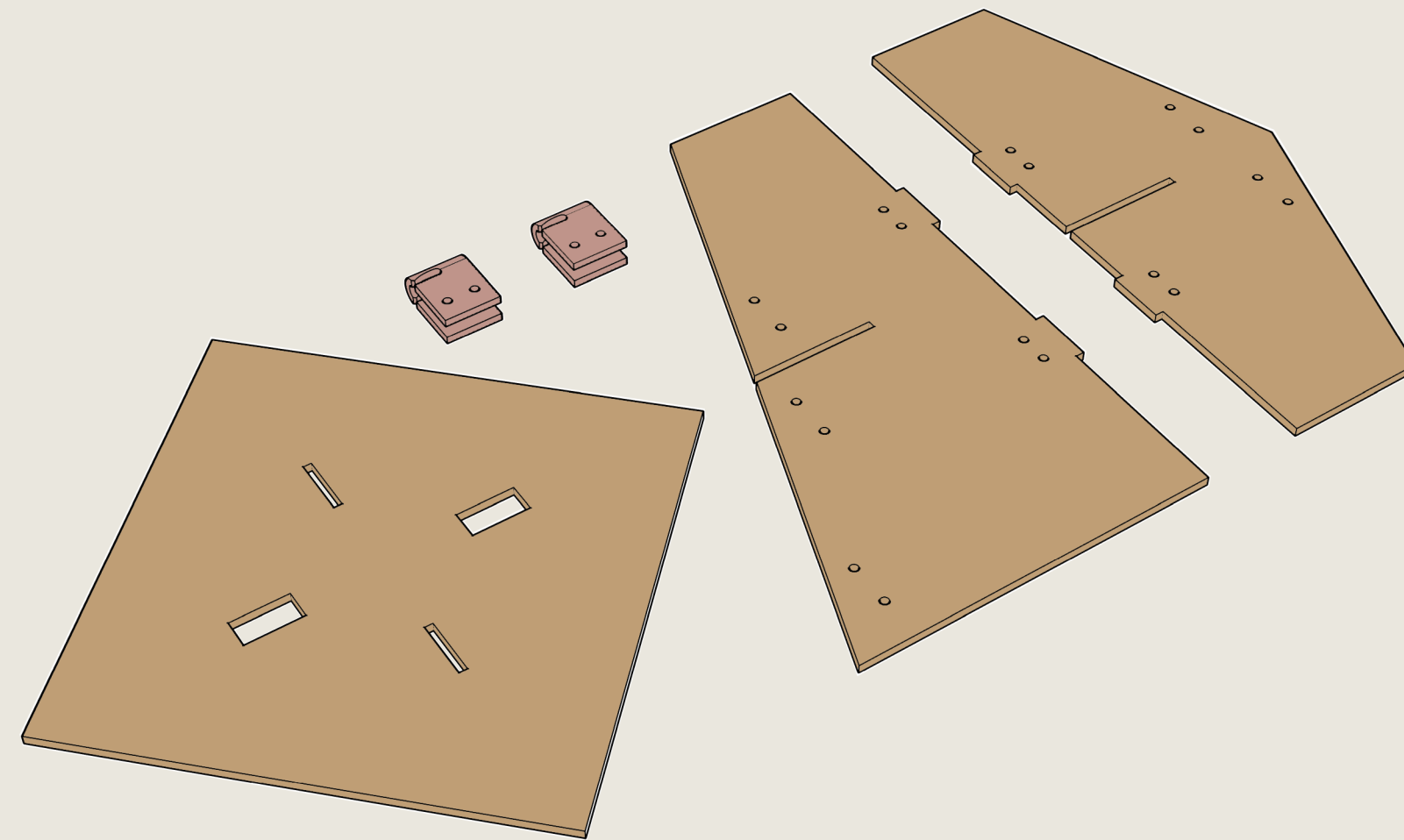
*Is a circular façade **system** that consists of modular **modules** ...*



Design Concept



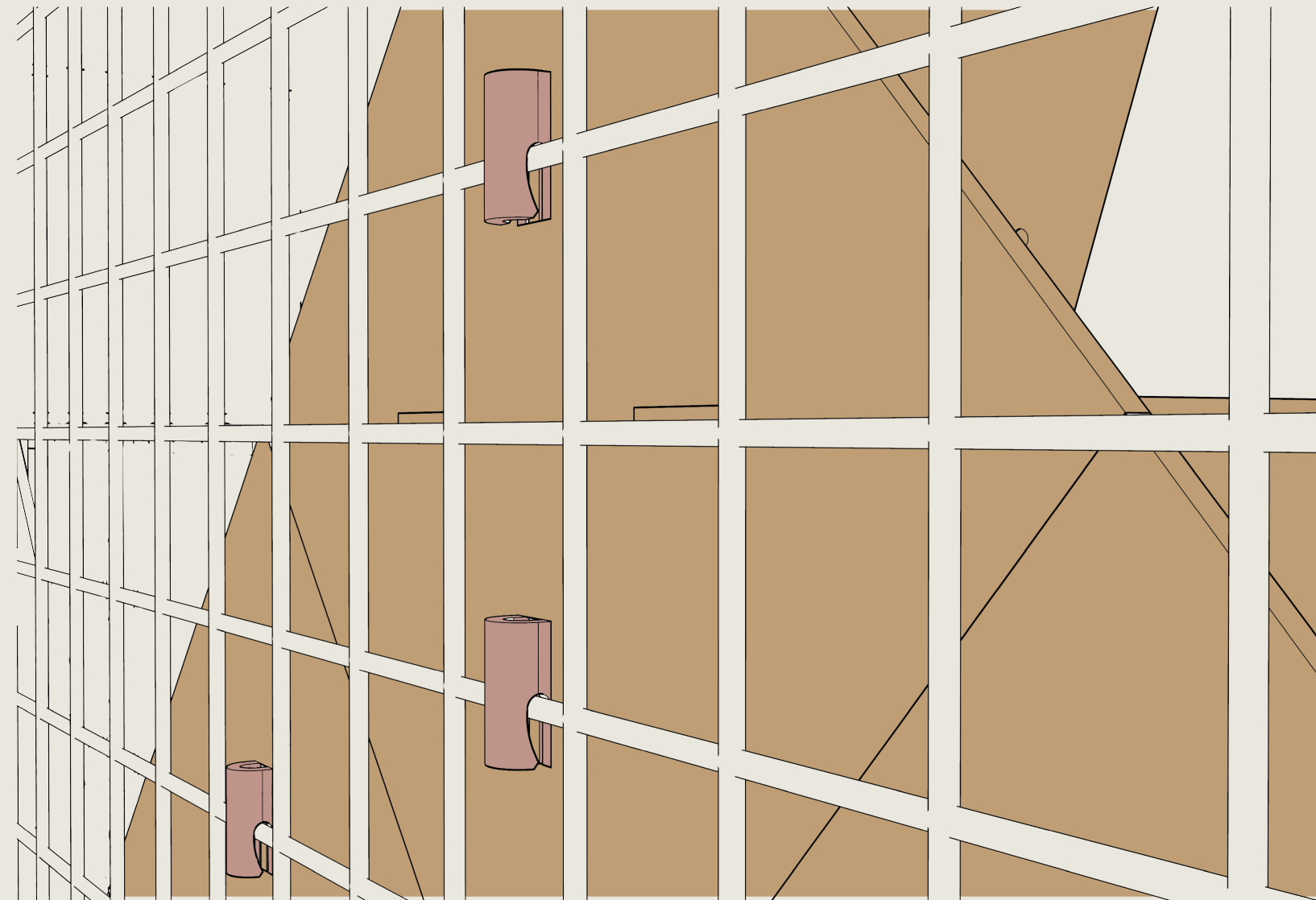
*... made from two-dimensional **elements** ...*



Design Concept

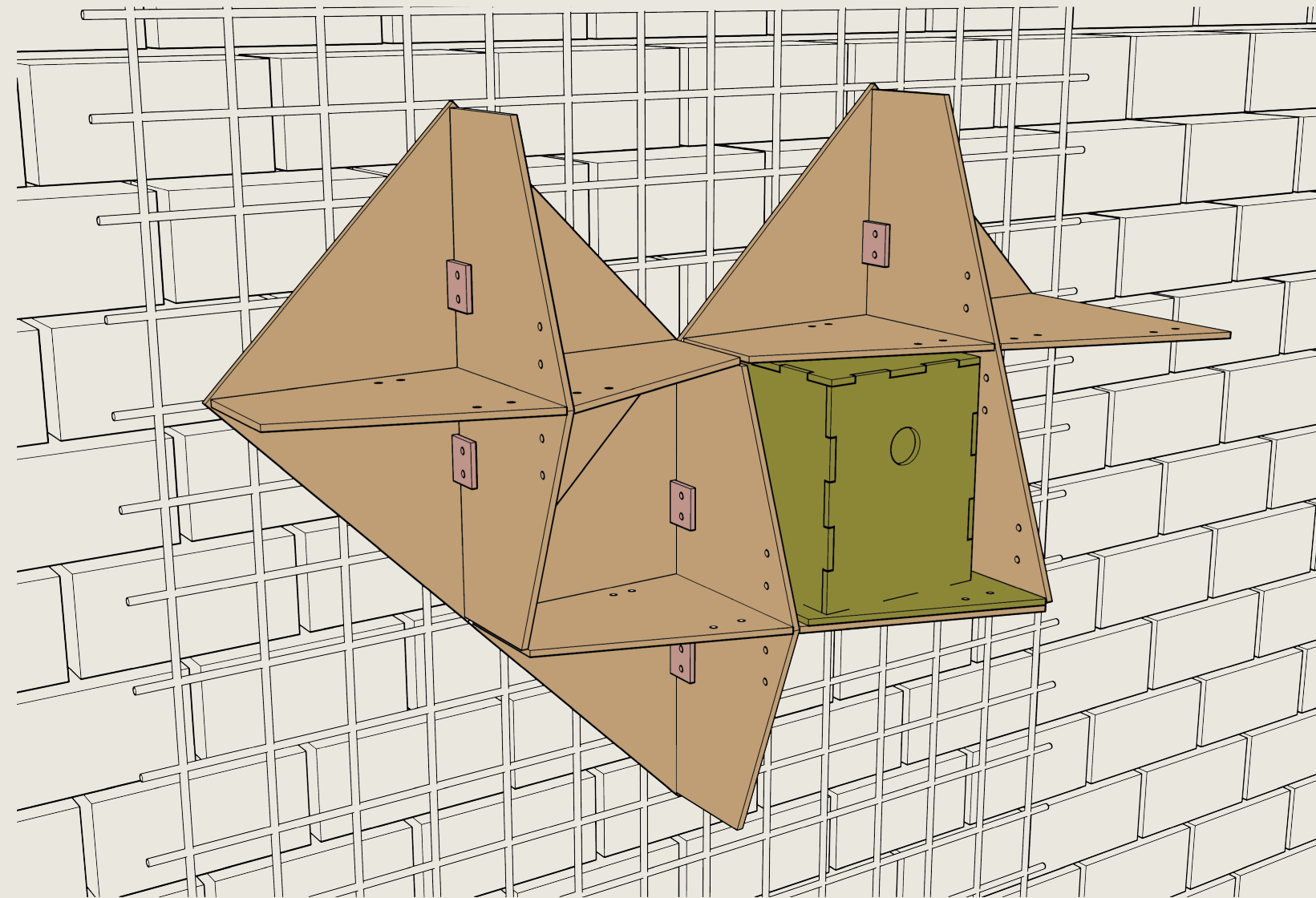


*... which are attached to a **secondary grid structure** fixed on the façade.*



Design Concept

*These modules are filled with the so-called **BioPods**.*



Design Concept

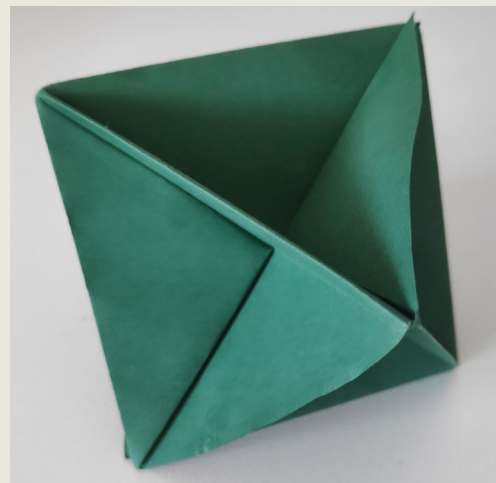


# The Design

# The Modules

# The shape

*From a paper origami model...*

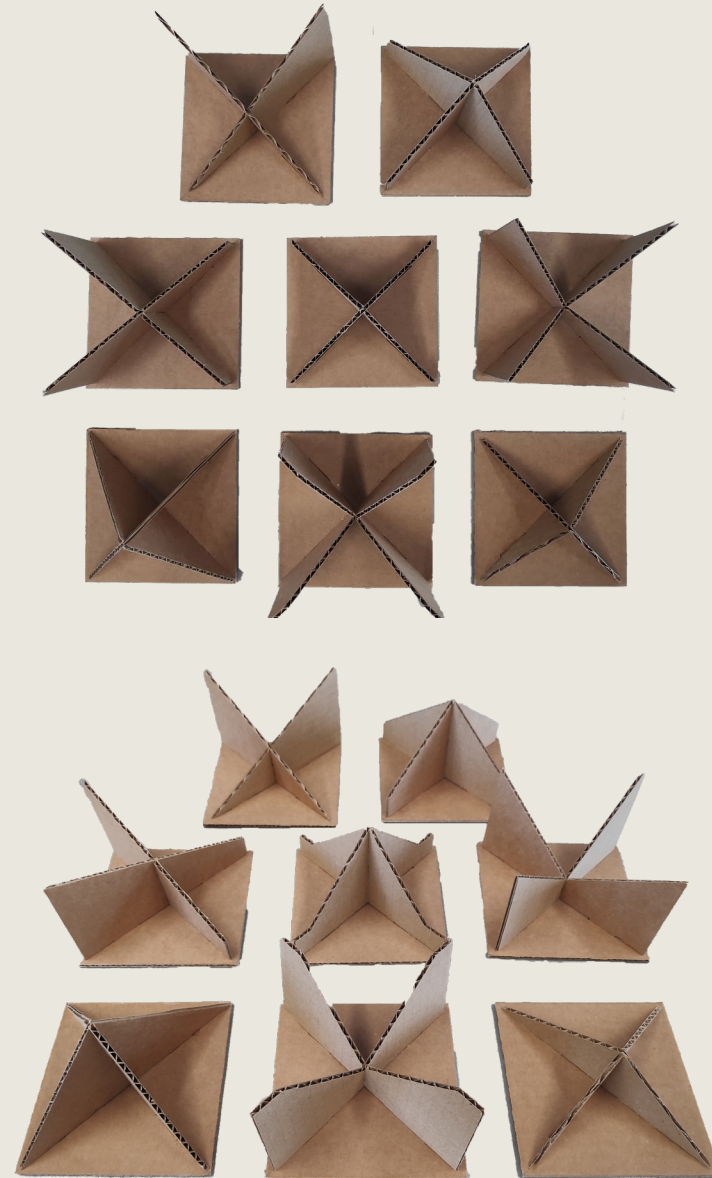
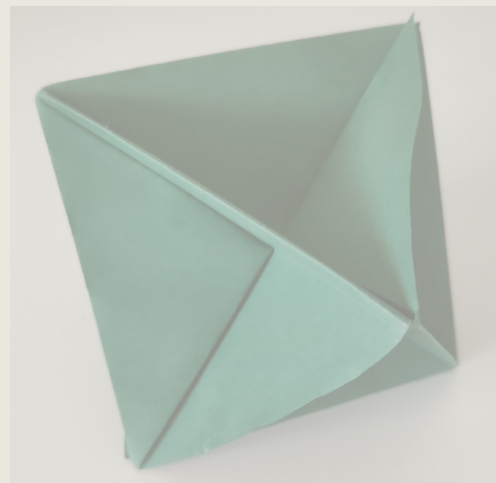


The Design



# The shape

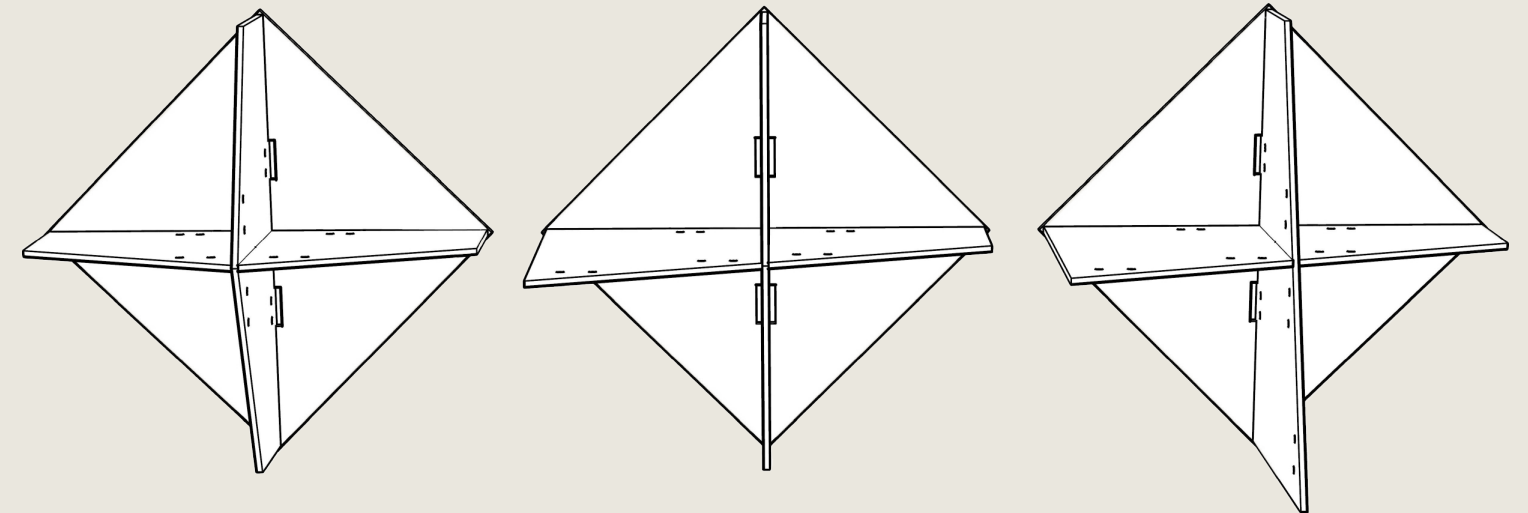
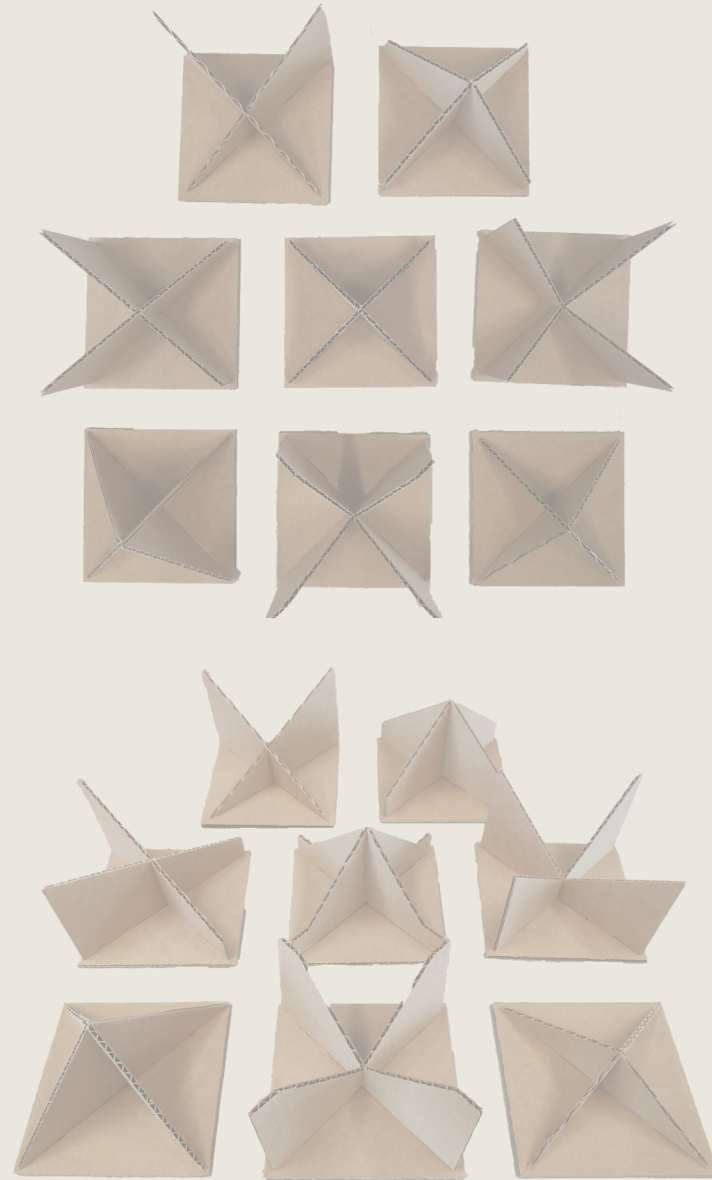
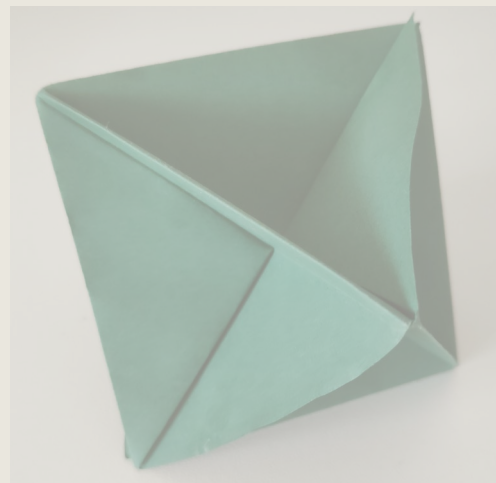
*... to shape experimentations...*



The Design

# The shape

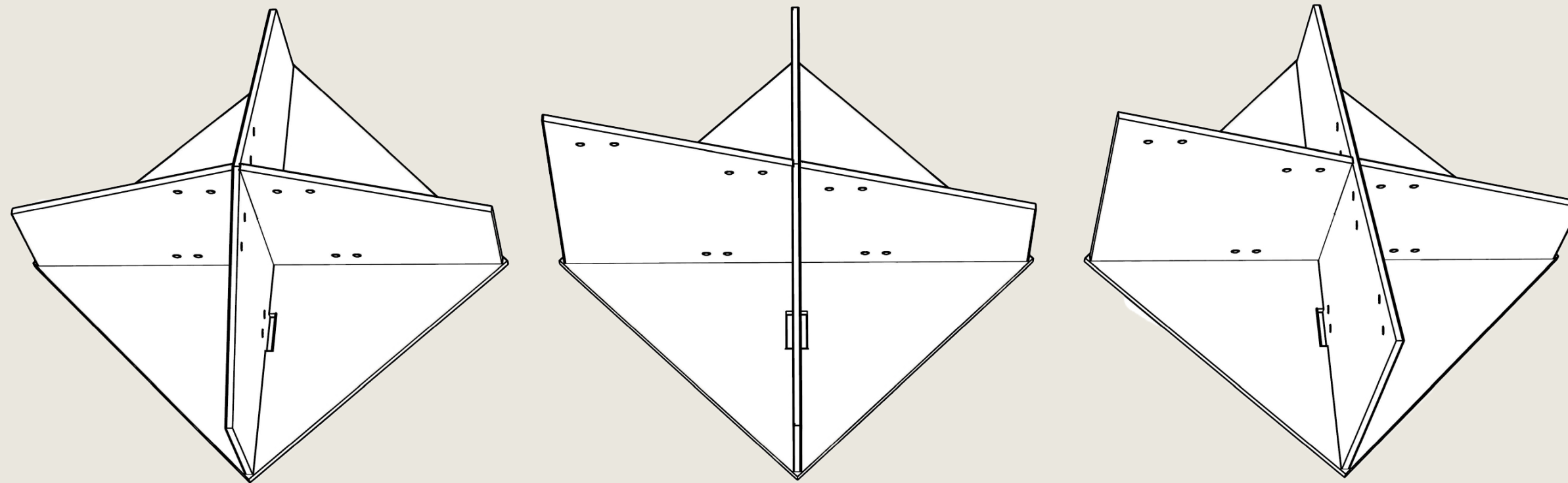
*... leading to the final modules*



The Design

# The principle

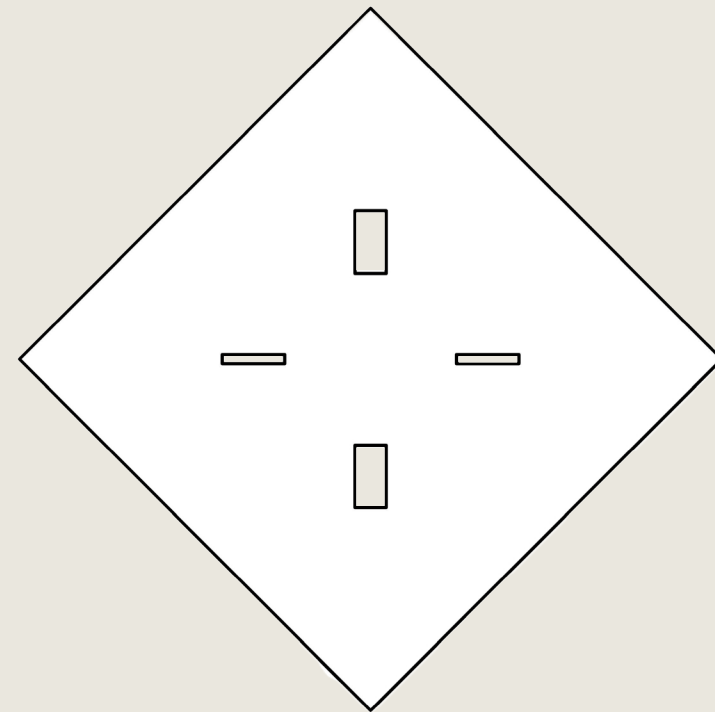
## *Three standardised modules*



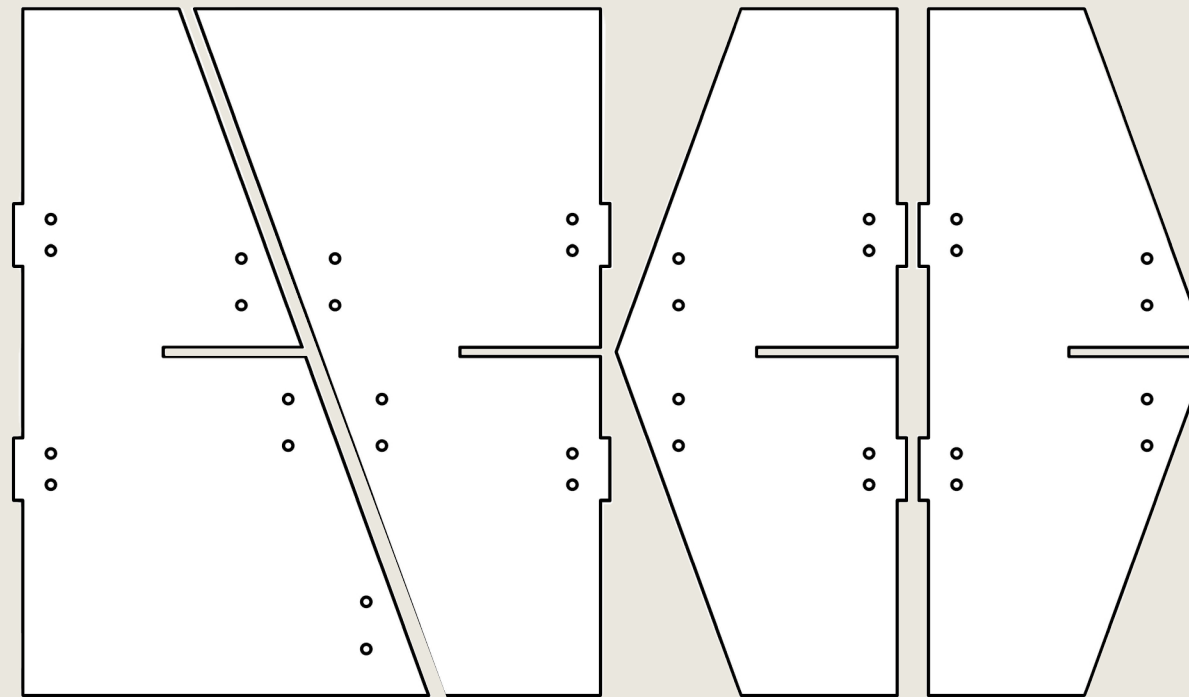
The Design

# The principle

*Constructed from five standardised components*



*Base element*



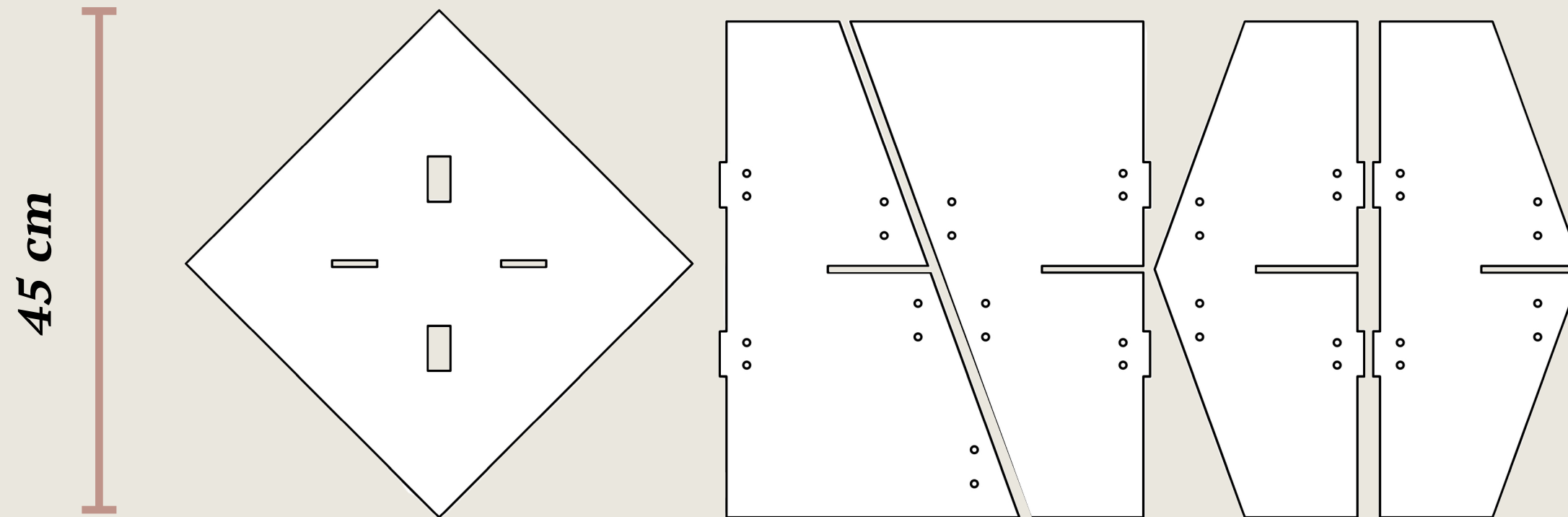
*Perpendicular elements*

The Design



# The size

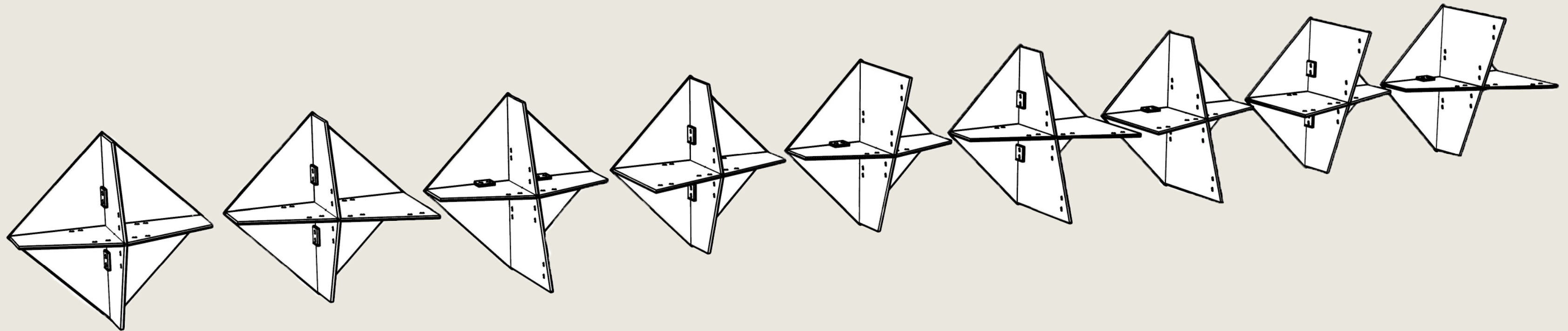
*Manageability for users  
& Biodiversity species' requirements*



The Design

# The principle

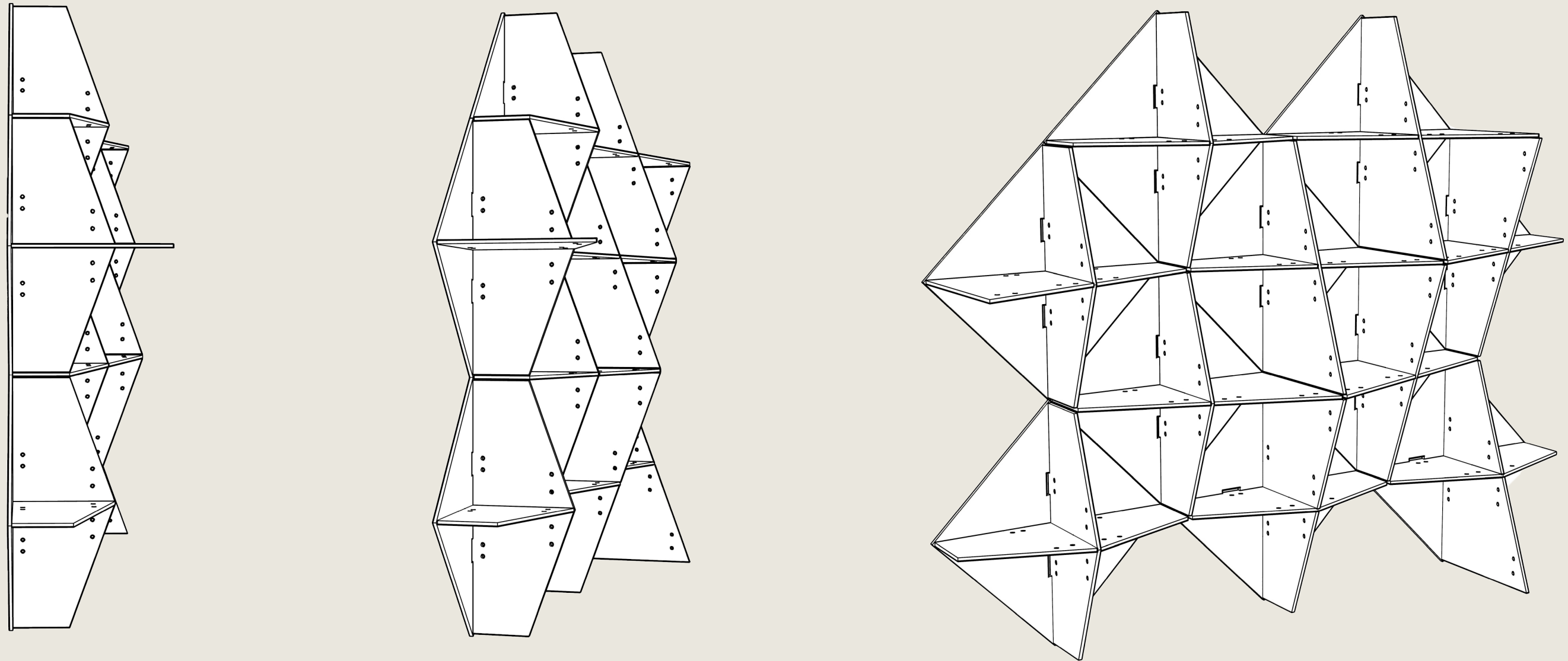
*Enabling nine unique orientations*



The Design

# The principle

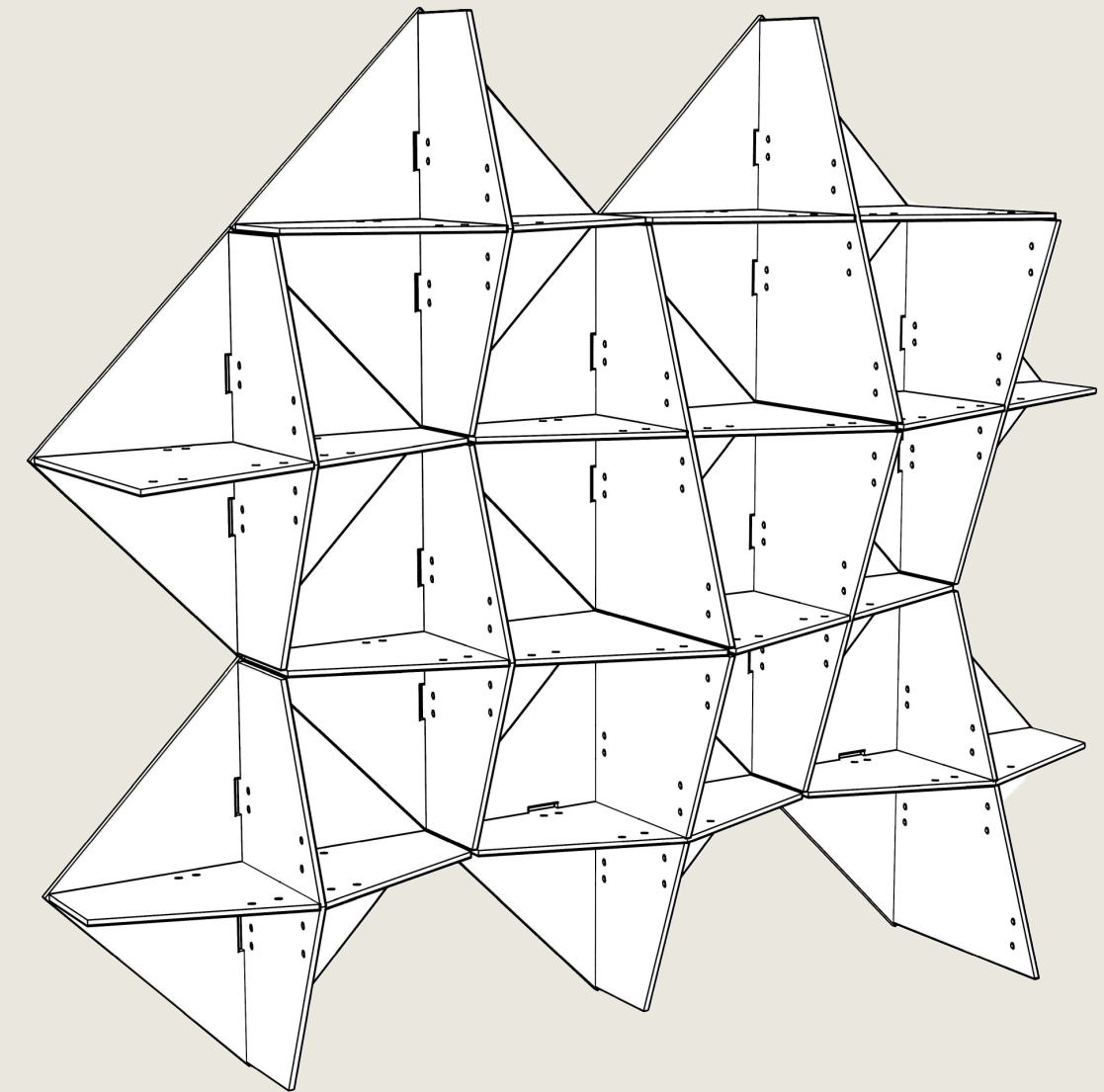
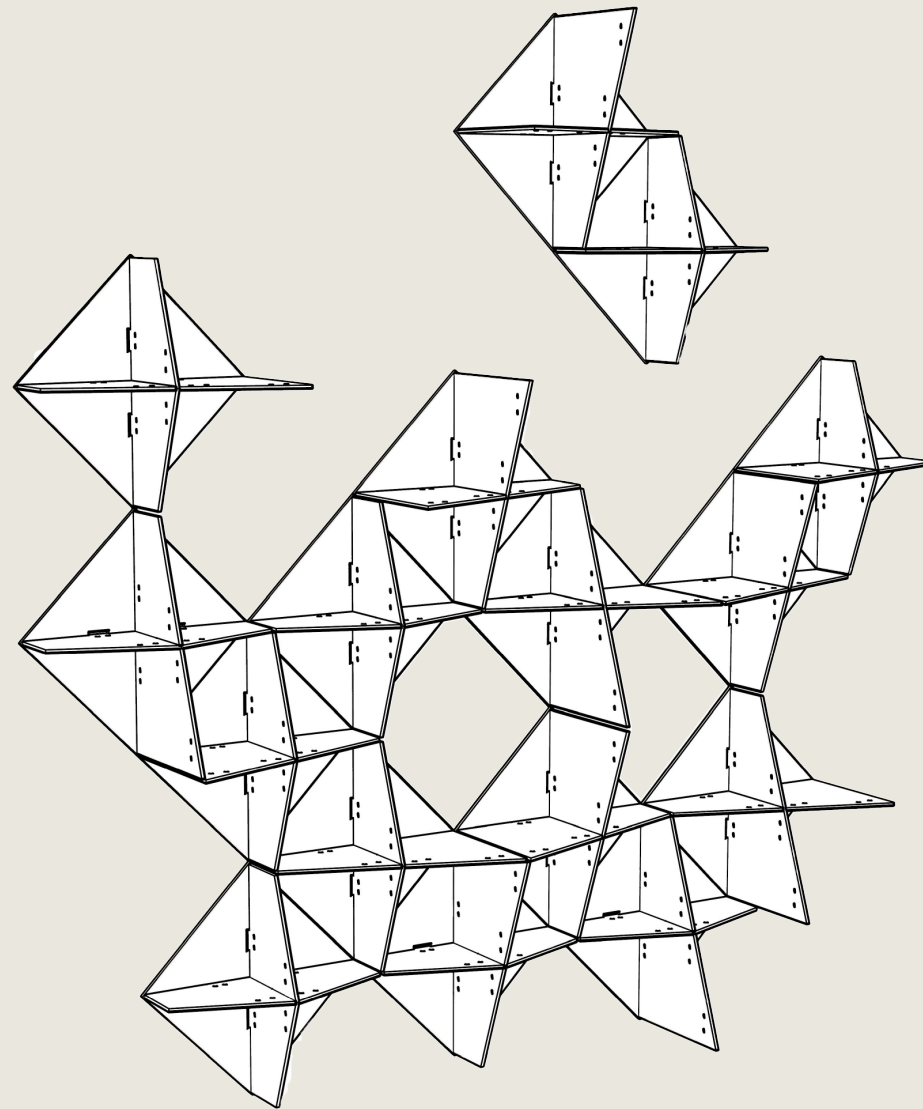
## *Generating an intriguing 3D language*



The Design

# The principle

*Endless configurations create  
various inner spaces*

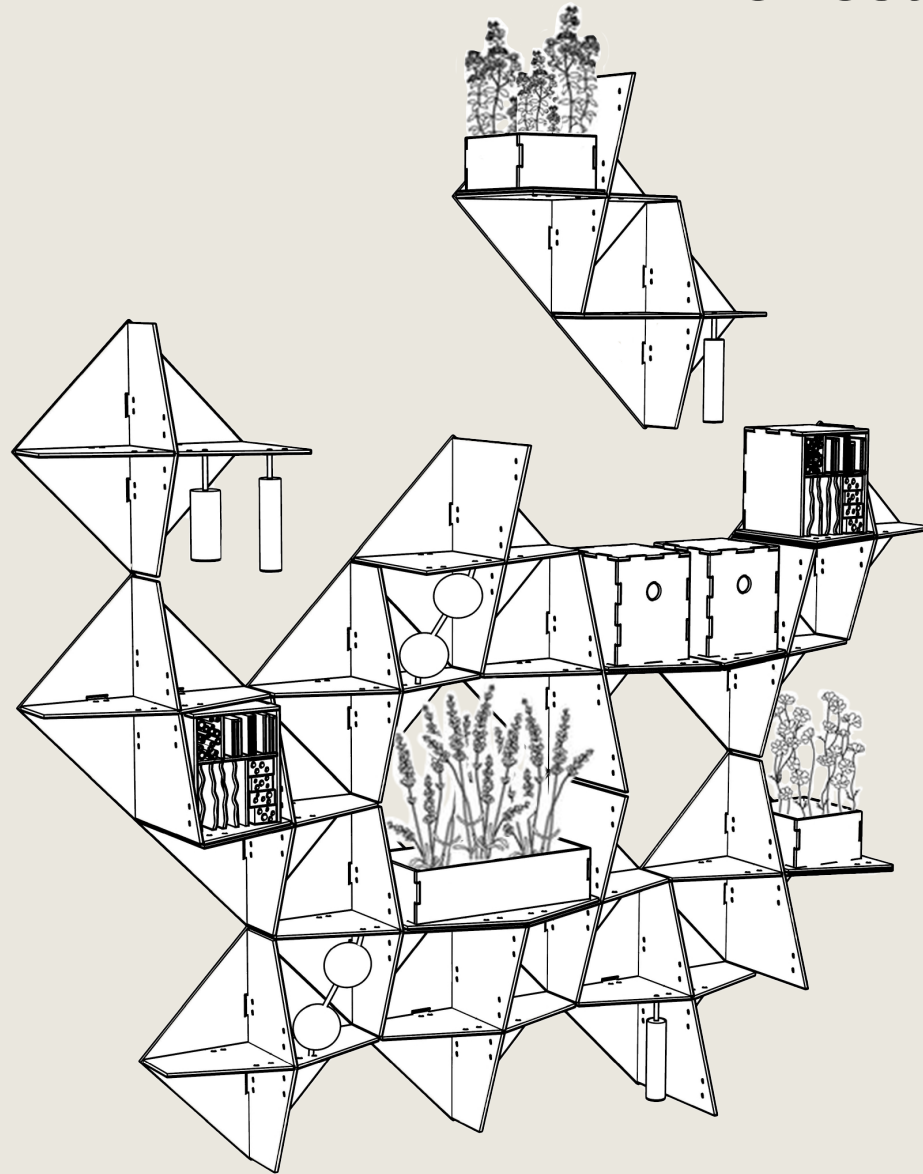


The Design



# The principle

*To foster urban flora and fauna*



The Design

# The BioPods

# Biodiversity species & BioPod functions



*Nesting boxes for birds*

*Other bird facilities*



*Insect hotels*

*Bat boxes*



*Planters (various sizes)*

*Climbing vegetation*



# Biodiversity species & BioPod functions

*Nesting boxes for birds*

*Other bird facilities*



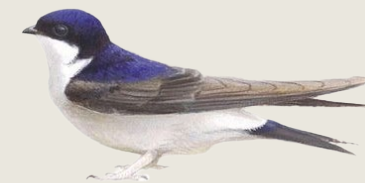
*House Sparrow*



*Bushbreeders*



*Starling*



*House Martin*



*Great Tit & Blue Tit*



*Swift*

The Design



# Biodiversity species & BioPod functions

*Bat boxes*



*Common Dwarf Bat*

The Design

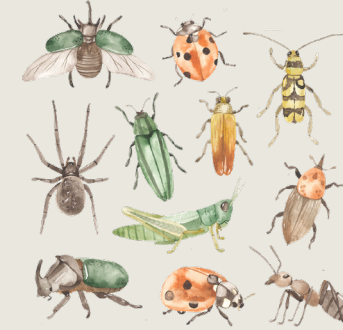
# Biodiversity species & BioPod functions



*Bees*



*Butterflies*



*Variety*

*Insect hotels*

The Design

# Biodiversity species & BioPod functions



*Succulents*



*Perennials*



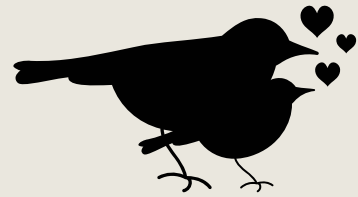
*Climbers*

*Planters (various sizes)*

*Climbing vegetation*

The Design

# Biodiversity requirements



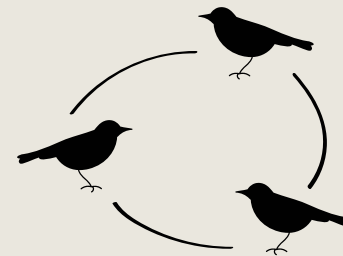
*Procreation*



*Residence*



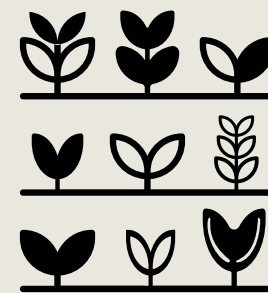
*Safety*



*Connection*



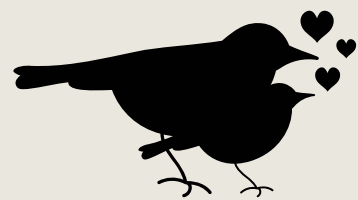
*Nutrition*



*Diversity*

The Design

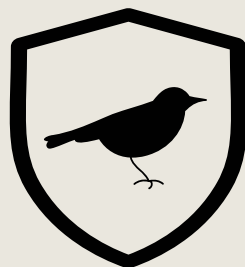
# Biodiversity requirements



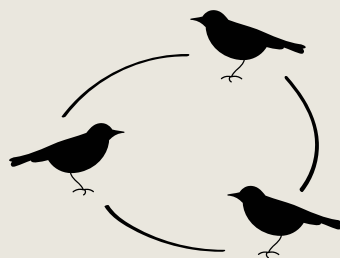
Procreation



Residence



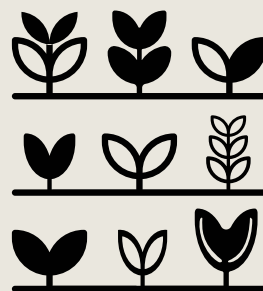
Safety



Connection



Nutrition



Diversity



HS House Sparrow



BB Bushbreeders



GT Great Tit



BT Blue Tit



DB Common Dwarf Bat



ST Starling



HM House Martin



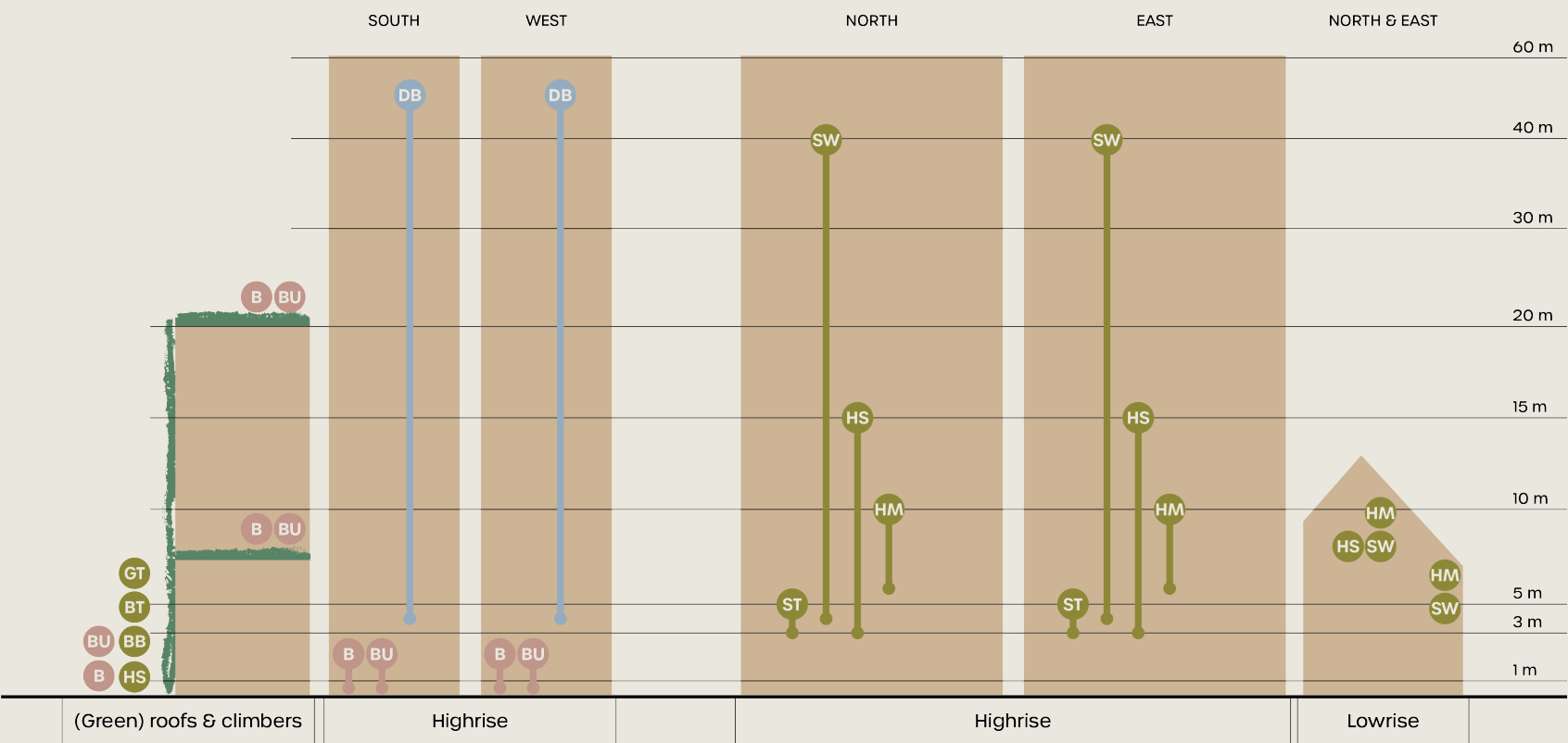
SW Swift



B Bee

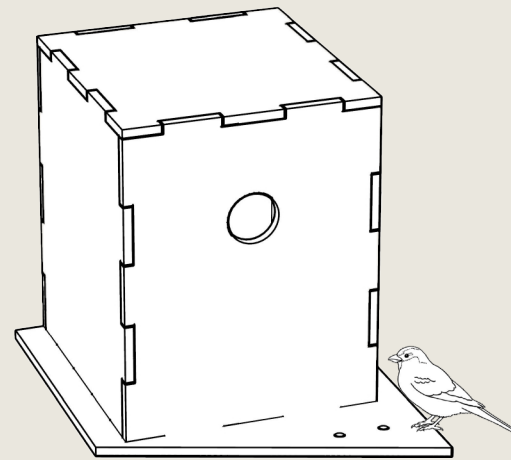


BU Butterfly



The Design

# BioPod designs



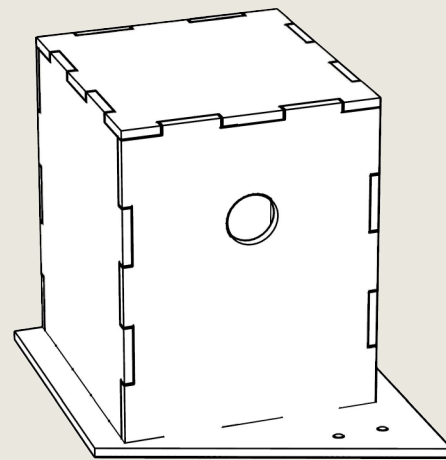
*Modular pods*



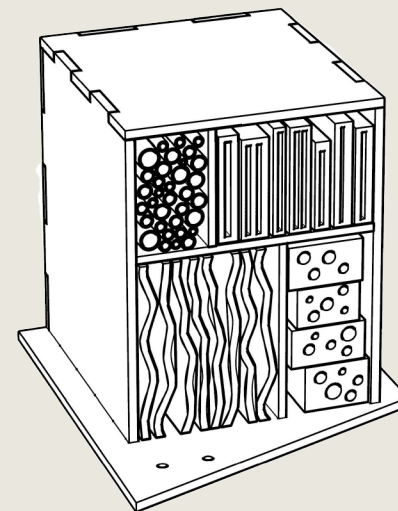
*Organic pods*

The Design

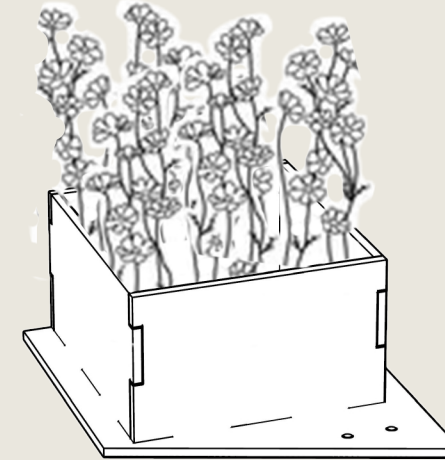
# Modular BioPods



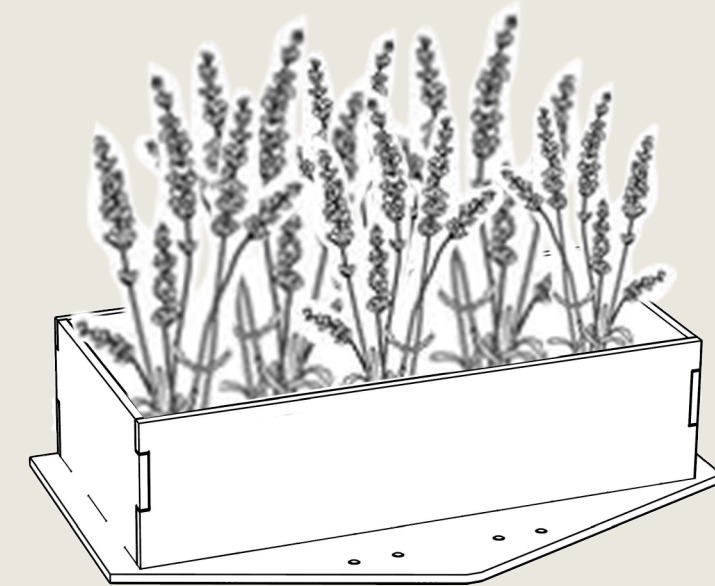
*Nesting boxes*



*Insect hotels*



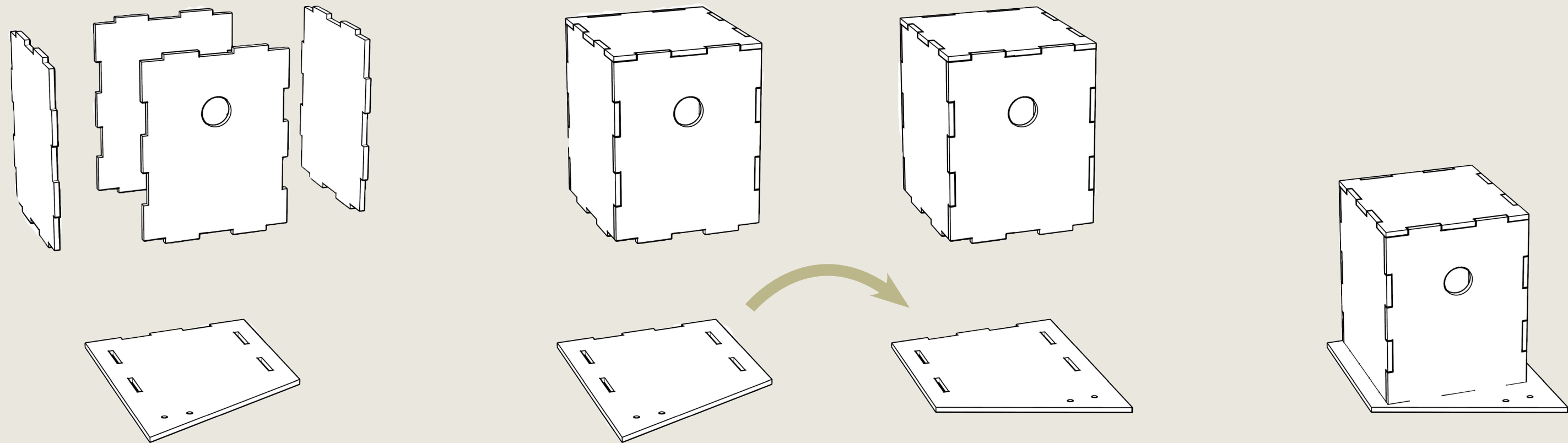
*Small planters*



*Large planters*

The Design

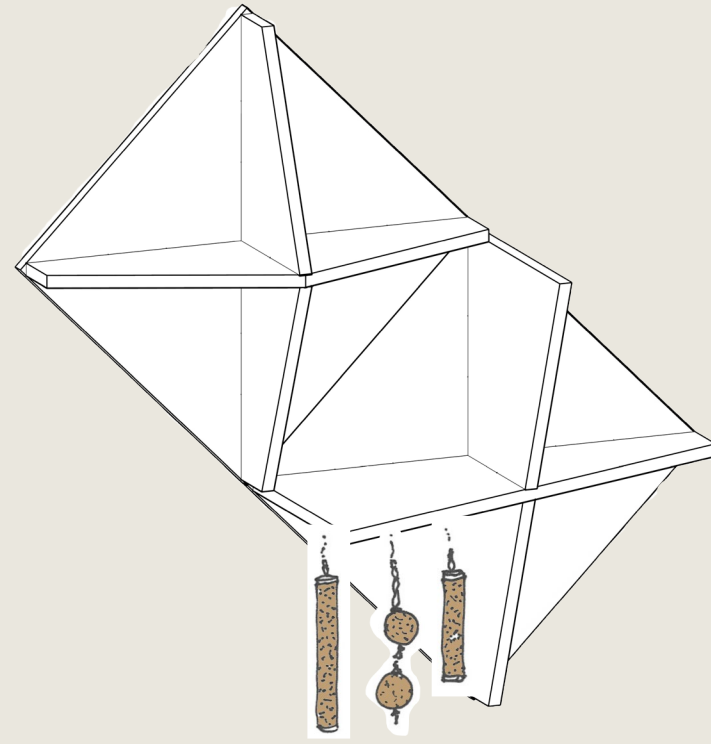
# The principle



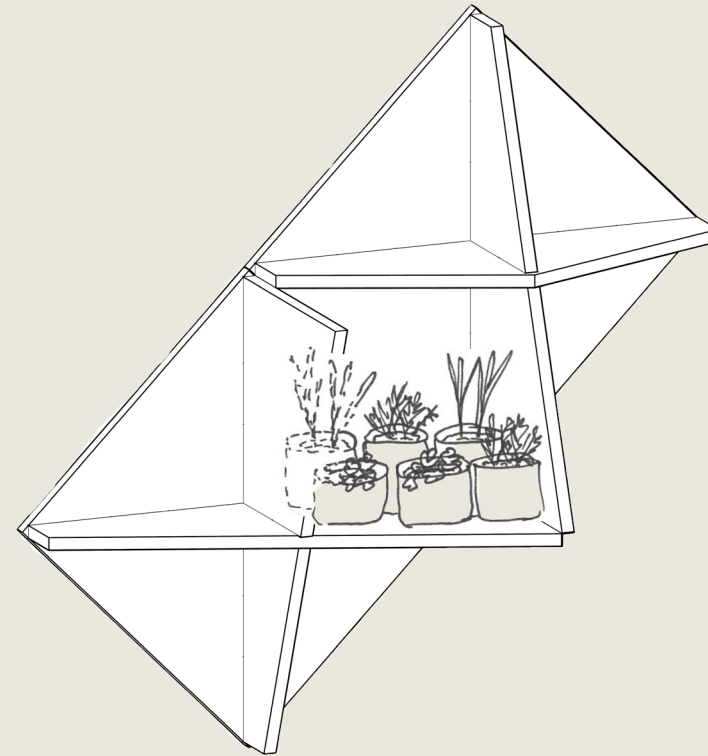
The Design



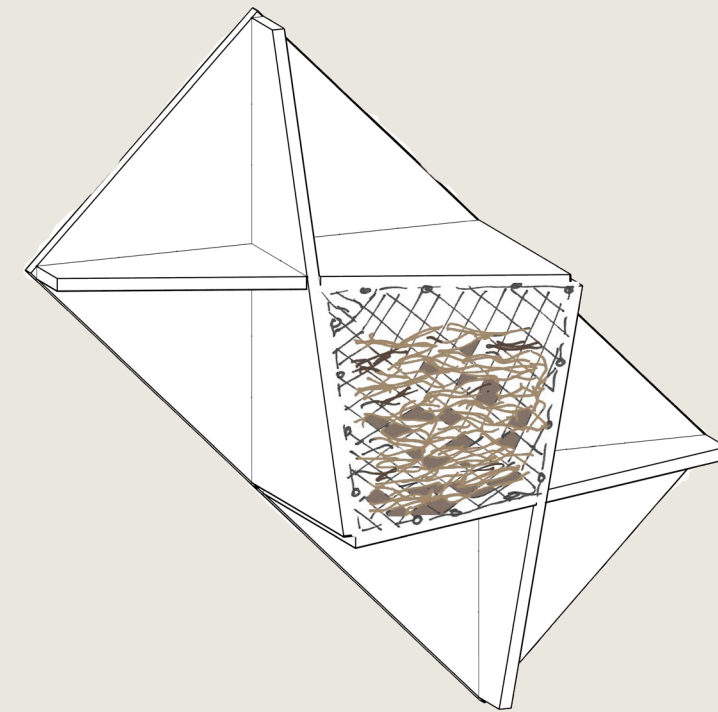
# Organic BioPods



***Bird feeders***



***Planters***



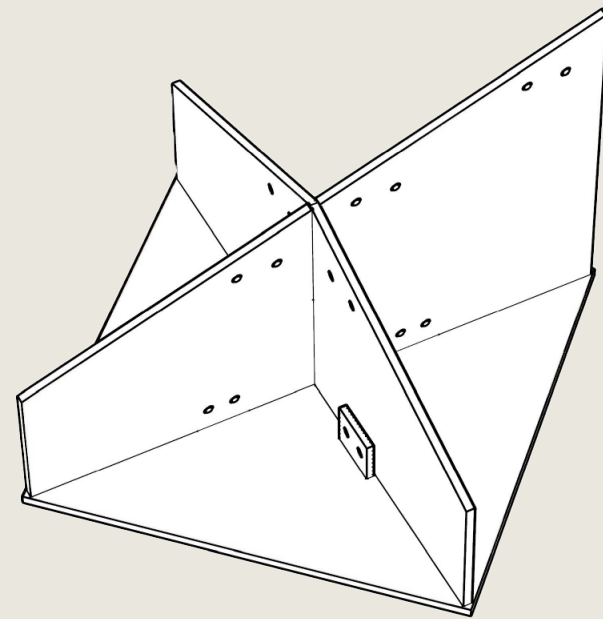
***Nesting material***

The Design



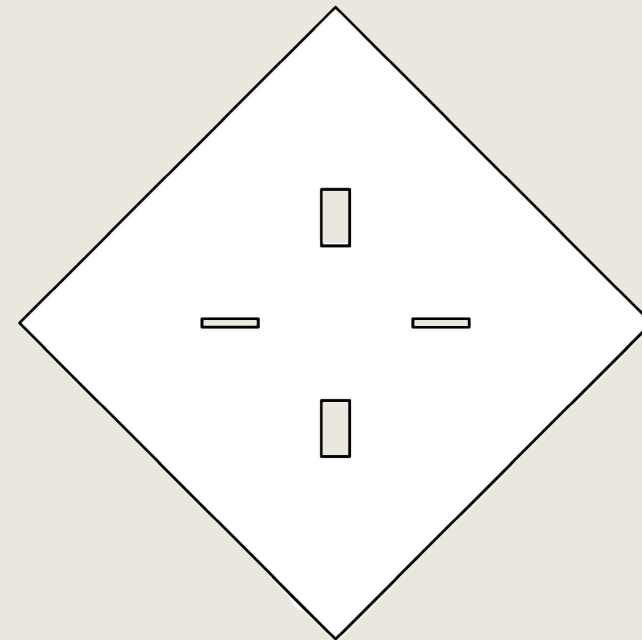
# The Connections

# Module assembly



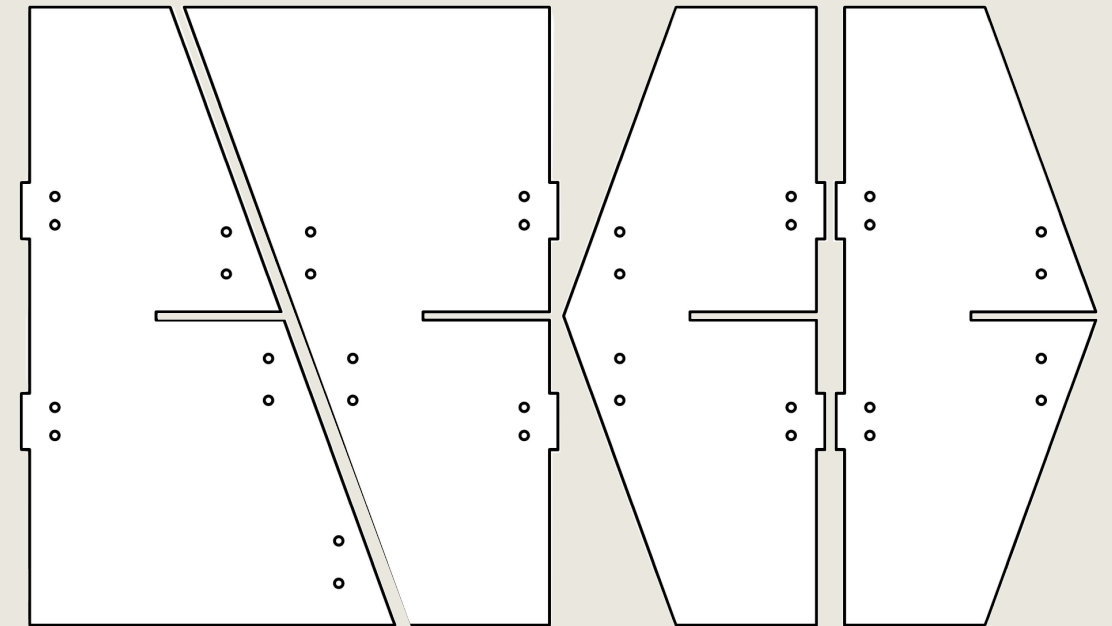
*One module*

=



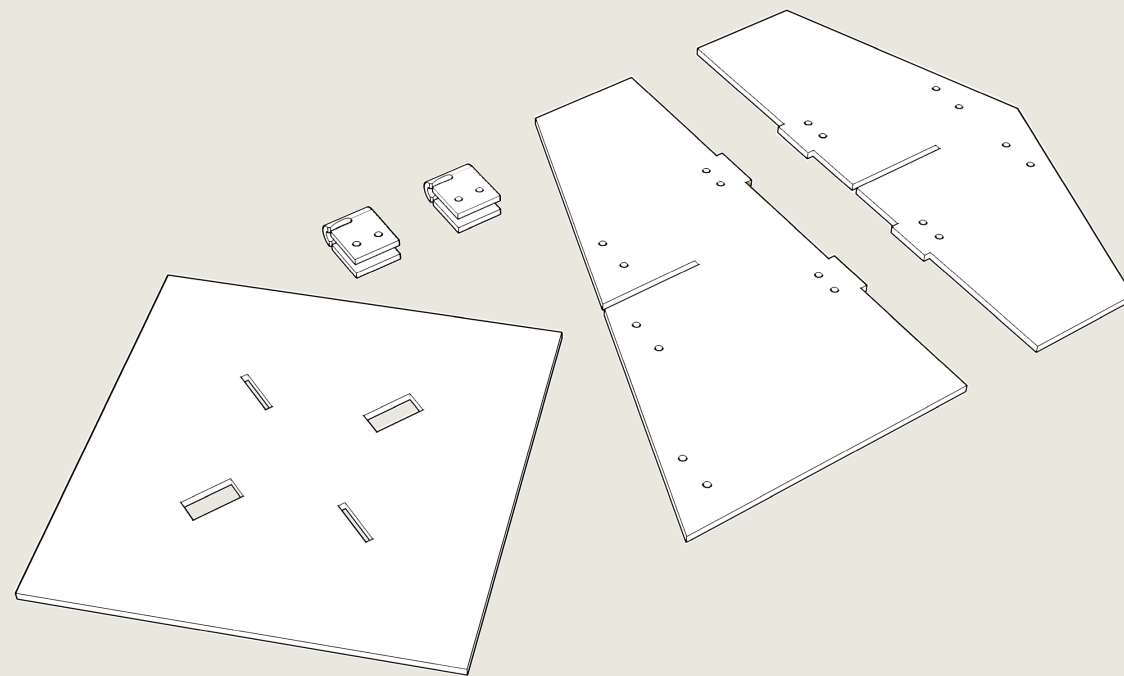
*Base element*

+ 2 of

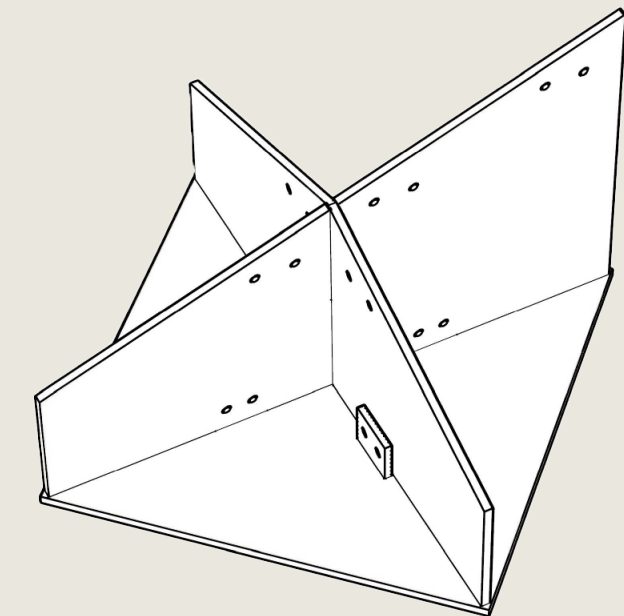
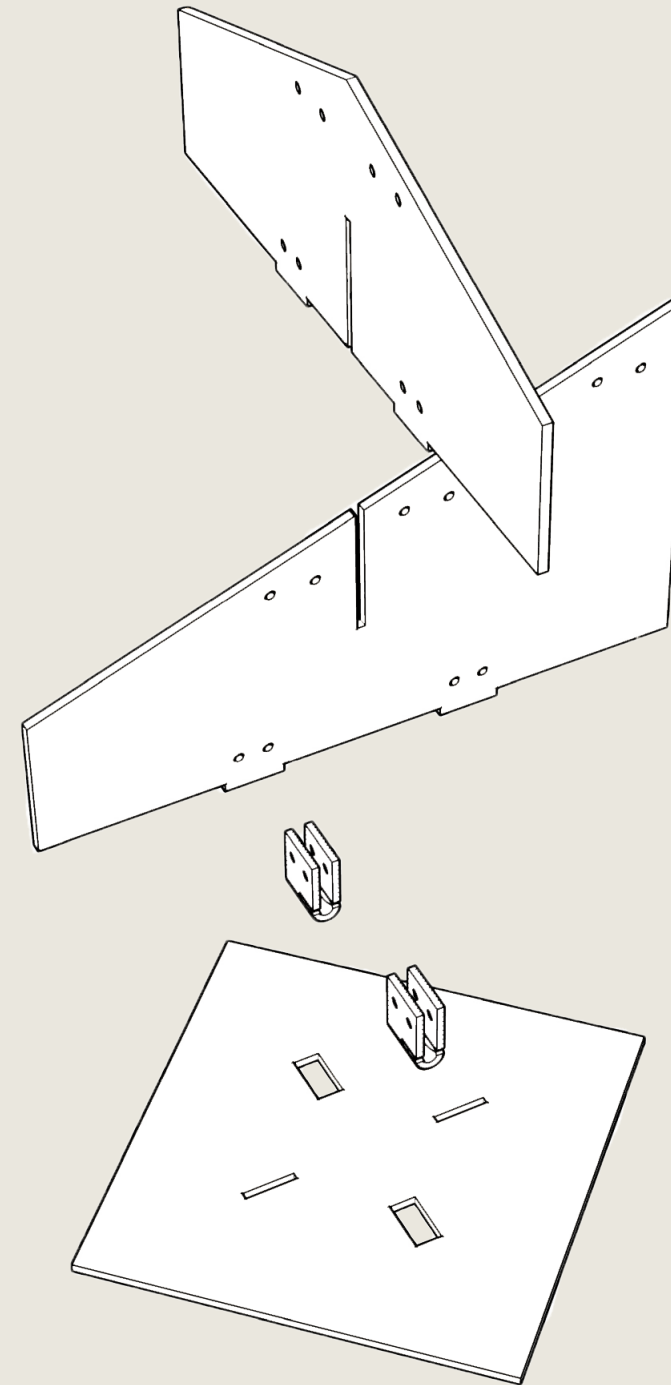


*Perpendicular elements*

# Module assembly



*Interlocking the components*



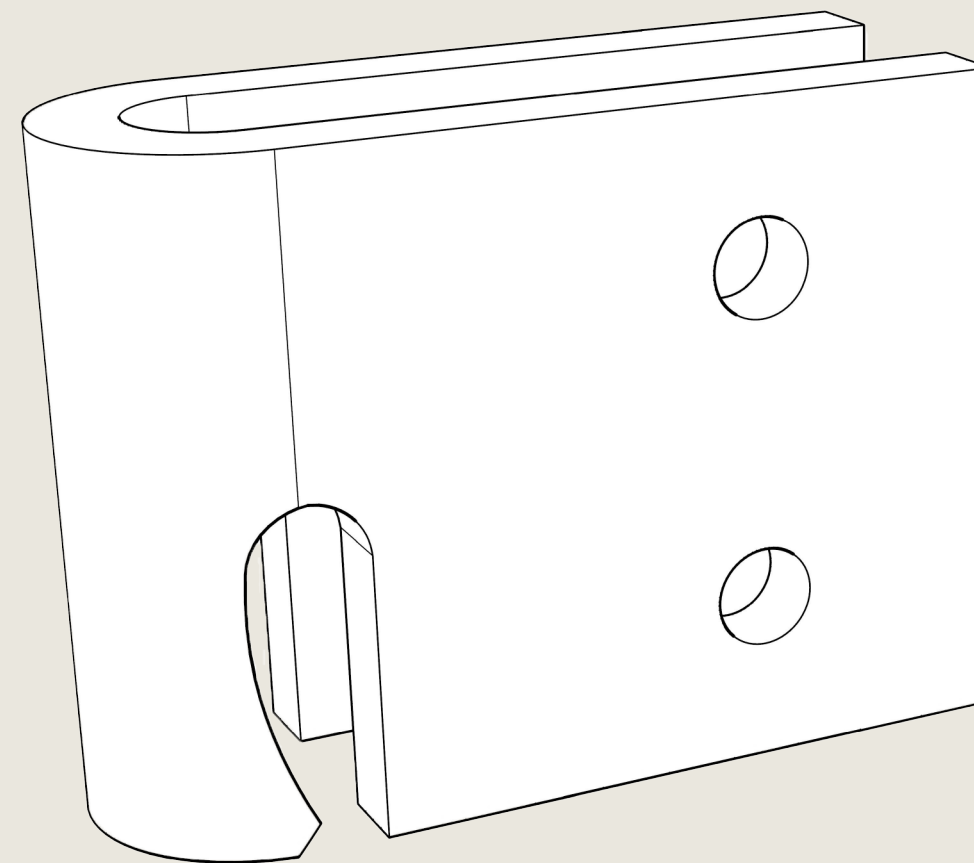
*Fixing the connectors*

The Design

# The 3D printed connector

*U-shape for required flexibility*

*Openings for bolts*

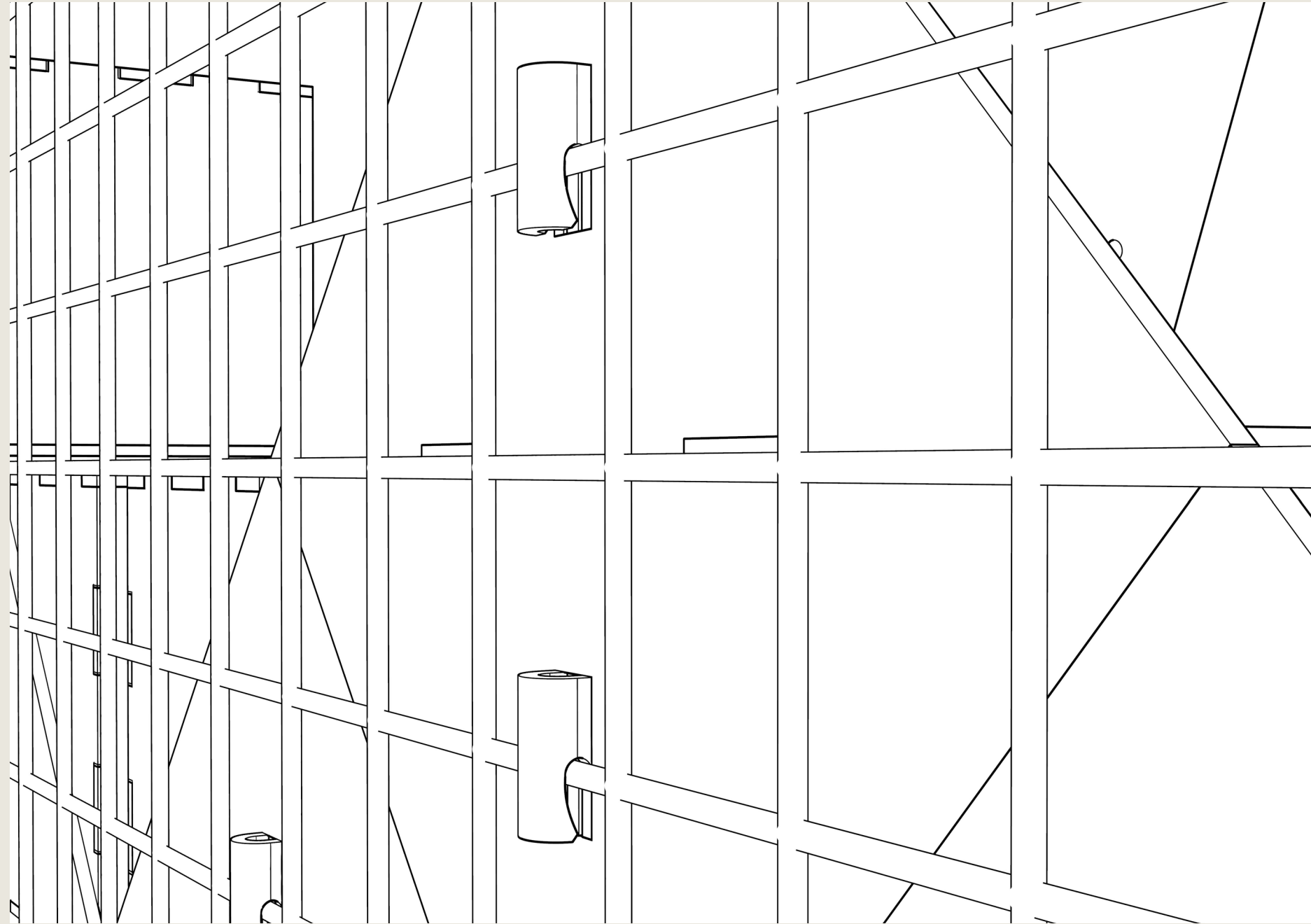


*Integrated clamping hook*

The Design

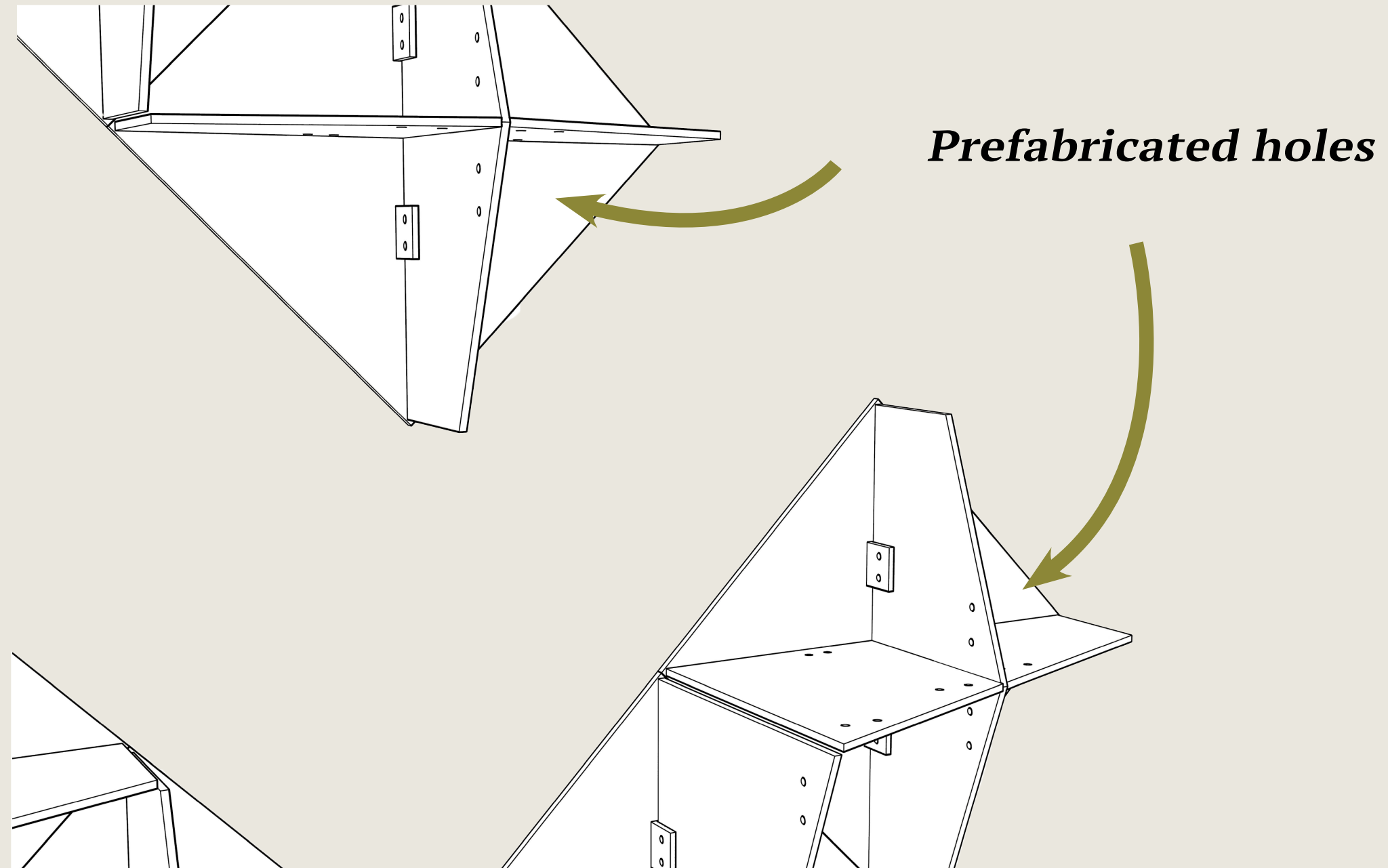


# The 3D printed connector



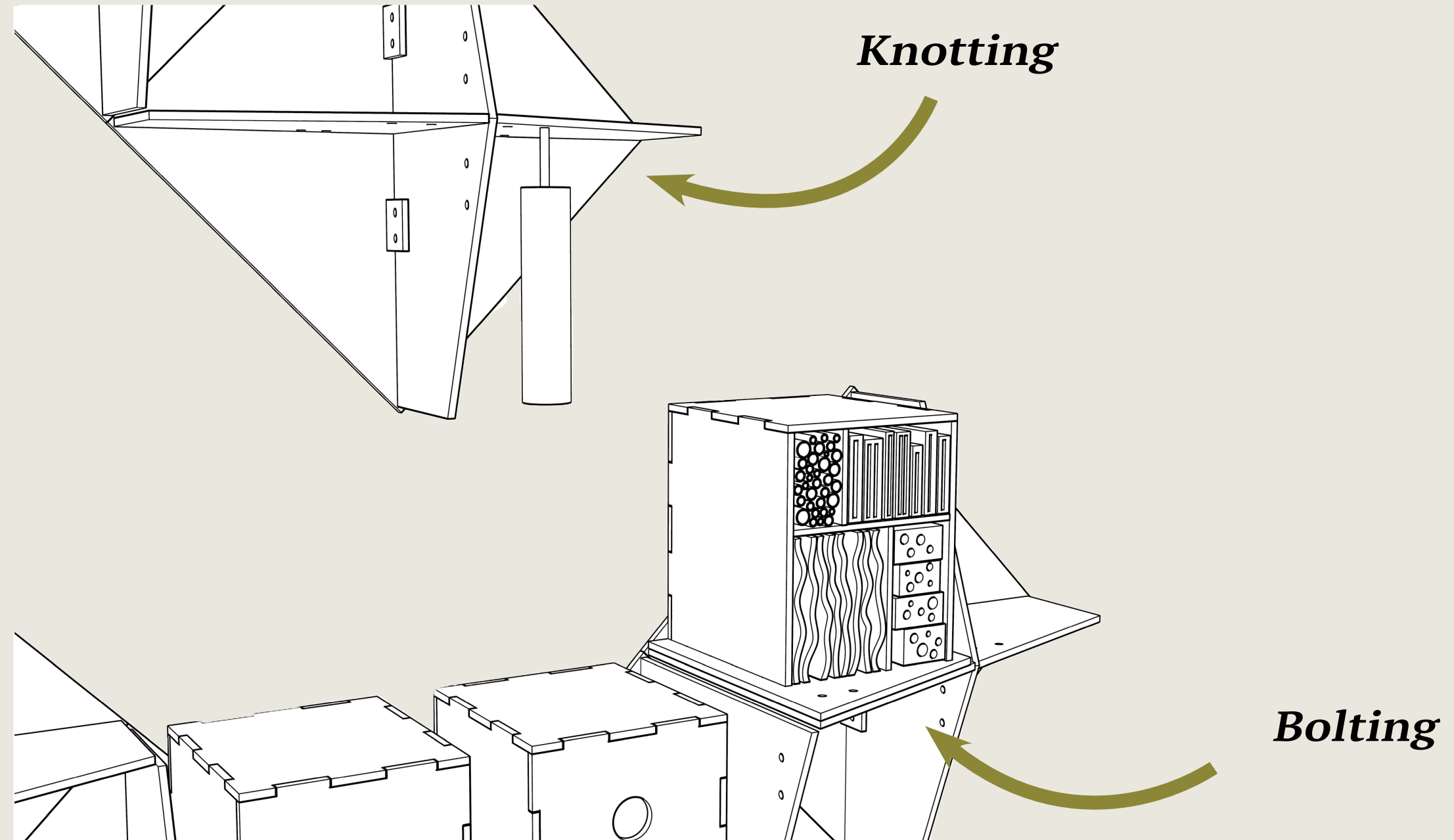
The Design

# Fixing the BioPods to the Modules




The Design

# Fixing the BioPods to the Modules



The Design

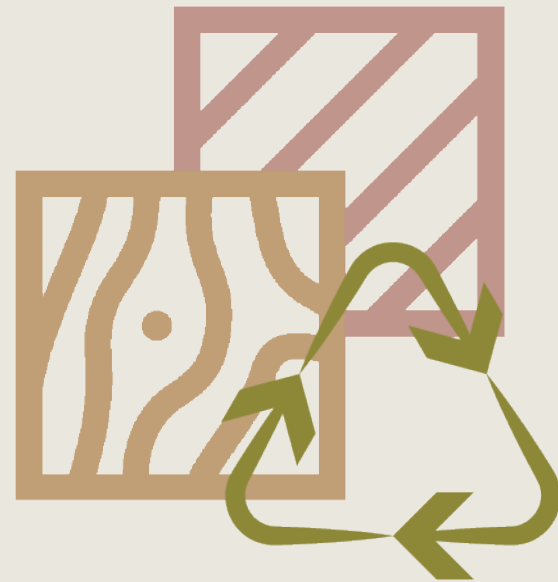




# Manufacturing & Materialisation

# Materialisation

*Reclaimed materials*



*Location & time dependant*



The Design



# Materialisation

***Timber***



***Plastics***



***HPL***



***Limestone***



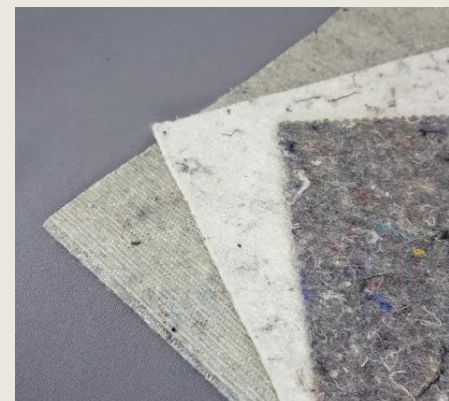
***Ceramics***



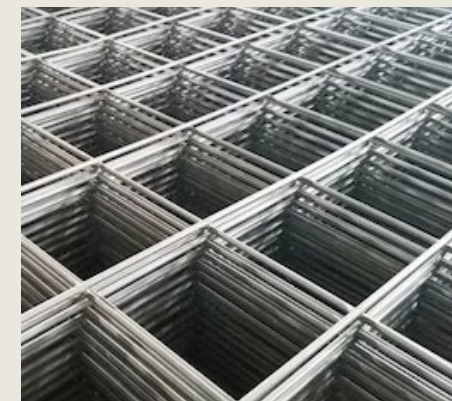
***Concrete  
plywood***



***Textiles***



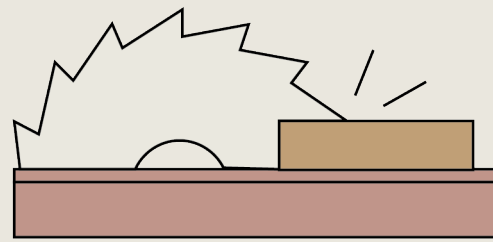
***Metal fence***



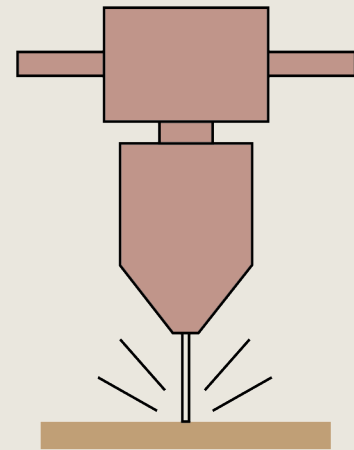
The Design

# Manufacturing

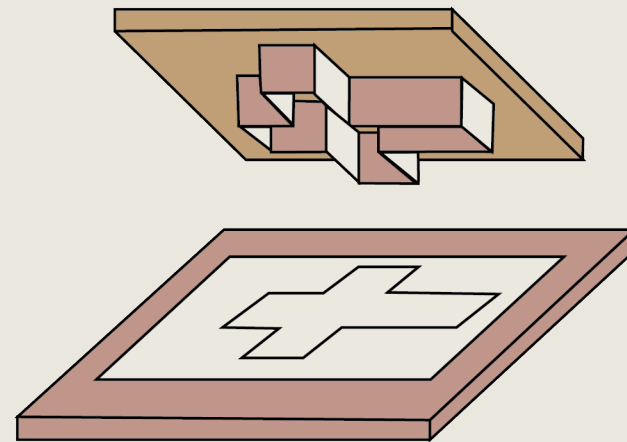
## *Low-tech manufacturing of (planar) components*



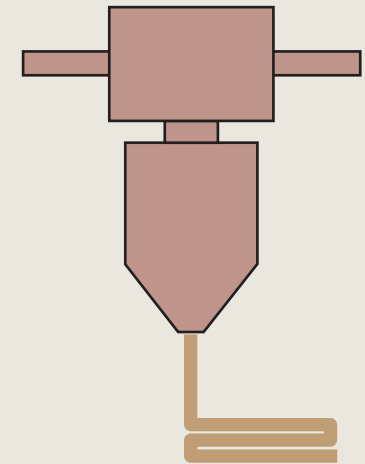
*Sawing*



*Laser cutting*



*Die cutting*



*3D printing*

The Design



# Lifecycle of the system

# Lifecycle

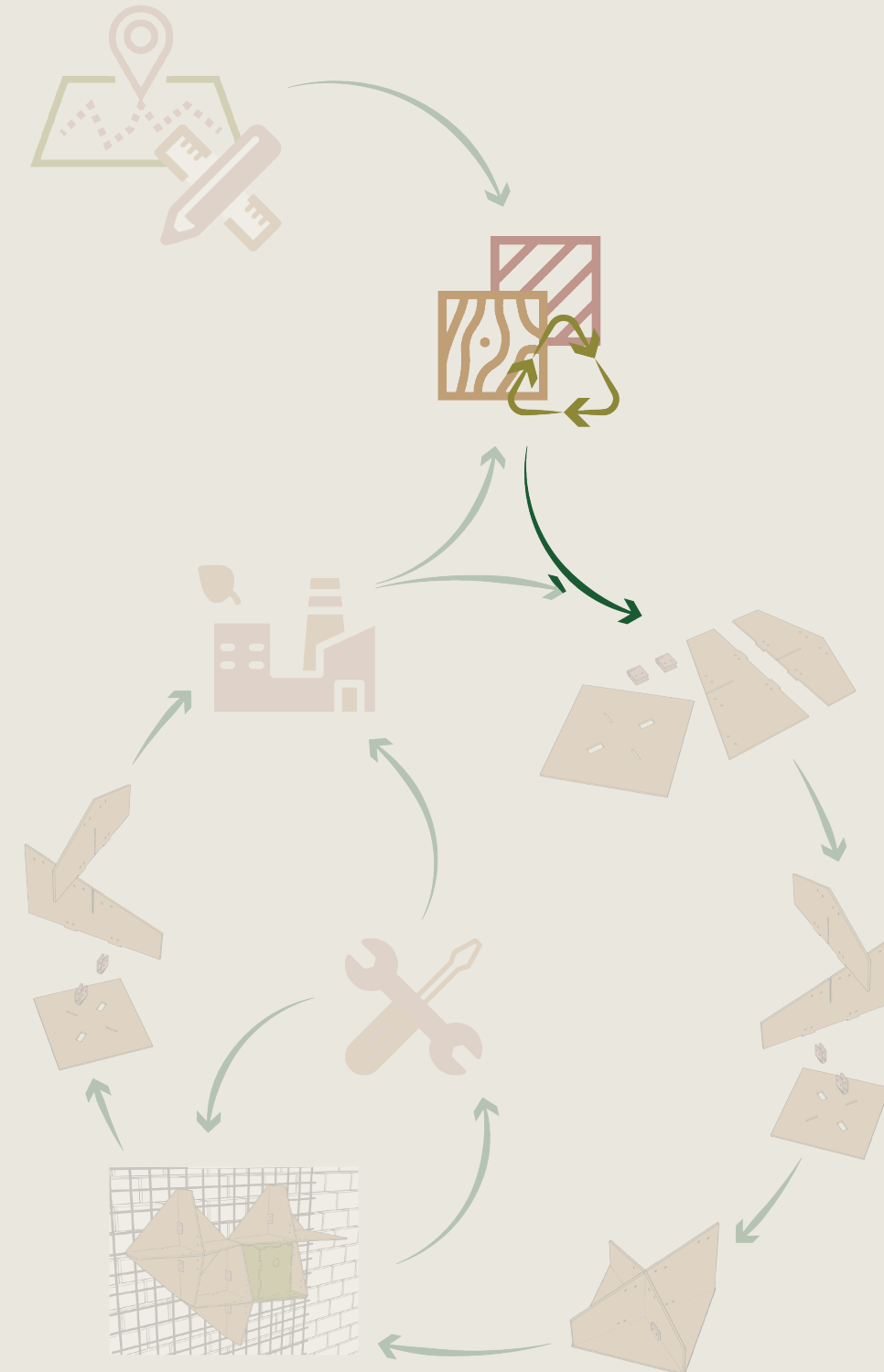
*Choosing a design location & fitting system configuration*



The Design

# Lifecycle

*Select materials*



The Design



# Lifecycle

*Manufacture components*



The Design



# Lifecycle

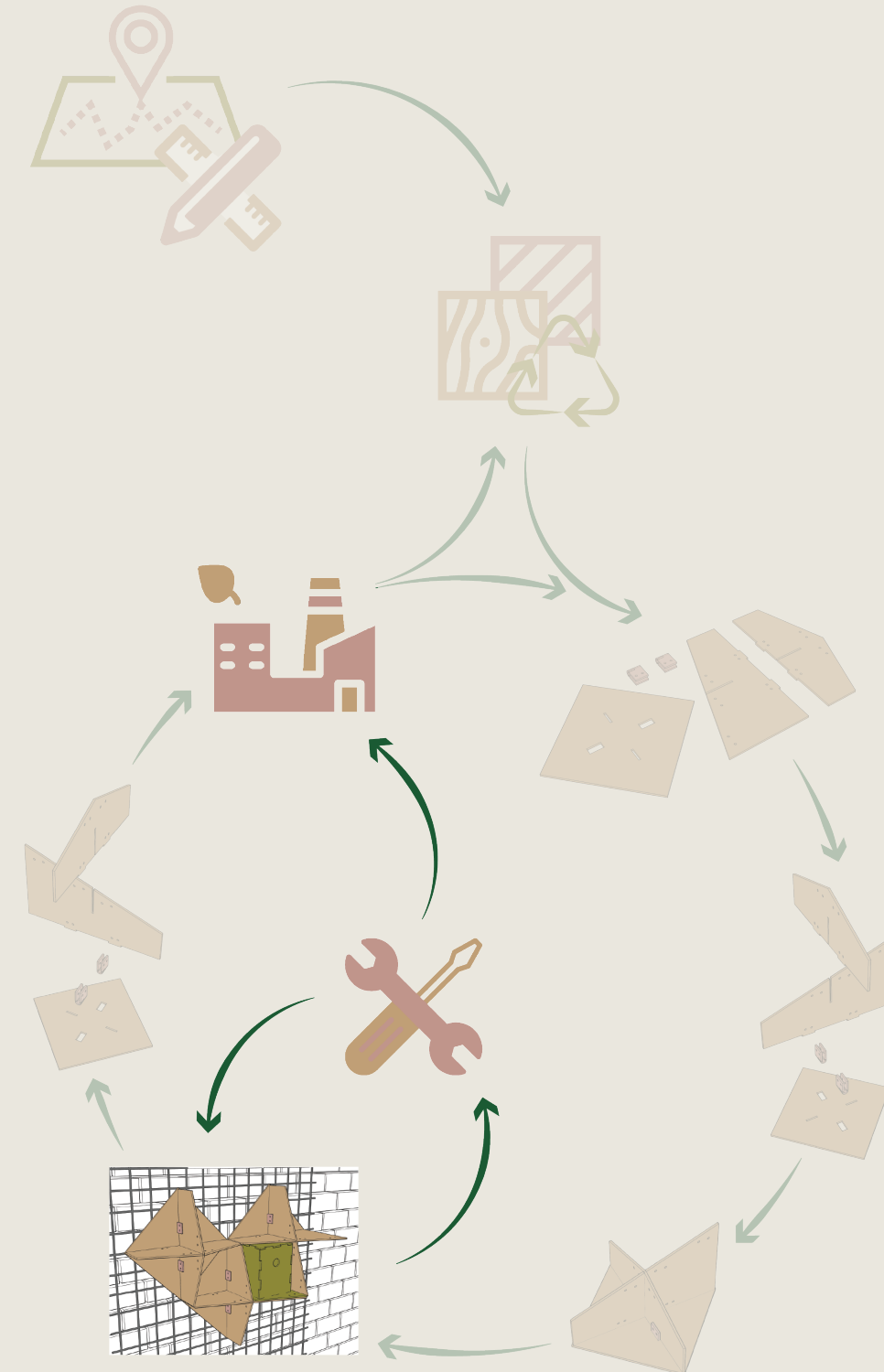
*Assembly of the system's  
components*



The Design

# Lifecycle

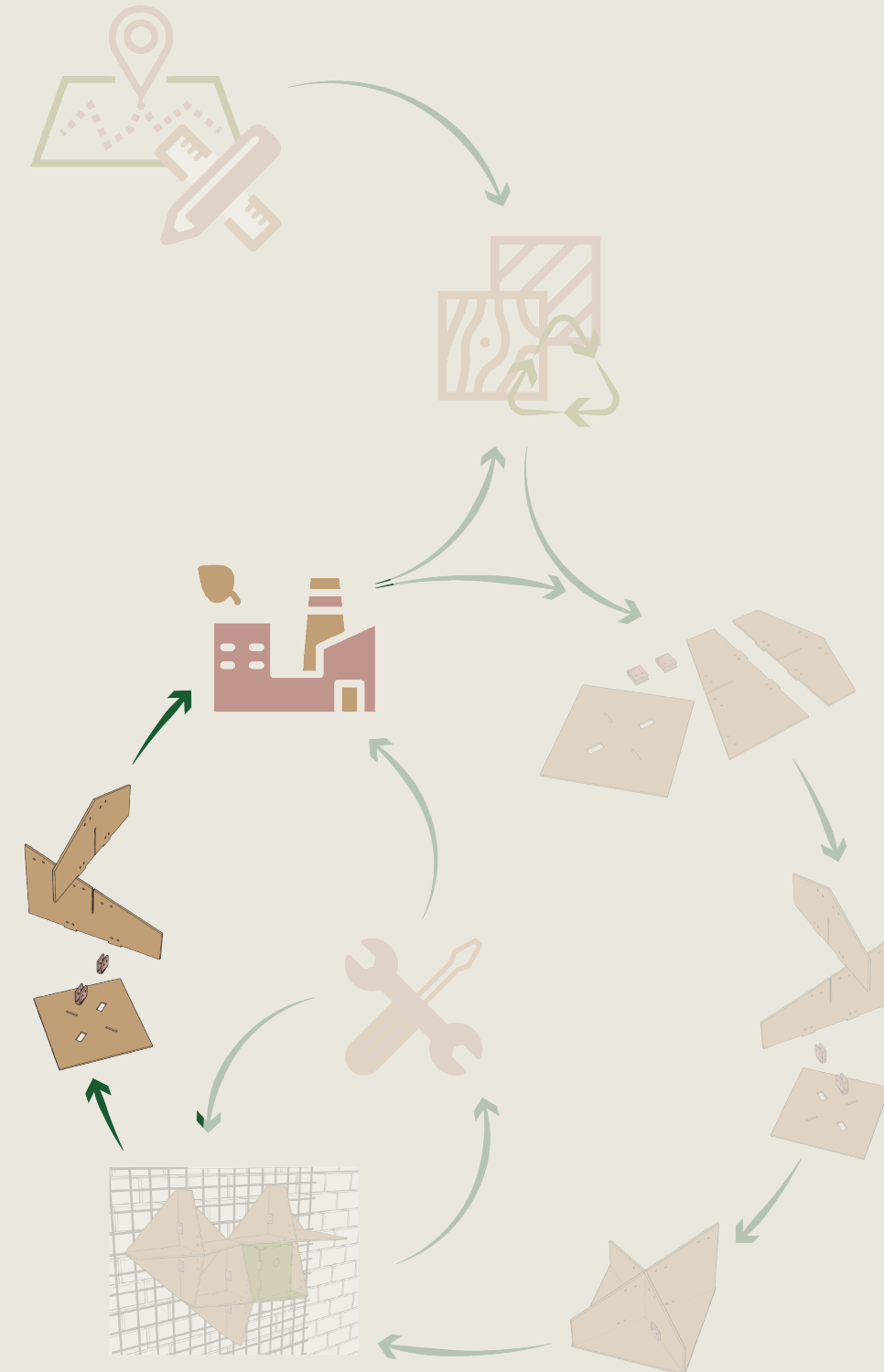
*Repair and maintenance*



The Design

# Lifecycle

## Disassembly of the system



## The Design

# Lifecycle

*Quality check of the components  
for future use*



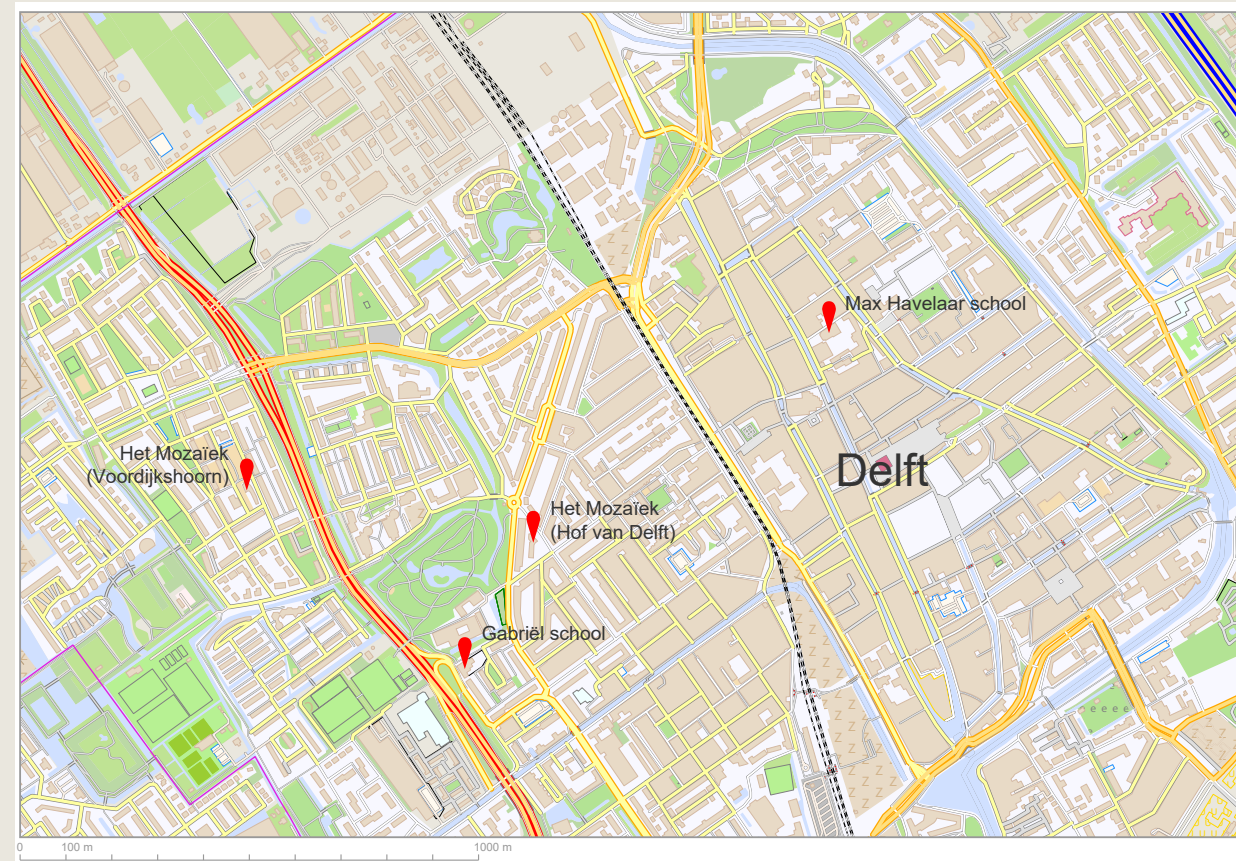
The Design



Design example



# Selecting a case study school in Delft



Het Mozaïek (Voordijkshoorn)



Het Mozaïek (Hof van Delft)



Gabriël school



Max Havelaar school

The Design



# Biodiversity Matrix

	<div></div> <div>Max Havelaar school</div>	<div></div> <div>Mozaïek school (Hof van Delft)</div>	<div></div> <div>Mozaïek school (Voordijkshoorn)</div>	<div></div> <div>Gabriel school</div>
	<div></div>	<div></div>	<div></div>	<div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>

Unknown / Irrelevant


































Good

Average

Bad

The Design

# Biodiversity Matrix

	<div></div> <div>Max Havelaar school</div>	<div></div> <div>Mozaïek school (Hof van Delft)</div>	<div></div> <div>Mozaïek school (Voordijkshoorn)</div>	<div></div> <div>Gabriel school</div>
	<div></div>	<div></div>	<div></div>	<div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>
	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>

Unknown / Irrelevant

Good

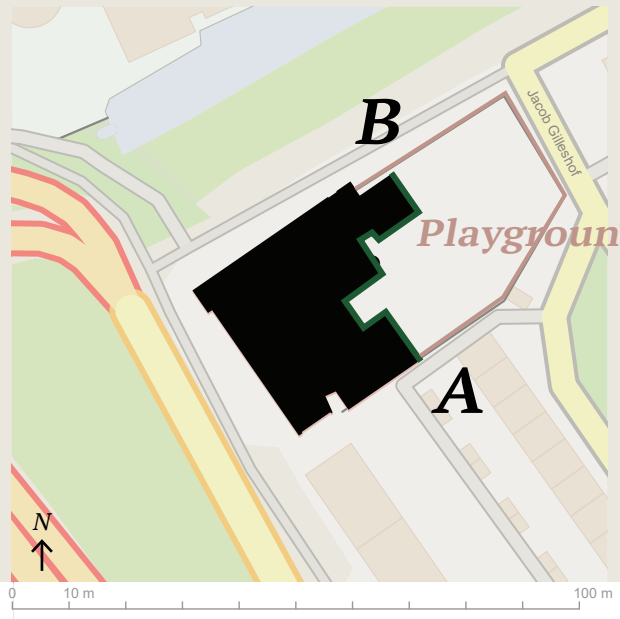
Average

Bad

The Design



# Gabriel school Biodiversity Map



*A      North-east      North-west      North-east      South-east      North-east      South-east      North-east      B*



- Empty modules
- Bird facilities
- Bird nesting boxes
- Vegetation
- Insect hotels
- Bat boxes

The Design

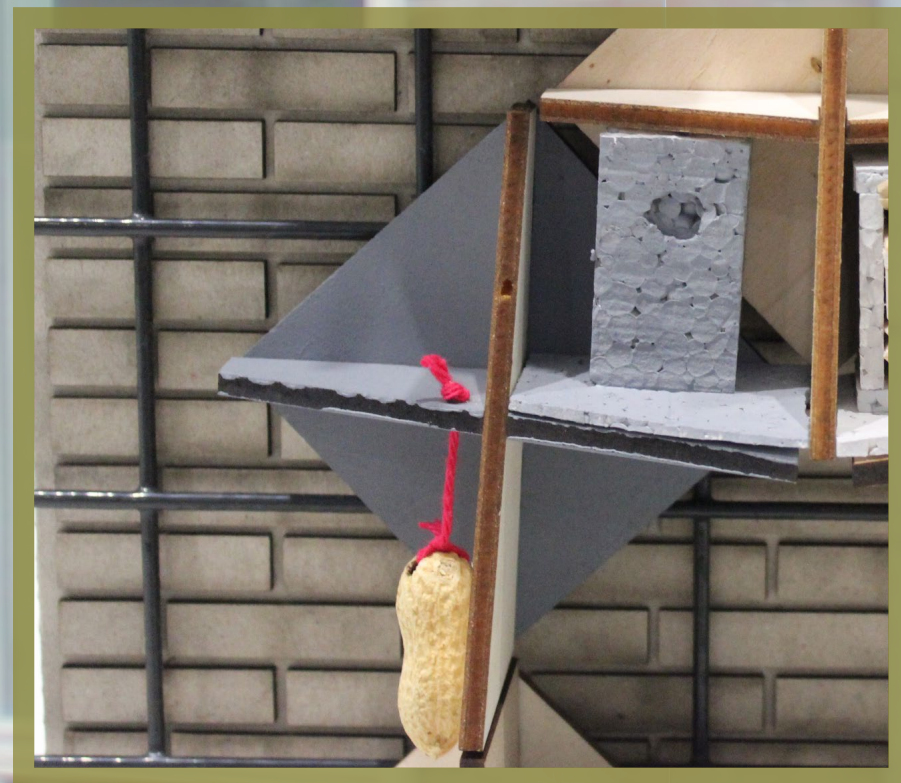










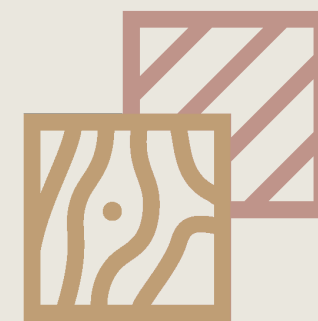




# Conclusions

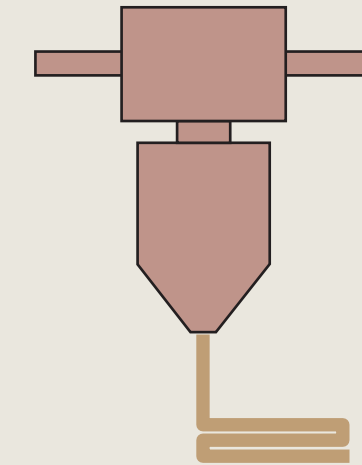
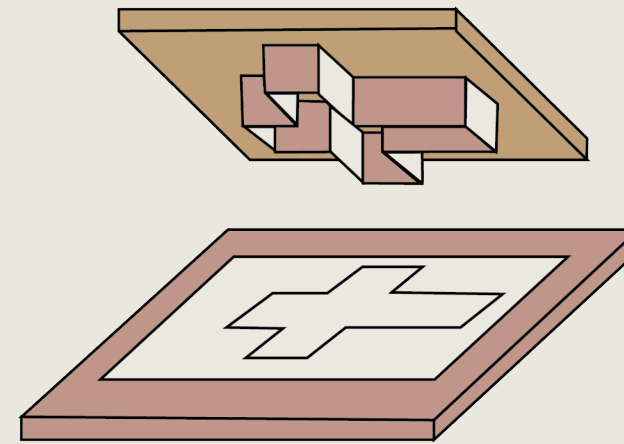
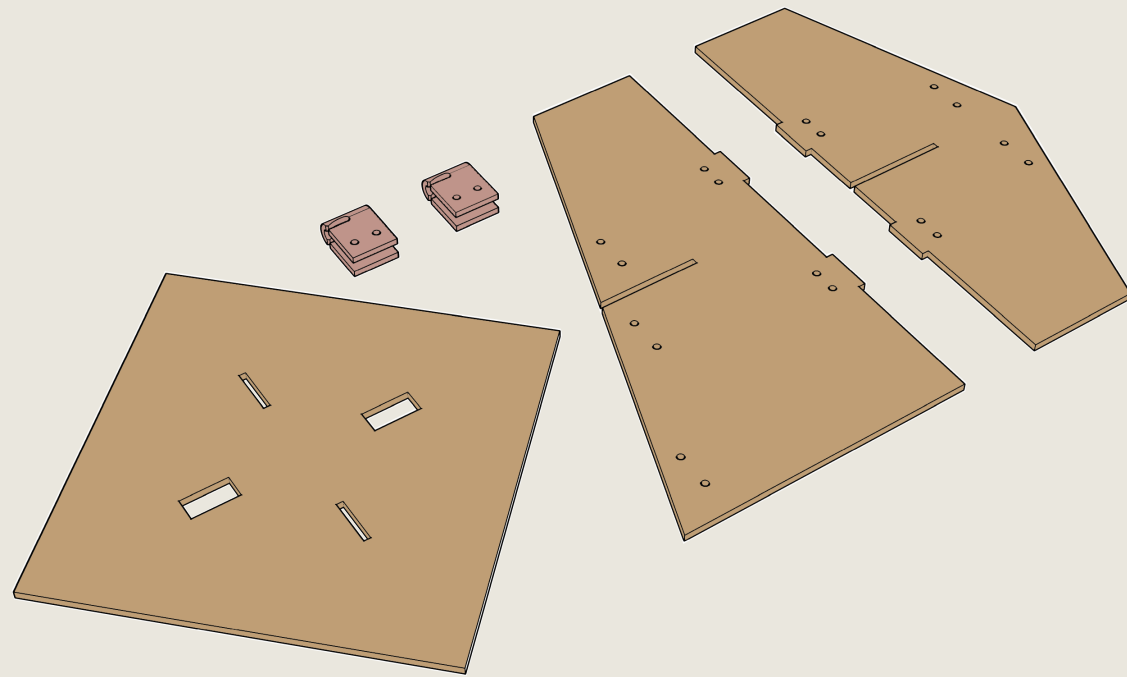
# Main objective

*Design a **low-tech**, three-dimensional, **circular** façade cladding system (product) utilising **waste materials** and which fosters **biodiversity** in urban environments in the Netherlands*



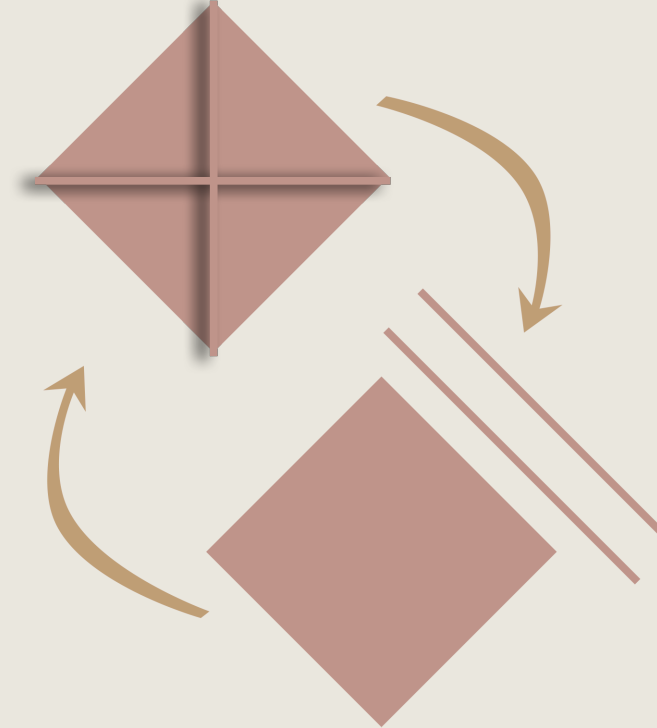
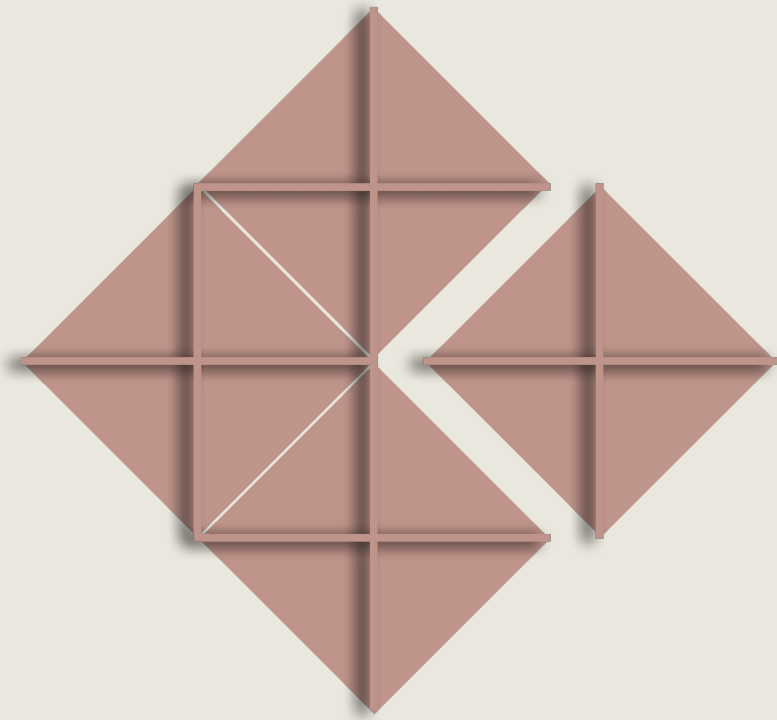
Conclusions

# Low-tech design principles



Conclusions

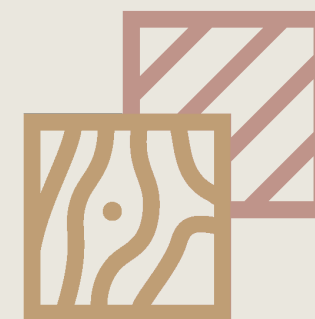
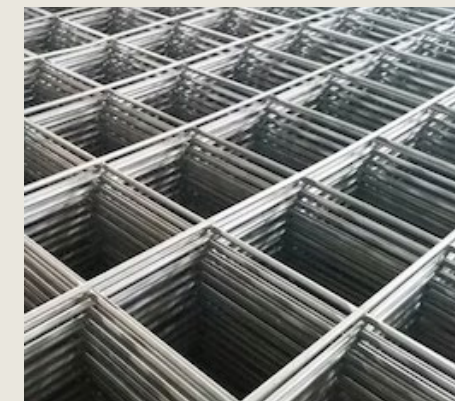
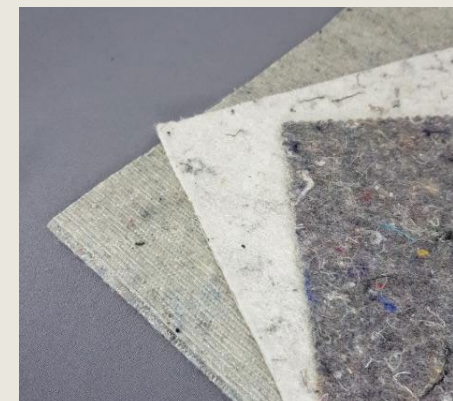
# Circular design strategies



Conclusions



# High potential for utilising waste materials



Conclusions

# Biodiversity implementations



Conclusions

# Recommendations for future research

*Circularity*

*Material testing with prototypes*

*End-of-life cycle analysis*

*User involvement*

Conclusions



# Recommendations for future research

*Biodiversity*

*Optimisation tool for location  
specific design configurations*

*Research on (large-scale) benefits*

*User involvement*

Conclusions





Thank You

