

PD LAB

THE DEVELOPMENT OF A BIOBASED CLADDING SYSTEM

by Mitchell Mac-Lean

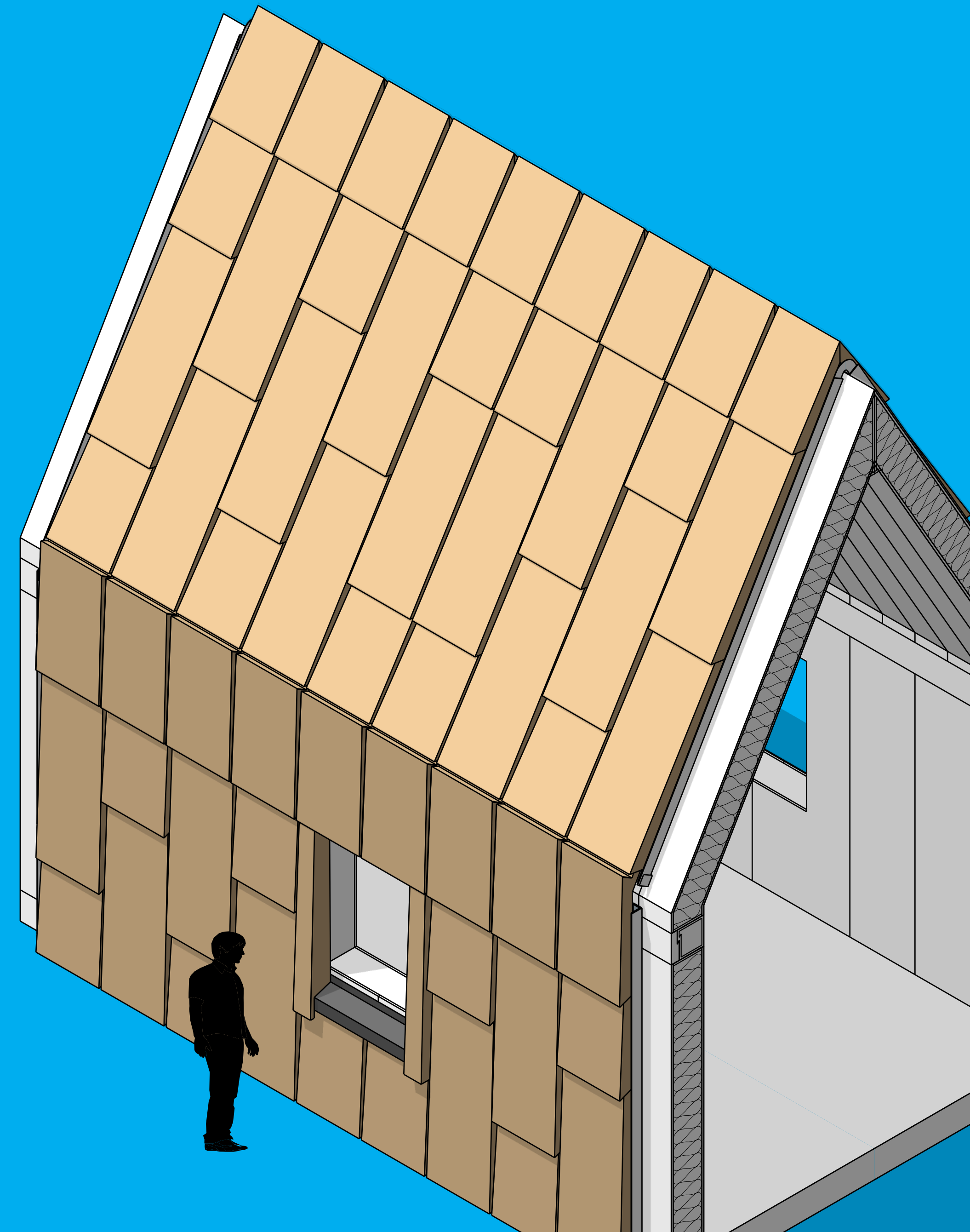
P5 presentation
29th of June 2018

prof. dr. ir. Tillmann Klein
dr. David Peck
ir. Pieter Stoutjesdijk

AE+T: Design of Construction
AE+T: Climate Design and Sustainability
AE+T: Architectural Engineering

Delegate member
dr. Wouter Jan Verheul

MBE: Urban Development Management



WHY

HOW


WHAT

let's start with some figures



40%

of energy consumption worldwide



40%

of material use worldwide

the building industry



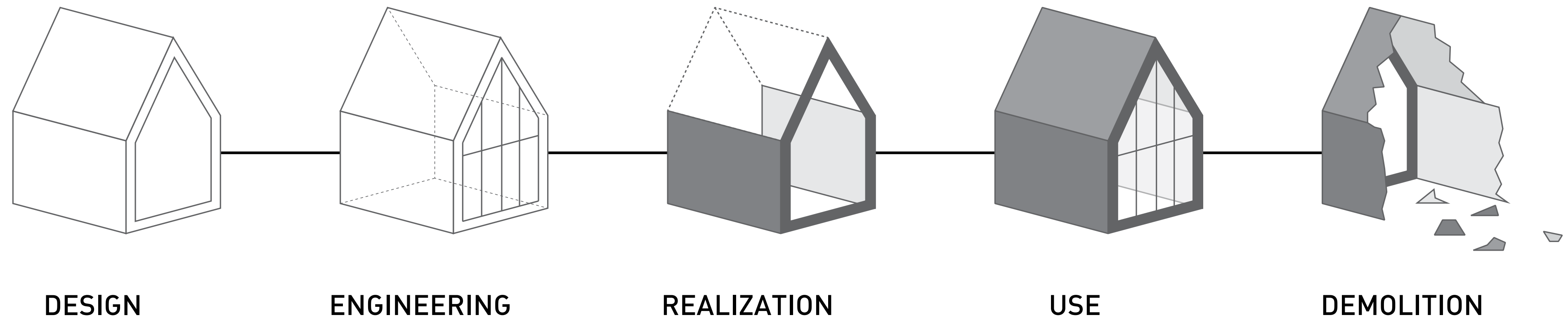
35%

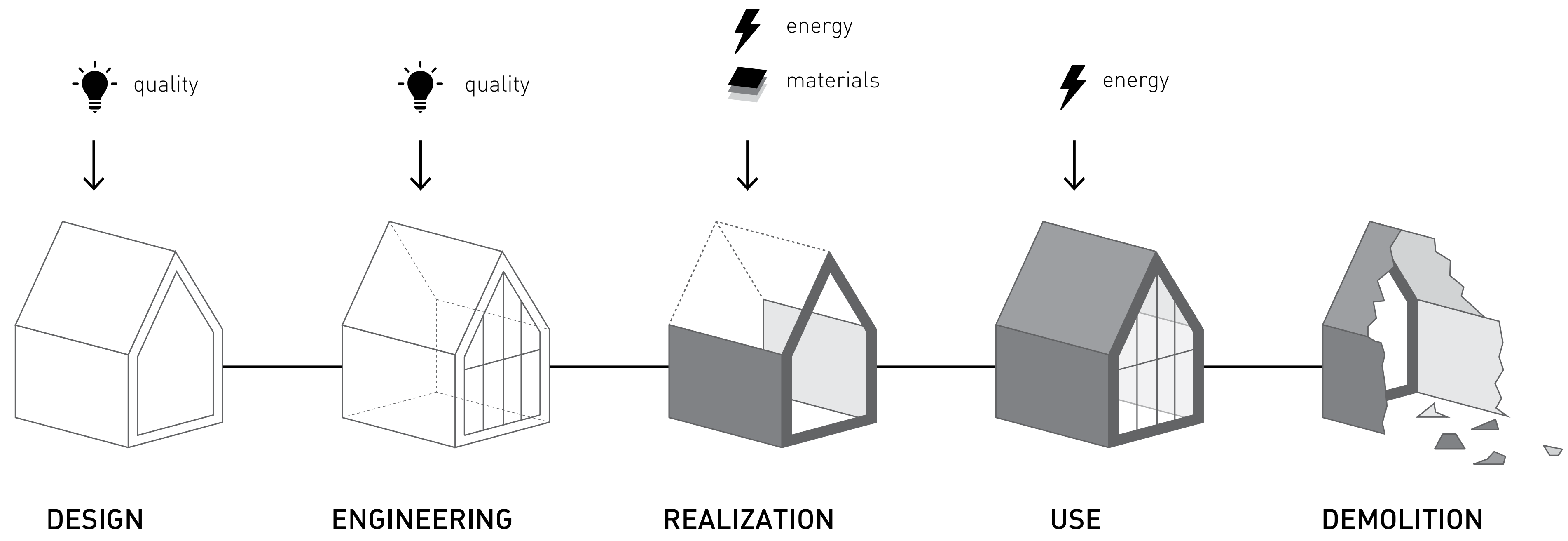
of waste generation worldwide

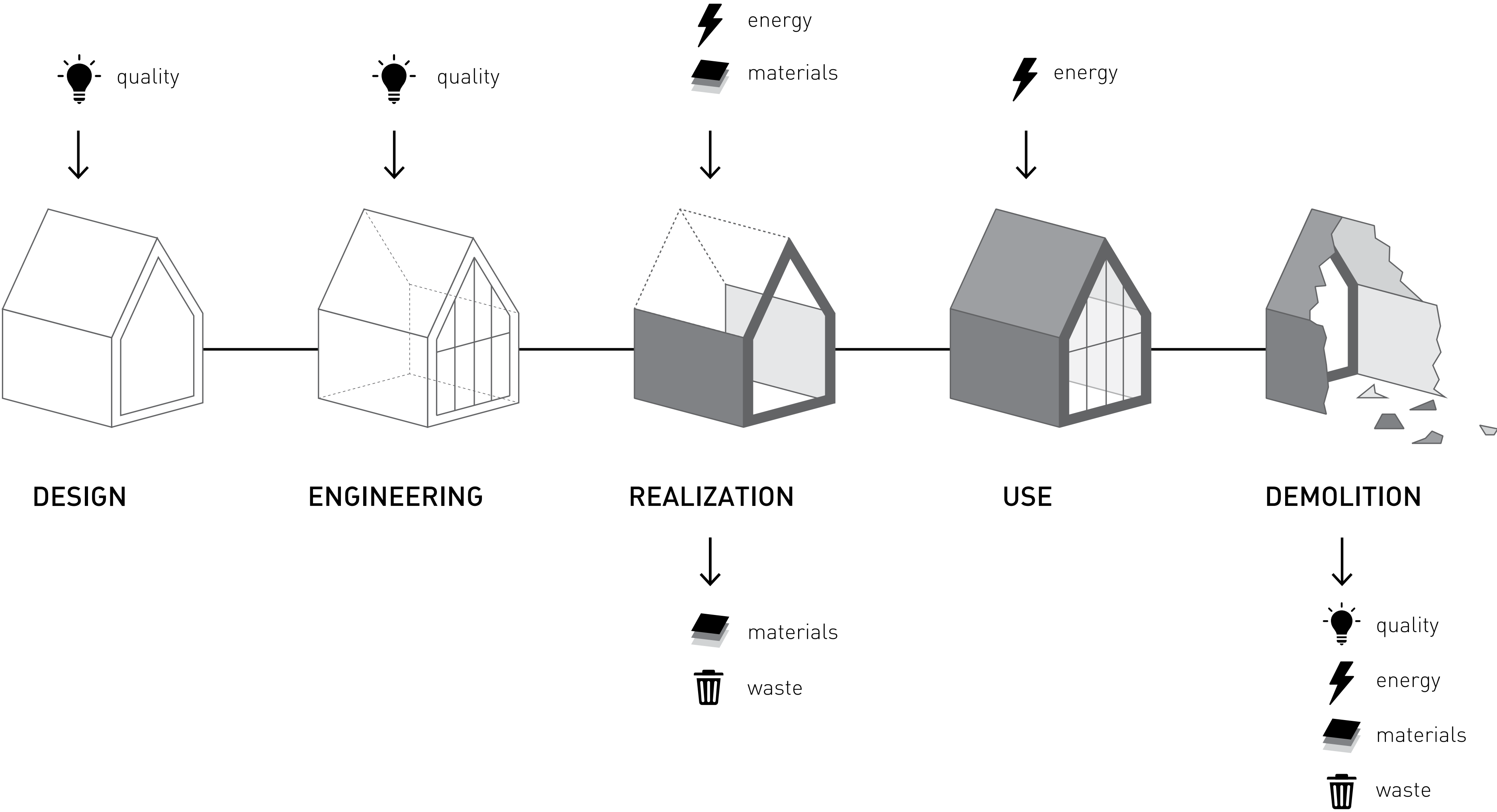
source: Apave.com

6/110

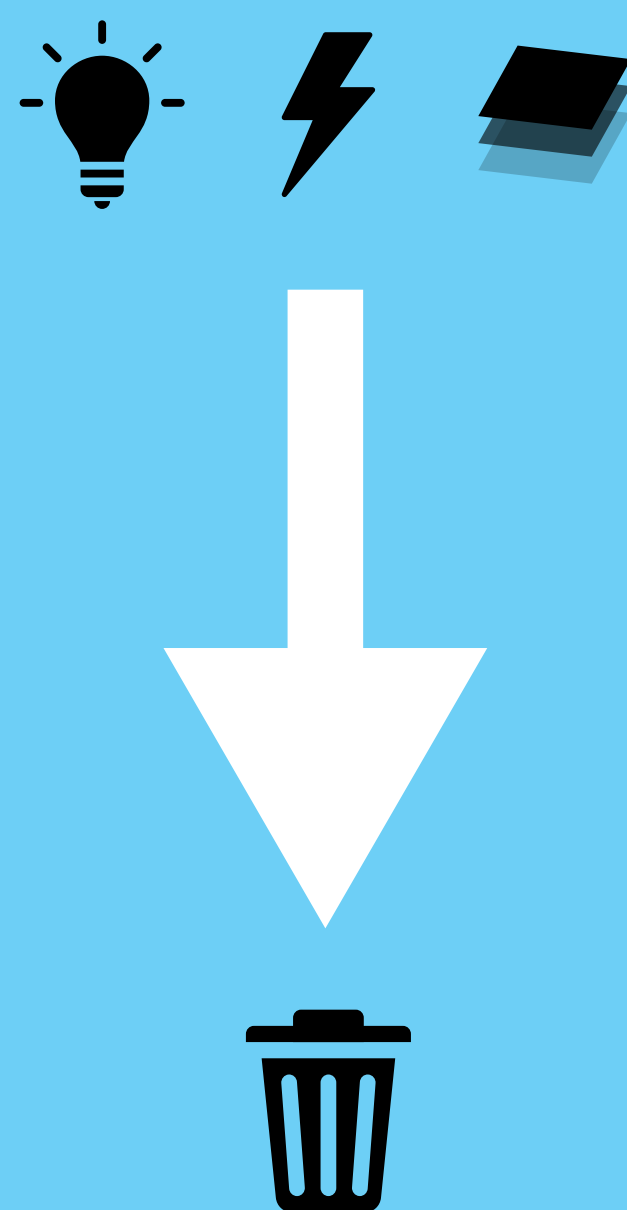
what are the causes?

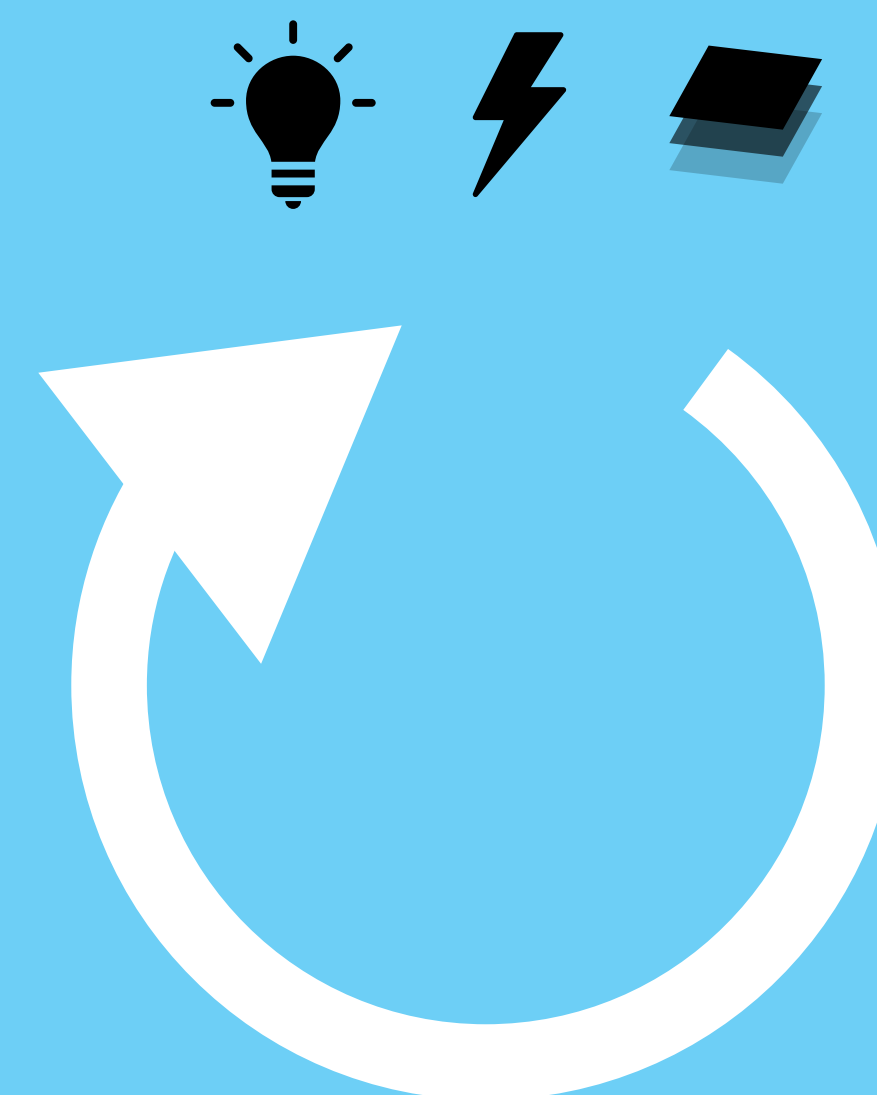


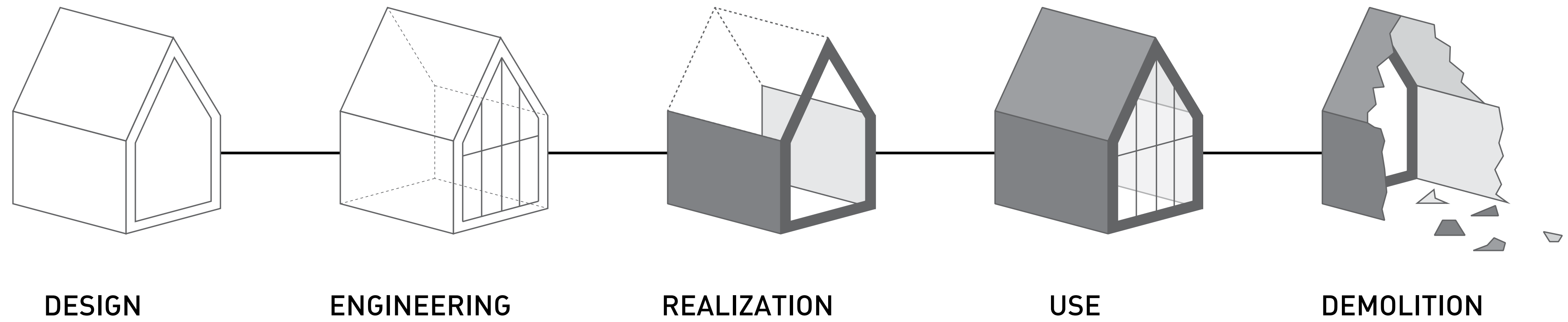


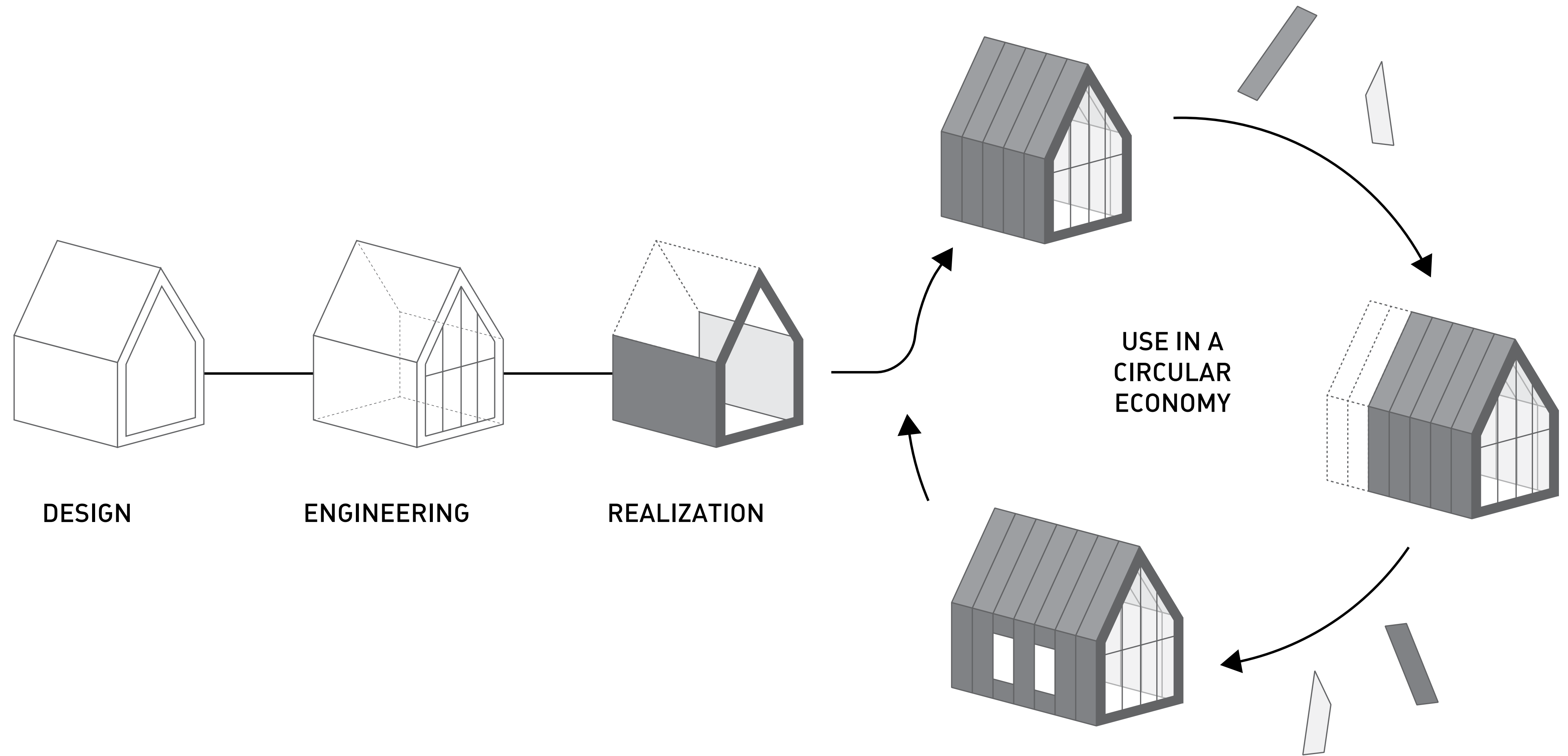


how to solve this problem?









translation to practice



Product Development Test Lab



////// BKCity

source: Bilow [2017]

17/11/17

circular building system



source: Bilow [2017]

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modular & adaptable

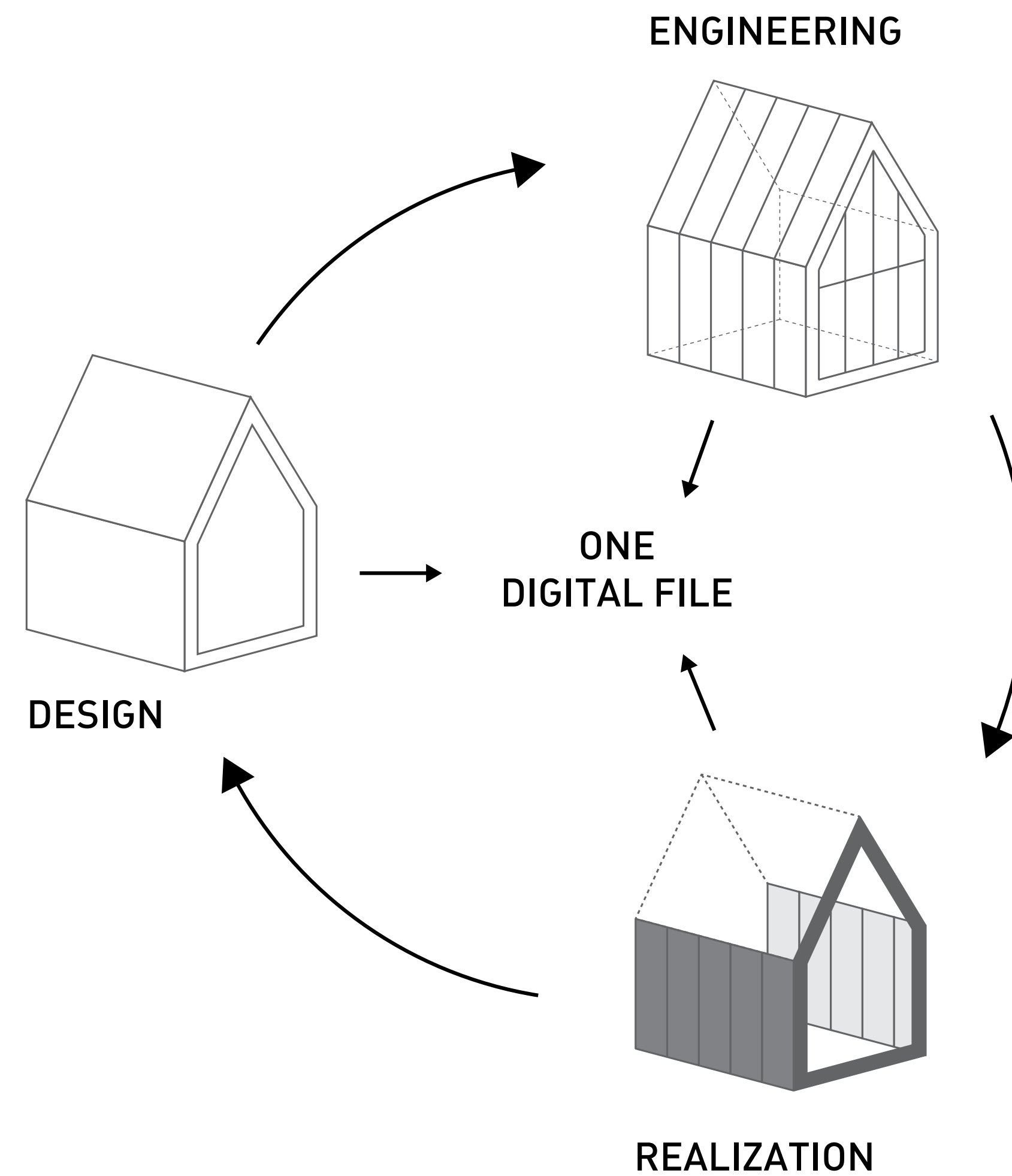


source: Lego.com

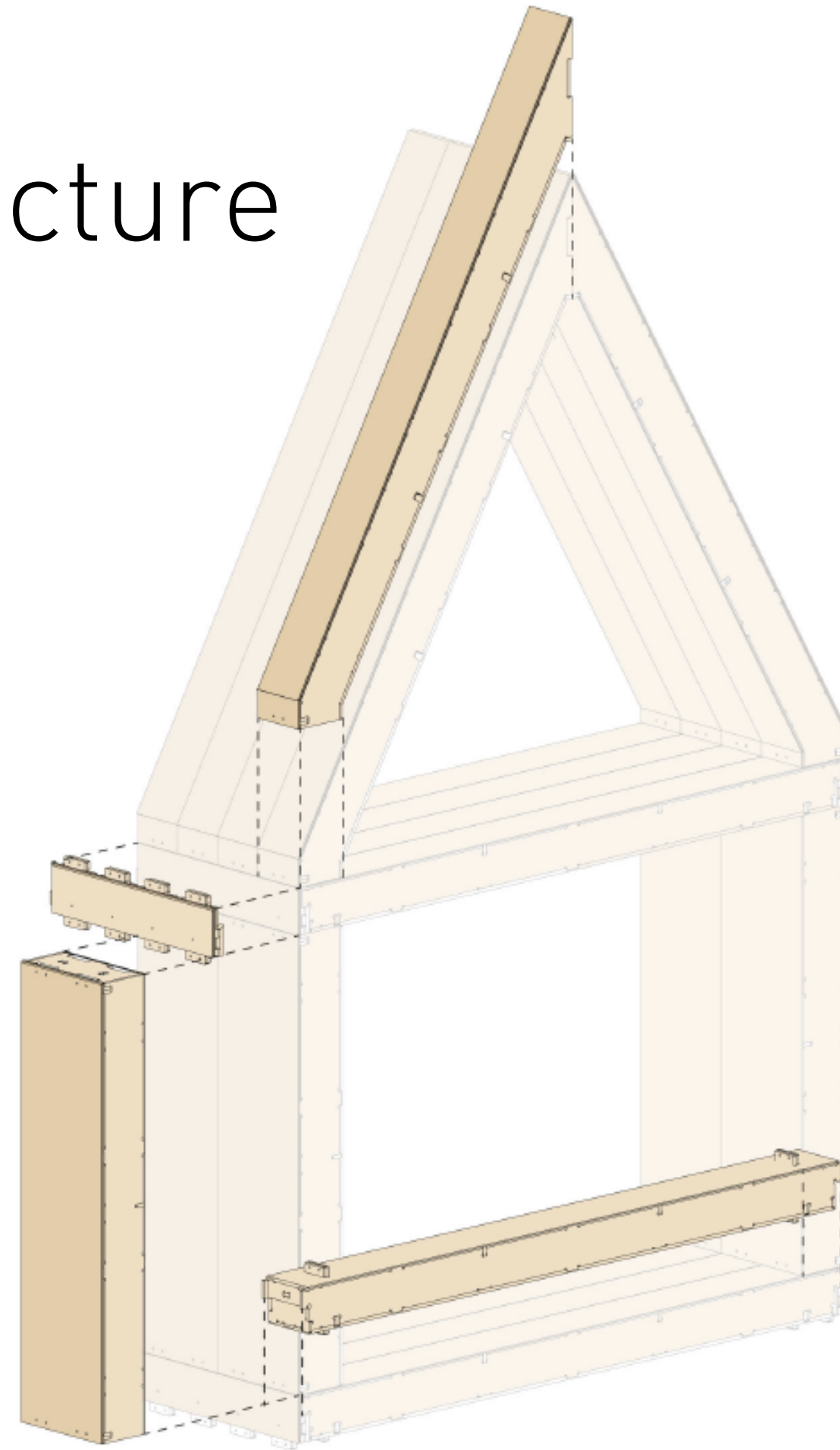
digital manufacturing techniques

source: Pexels.com

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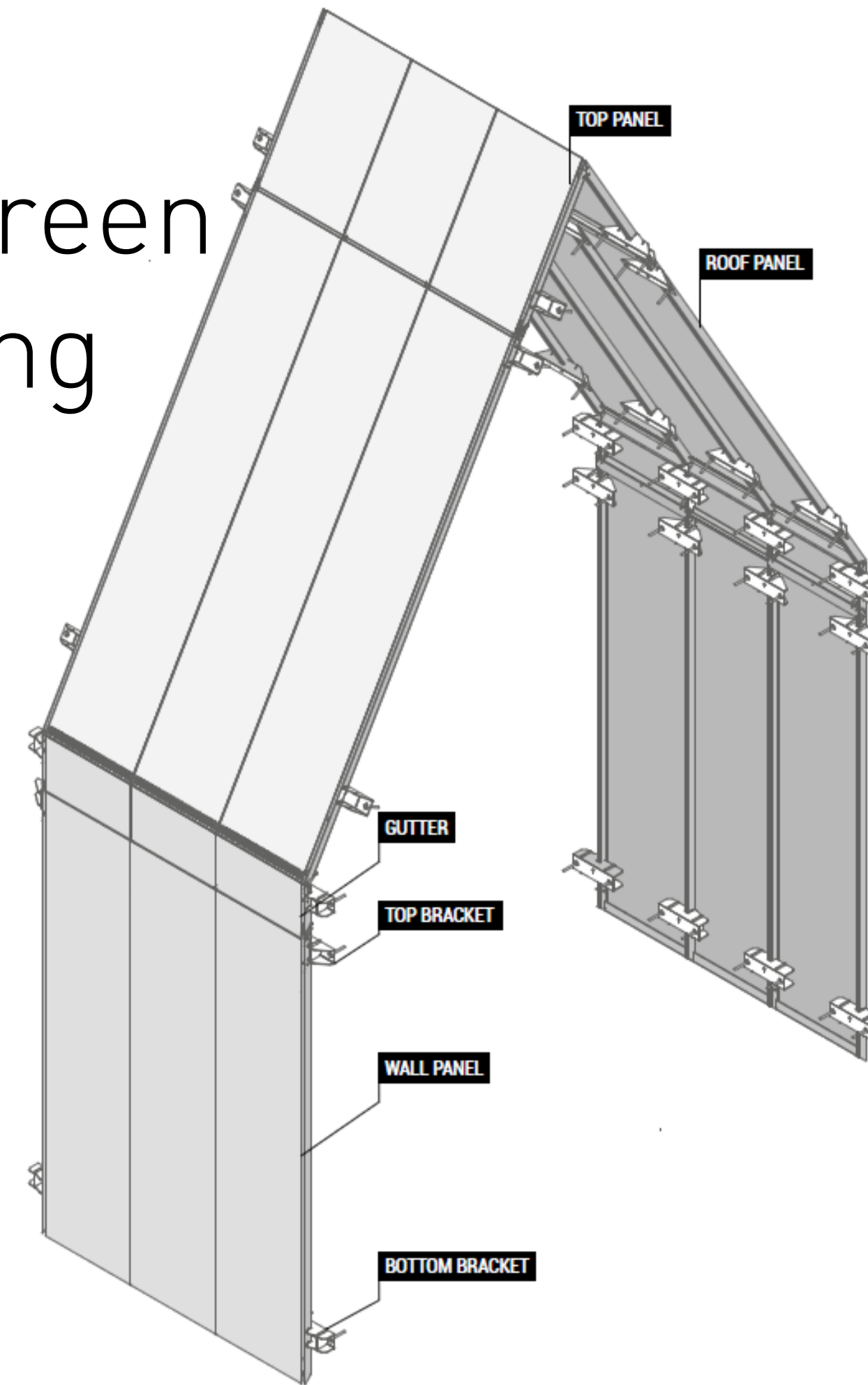


structure



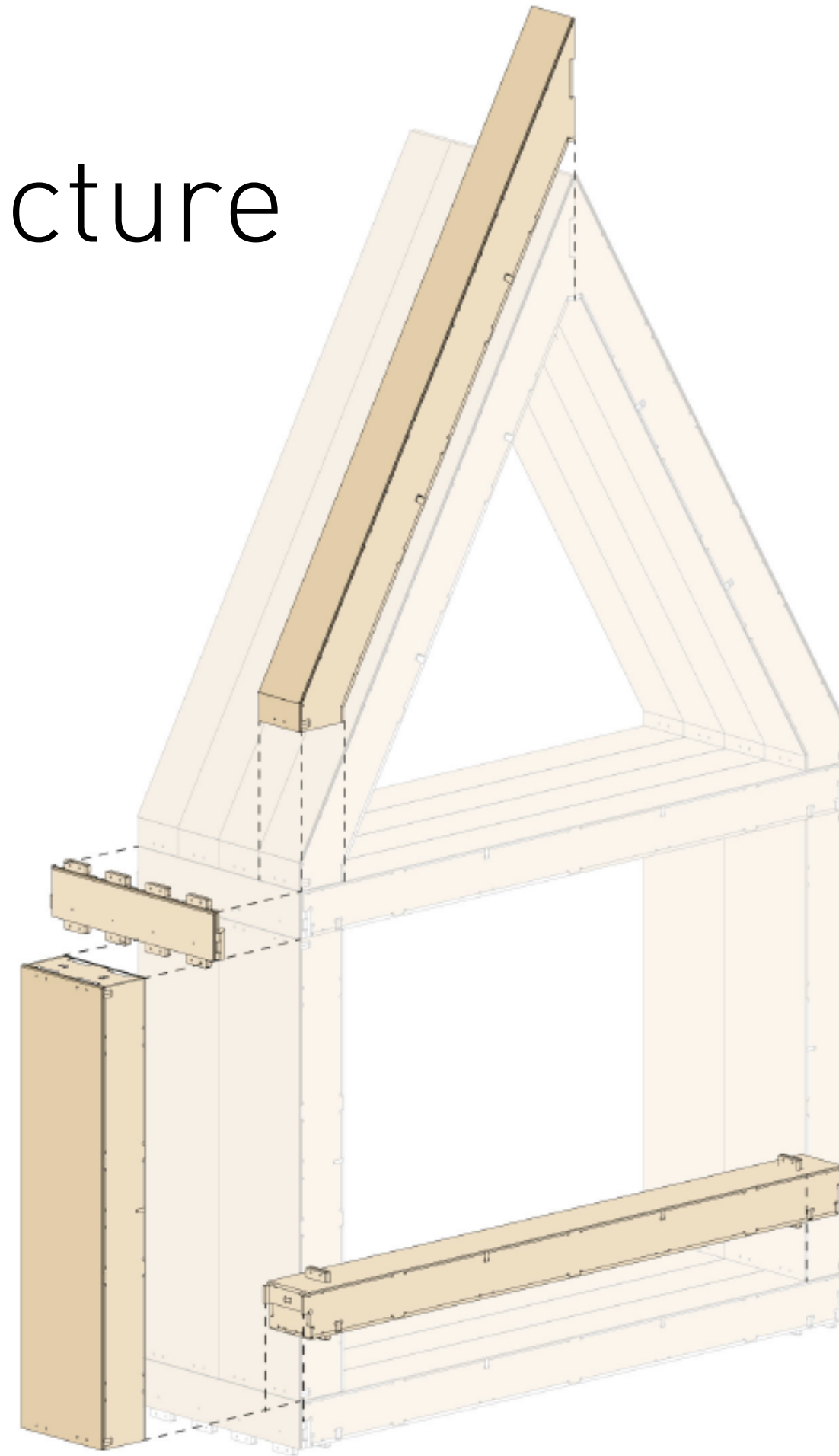
source: Van der Knaap (2016)

rainscreen
cladding



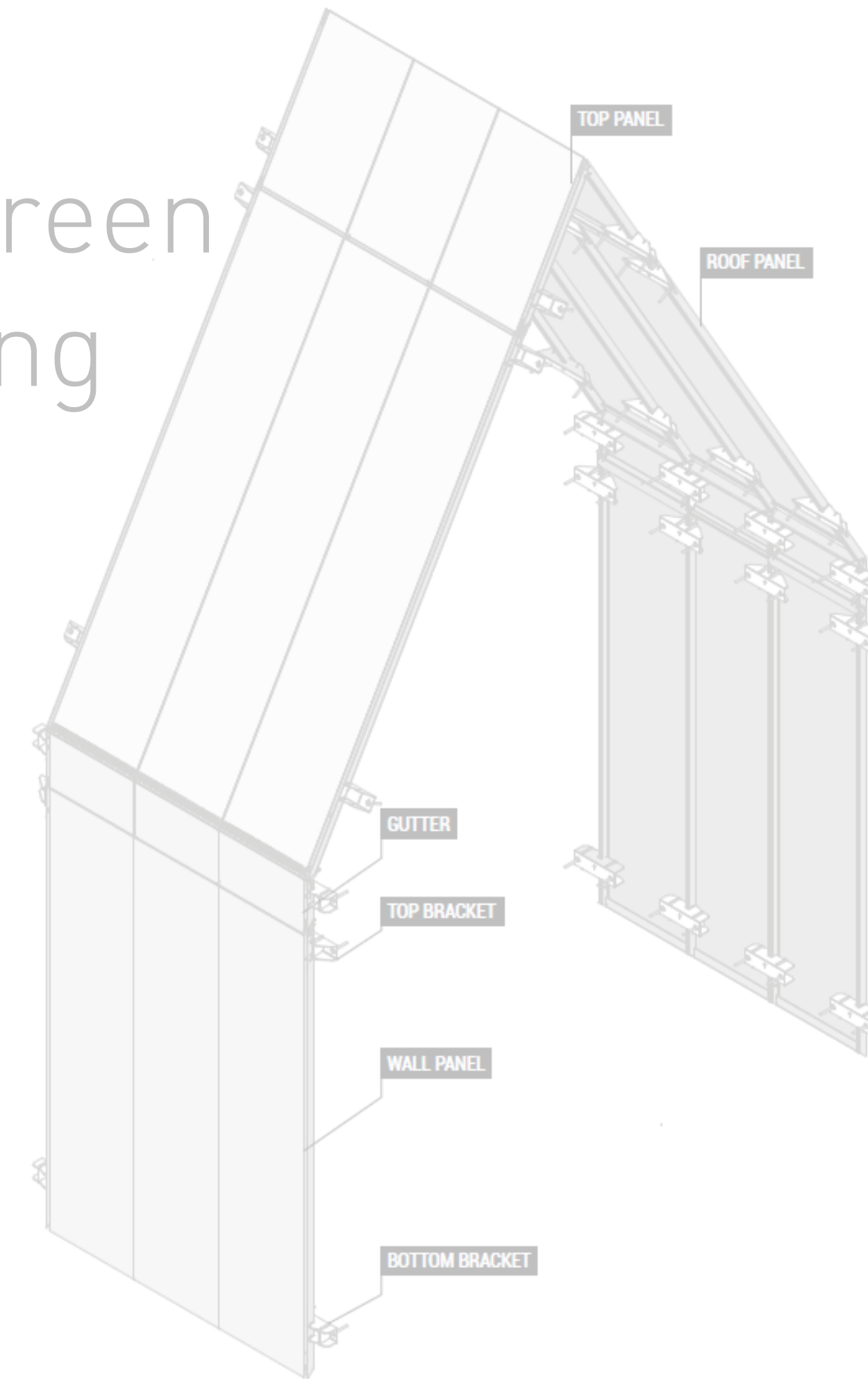
source: Van Veen (2016)

structure

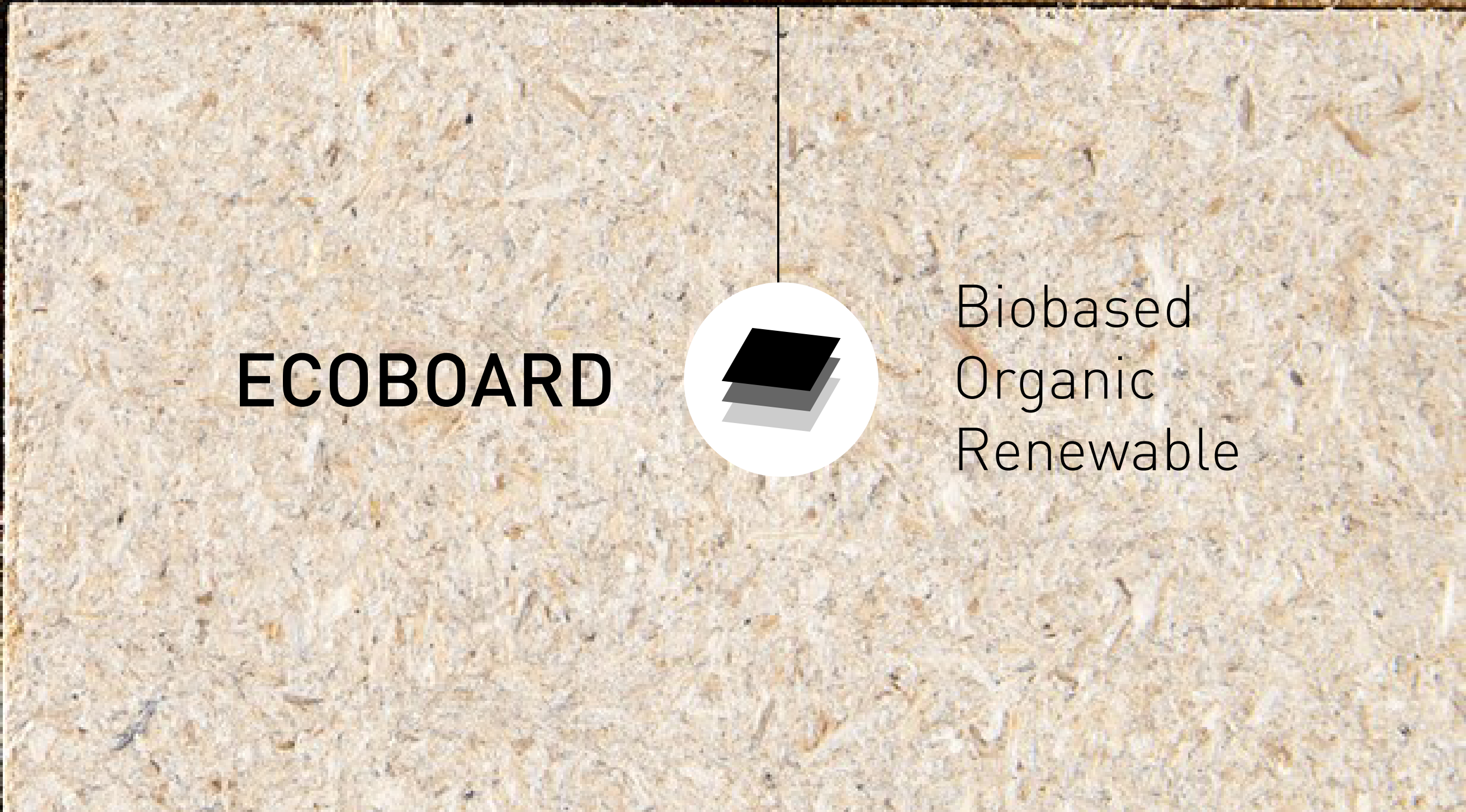
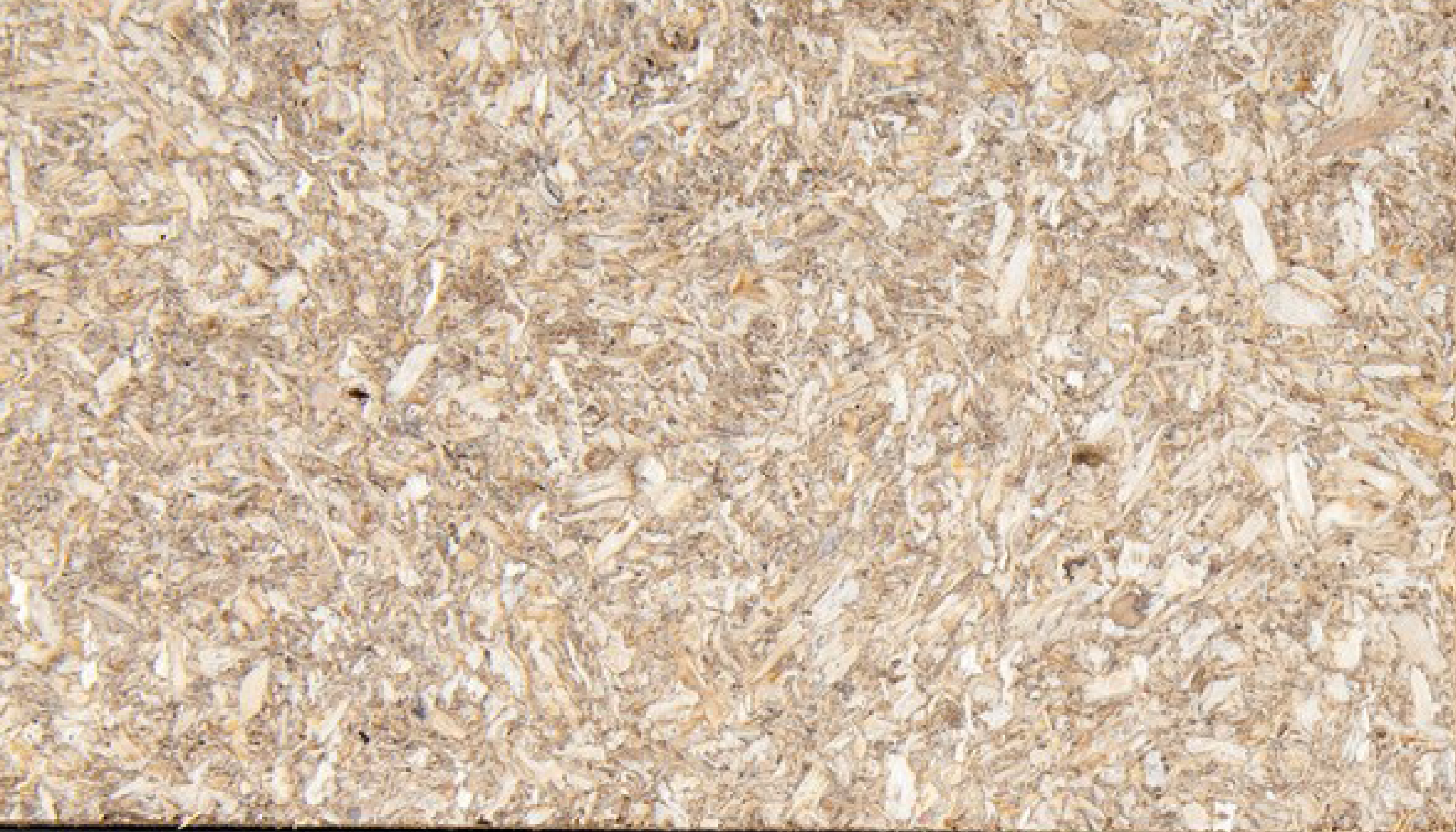


source: Van der Knaap (2016)

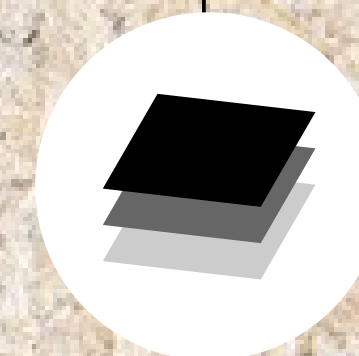
rainscreen
cladding



source: Van Veen (2016)



ECOBOARD

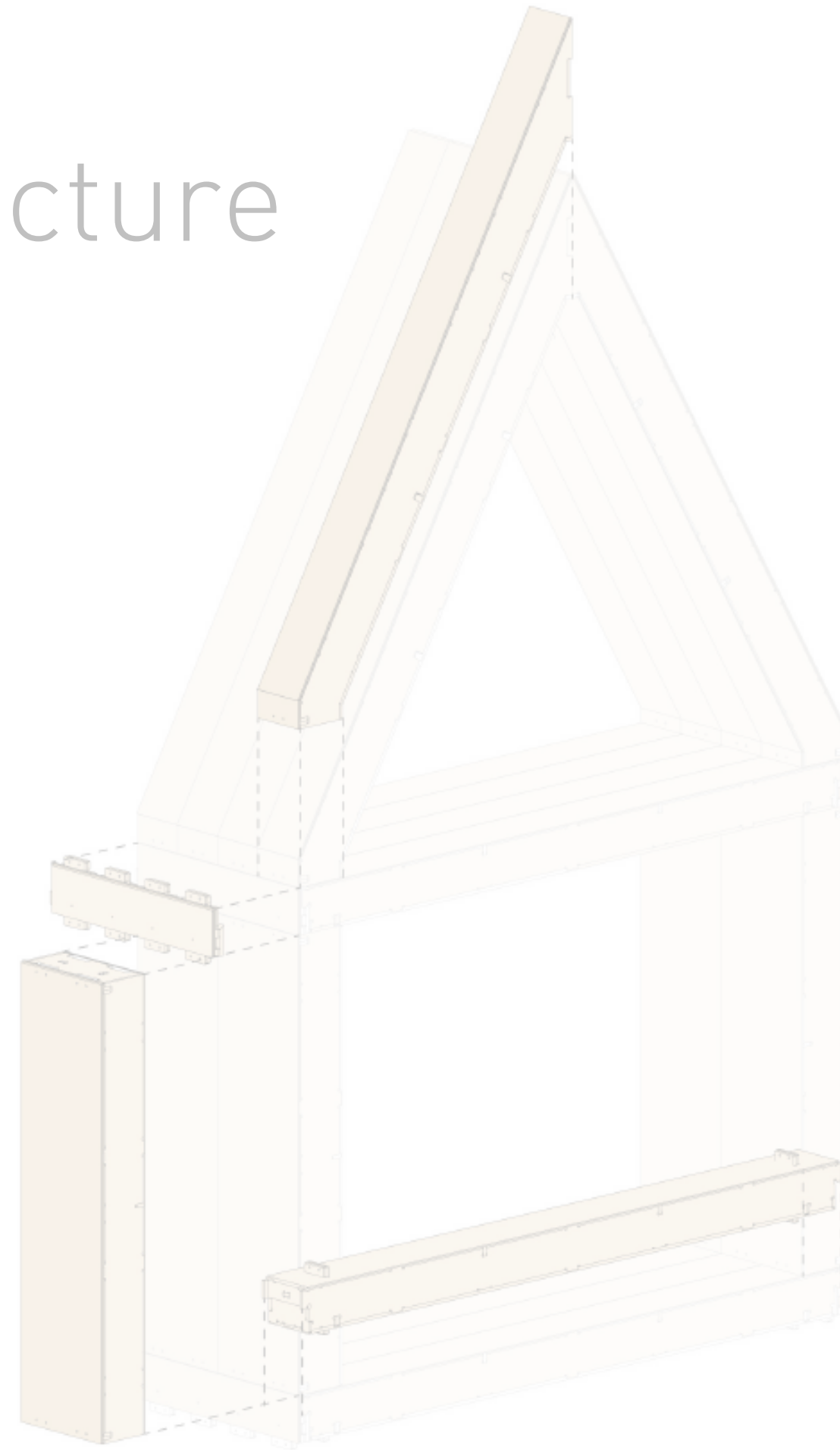


Biobased
Organic
Renewable

source: Materia.nl

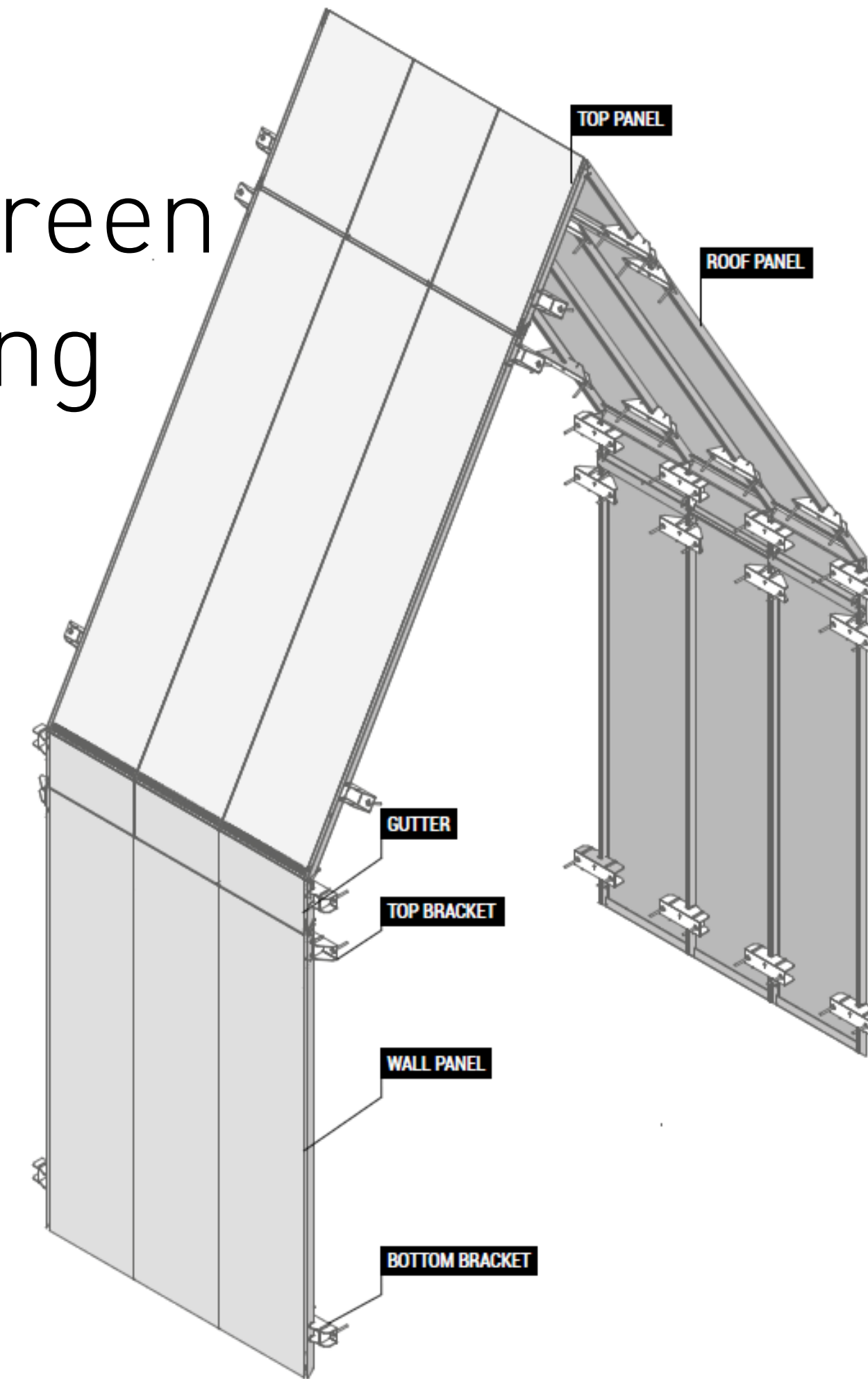
22/110

structure



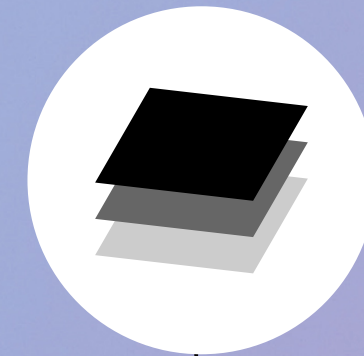
source: Van der Knaap (2016)

rainscreen
cladding



source: Van Veen (2016)

REYNOBOND

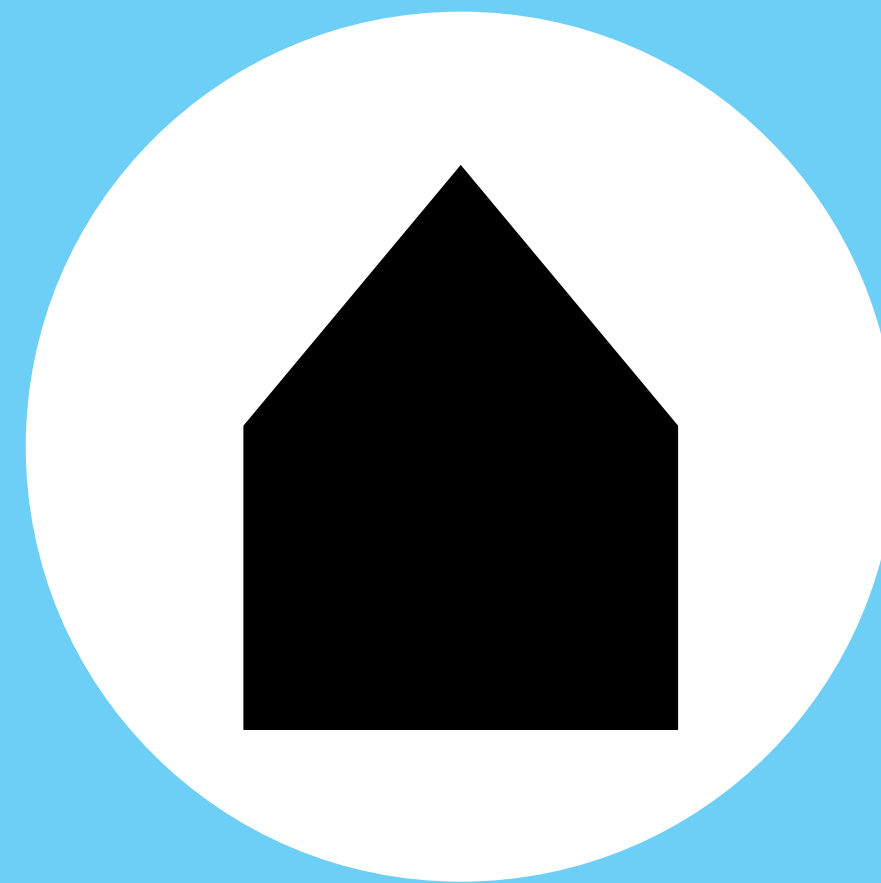


Non-renewable
Hard to recycle



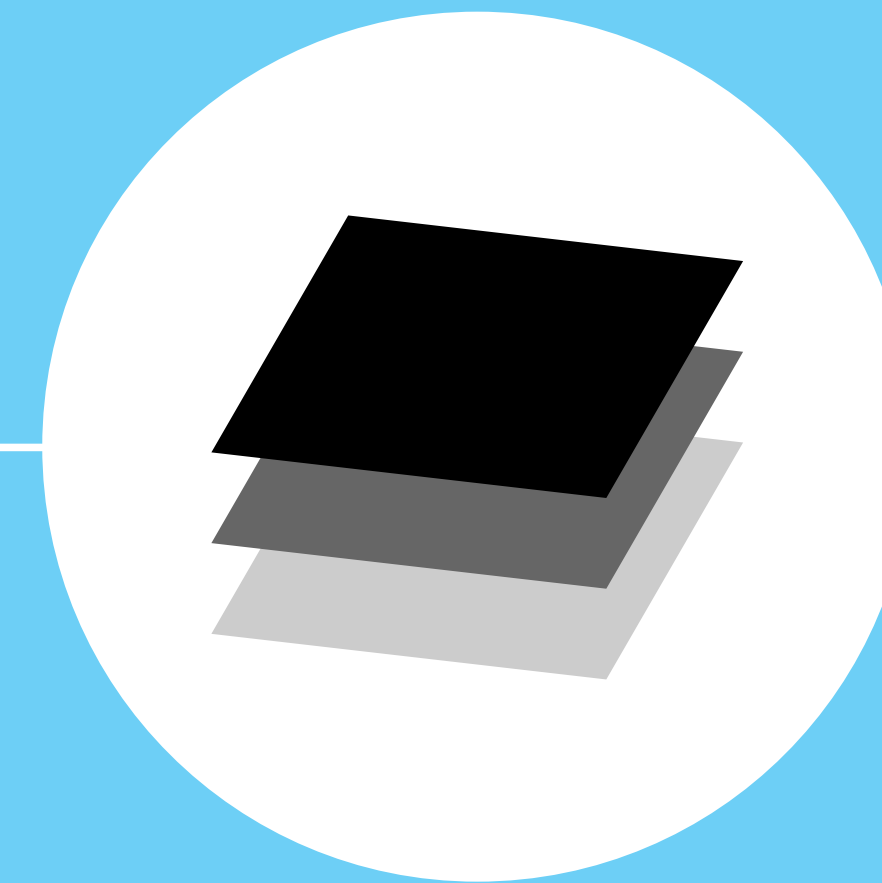
source: Van Veen [2016]

RESEARCH GOAL



DESIGN

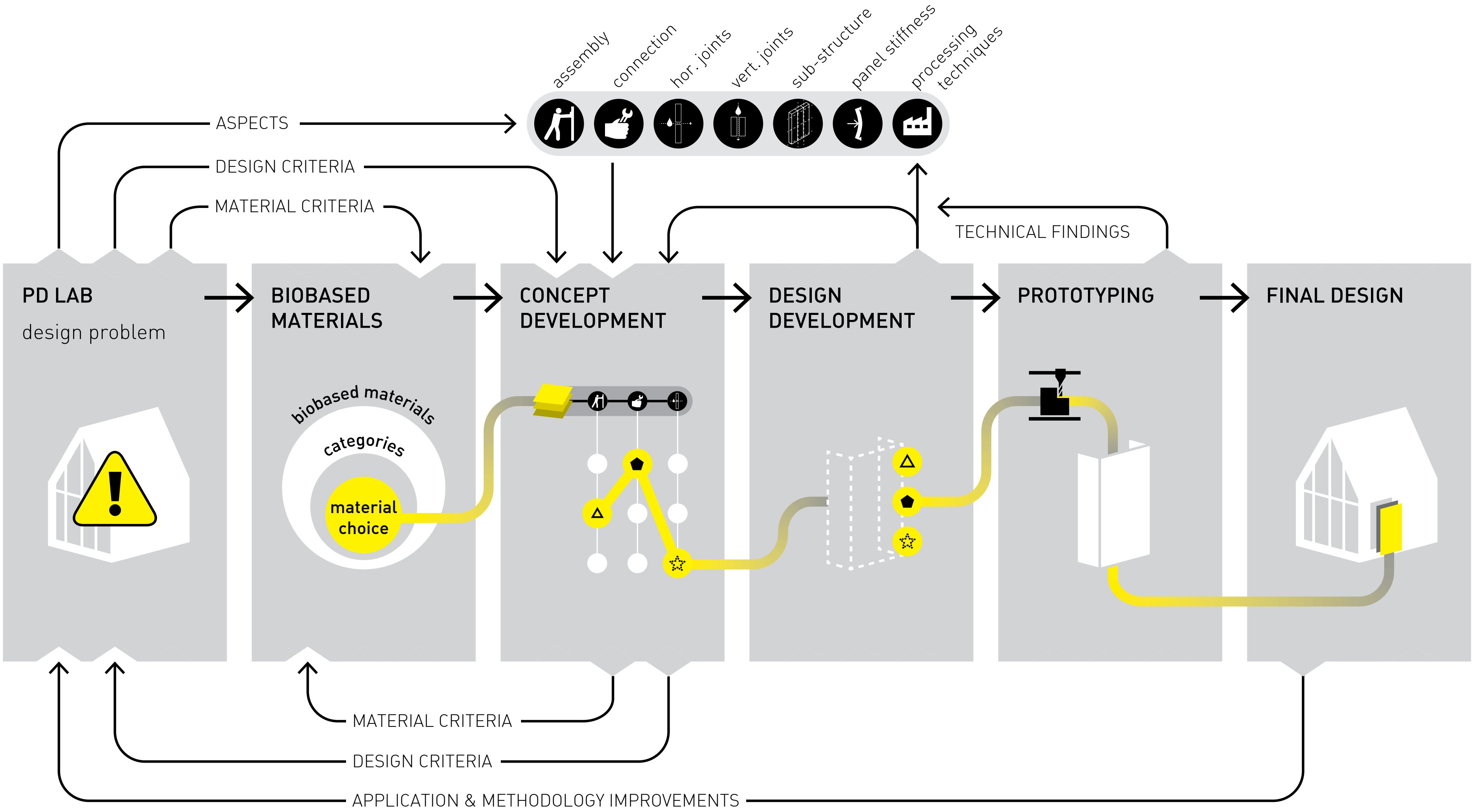
rainscreen
cladding system



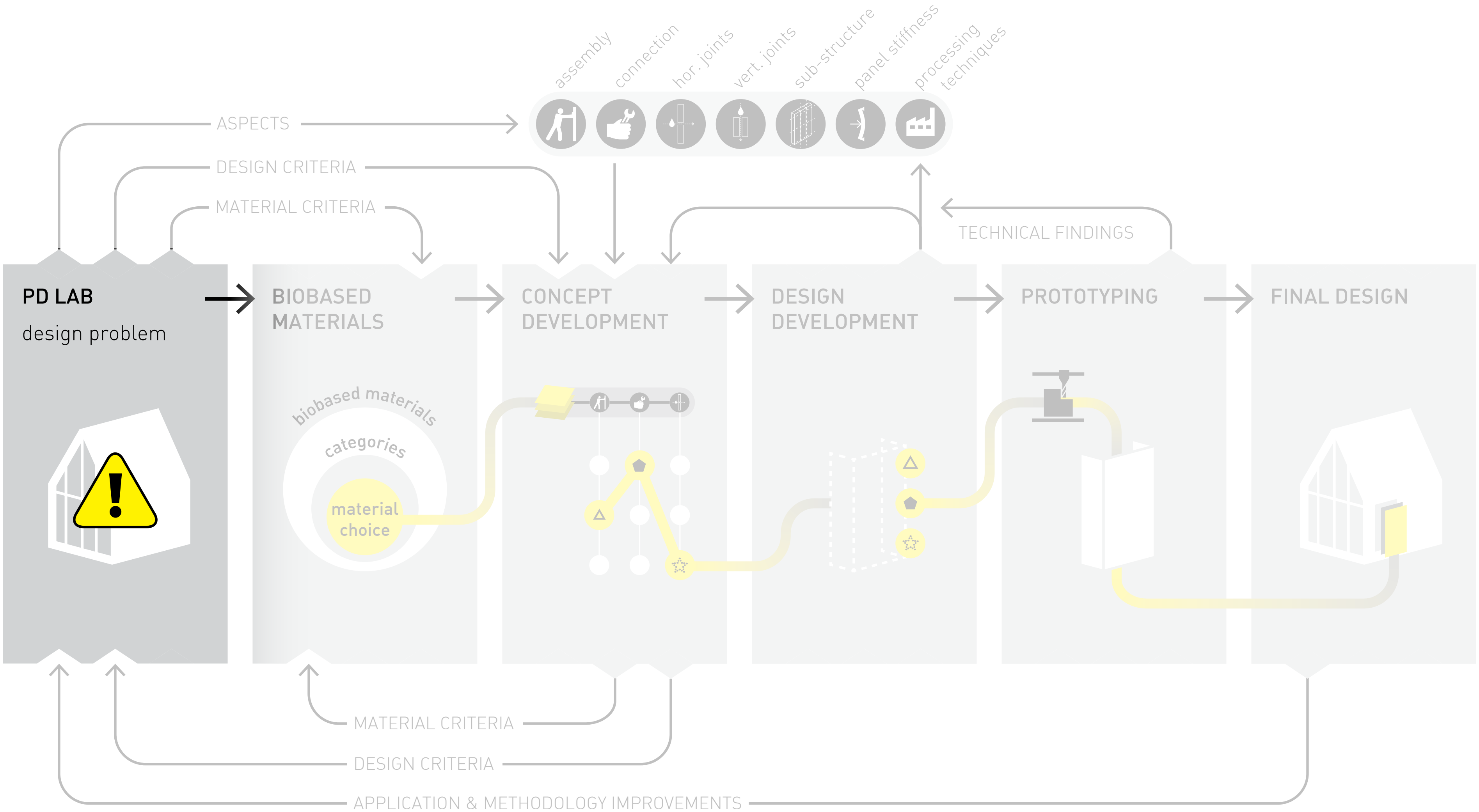
MATERIAL

biobased material

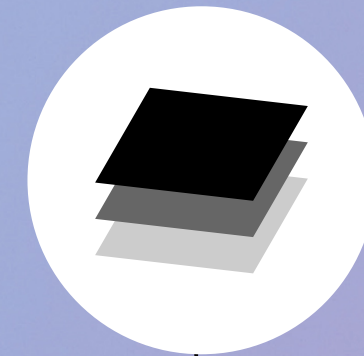
**How can biobased materials be applied
to develop a modular and demountable
cladding system for the PD lab?**



let's start!

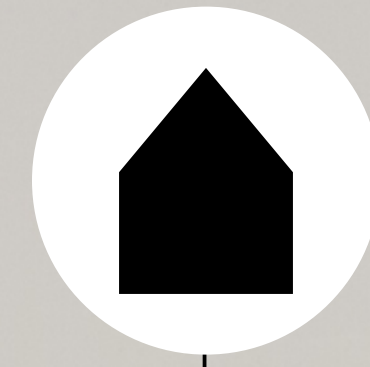


REYNOBOND

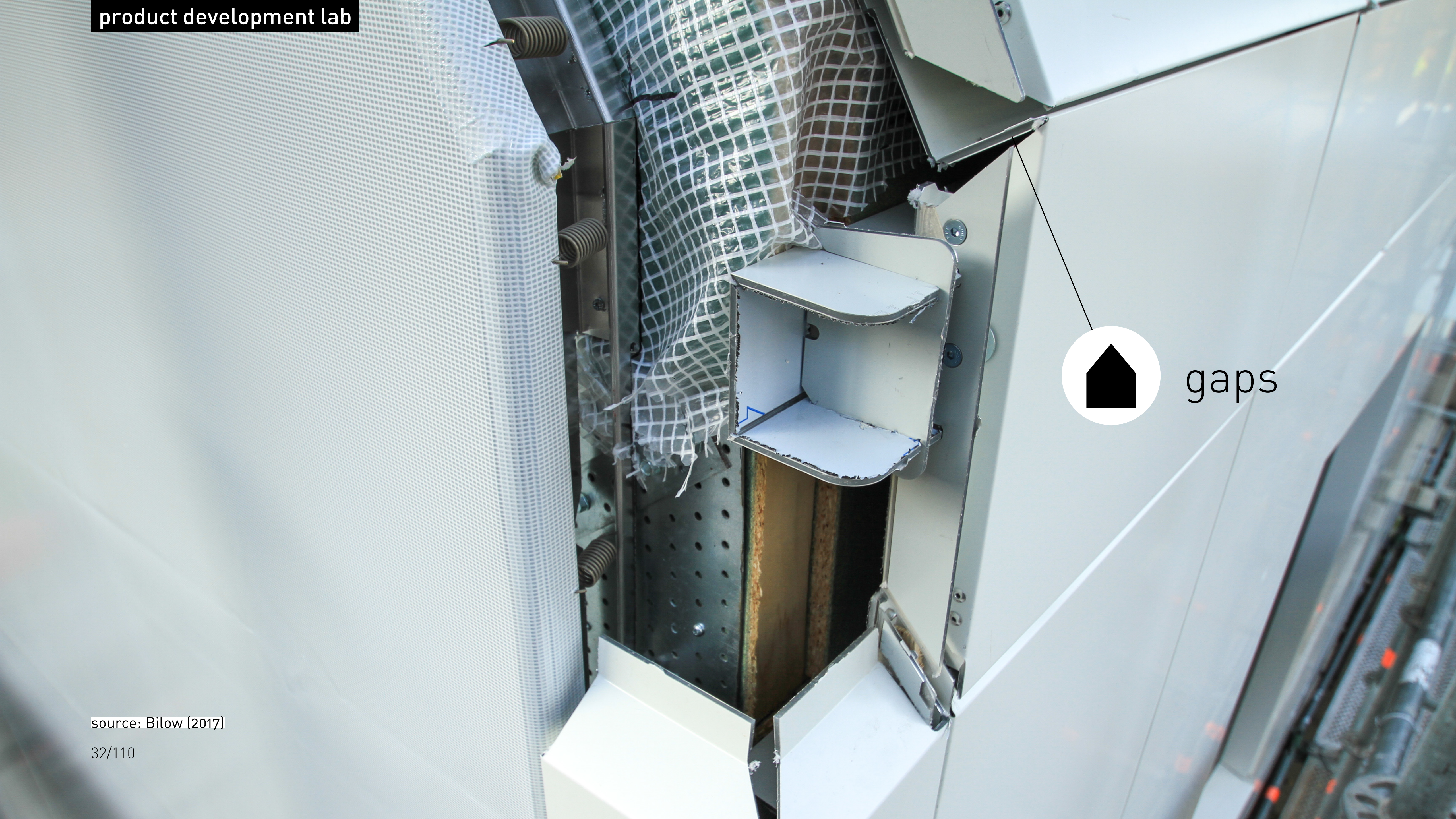


Non-renewable
Hard to recycle

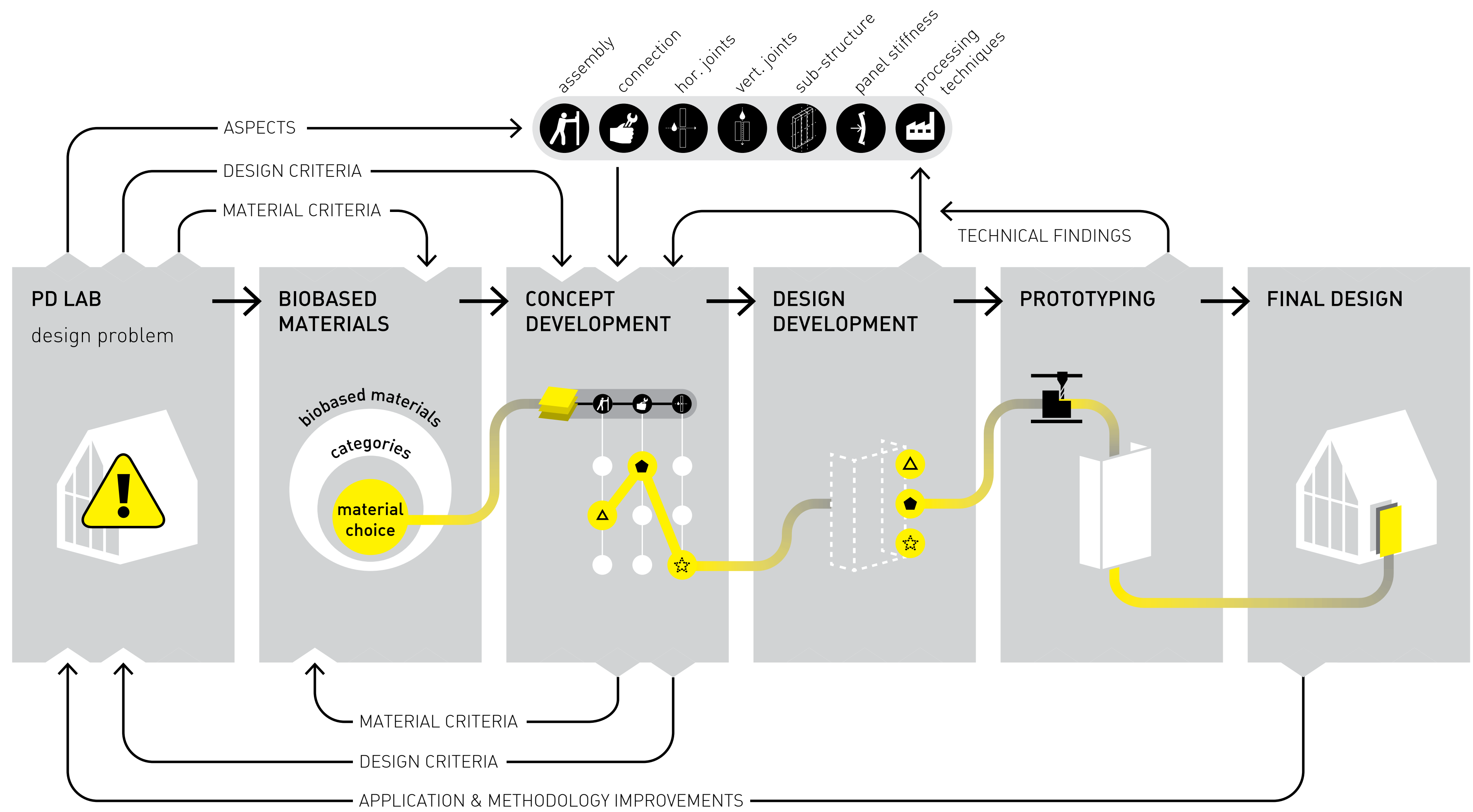
source: Van Veen [2016]



no space for
adjustment

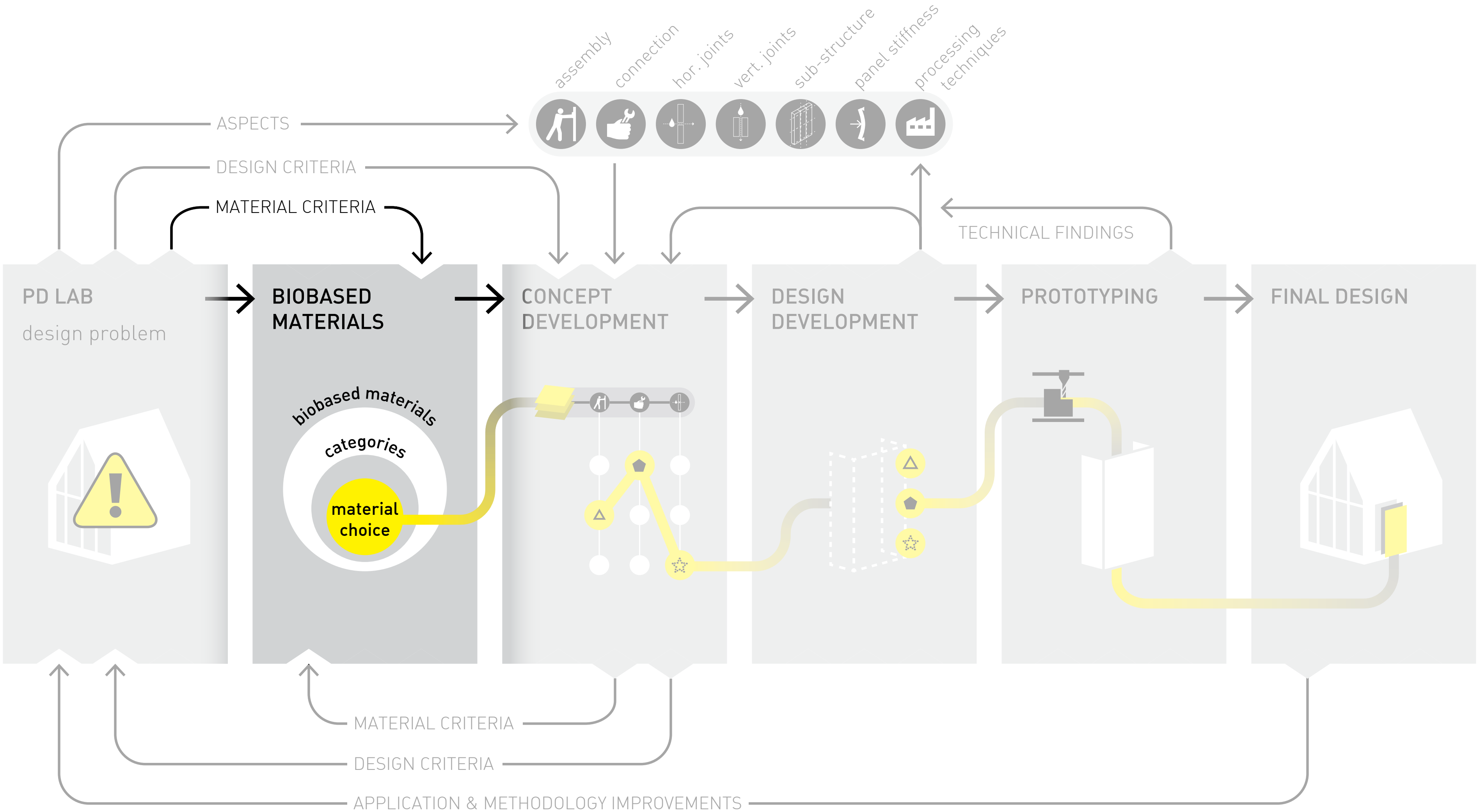


source: Bilow (2017)





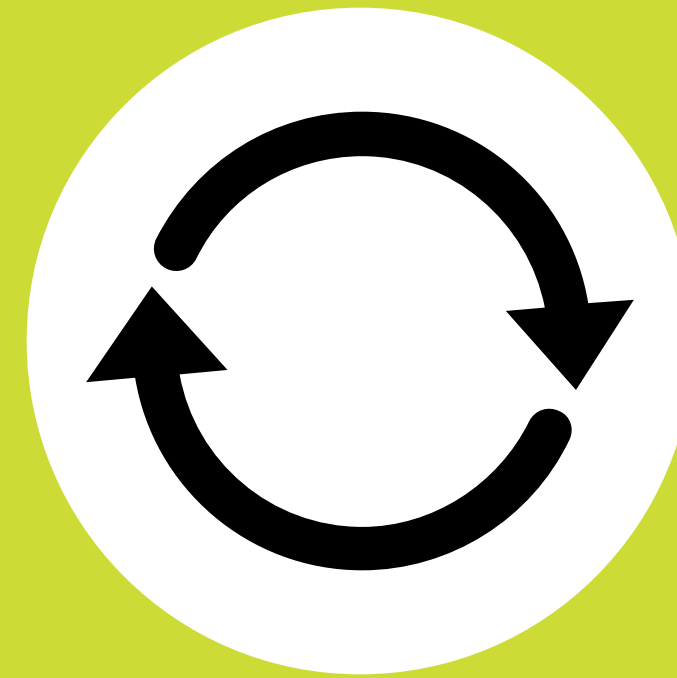
biobased materials



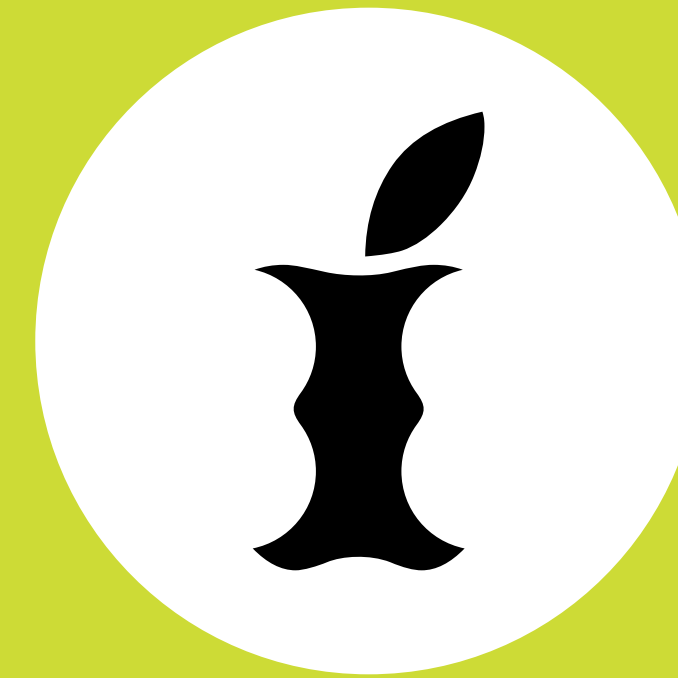
biobased materials



organic

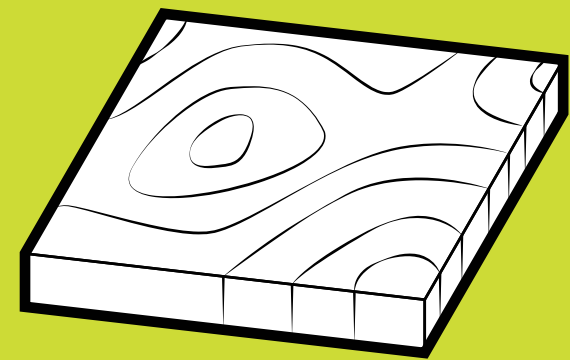


renewable

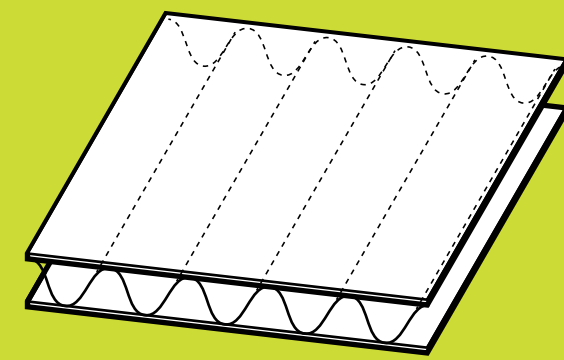


can be
biodegradable

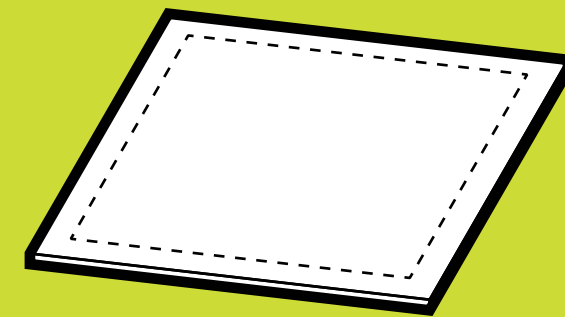
familiar categories



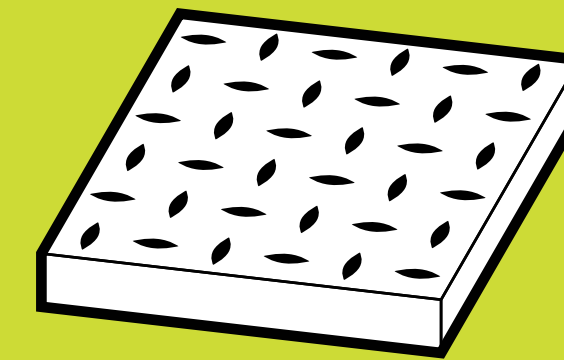
WOOD



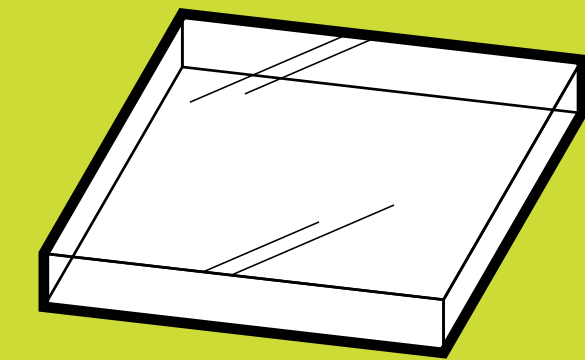
**PAPER,
CARDBOARD**



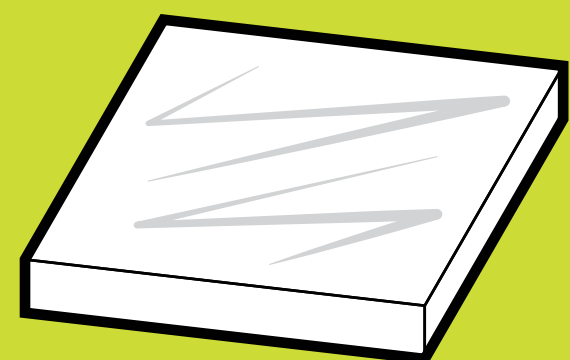
**LEATHER,
HIDE**



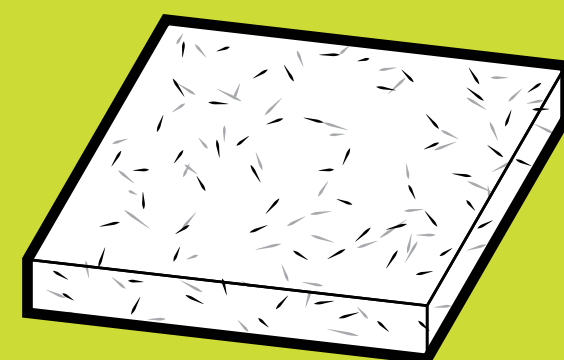
METAL



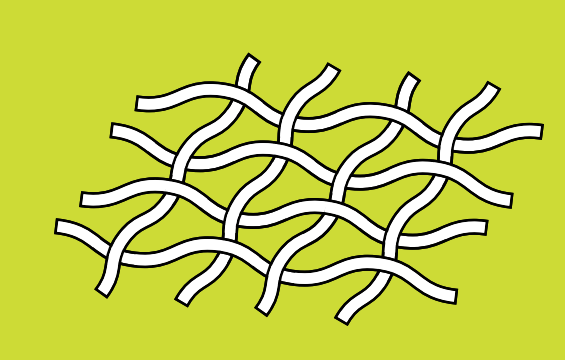
**GLASS,
CERAMICS**



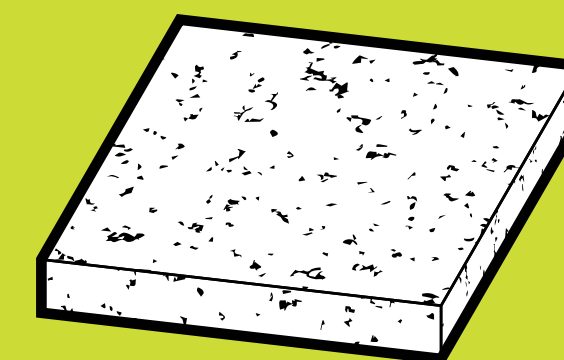
PLASTICS



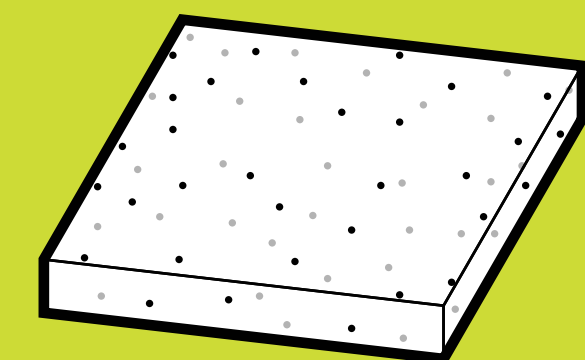
COMPOSITES



TEXTILES

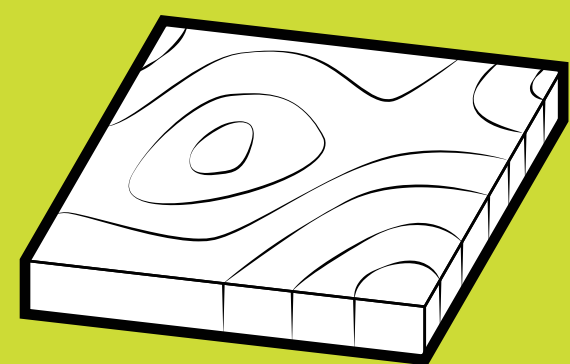


STONE

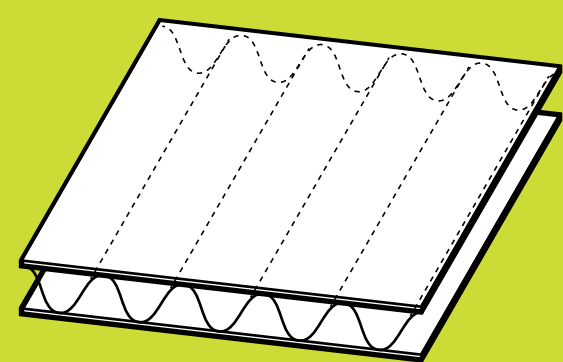


CONCRETE

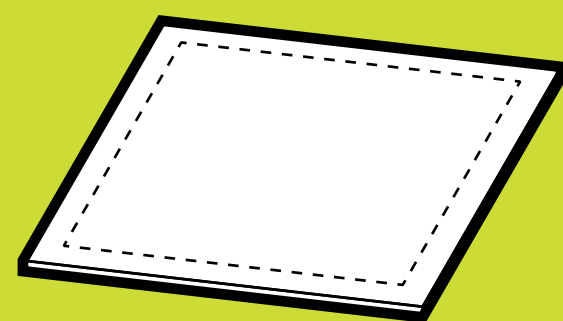
biobased categories



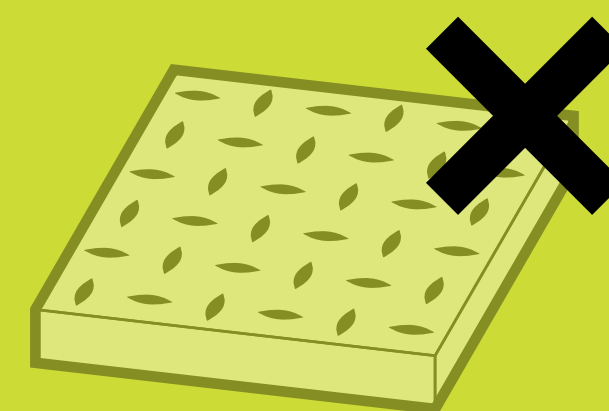
WOOD



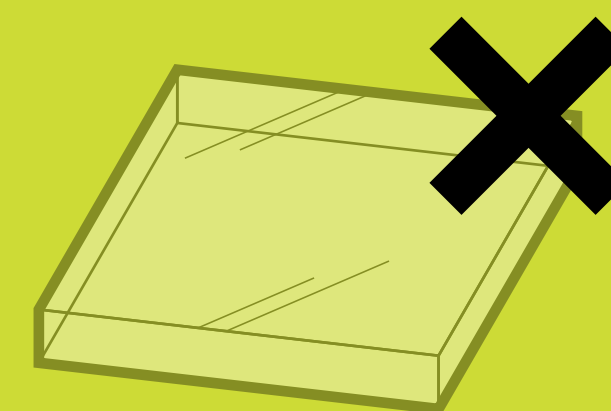
**PAPER,
CARDBOARD**



**LEATHER,
HIDE**



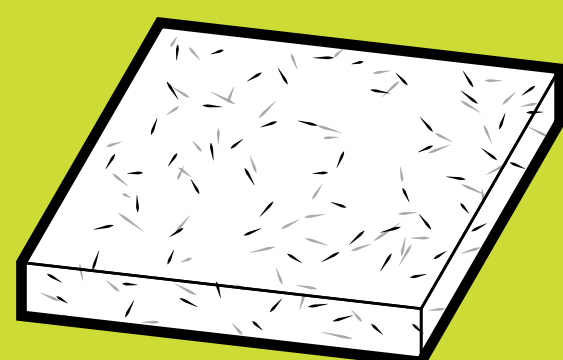
METAL



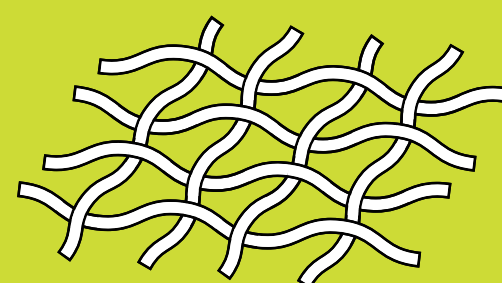
**GLASS,
CERAMICS**



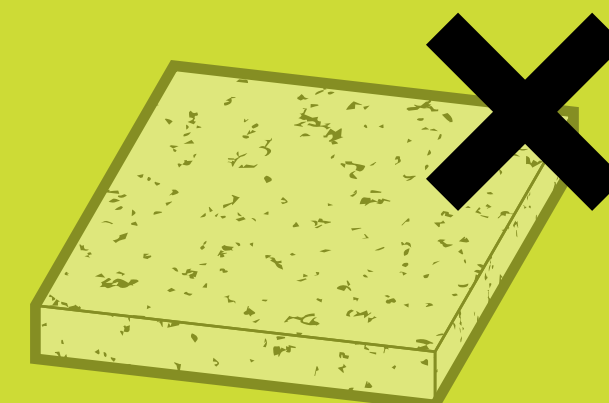
PLASTICS



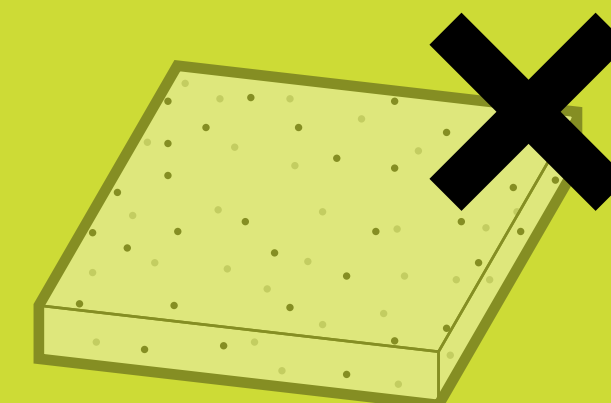
COMPOSITES



TEXTILES

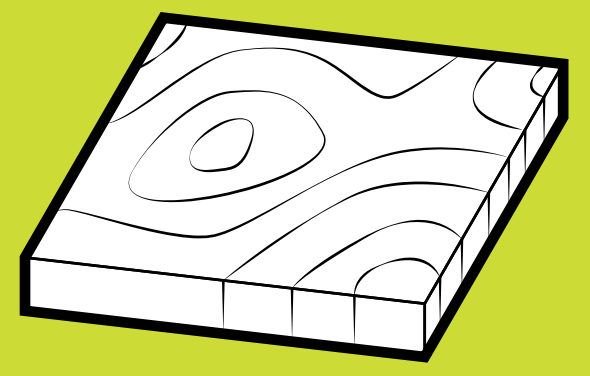


STONE

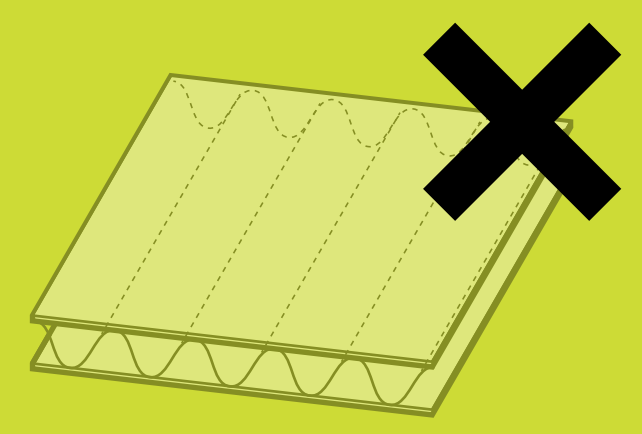


CONCRETE

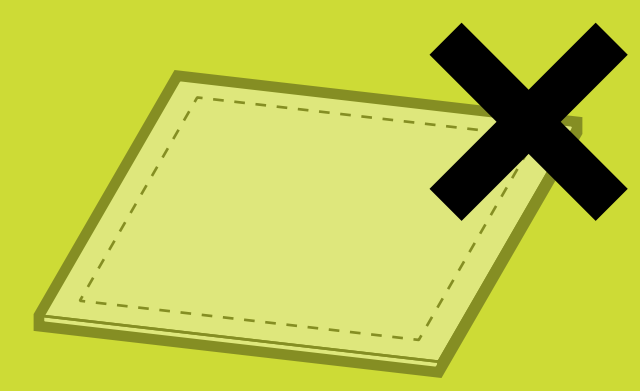
suitable for cladding



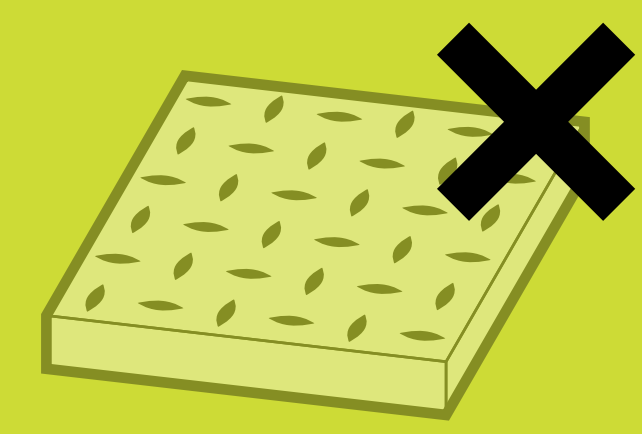
WOOD



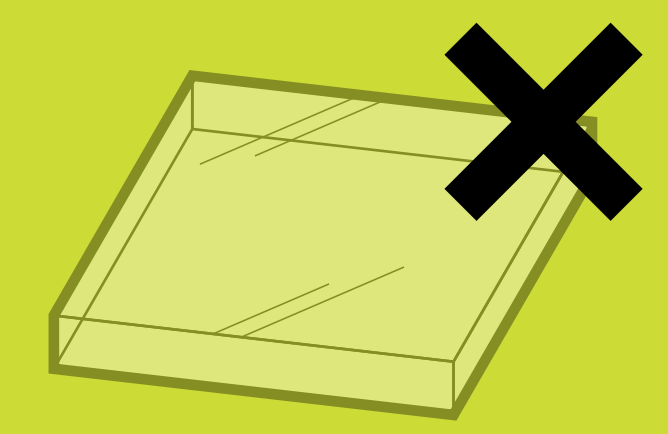
**PAPER,
CARDBOARD**



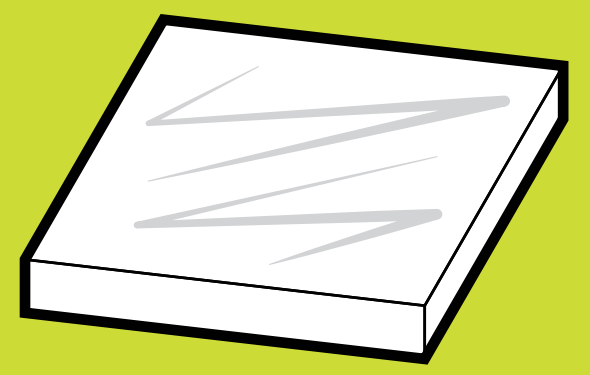
**LEATHER,
HIDE**



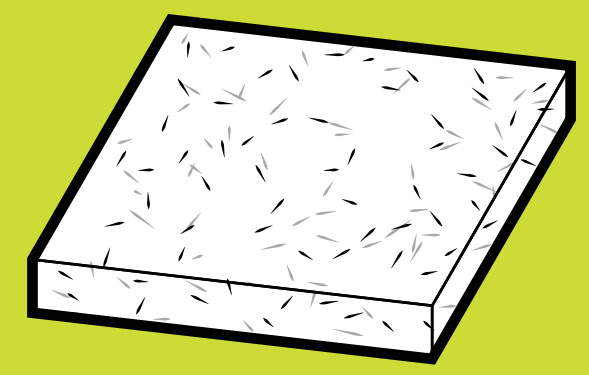
METAL



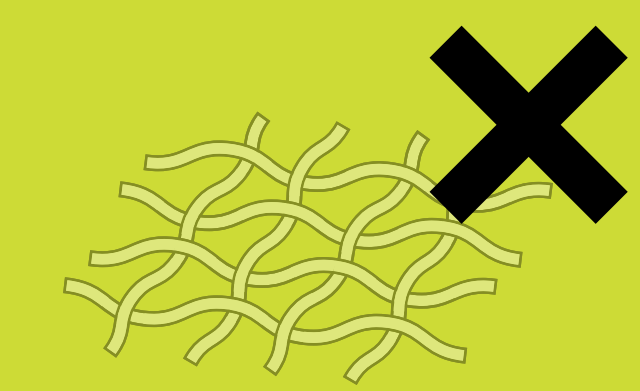
**GLASS,
CERAMICS**



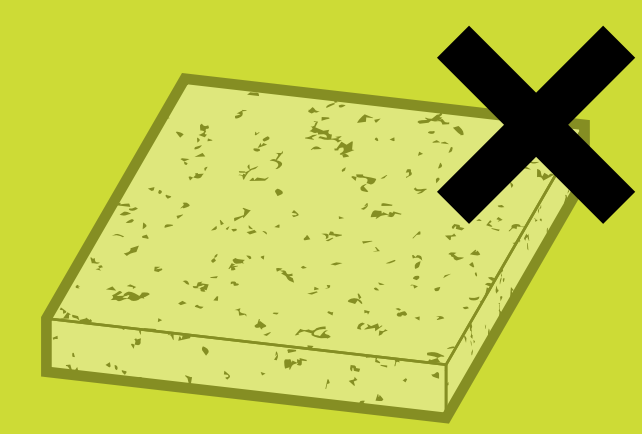
PLASTICS



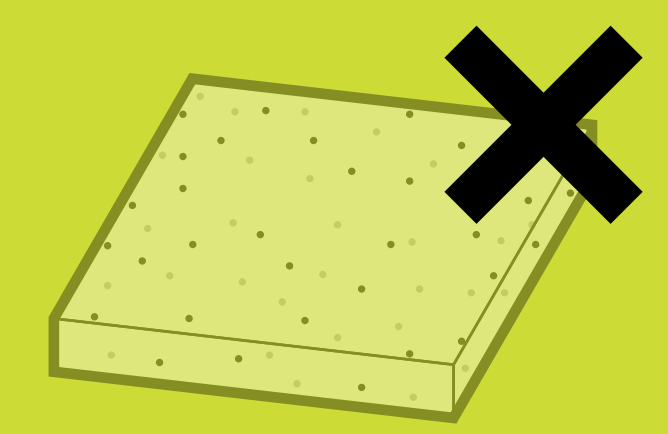
COMPOSITES



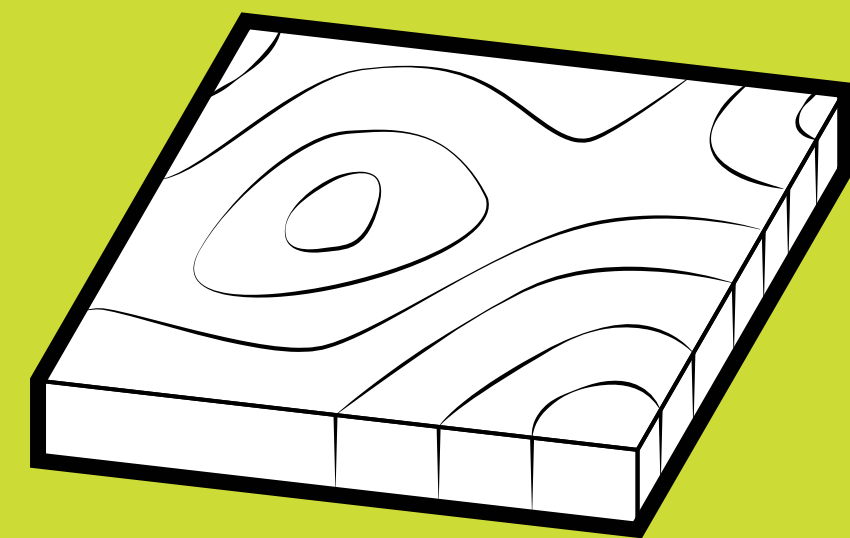
TEXTILES



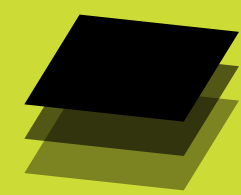
STONE



CONCRETE



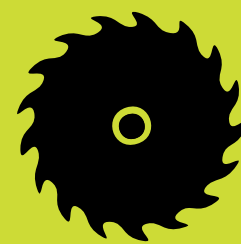
WOOD



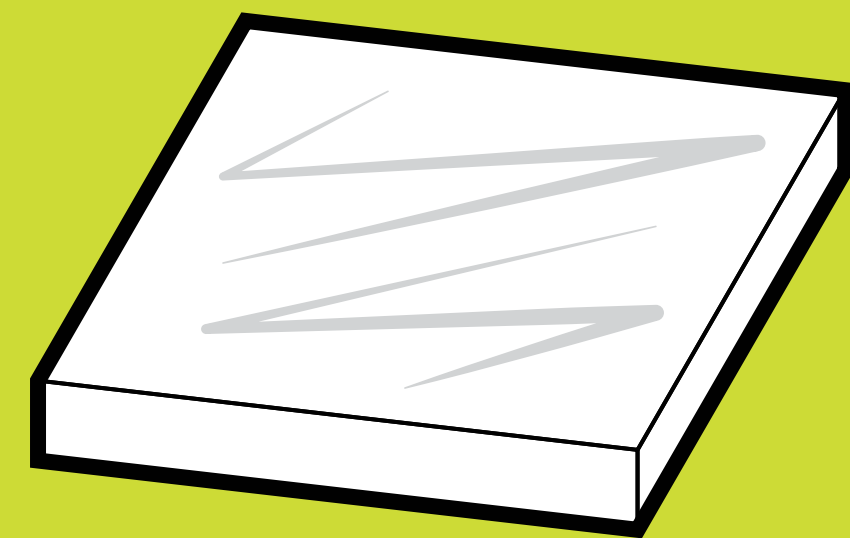
traditional material



comfortable look and feel



far developed processing techniques



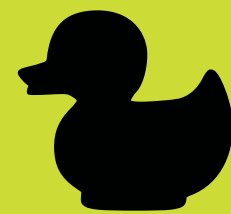
PLASTICS



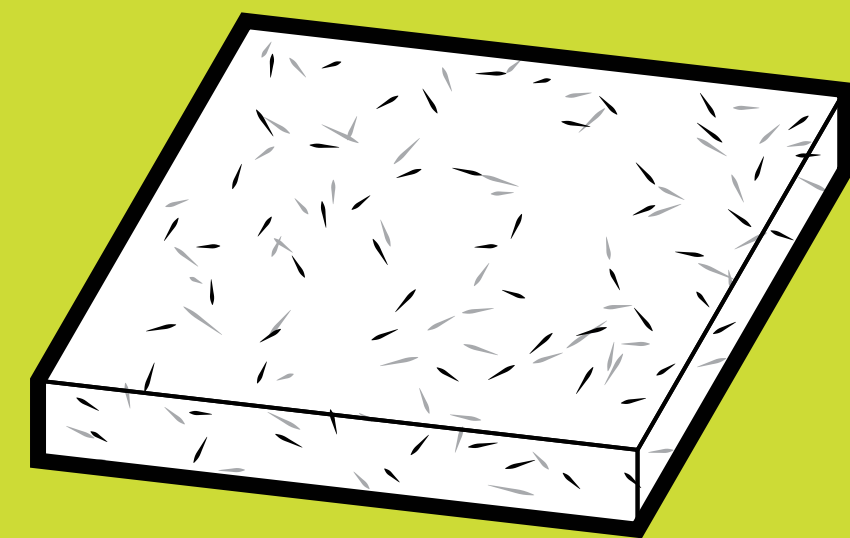
innovative building material



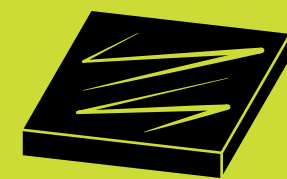
able to be moulded



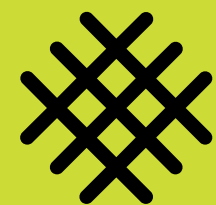
enables complex shapes



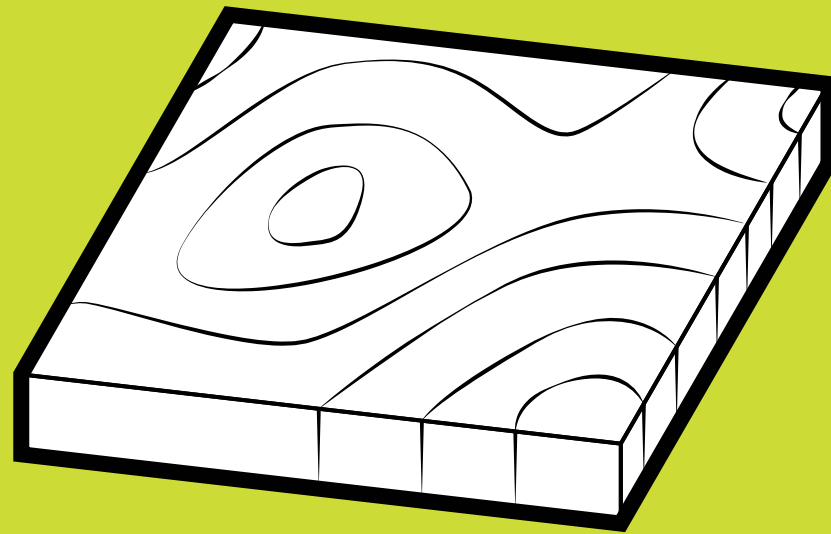
COMPOSITES



plastics + reinforcement

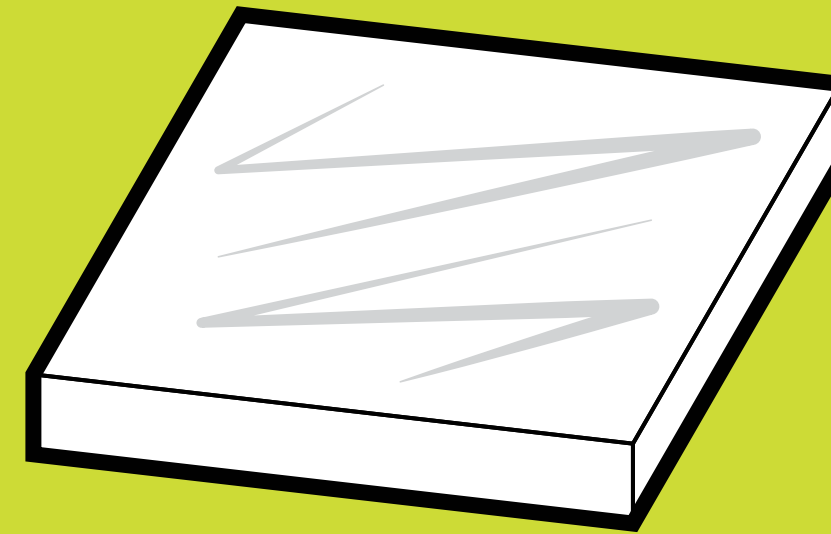


strength - weight ratio



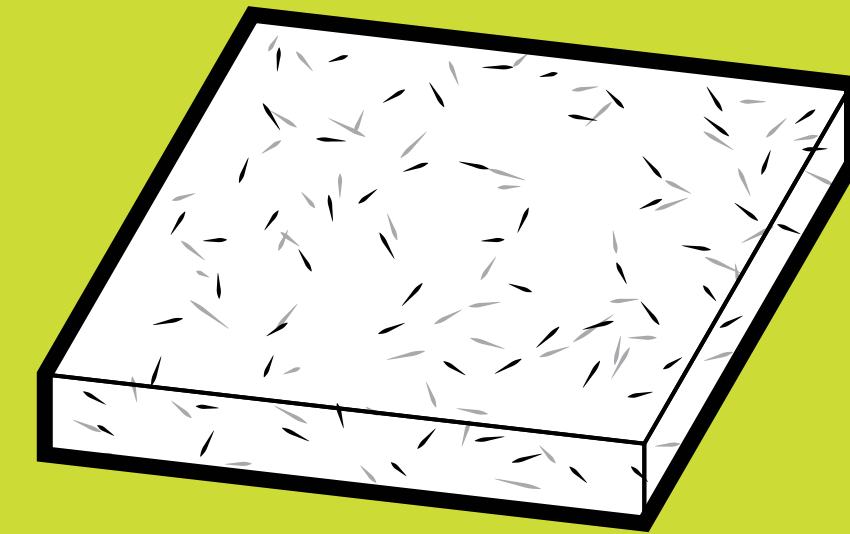
WOOD

traditional



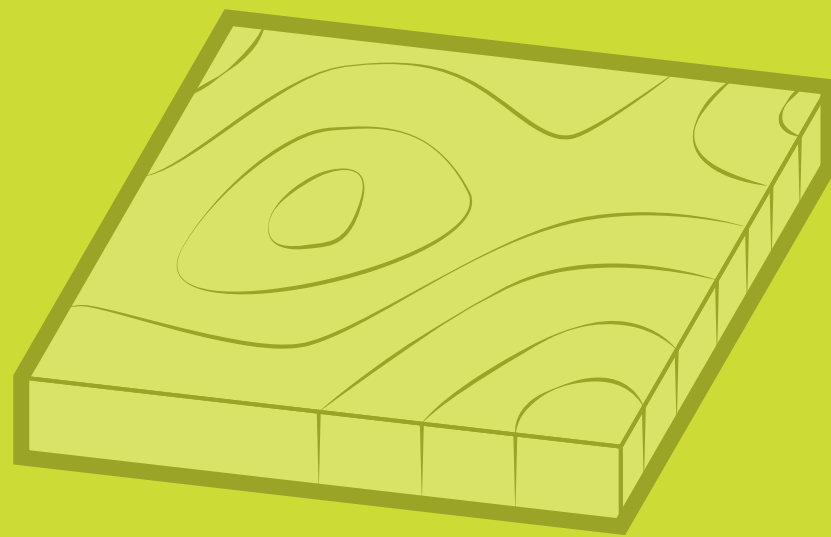
PLASTICS

innovative



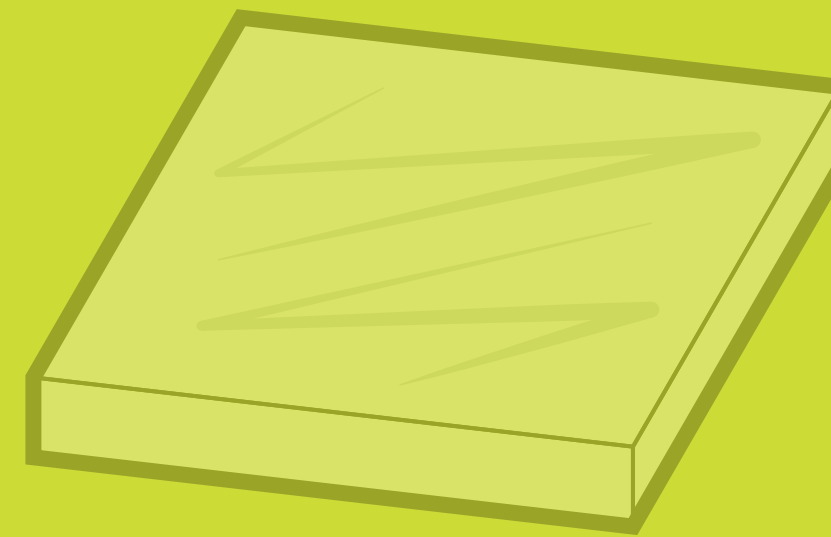
COMPOSITES

innovative
+
extra strength



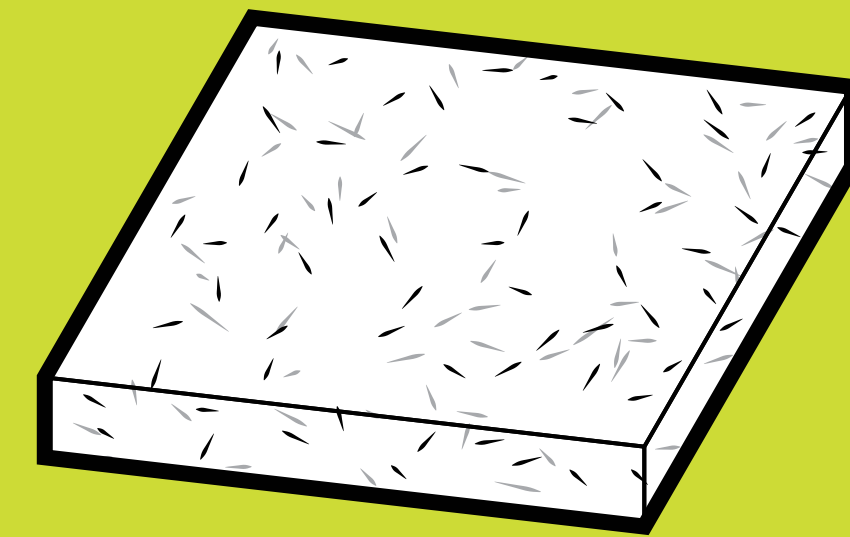
WOOD

traditional



PLASTICS

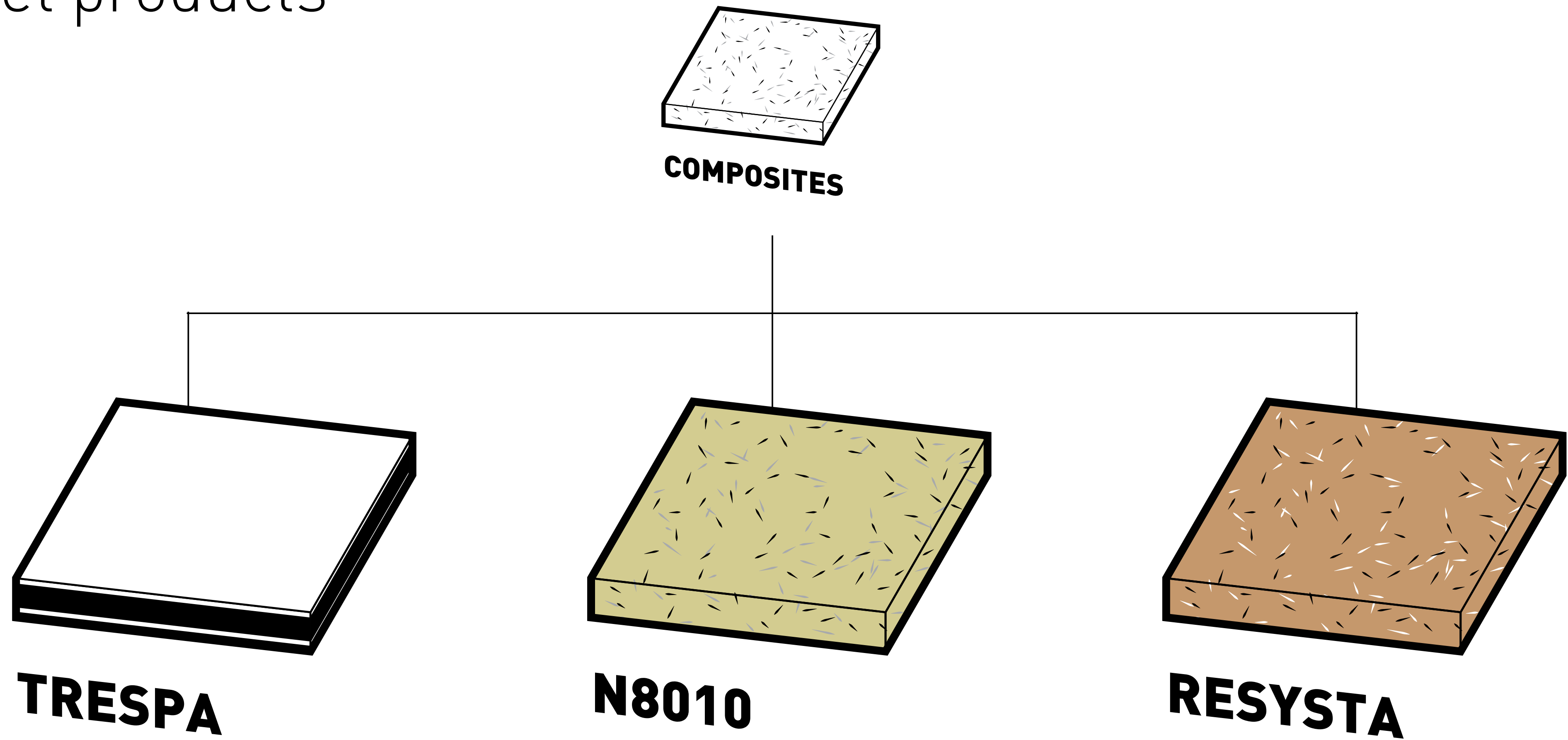
innovative



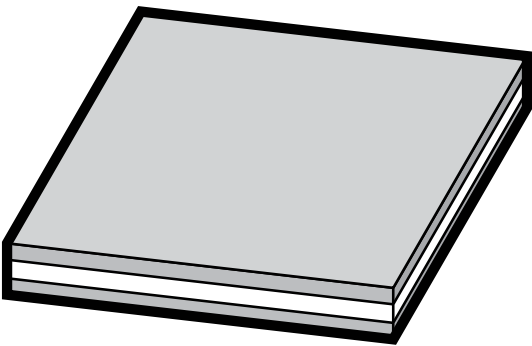
COMPOSITES

innovative
+
extra strength

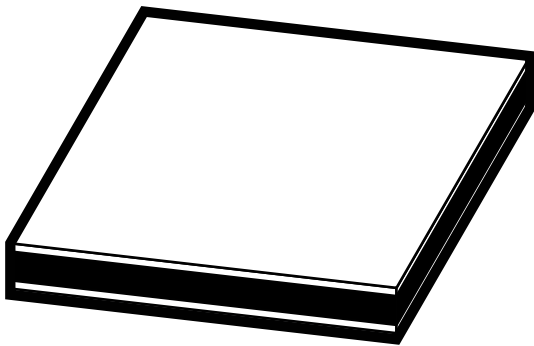
market products



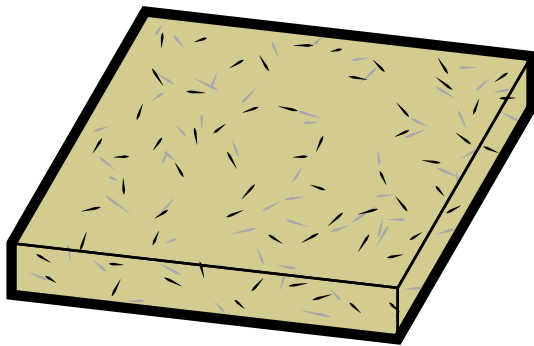
assessment



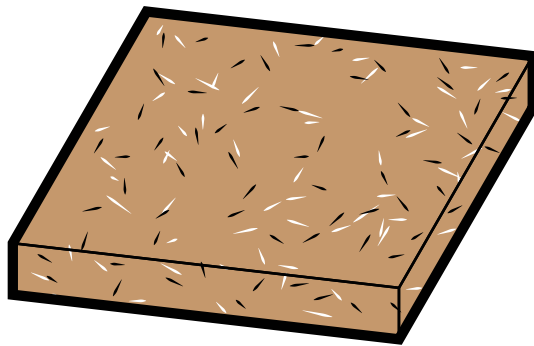
REYNOBOND
(BENCHMARK)



TRESPA



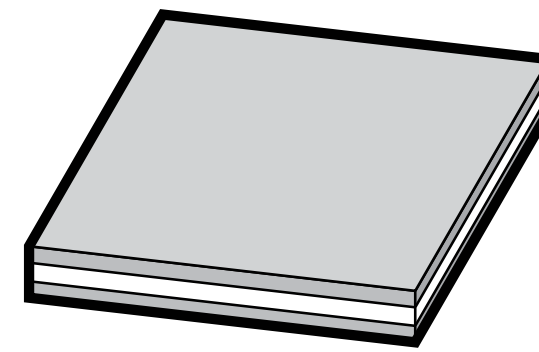
N8010



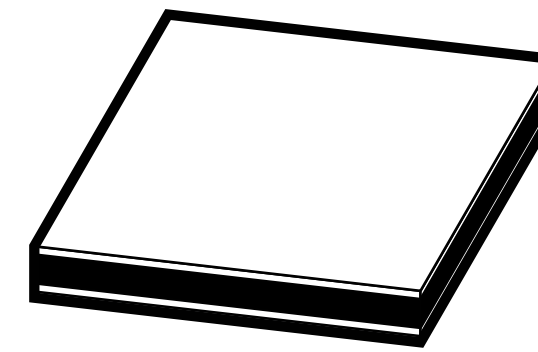
RESYSTA

MARKET PRODUCT	<div><div></div><div></div><div></div></div>	
BIOBASED >50%	<div><div></div><div></div><div></div></div>	
WATER RESISTANT	<div><div></div><div></div><div></div></div>	
WATER ABSORPTION	<div><div></div><div></div><div></div></div>	mass. %
DENSITY	<div><div></div></div>	g/cm3
FLEXURAL MODULUS	<div><div></div><div></div></div>	MPa
SUITABLE PROCESSES	<div><div></div><div></div><div></div></div>	-
AVAILABLE COLOURS	<div><div></div></div>	-
BIOBASED SHARE	<div><div></div><div></div><div></div></div>	mass. %
RECYCLING RATE	<div><div></div><div></div><div></div></div>	vol. %
FIRE SAFETY CLASS	<div><div></div><div></div></div>	-
MAX SERVICE TEMPERATURE	<div><div></div></div>	°C
COSTS	<div><div></div><div></div></div>	EUR/m2 4mm

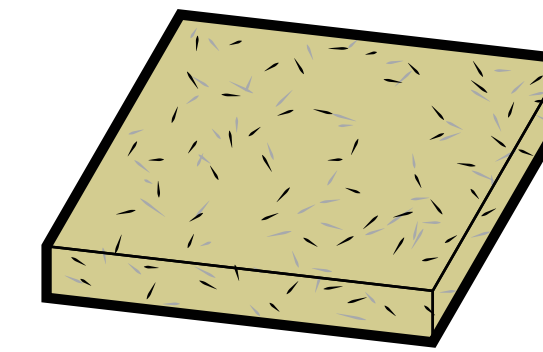
assessment



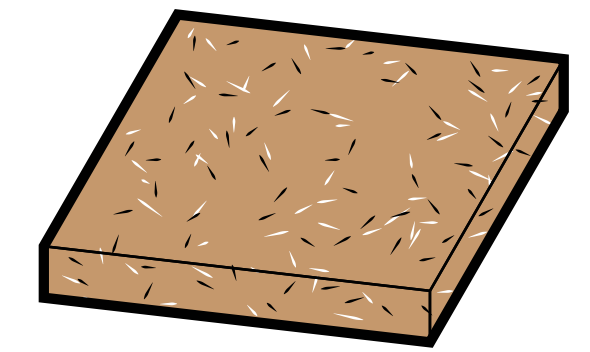
REYNOBOND
(BENCHMARK)



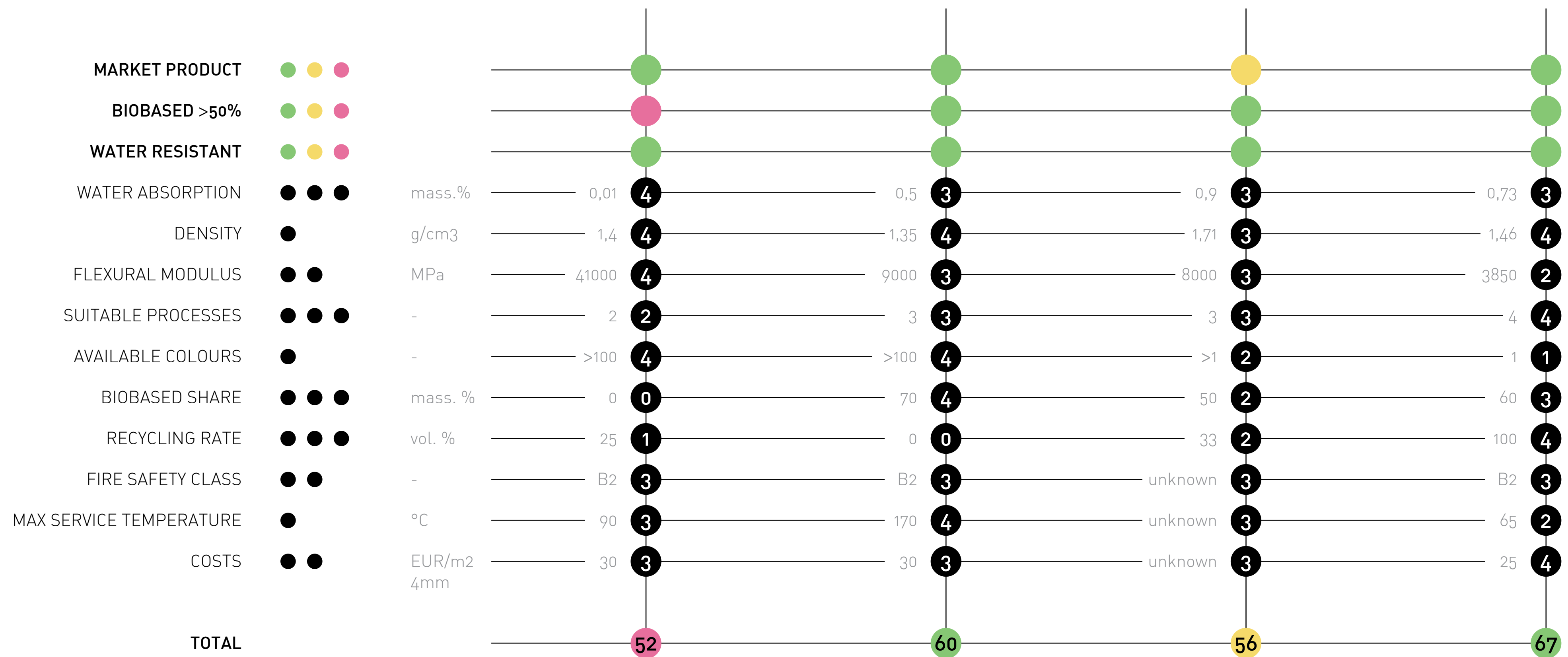
TRESPA



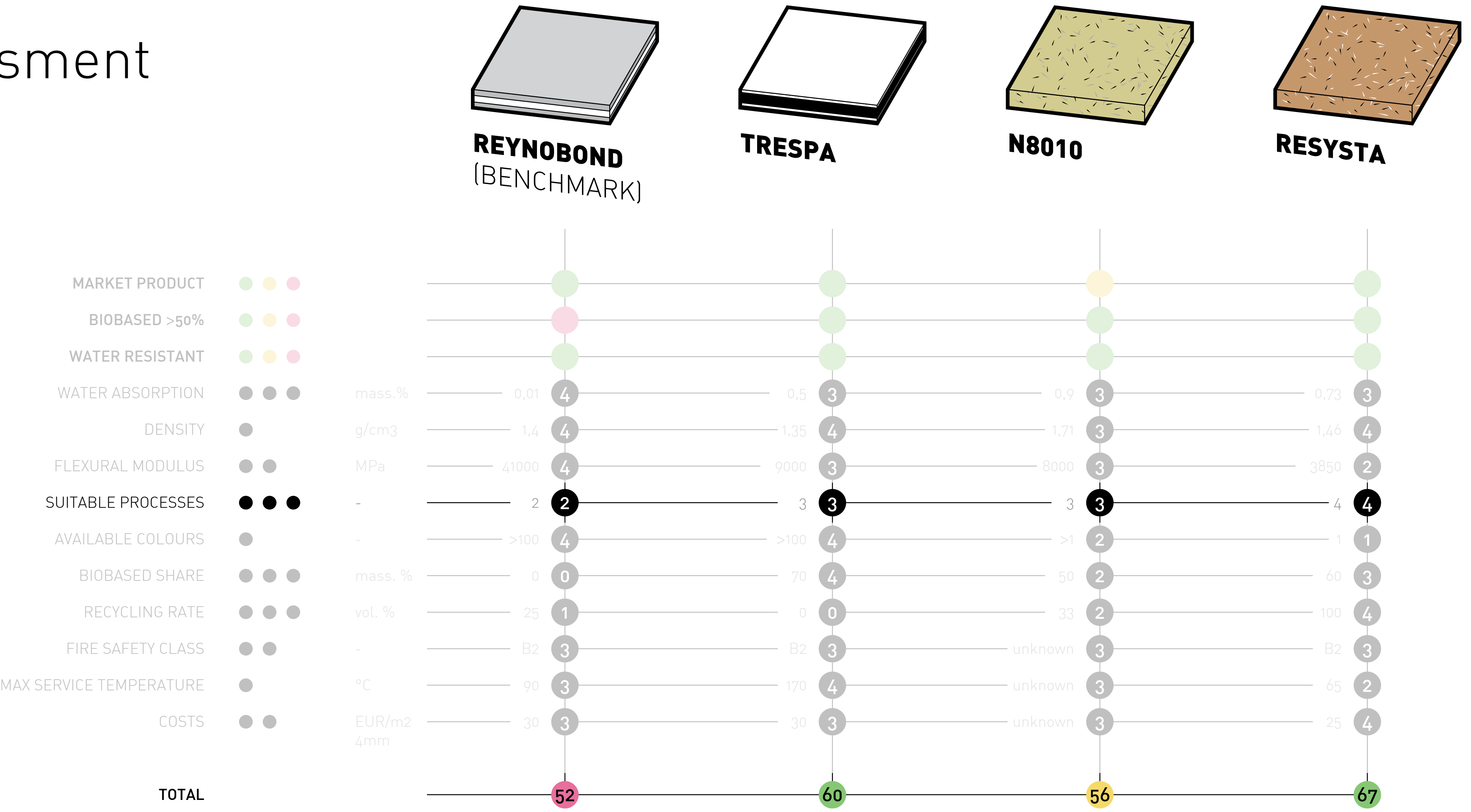
N8010



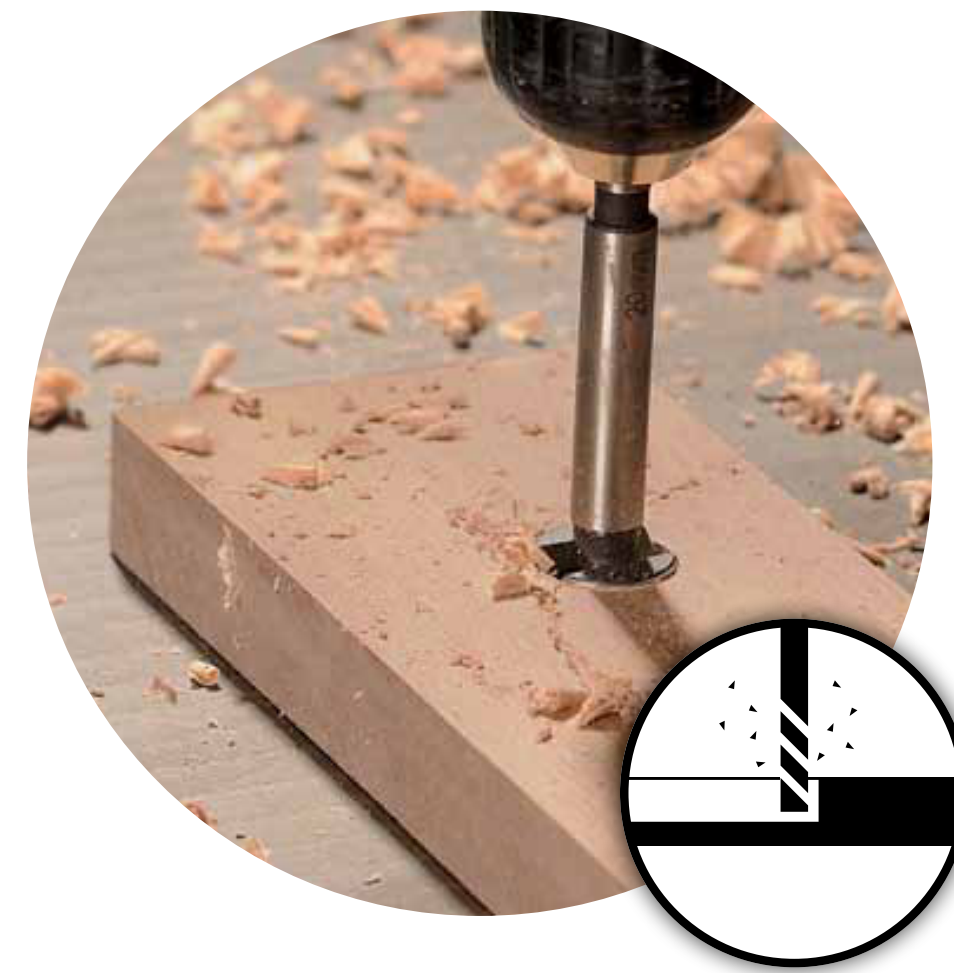
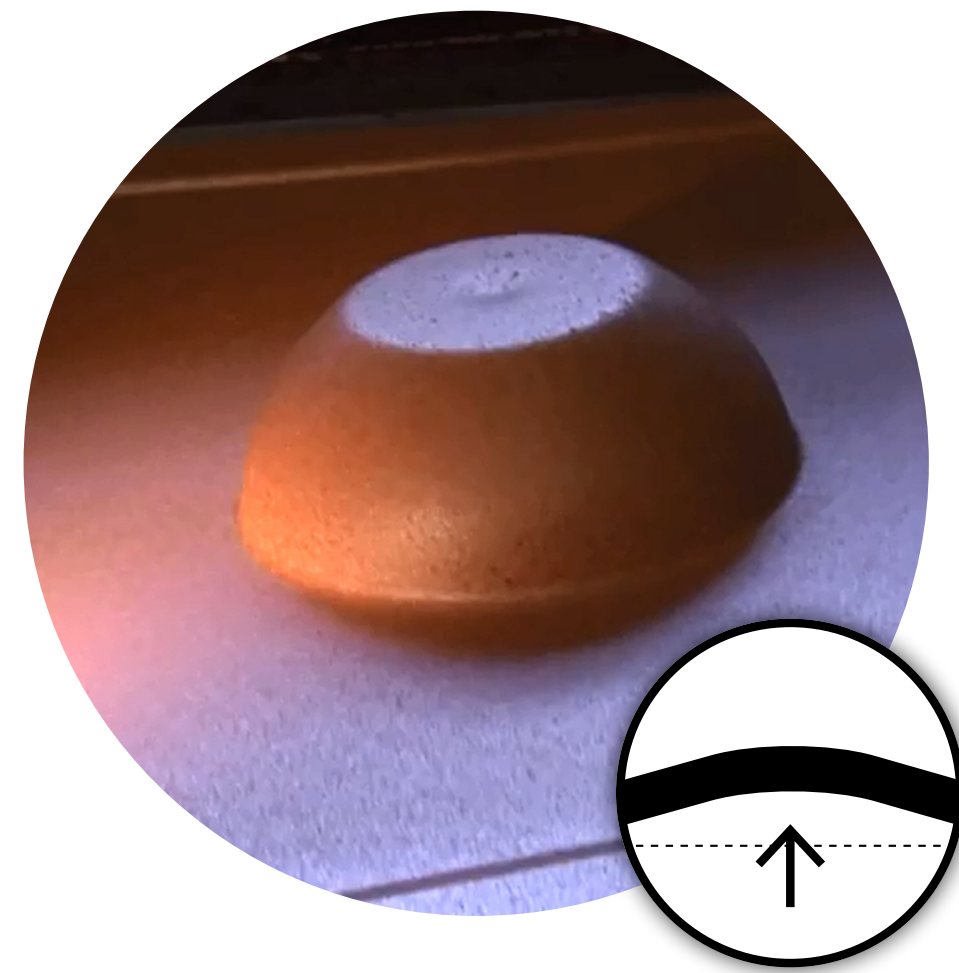
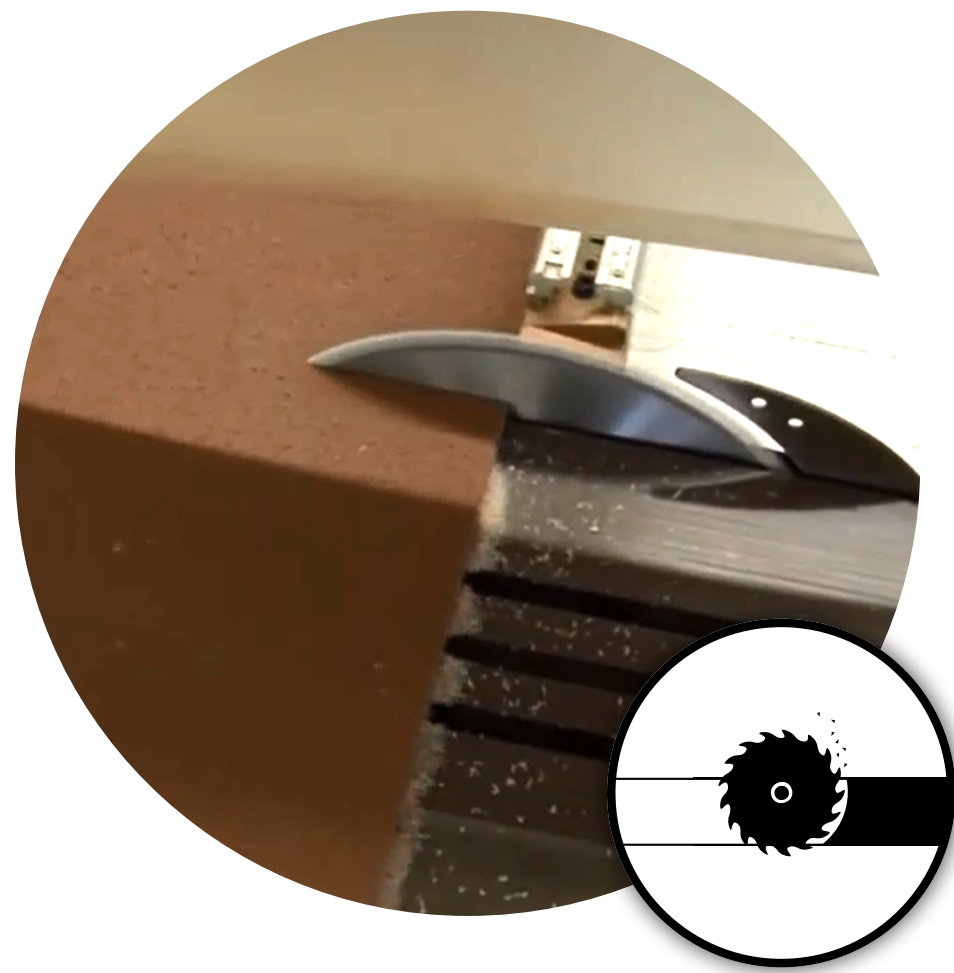
RESYSTA

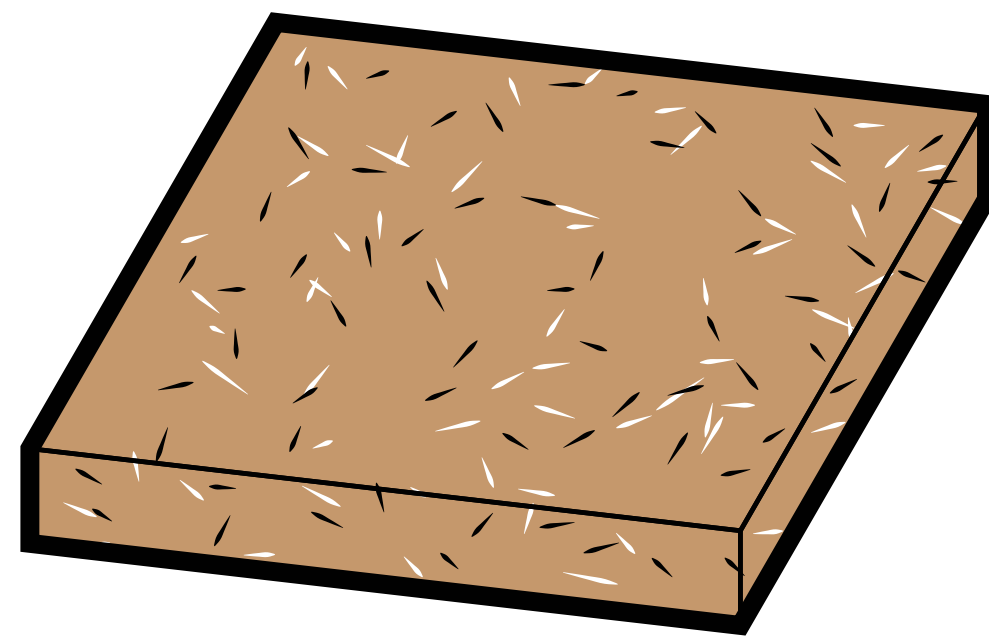


assessment



suitable processes

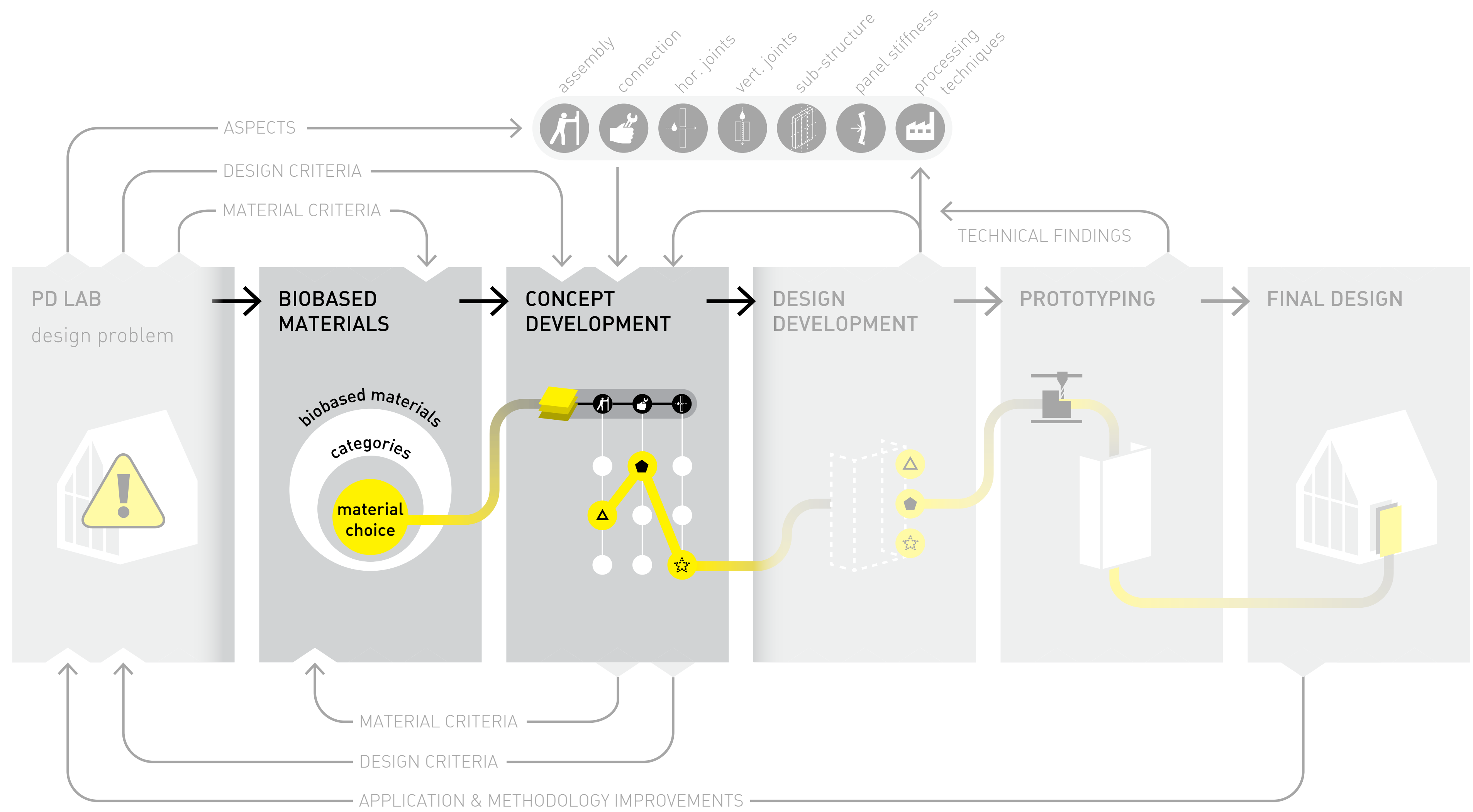




RESYSTA

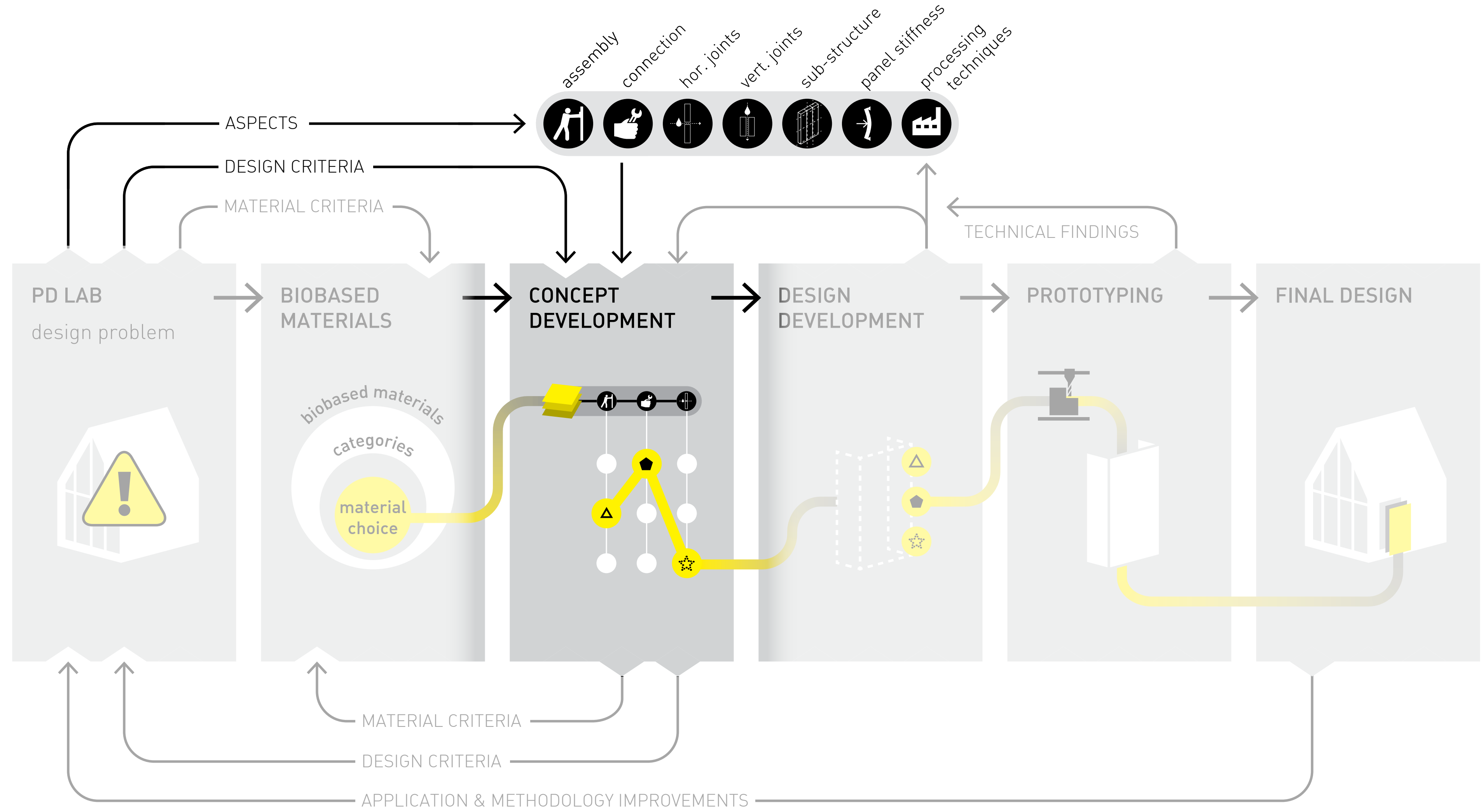


decking profiles





concept development

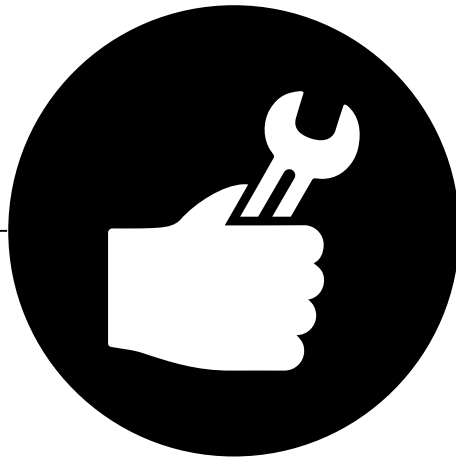


aspects

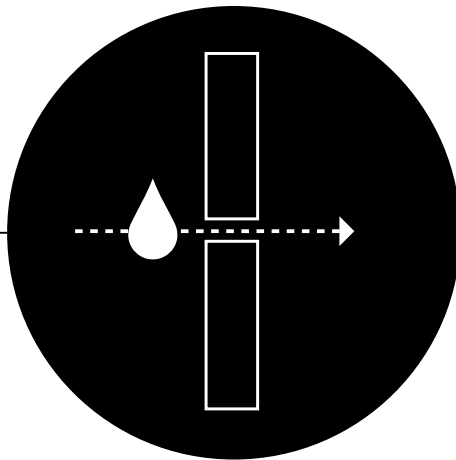
ASSEMBLY



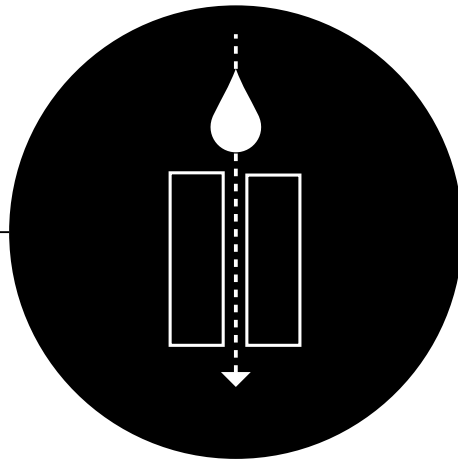
CONNECTION



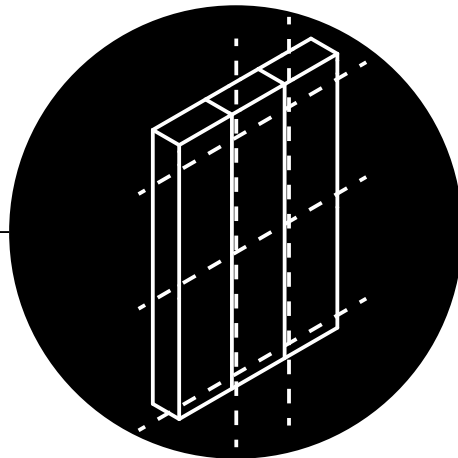
HORIZONTAL
JOINTS



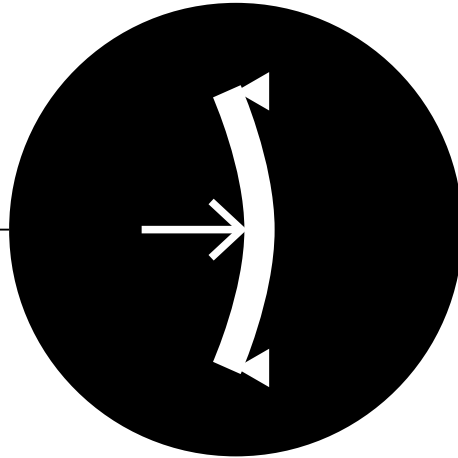
VERTICAL
JOINTS



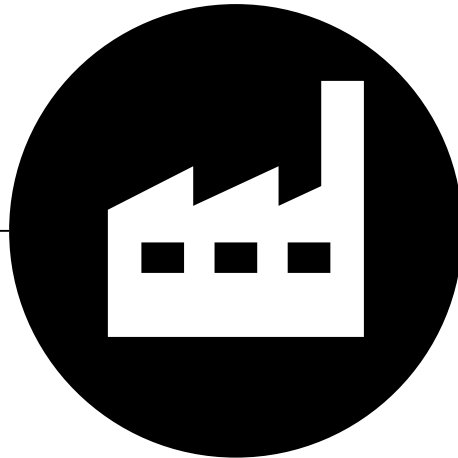
SUB-
CONSTRUCTION



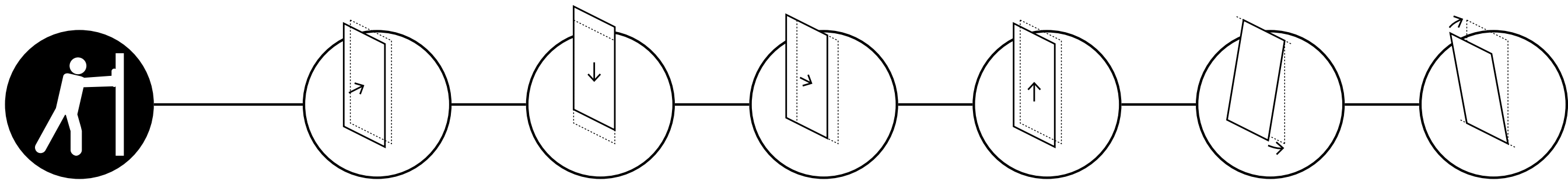
PANEL
STIFFNESS



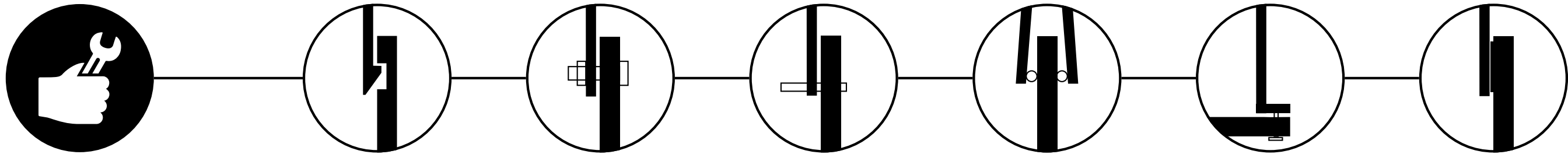
PROCESSING
TECHNIQUES



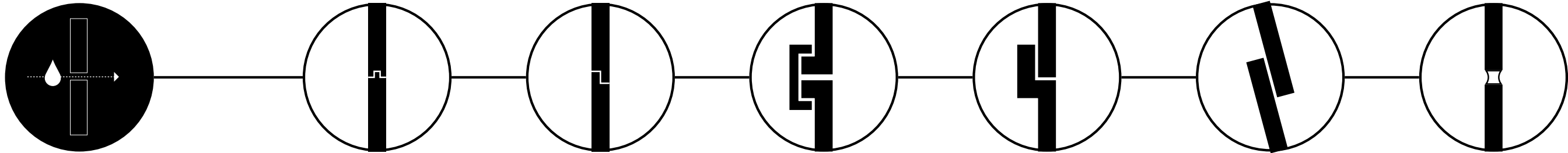
ASSEMBLY



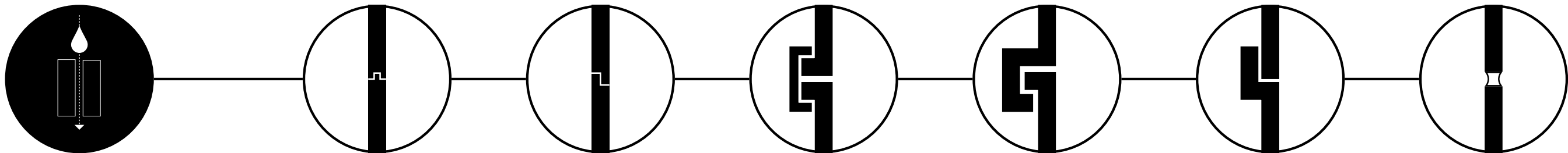
CONNECTION



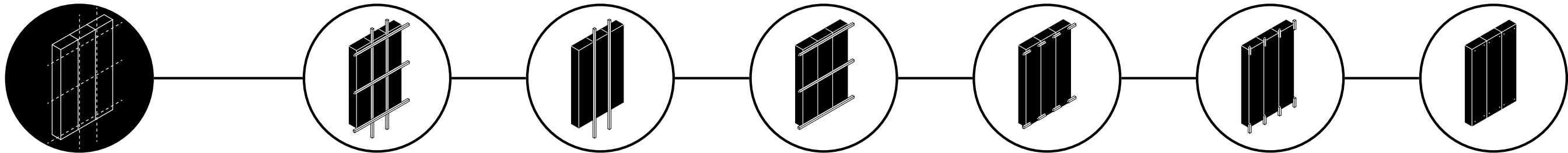
HORIZONTAL JOINTS



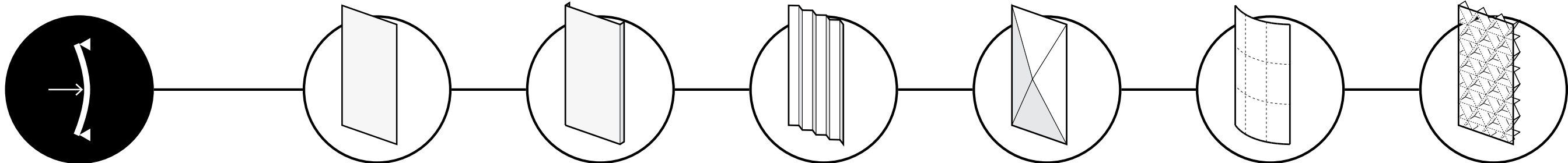
VERTICAL JOINTS



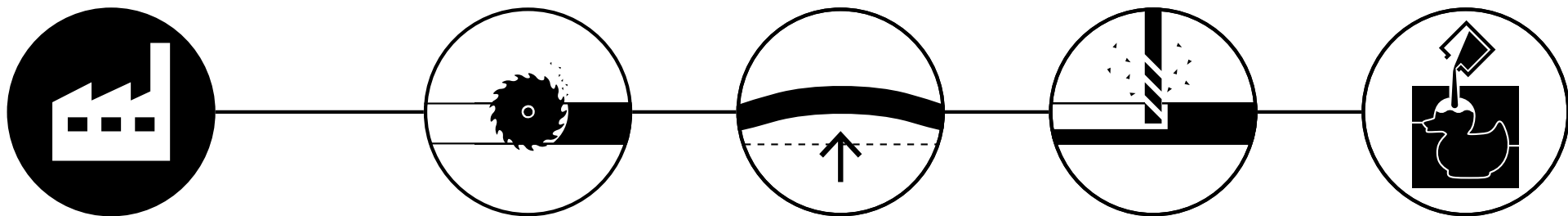
SUB-CONSTRUCTION



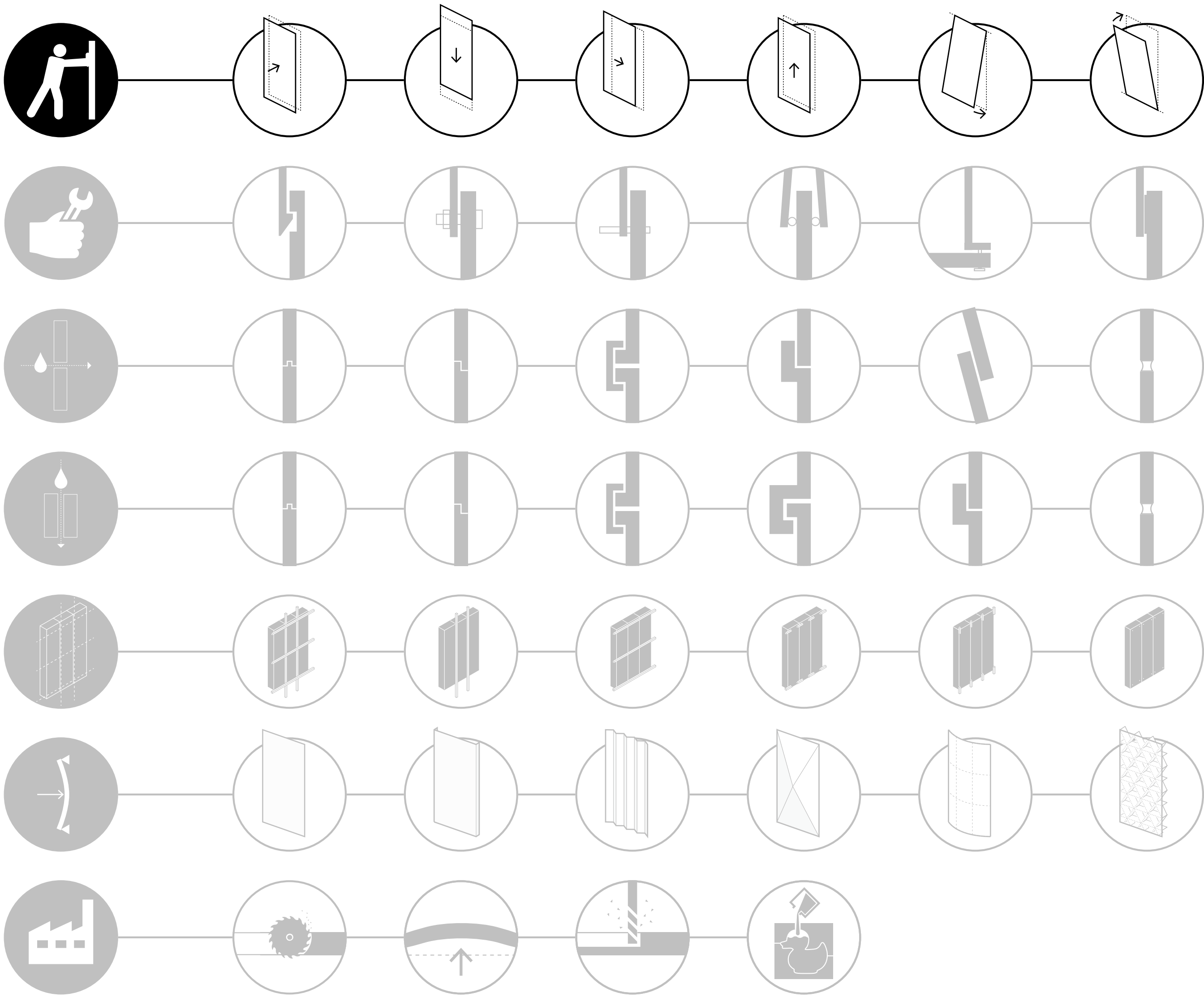
PANEL STIFFNESS



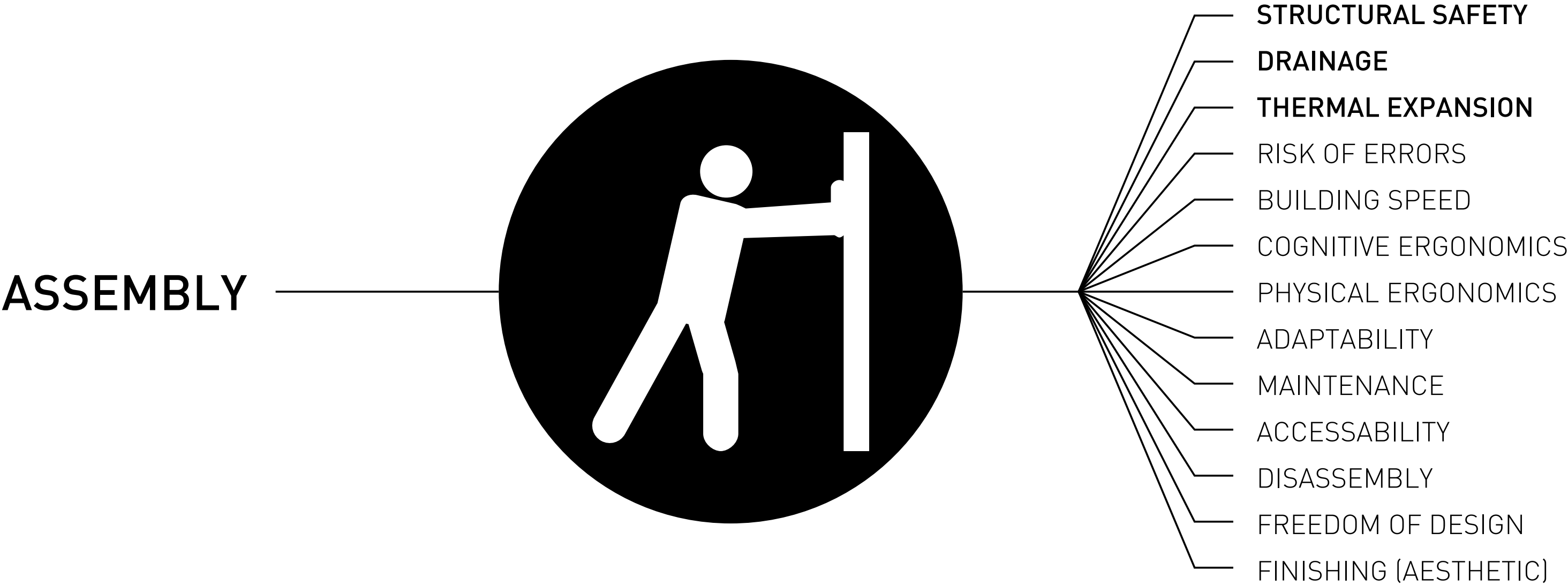
PROCESSING TECHNIQUES



ASSEMBLY

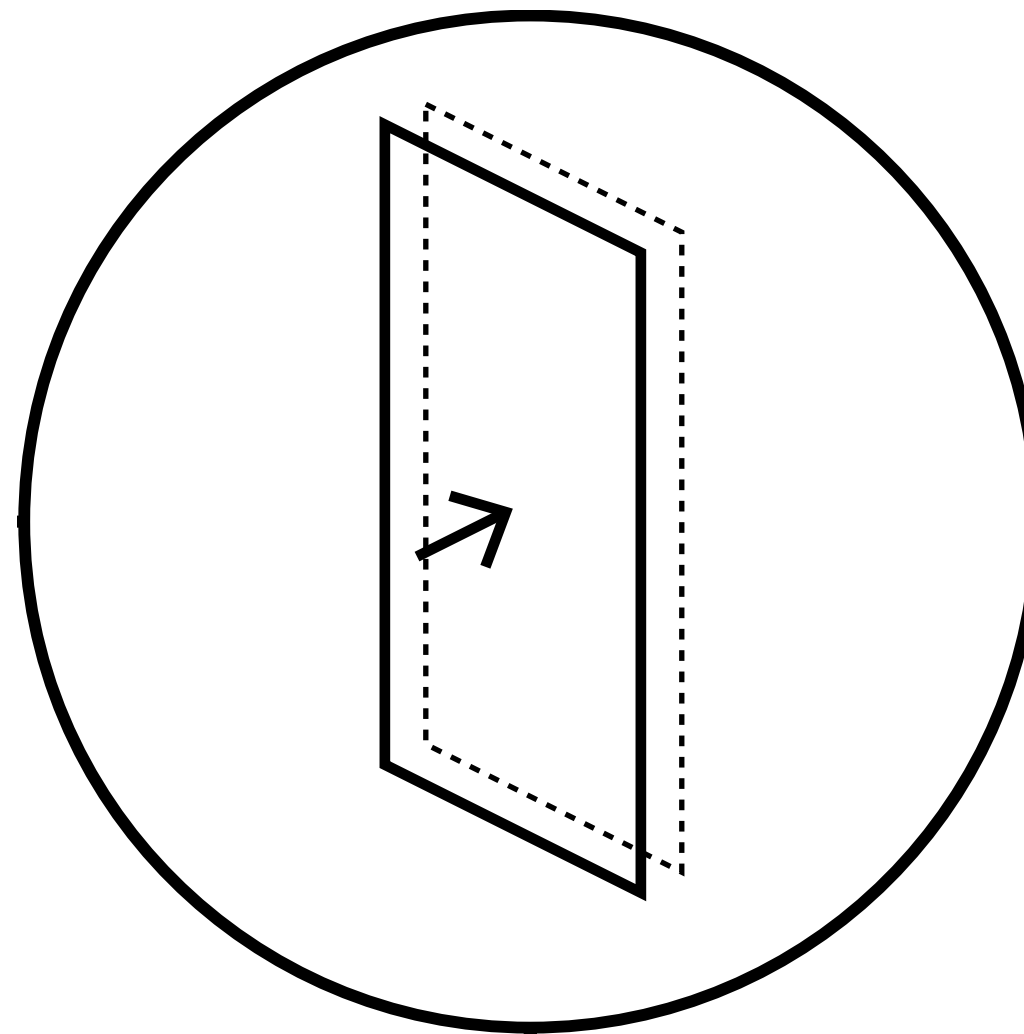


criteria

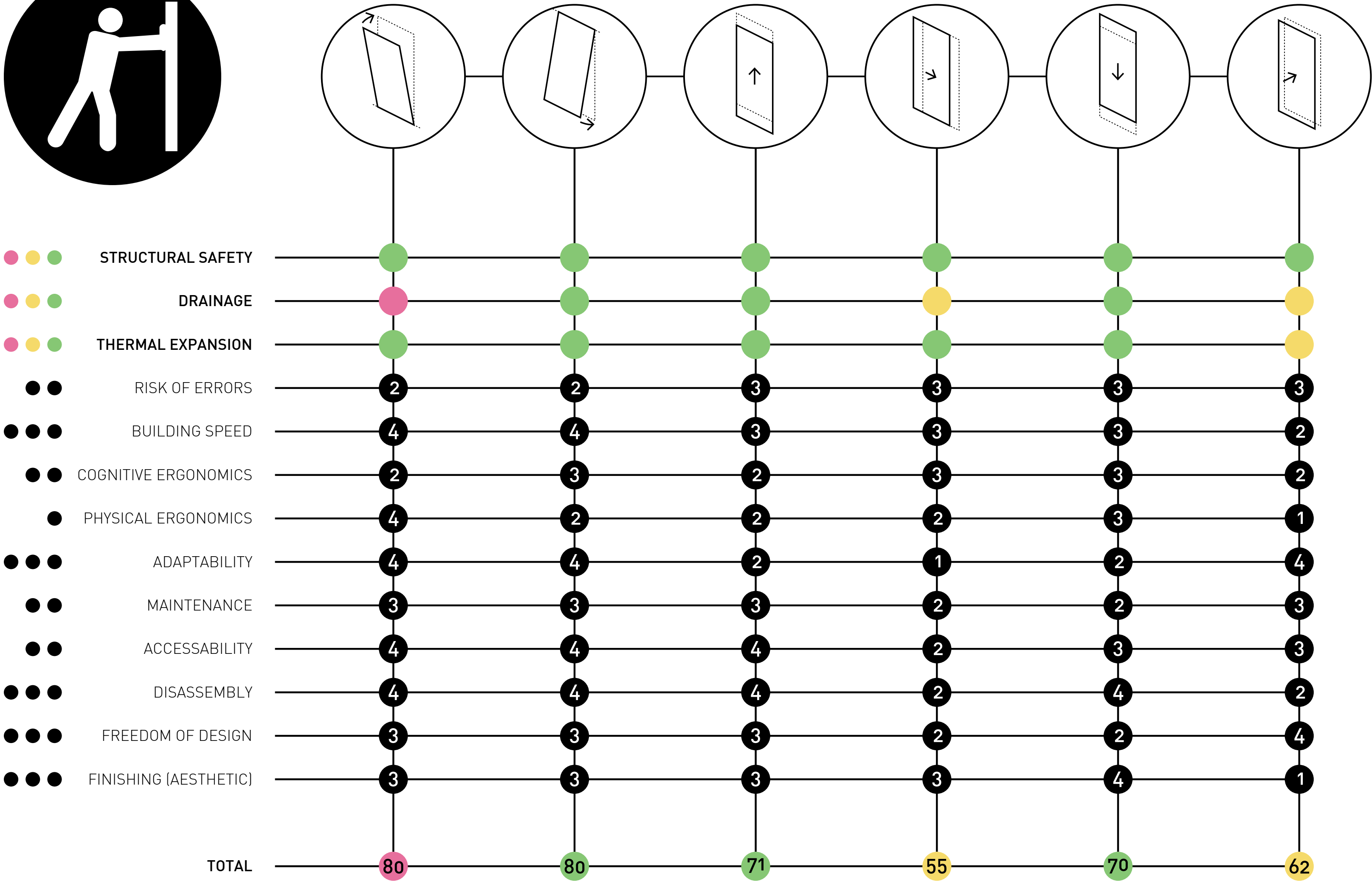




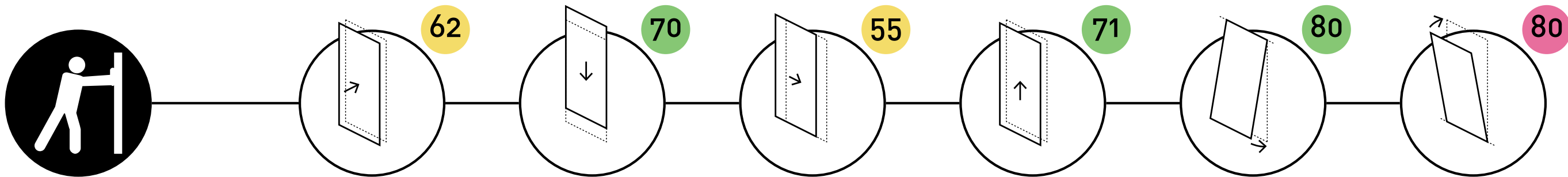
FRONT



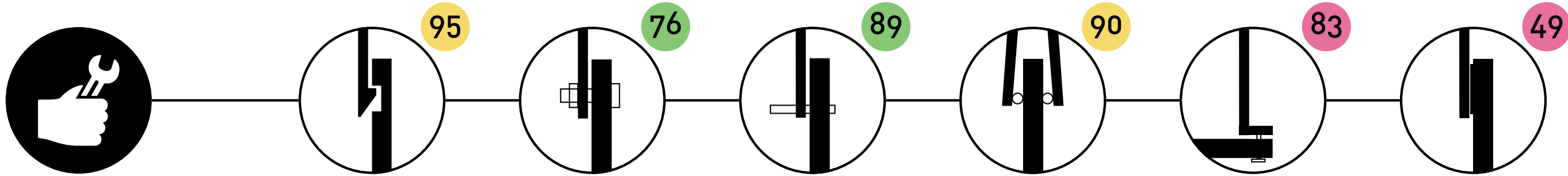
- possible to (dis)assemble single panel
- assembly by one person might be difficult
- complex rainwater drainage



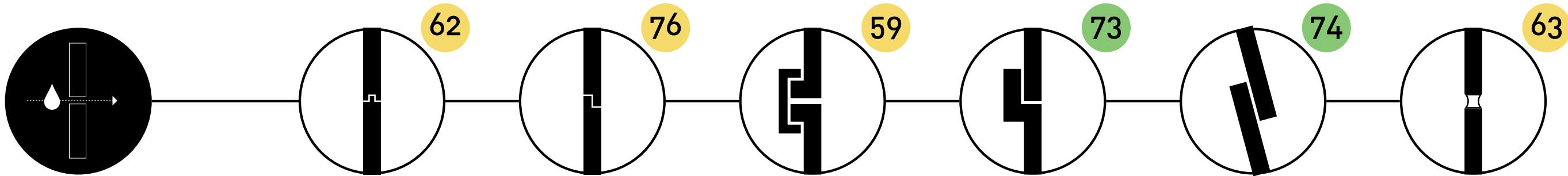
ASSEMBLY



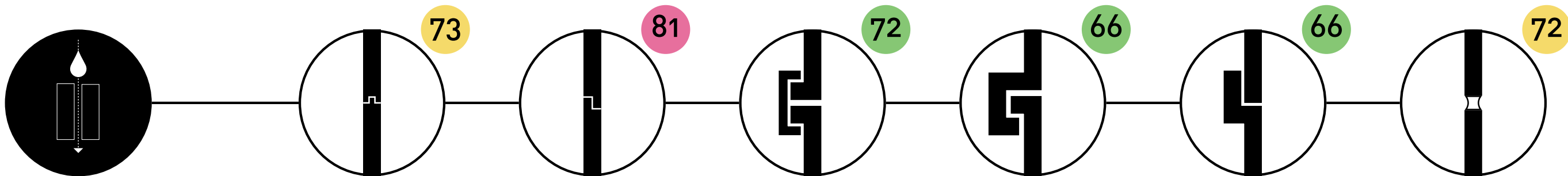
CONNECTION



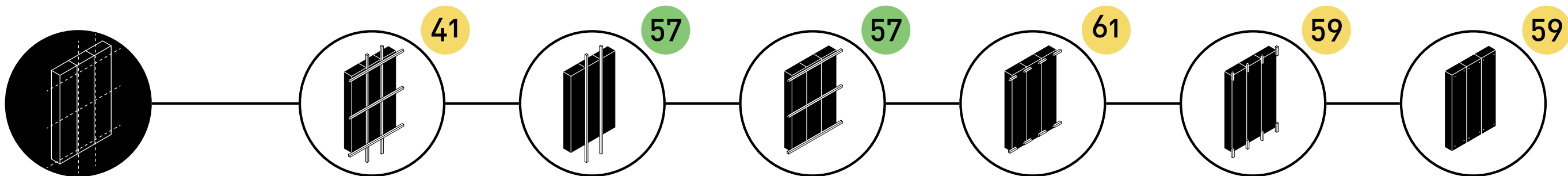
HORIZONTAL JOINTS



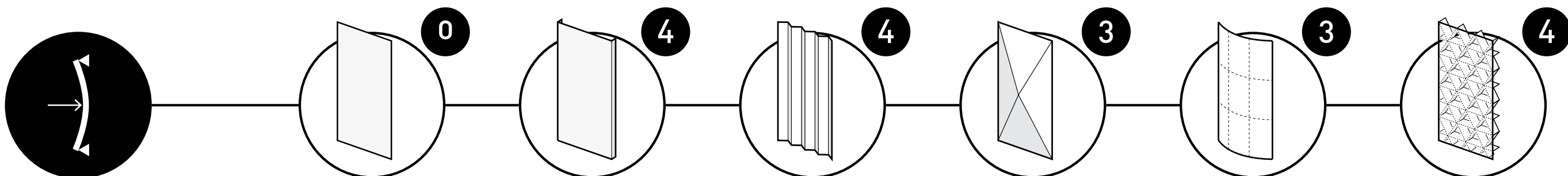
VERTICAL JOINTS



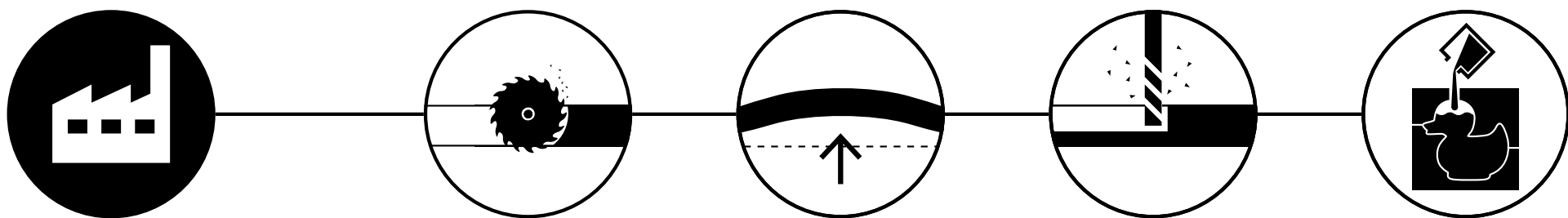
SUB-CONSTRUCTION

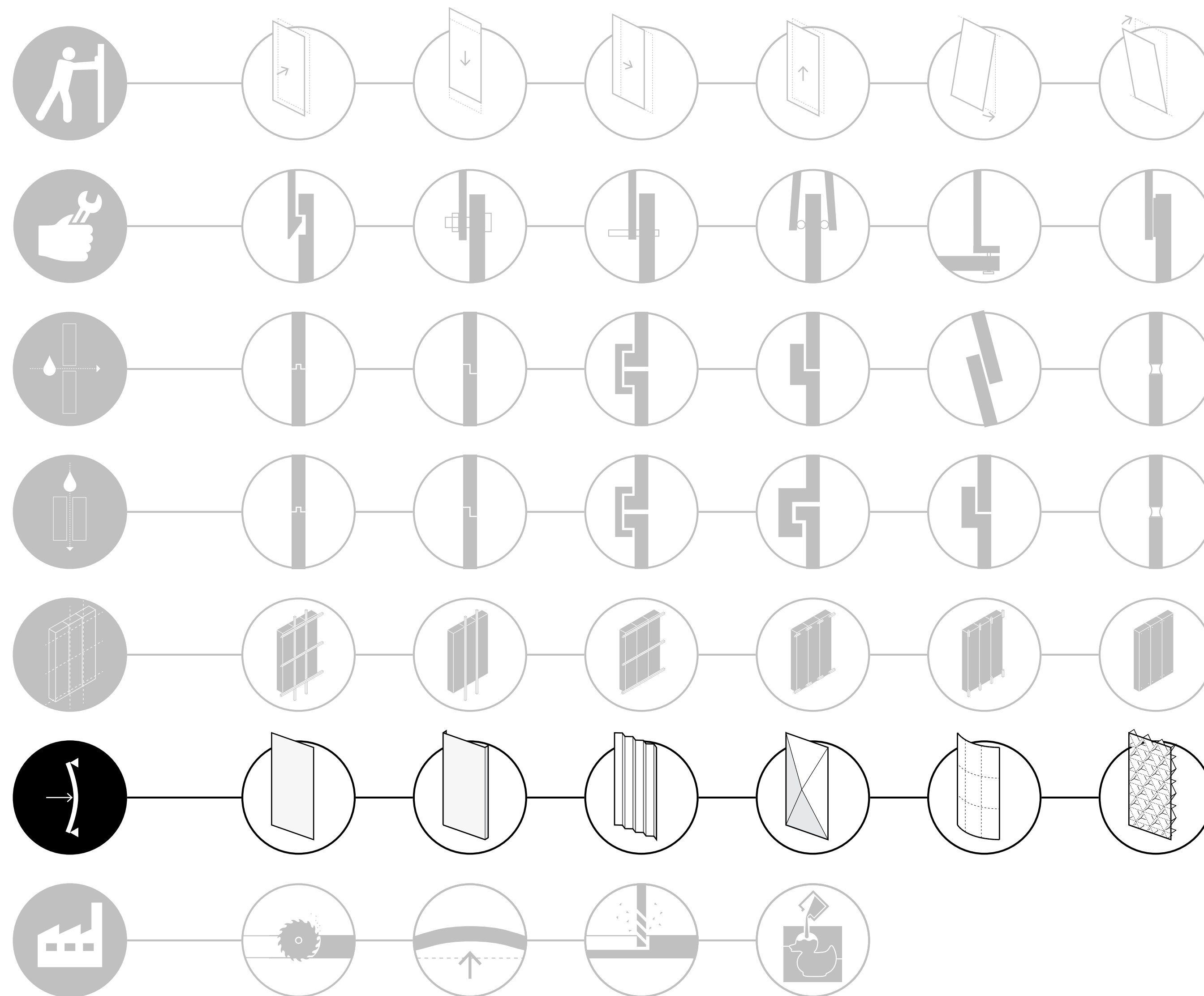


PANEL STIFFNESS



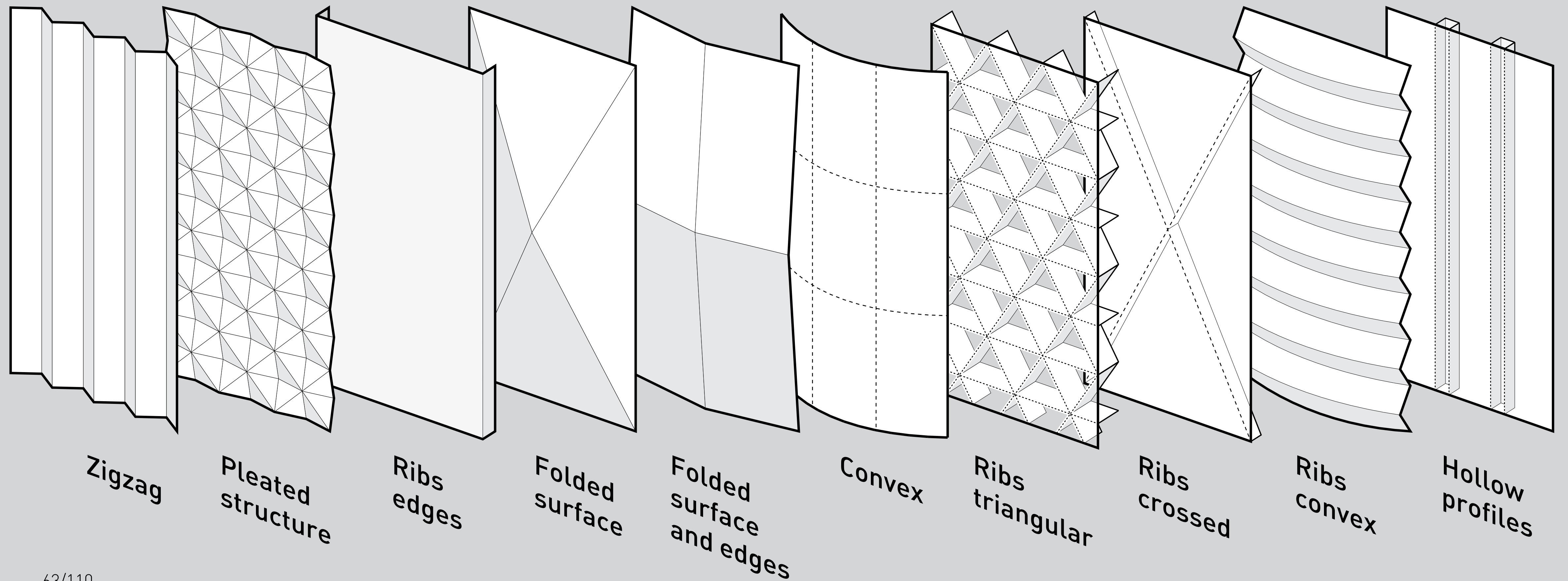
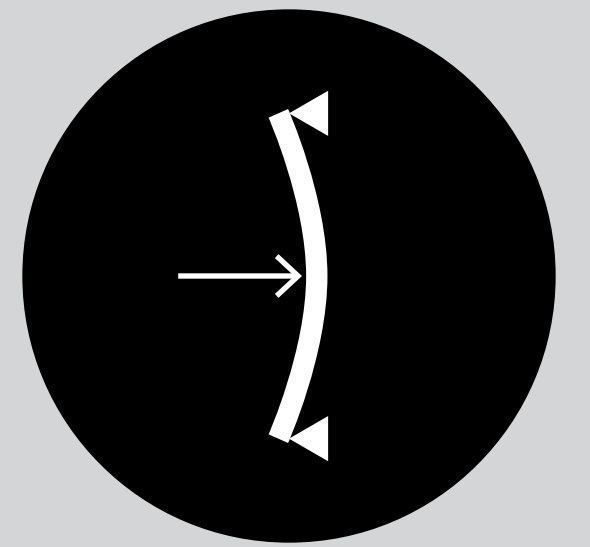
PROCESSING TECHNIQUES

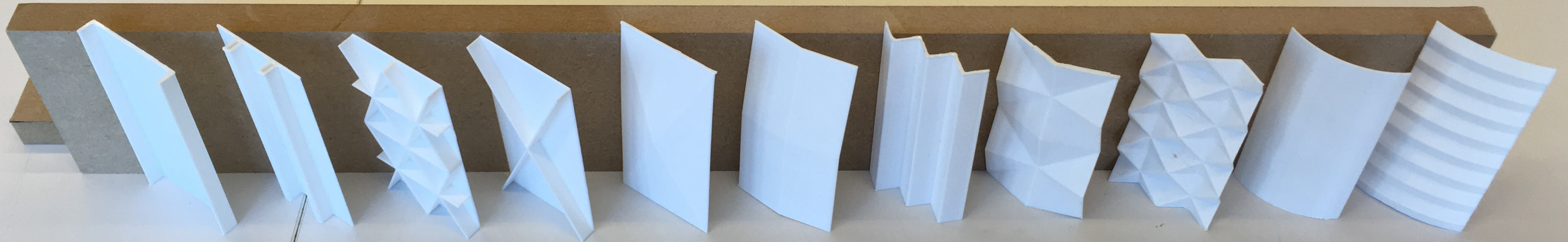
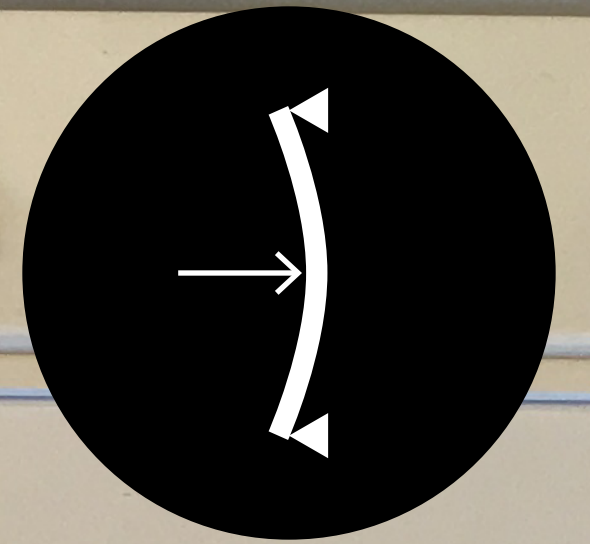


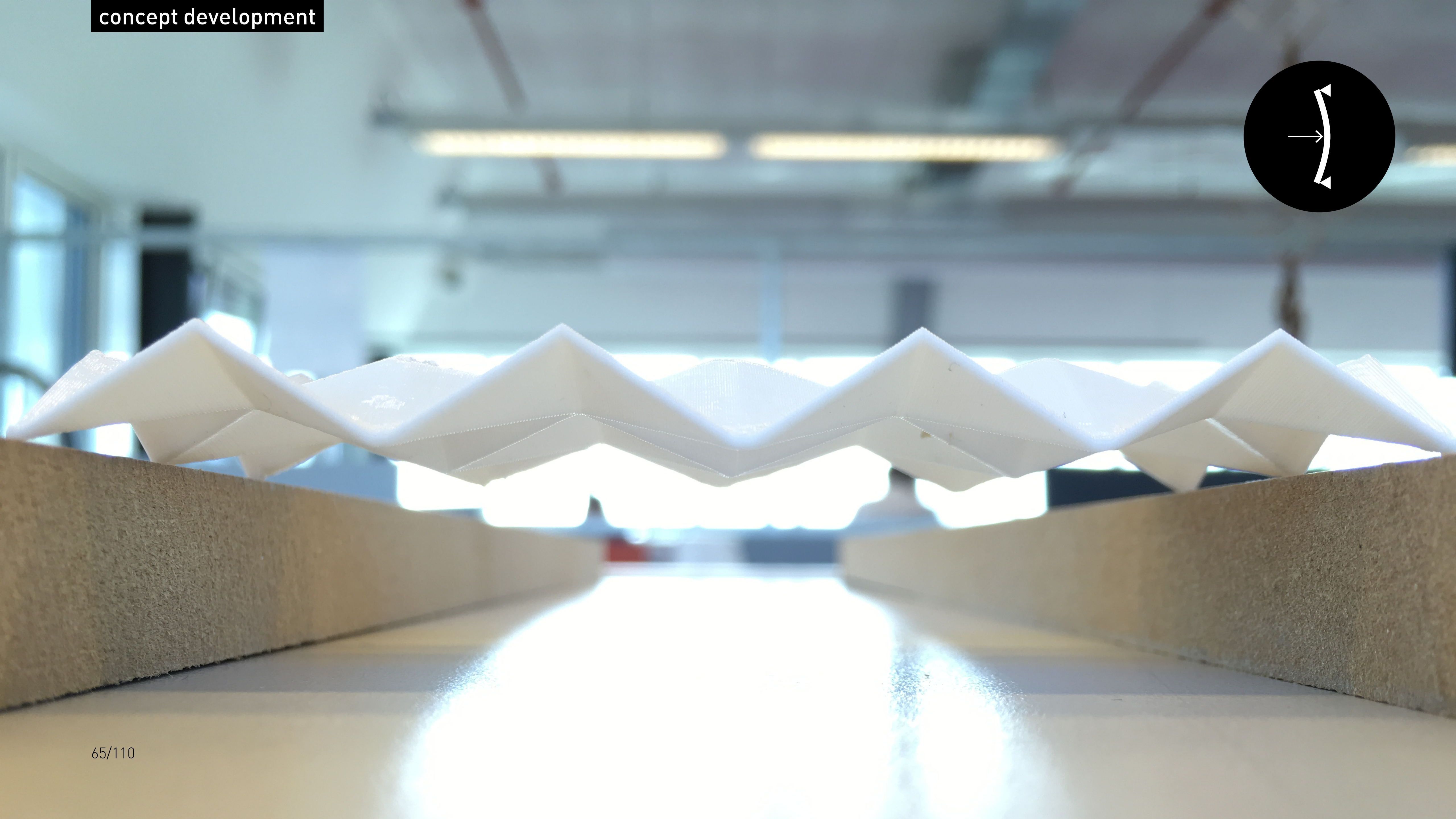
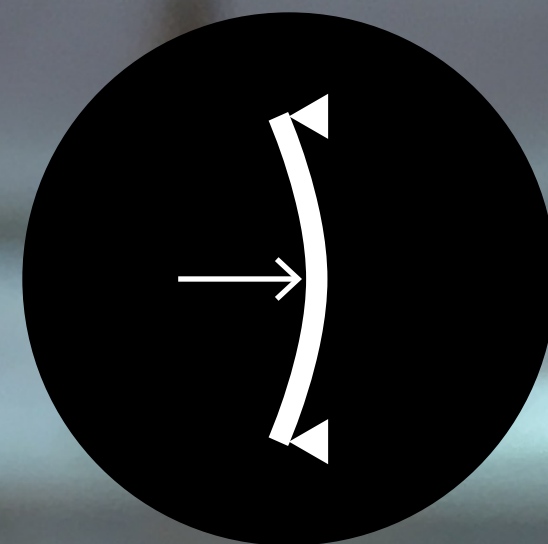


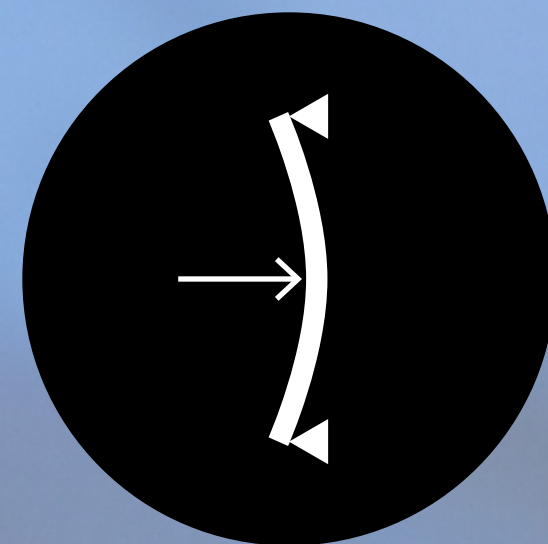
PANEL STIFFNESS

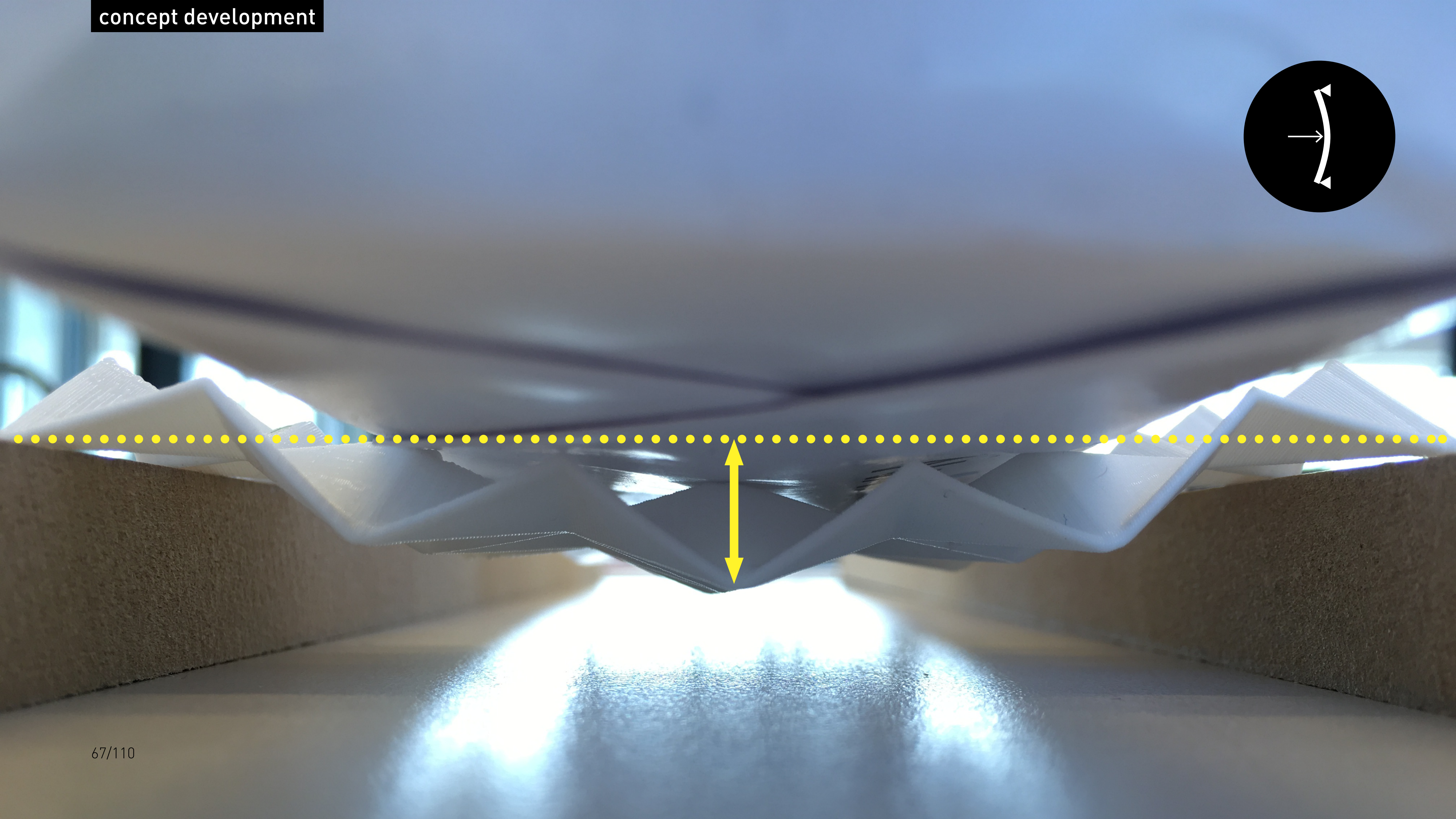
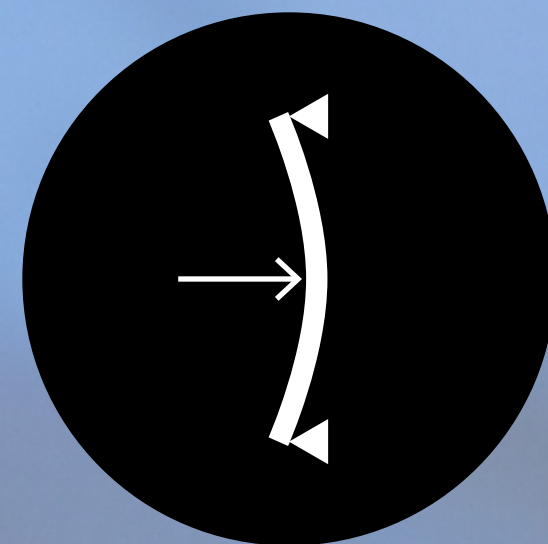
panel stiffness



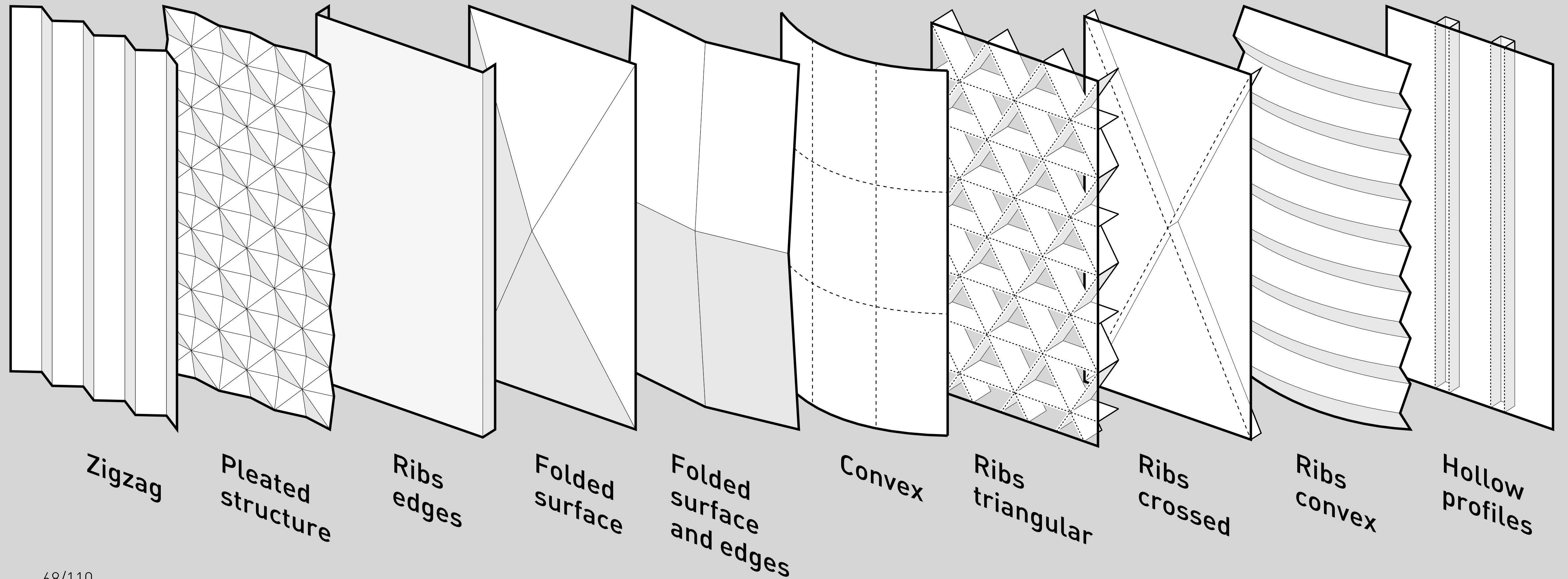




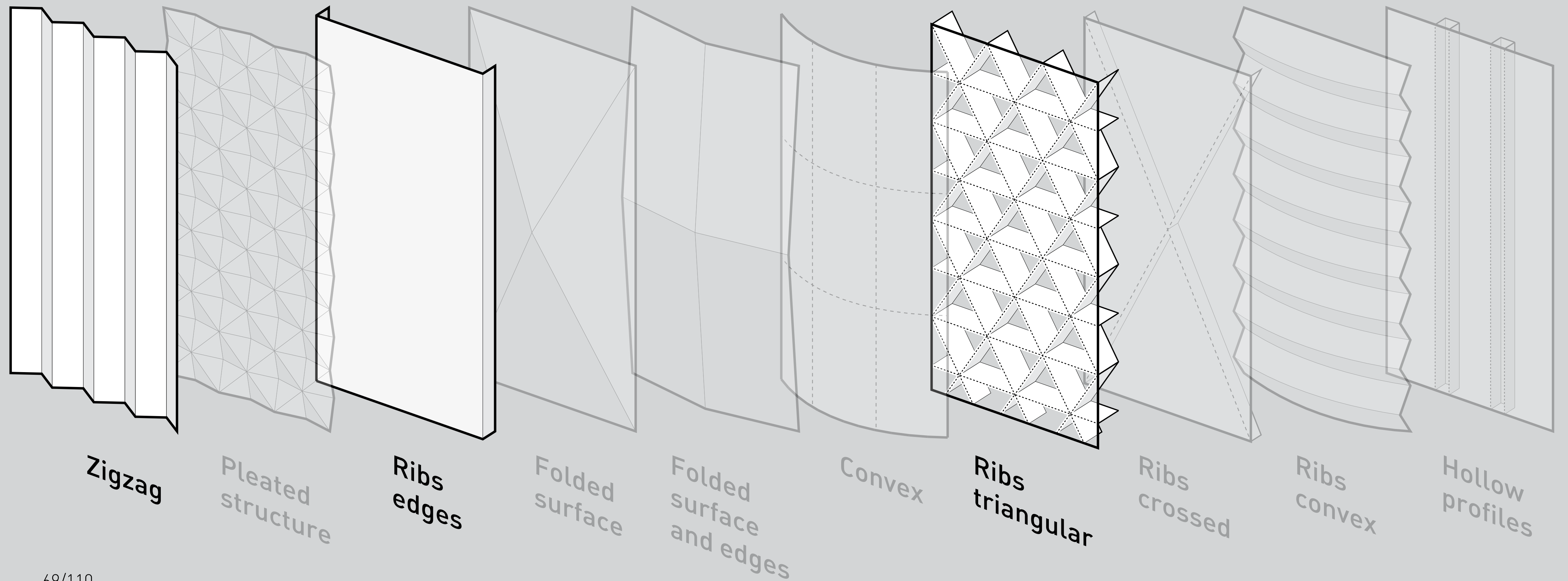


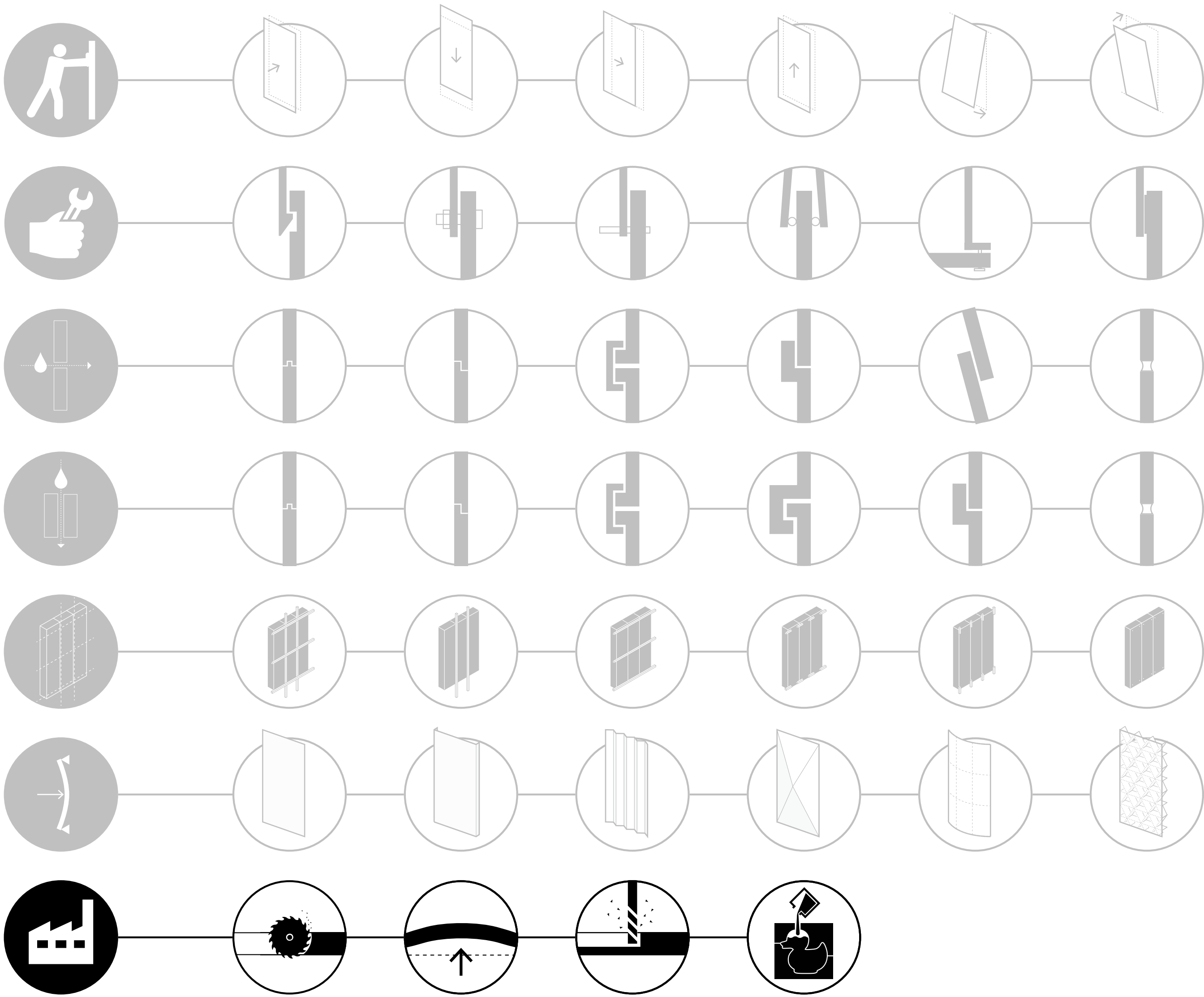


panel stiffness



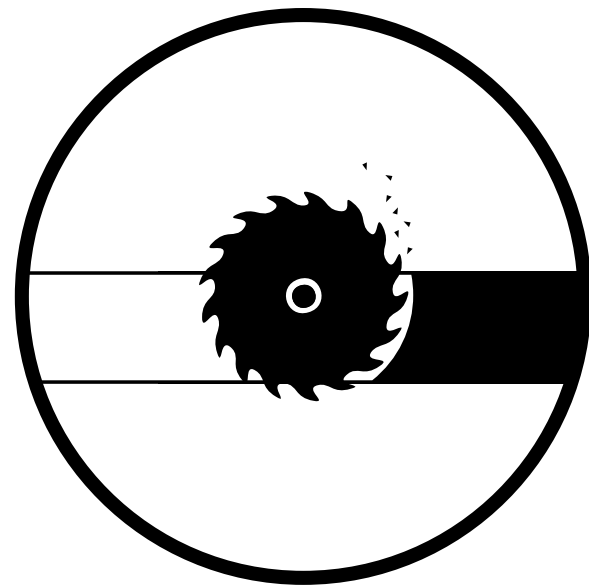
panel stiffness





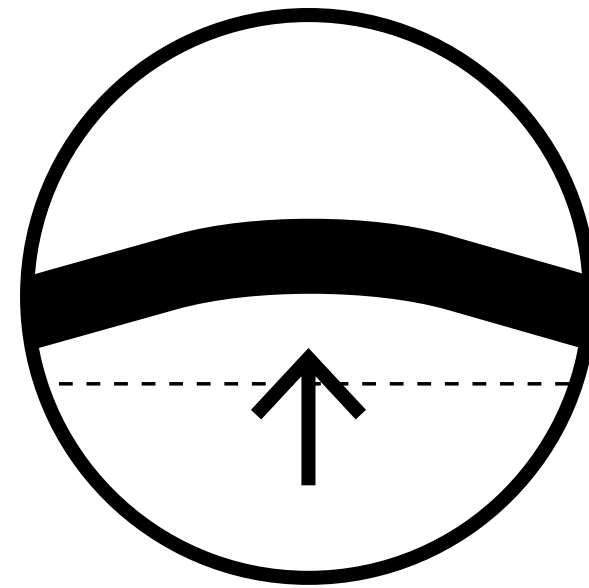
PROCESSING
TECHNIQUES

processing techniques



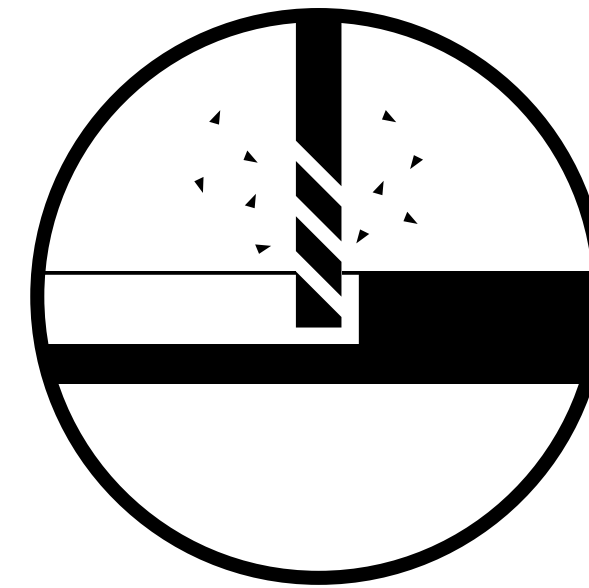
CUTTING

Sawing
Cutting
Punching



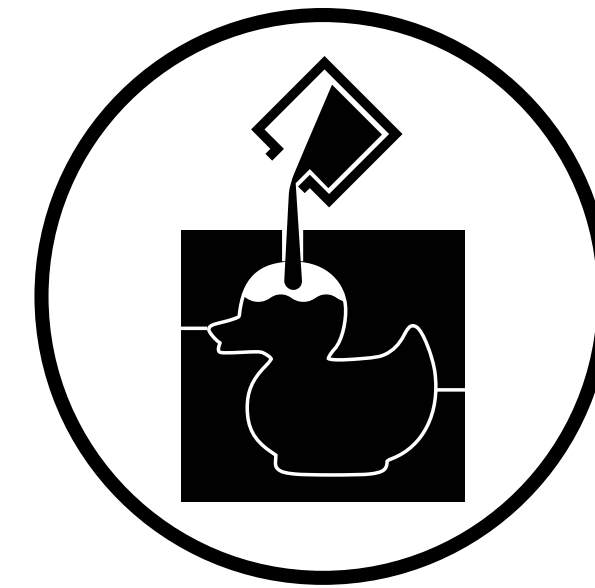
DEFORMING

Folding/bending
Calendering
Thermoforming
3D printing



MACHINING

Drilling
Milling
Turning
Routing

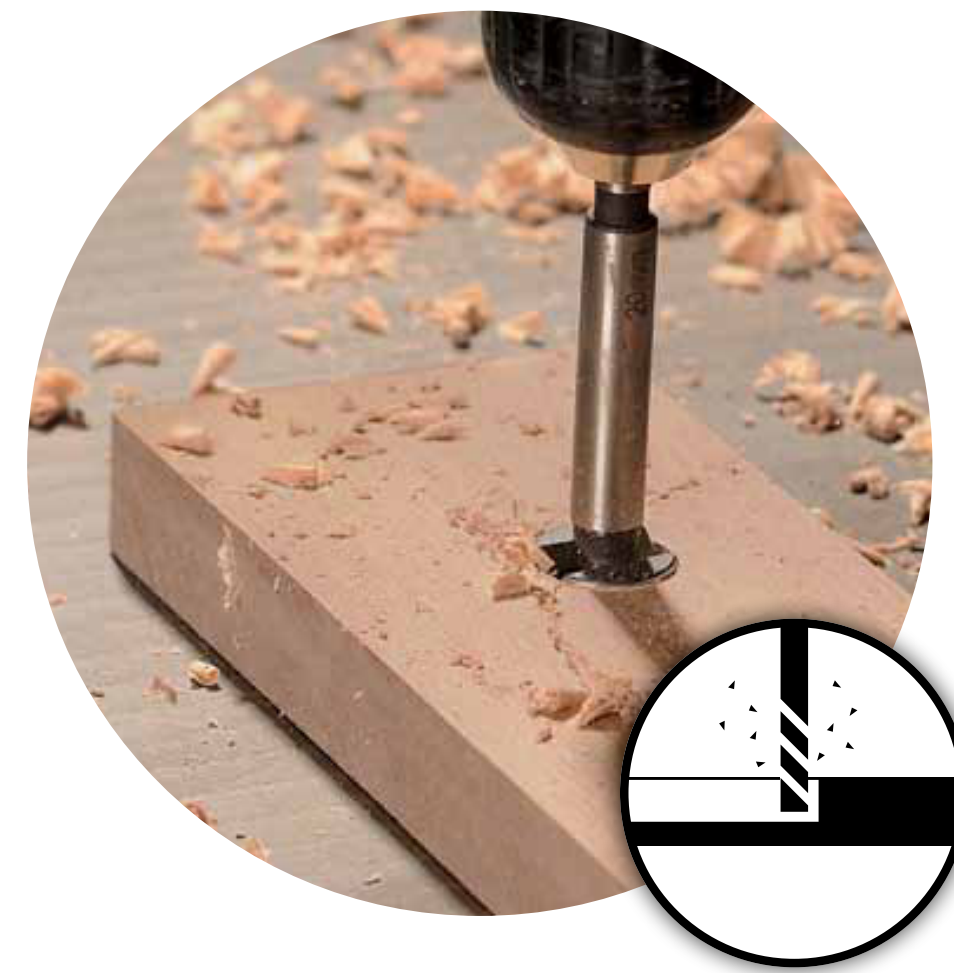
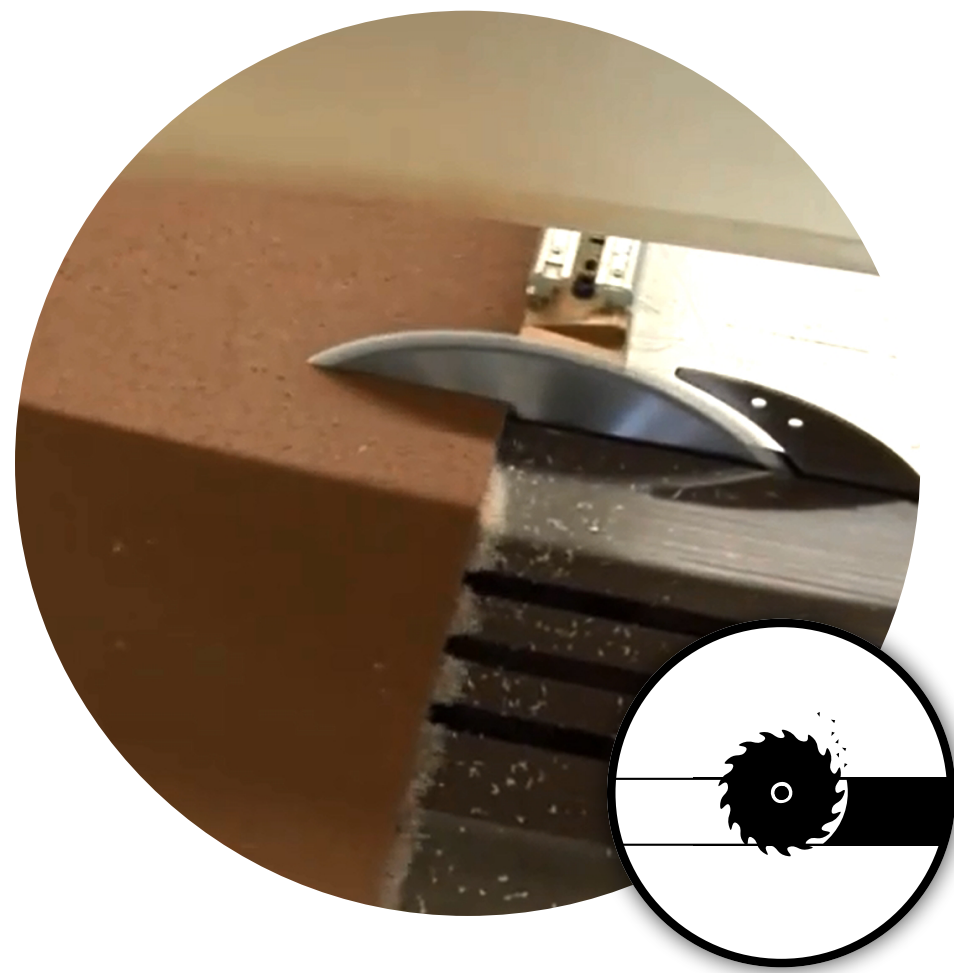


MOULDING

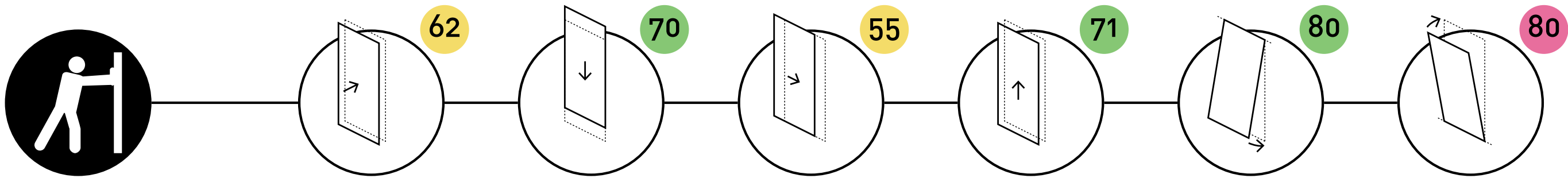
Founding
Forging
Sintering
Cast moulding
Resin moulding
Injection
Rotational moulding
Extrusion

Based on: Kula et al., 2013

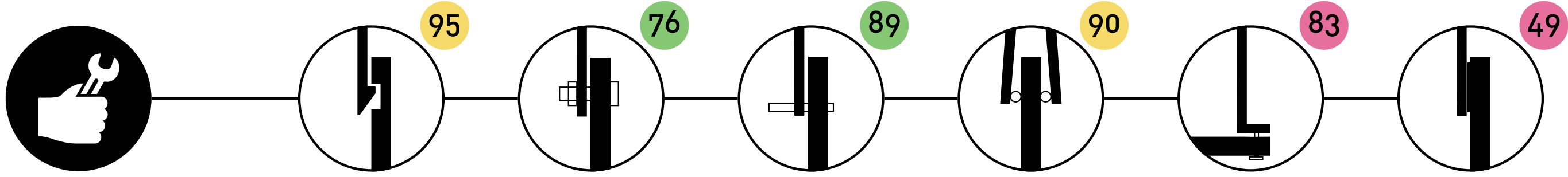
what does the material want?



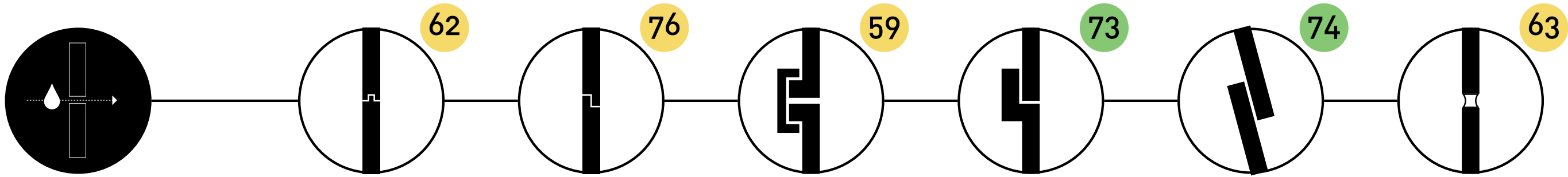
ASSEMBLY



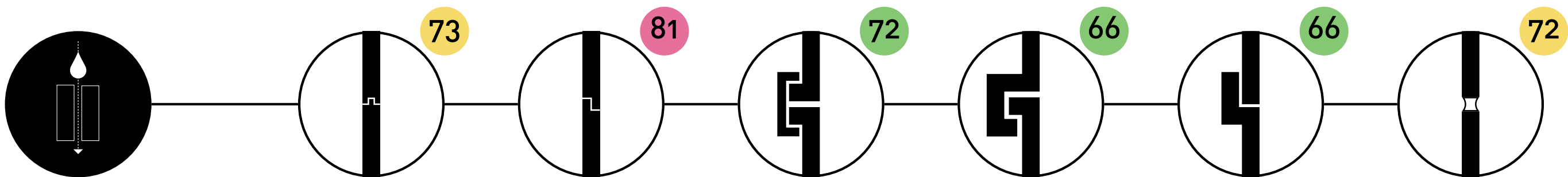
CONNECTION



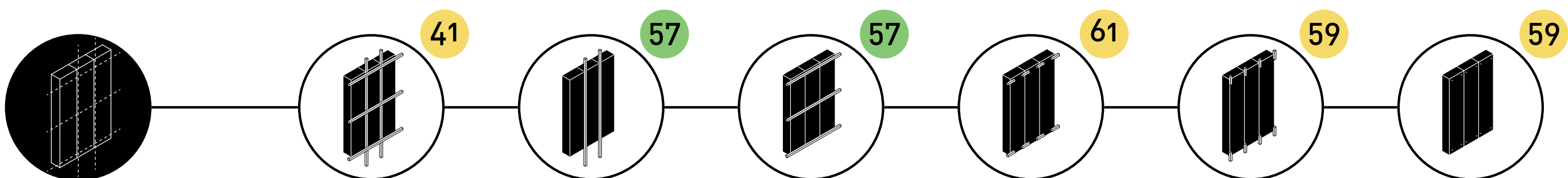
HORIZONTAL JOINTS



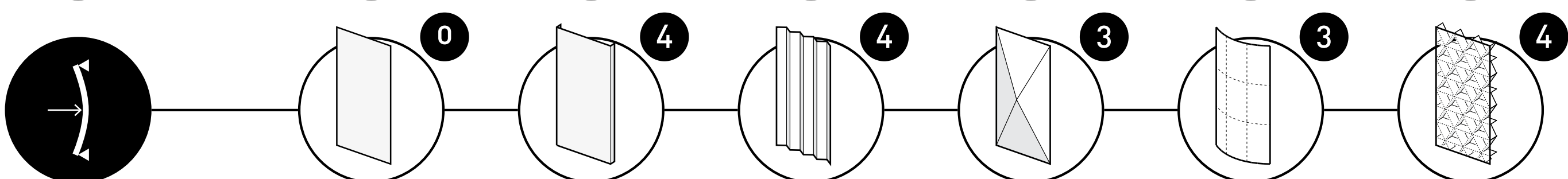
VERTICAL JOINTS



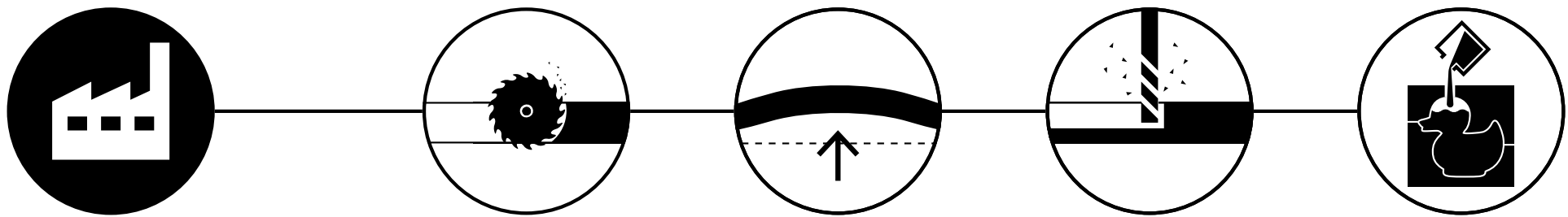
SUB-CONSTRUCTION



PANEL STIFFNESS



PROCESSING TECHNIQUES



ASSEMBLY

CONNECTION

HORIZONTAL JOINTS

VERTICAL JOINTS

SUB-CONSTRUCTION

PANEL STIFFNESS

PROCESSING TECHNIQUES

RECTANGULAR

DIAMOND

ACCOLADE

EXTRUDED

TAPERED

ASSEMBLY

CONNECTION

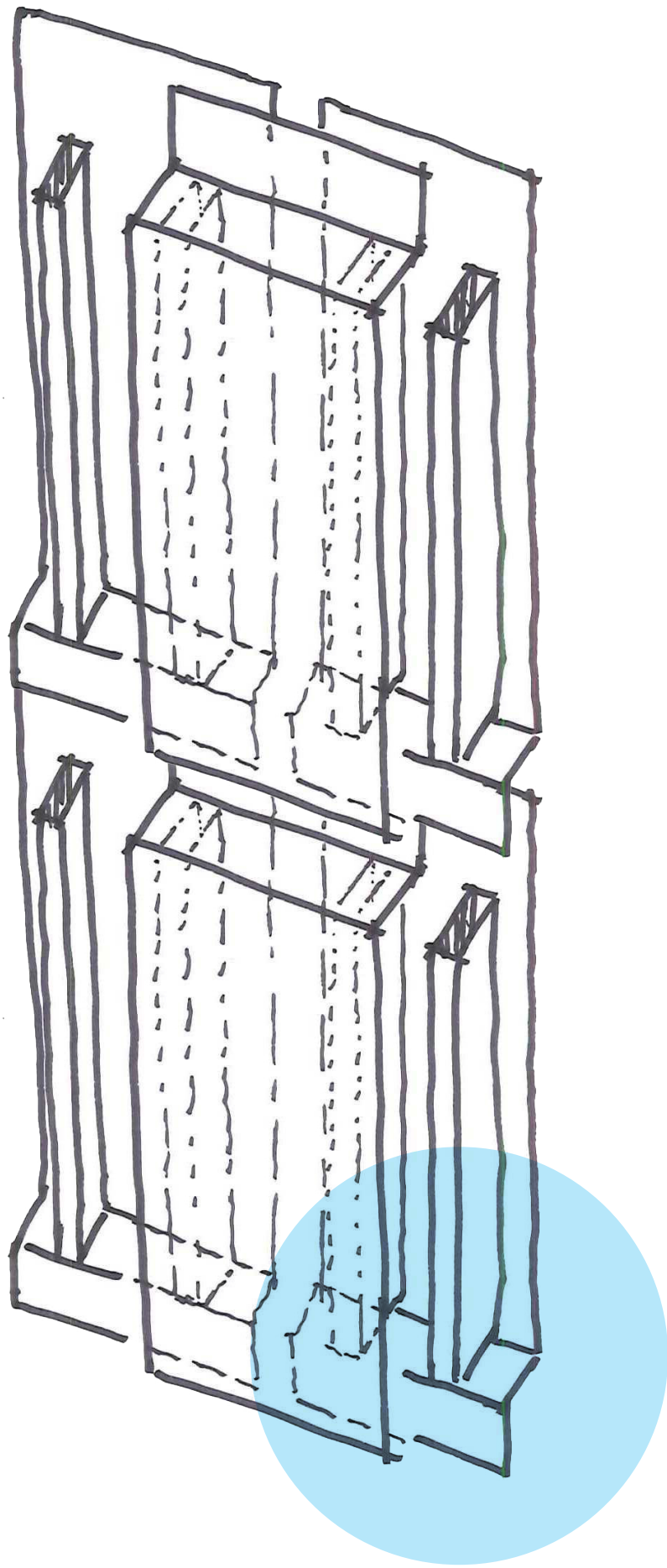
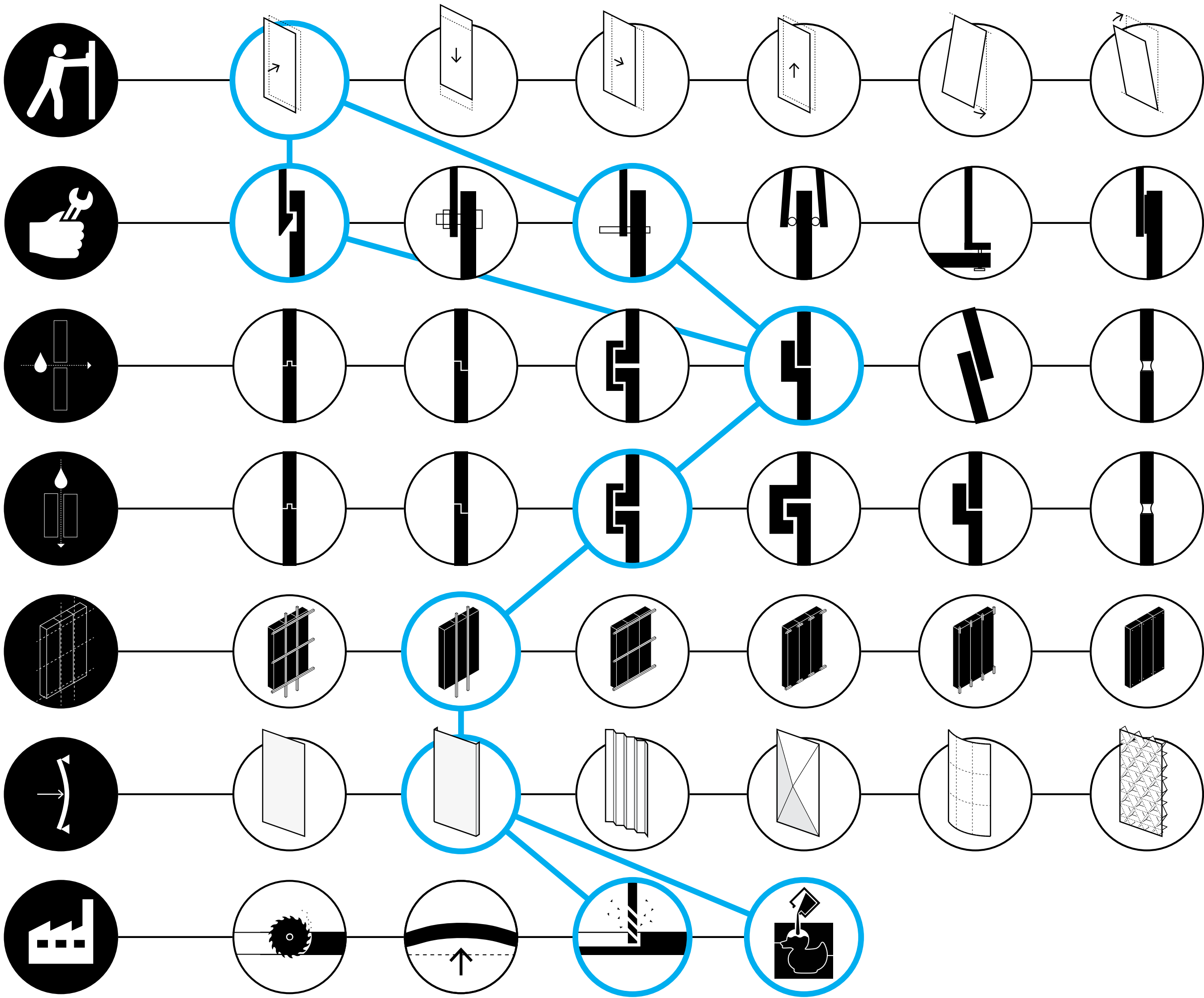
HORIZONTAL JOINTS

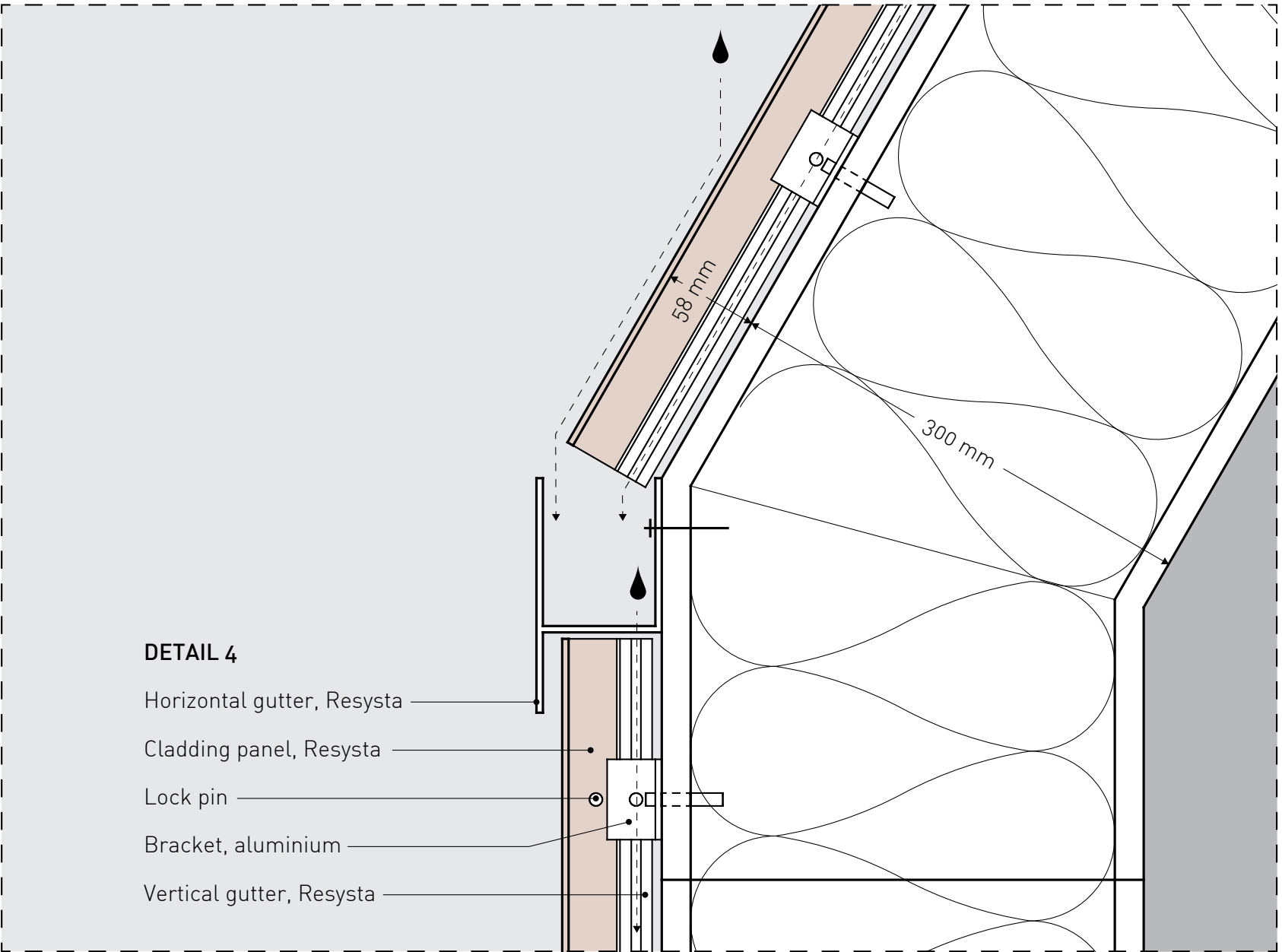
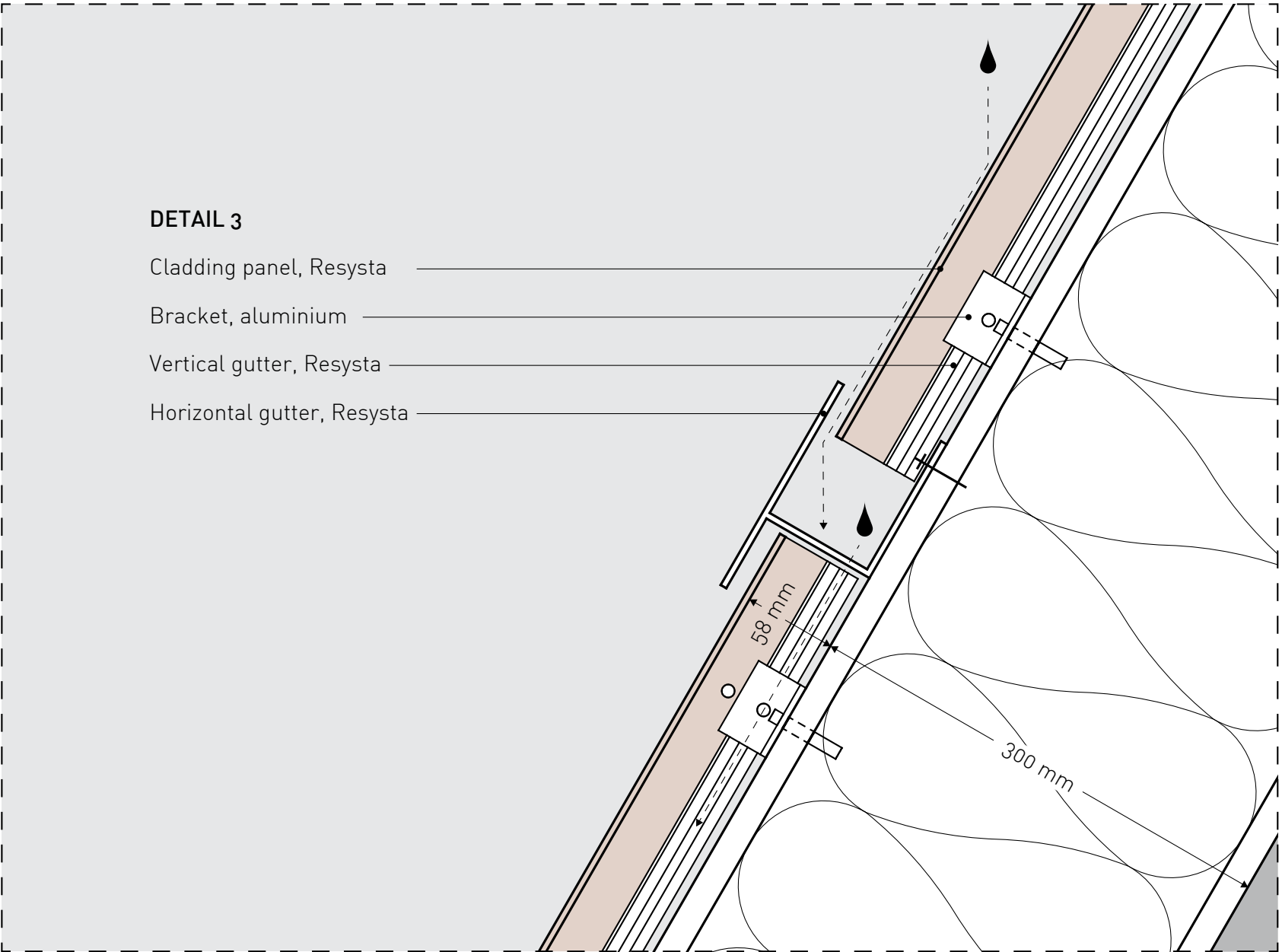
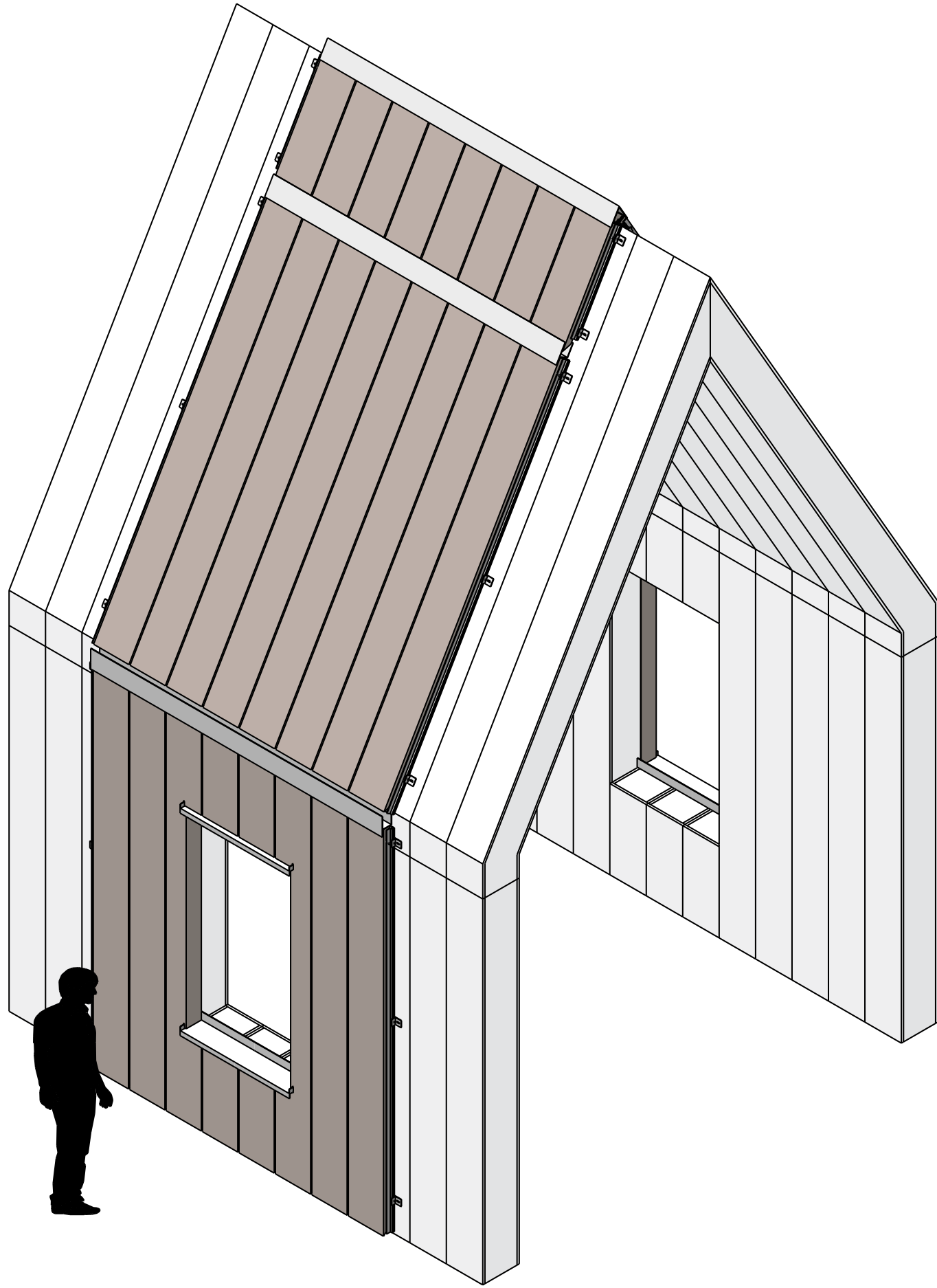
VERTICAL JOINTS

SUB-CONSTRUCTION

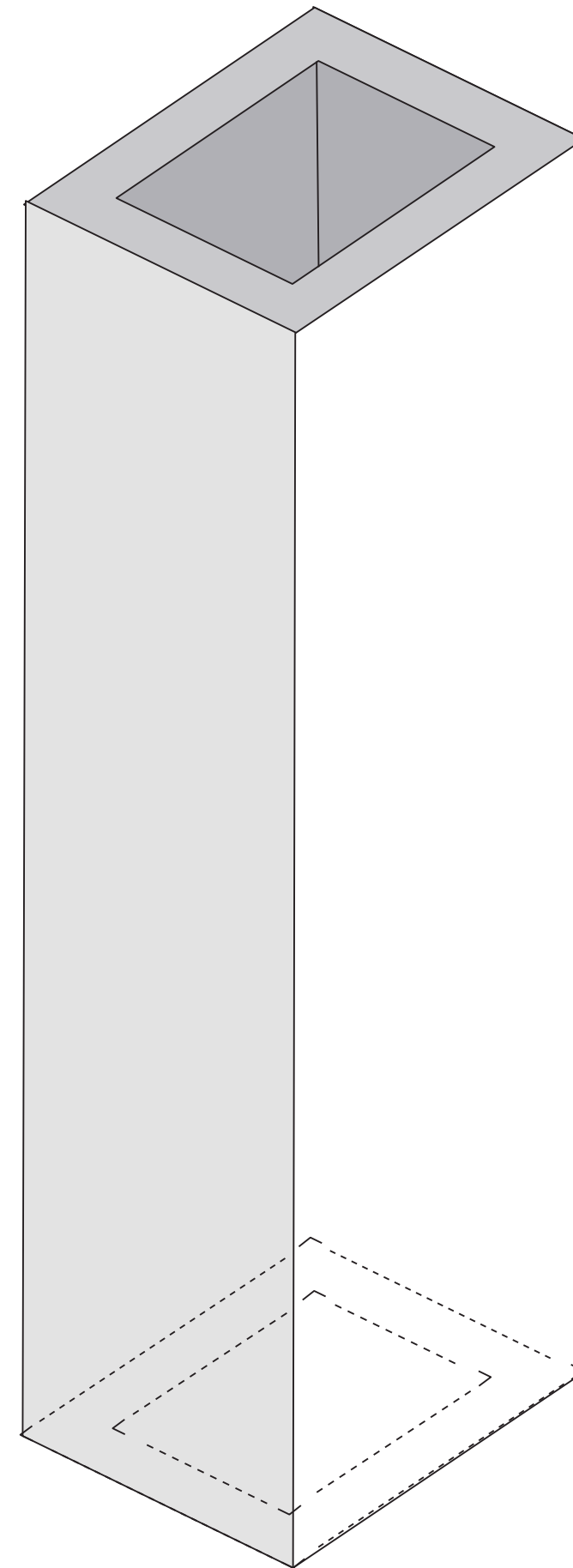
PANEL STIFFNESS

PROCESSING TECHNIQUES

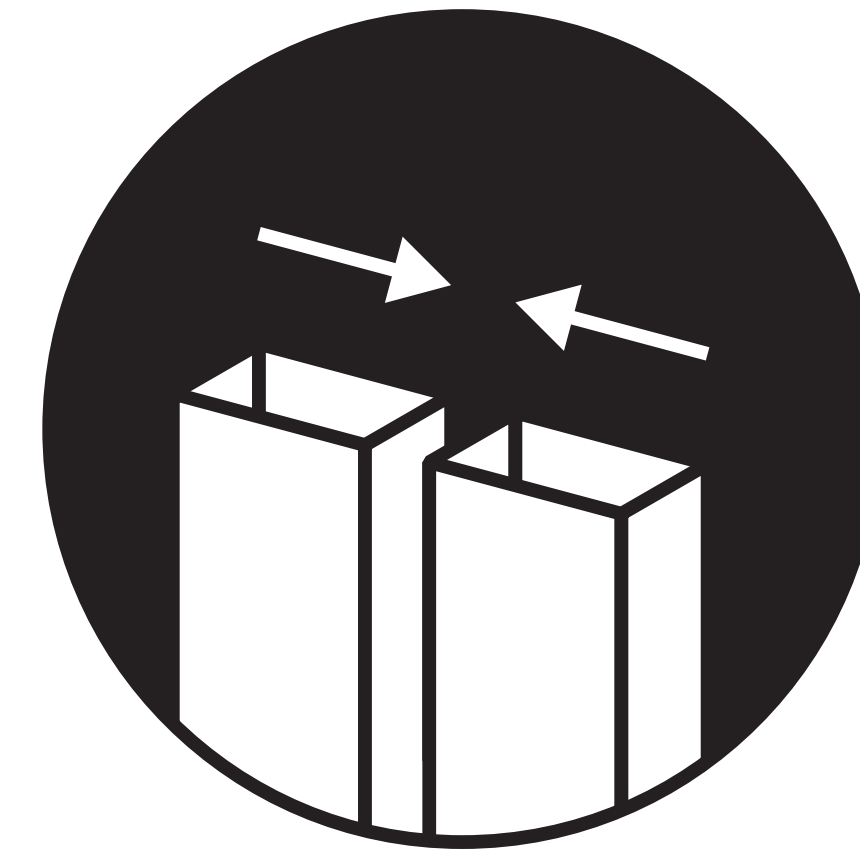




2D: design freedom



continuous production

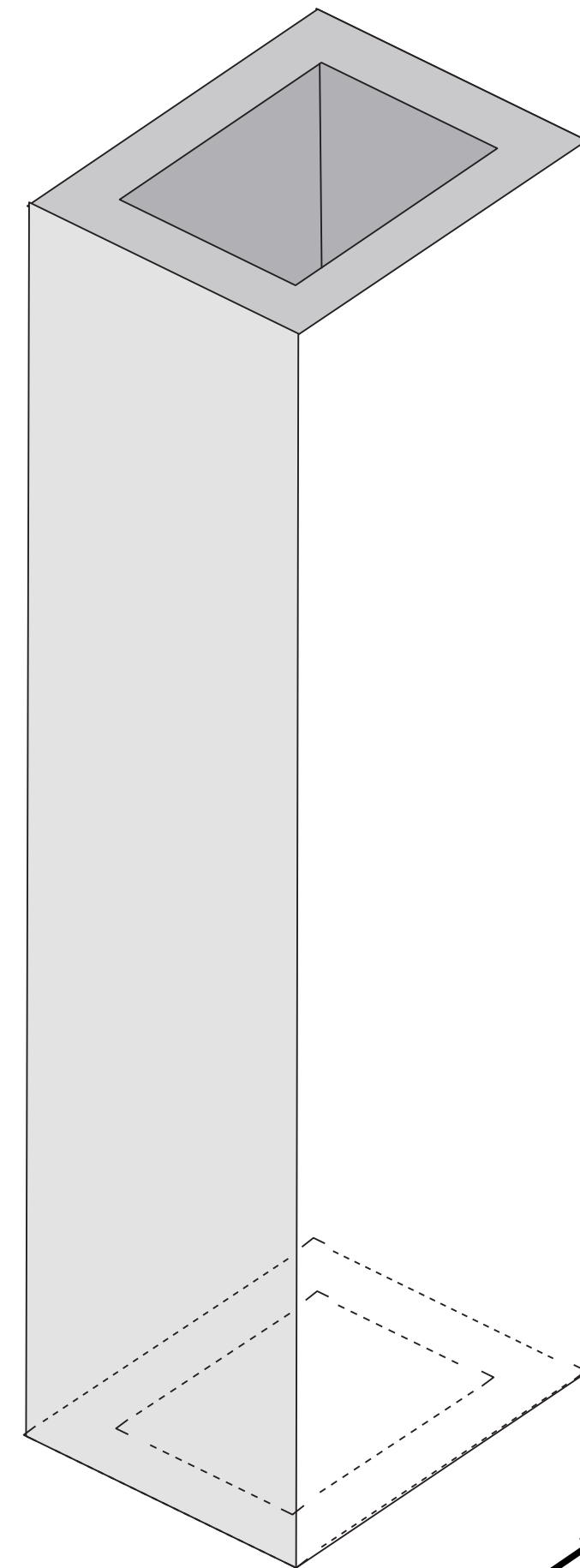


2D: design freedom

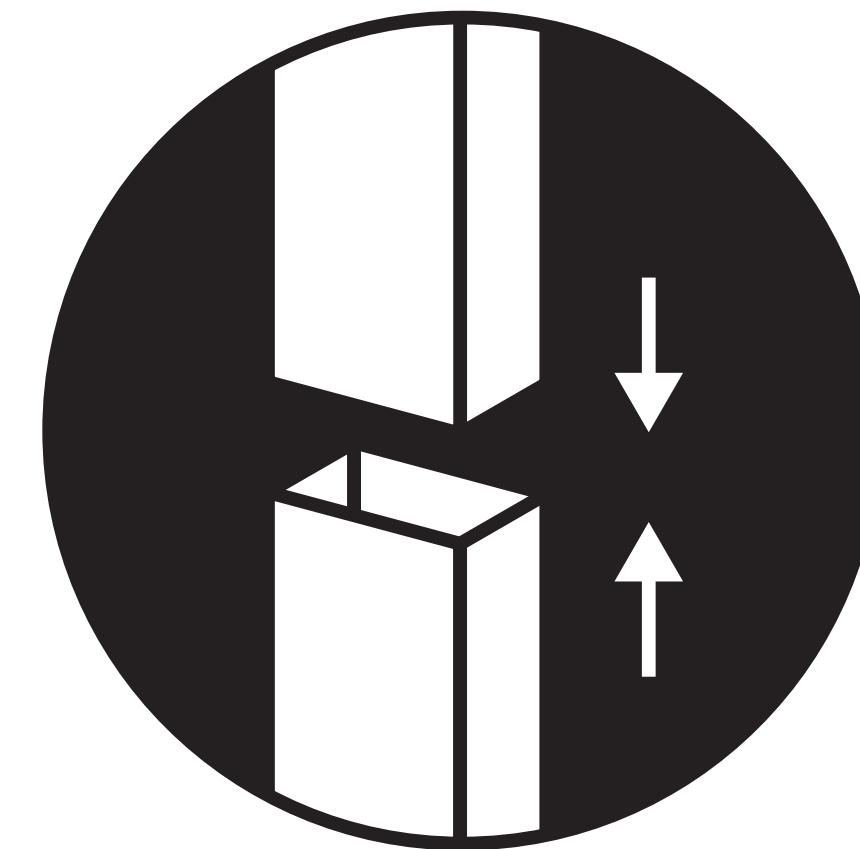
3D: fixed cross section

continuous production

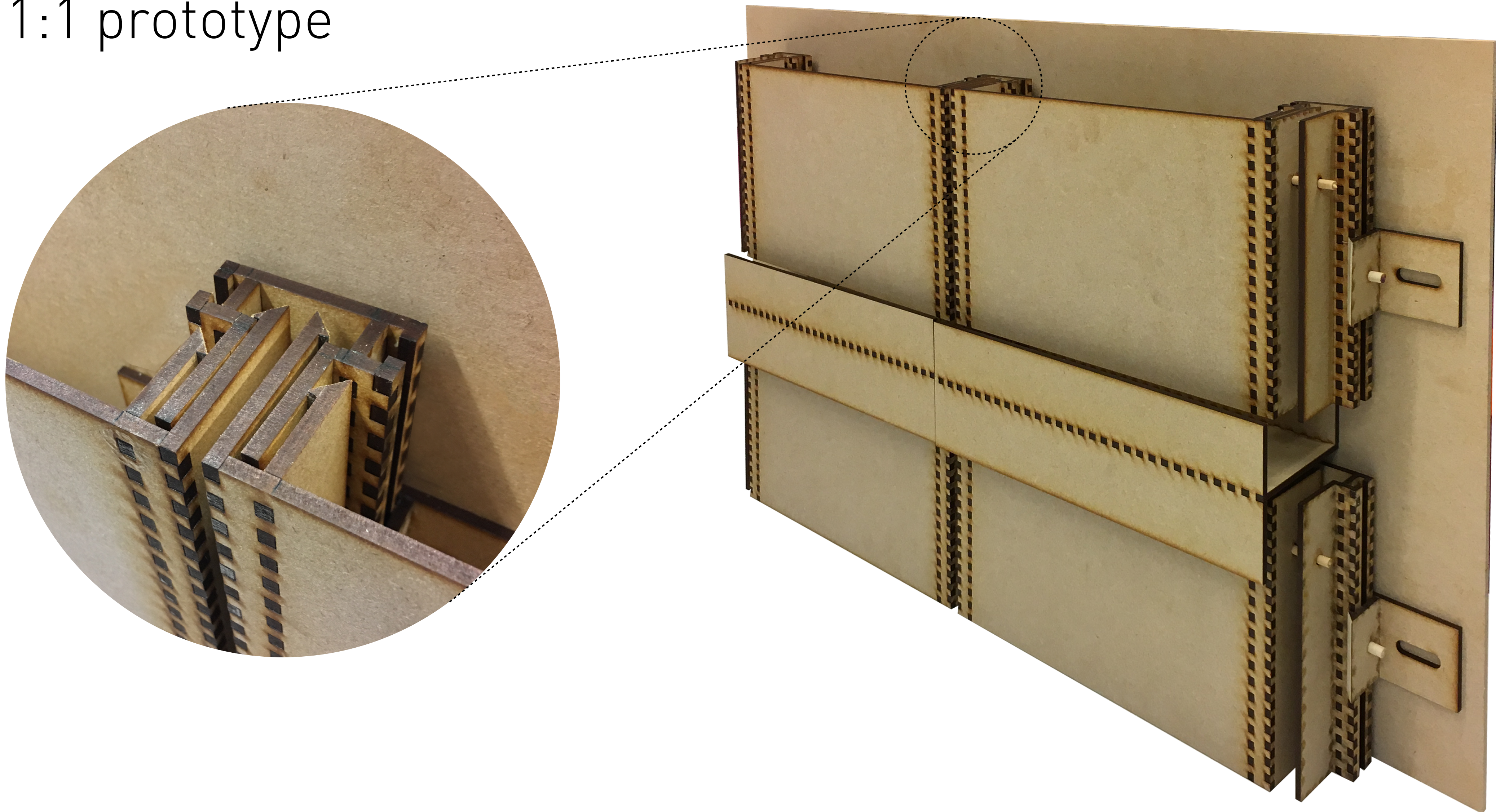
high investment costs



max. 300 mm



1:1 prototype



ASSEMBLY

CONNECTION

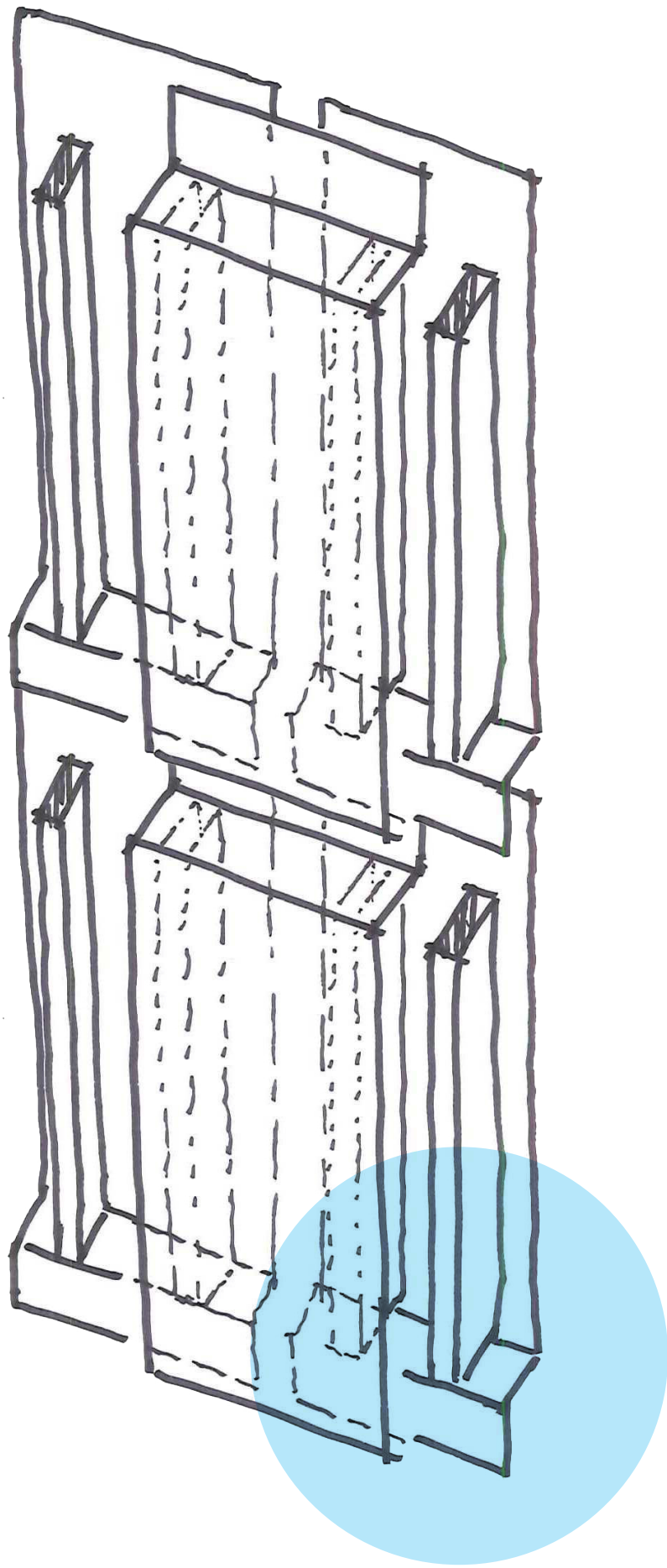
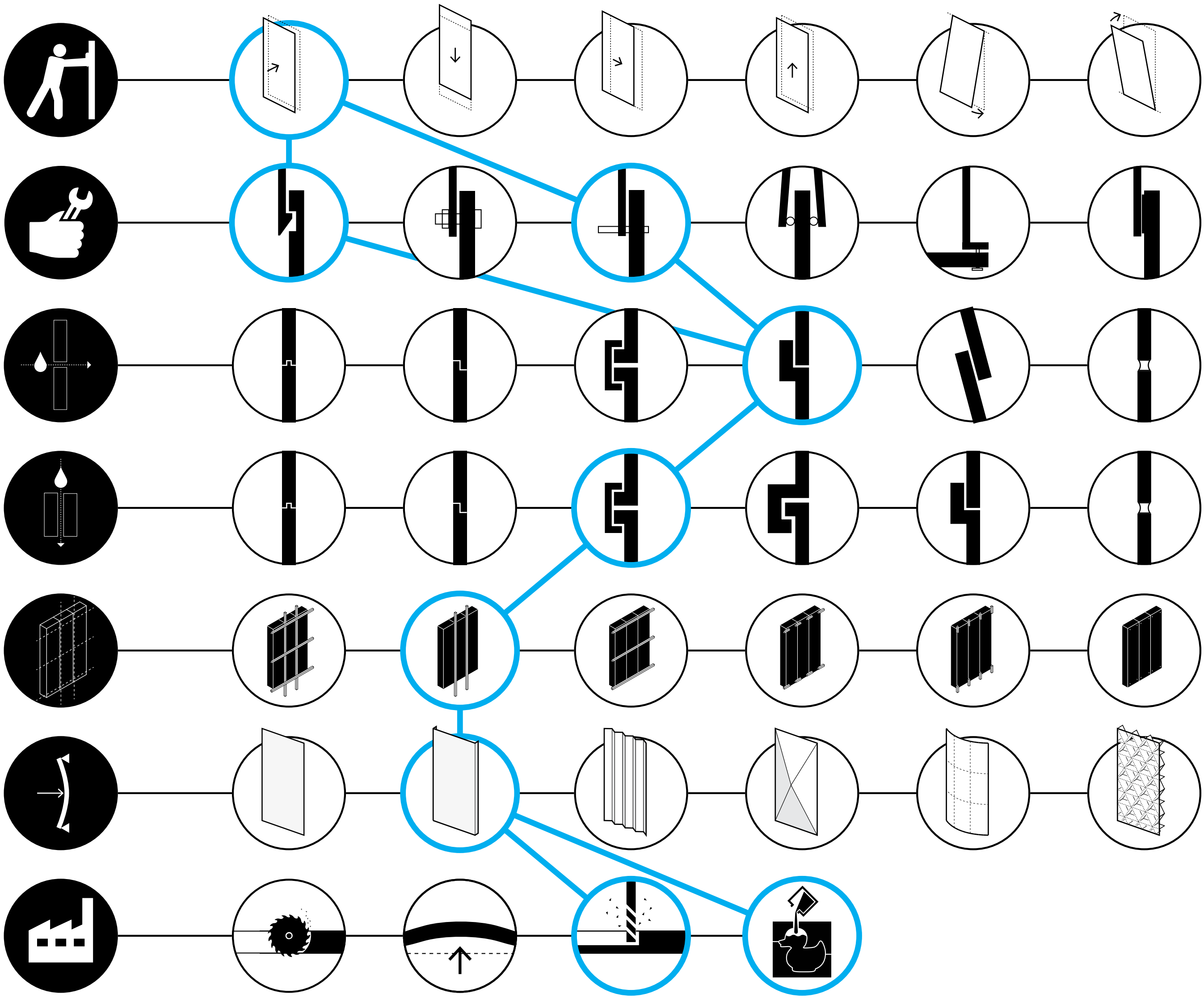
HORIZONTAL JOINTS

VERTICAL JOINTS

SUB-CONSTRUCTION

PANEL STIFFNESS

PROCESSING TECHNIQUES



ASSEMBLY

CONNECTION

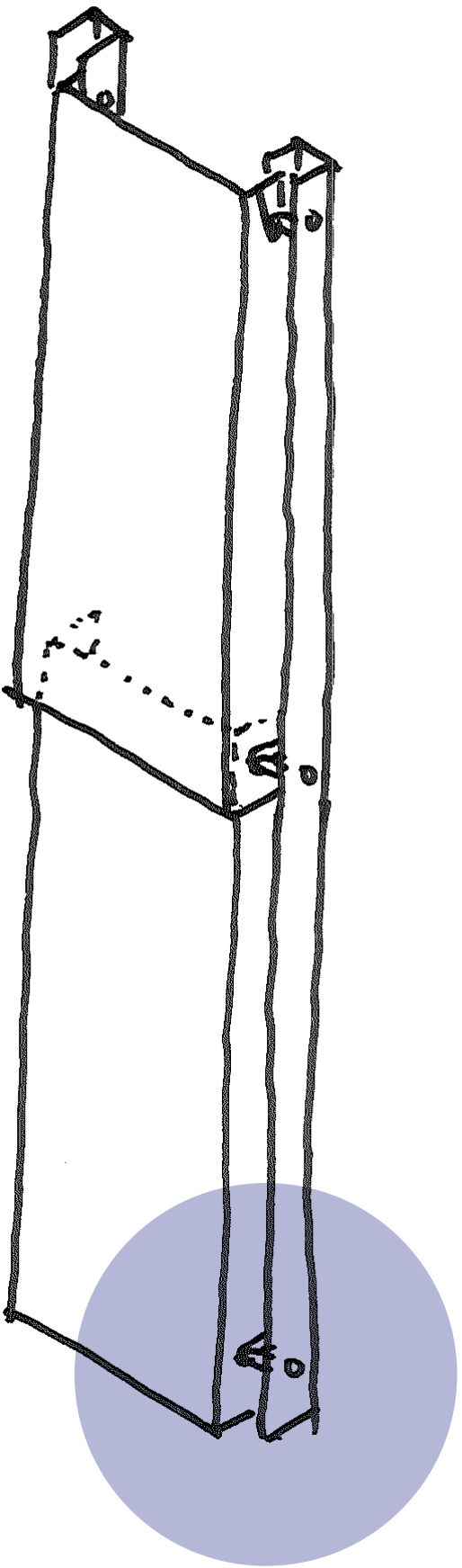
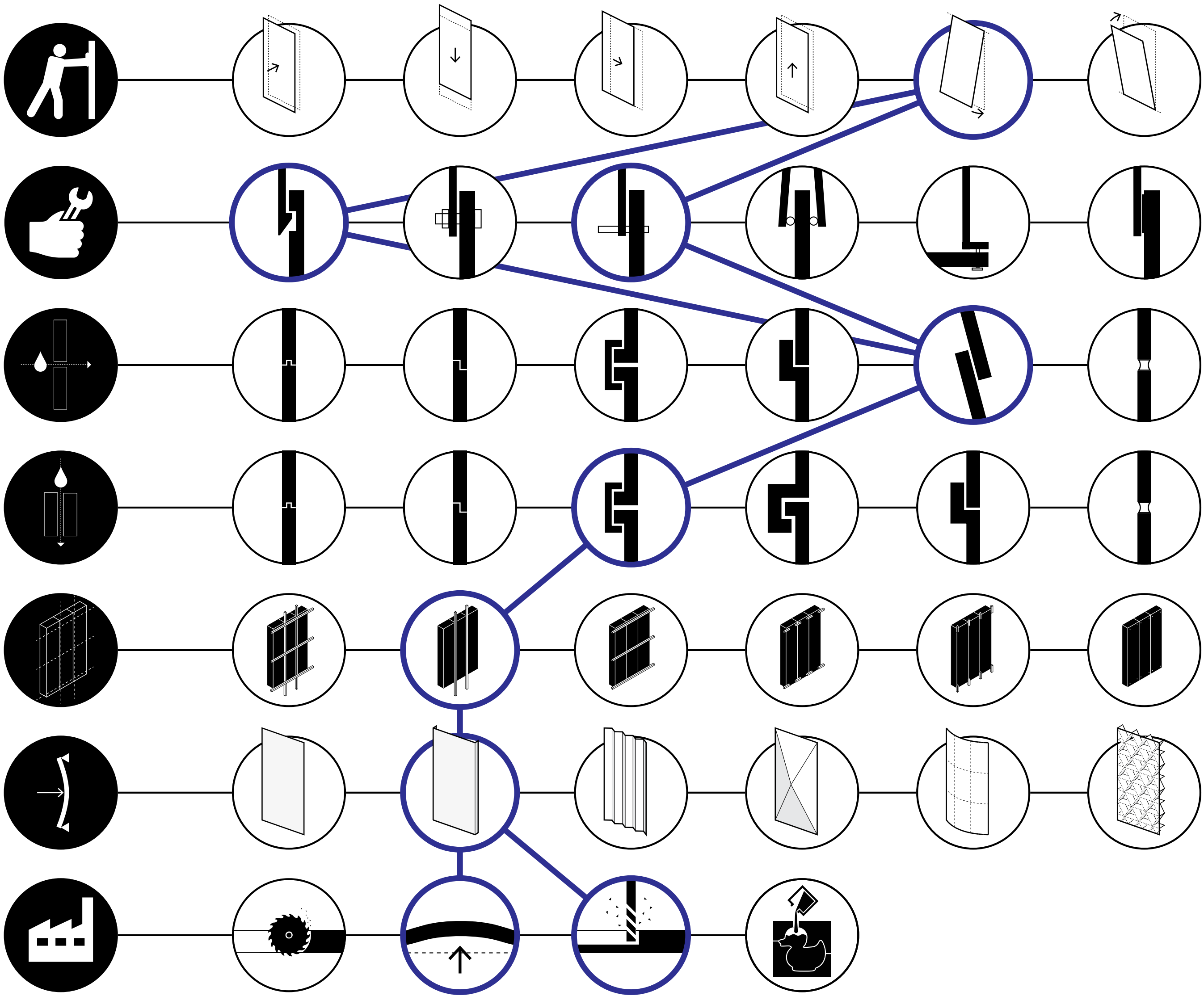
HORIZONTAL
JOINTS

VERTICAL
JOINTS

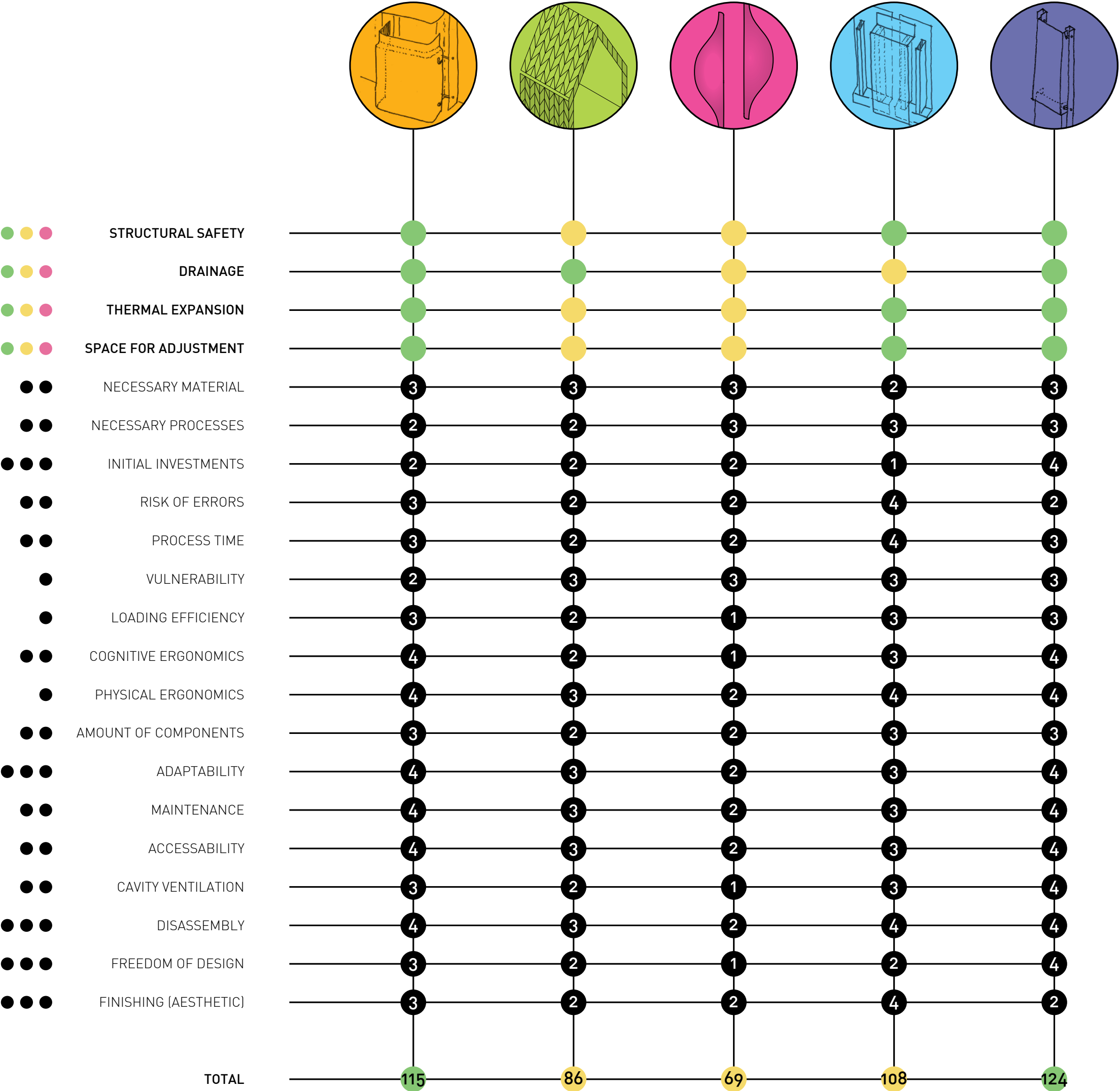
SUB-CONSTRUCTION

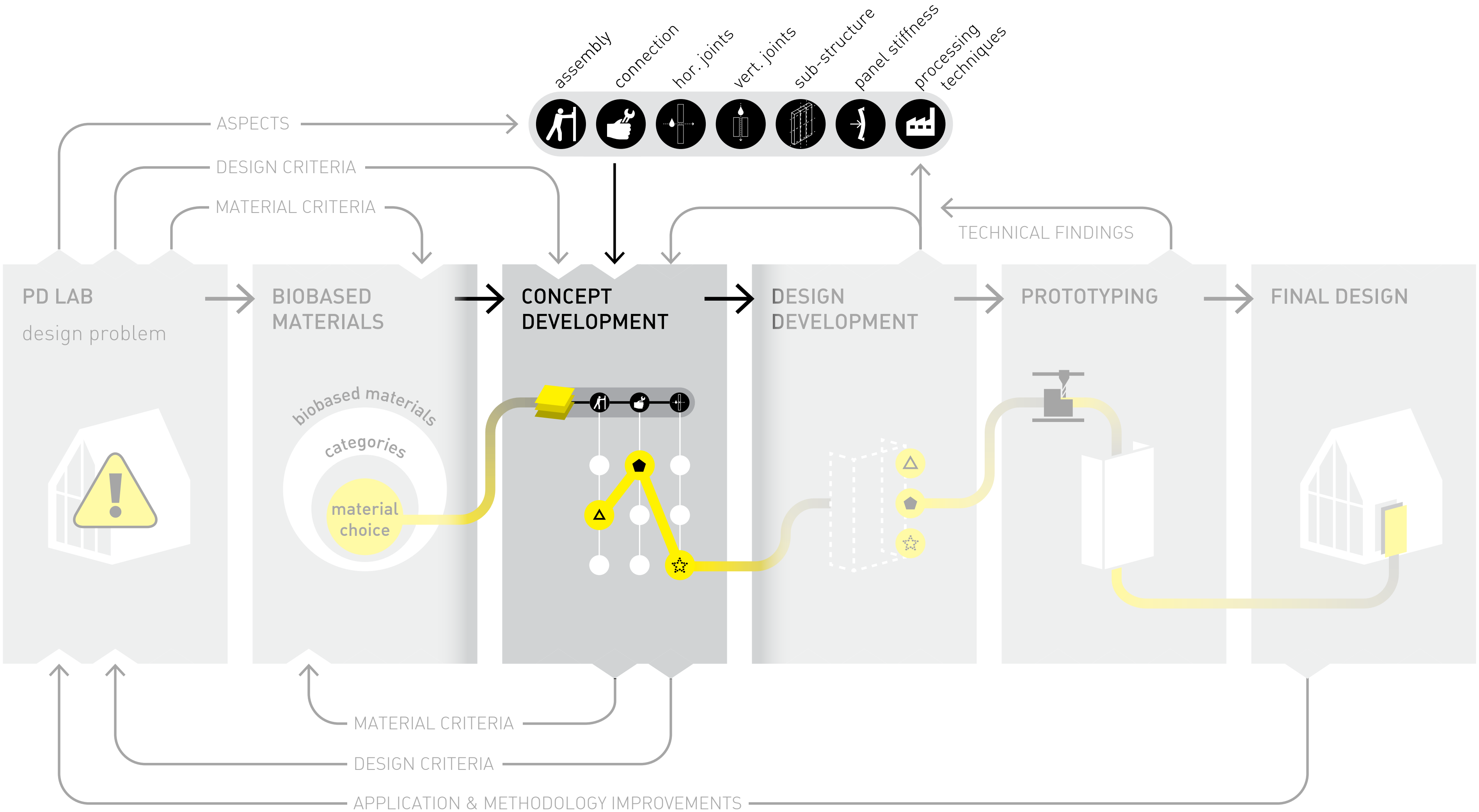
PANEL STIFFNESS

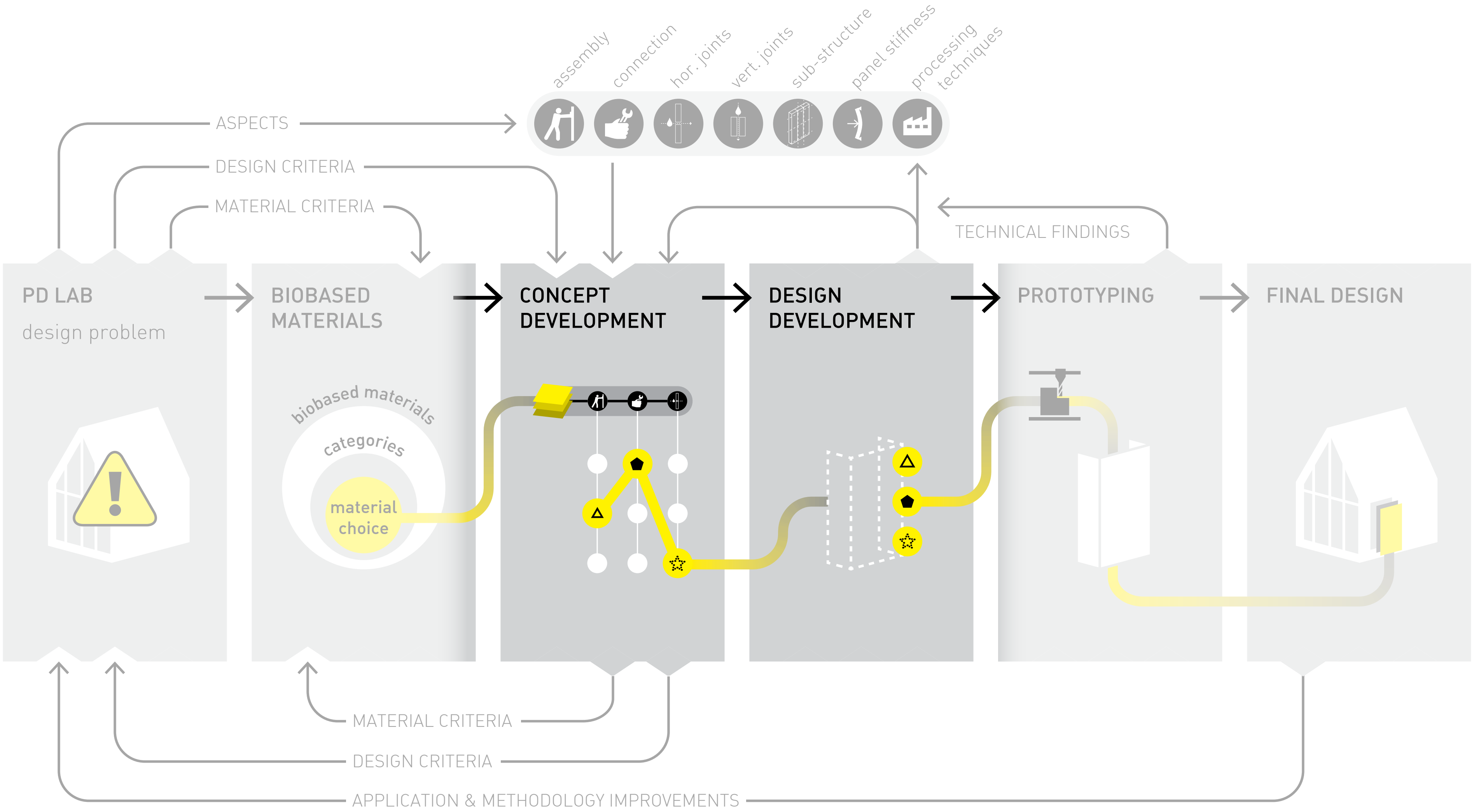
PROCESSING
TECHNIQUES



assessment



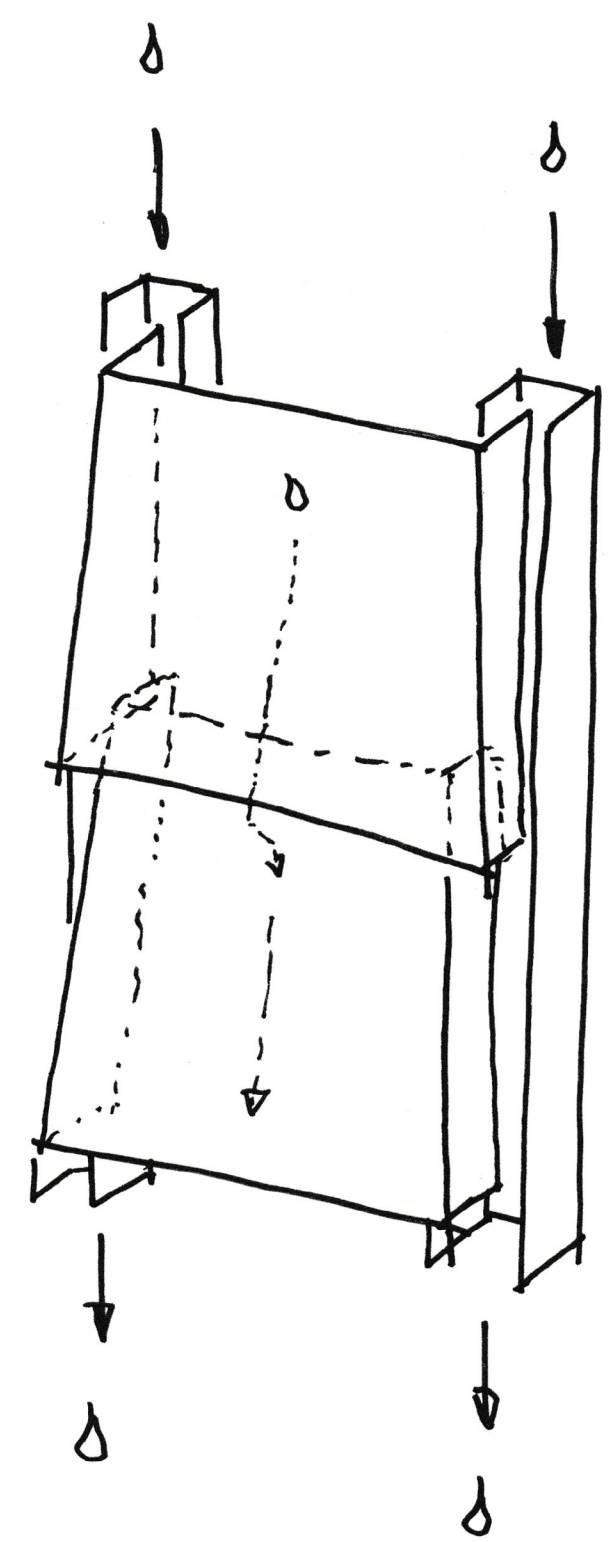




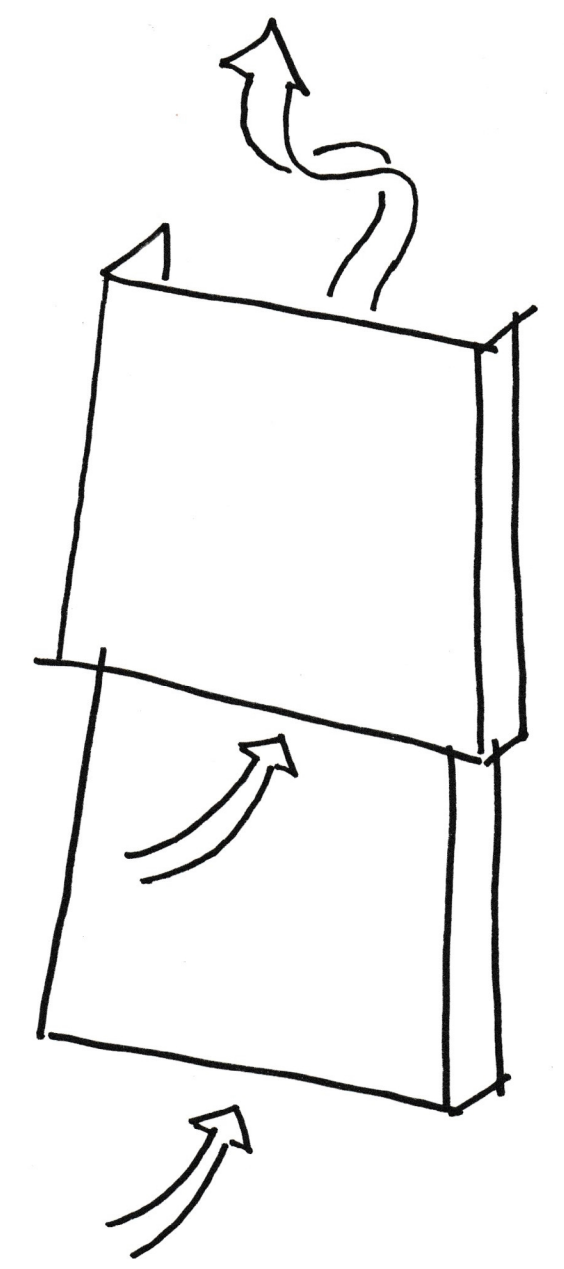
design development

functions
+
production

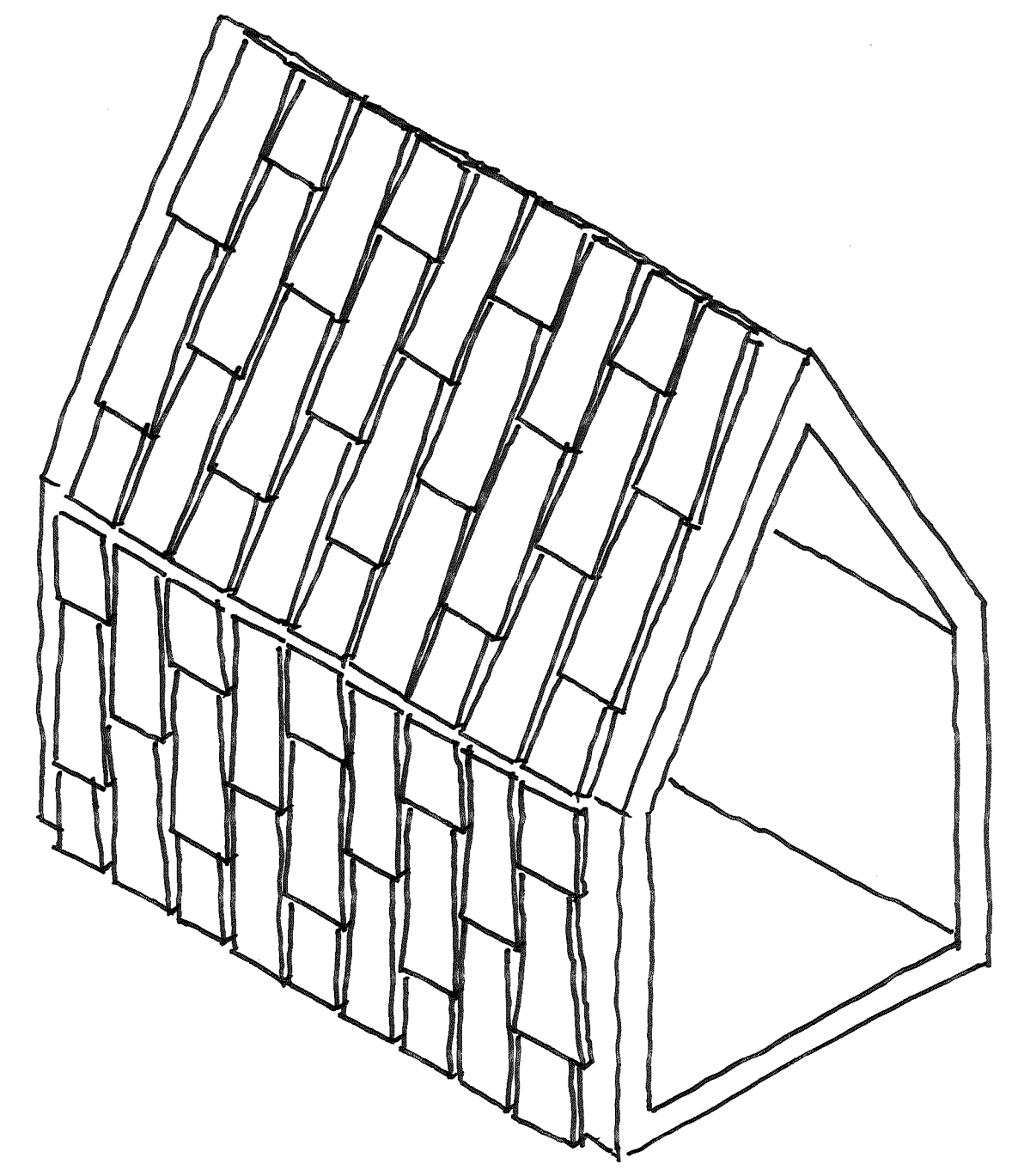
functions



DRAINAGE

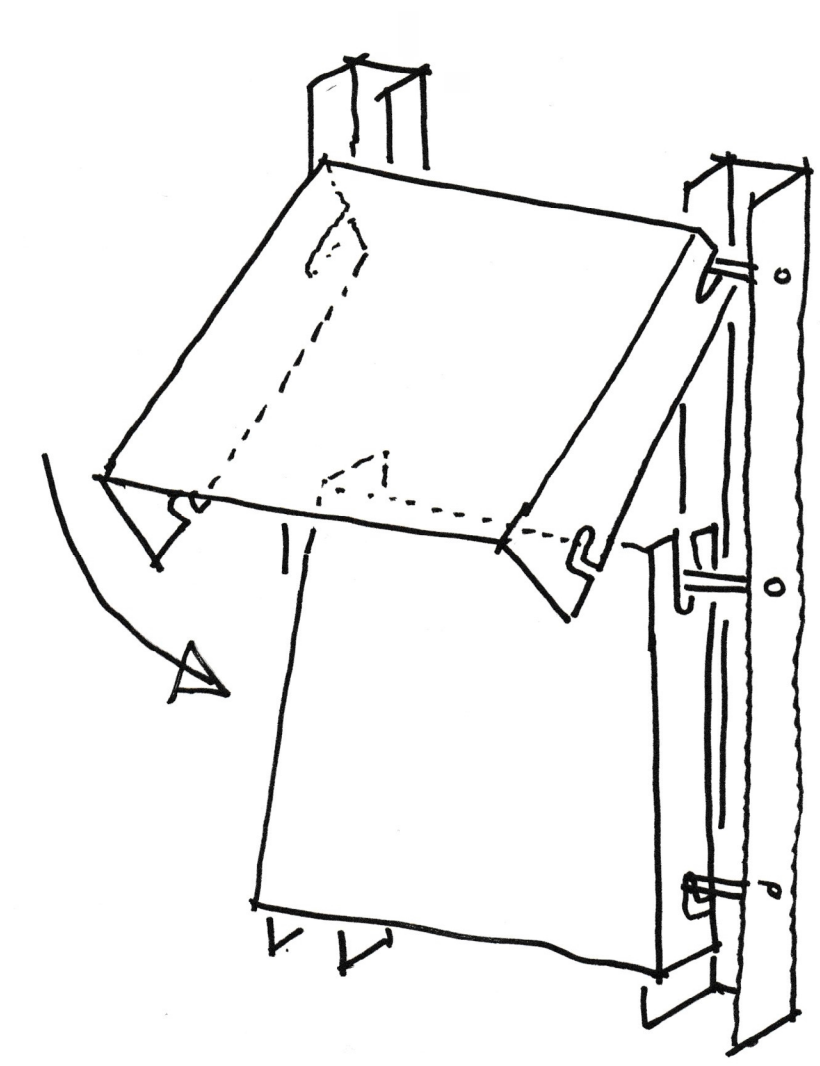


CAVITY
VENTILATION

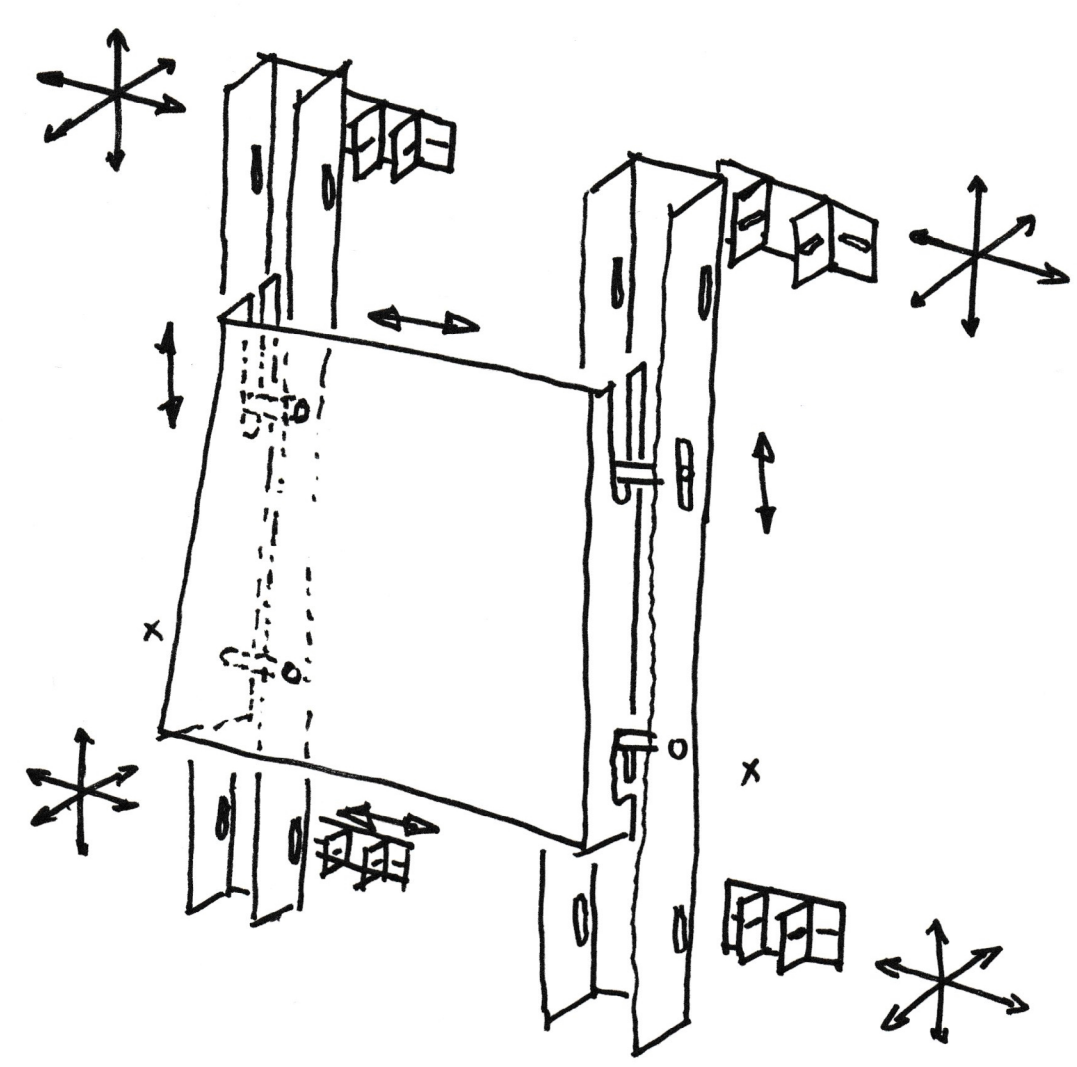


AESTHETICS

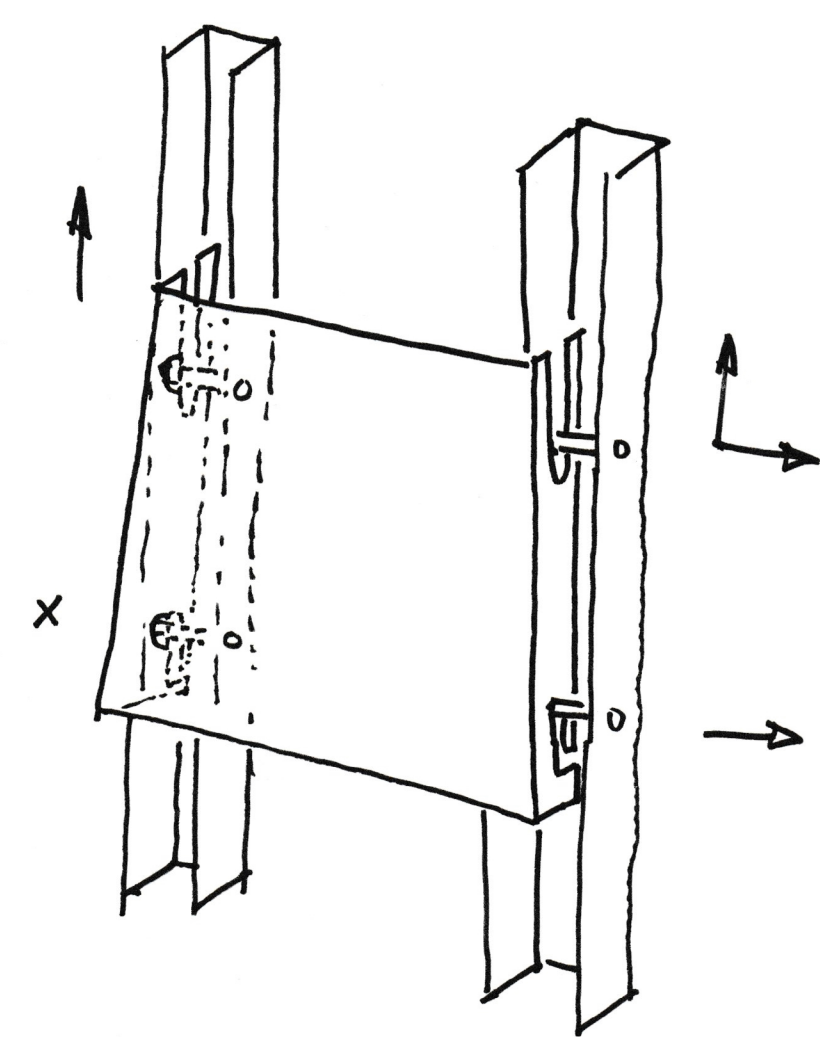
functions



ASSEMBLY

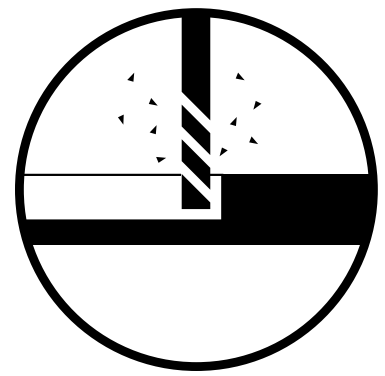


SPACE FOR
ADJUSTMENT

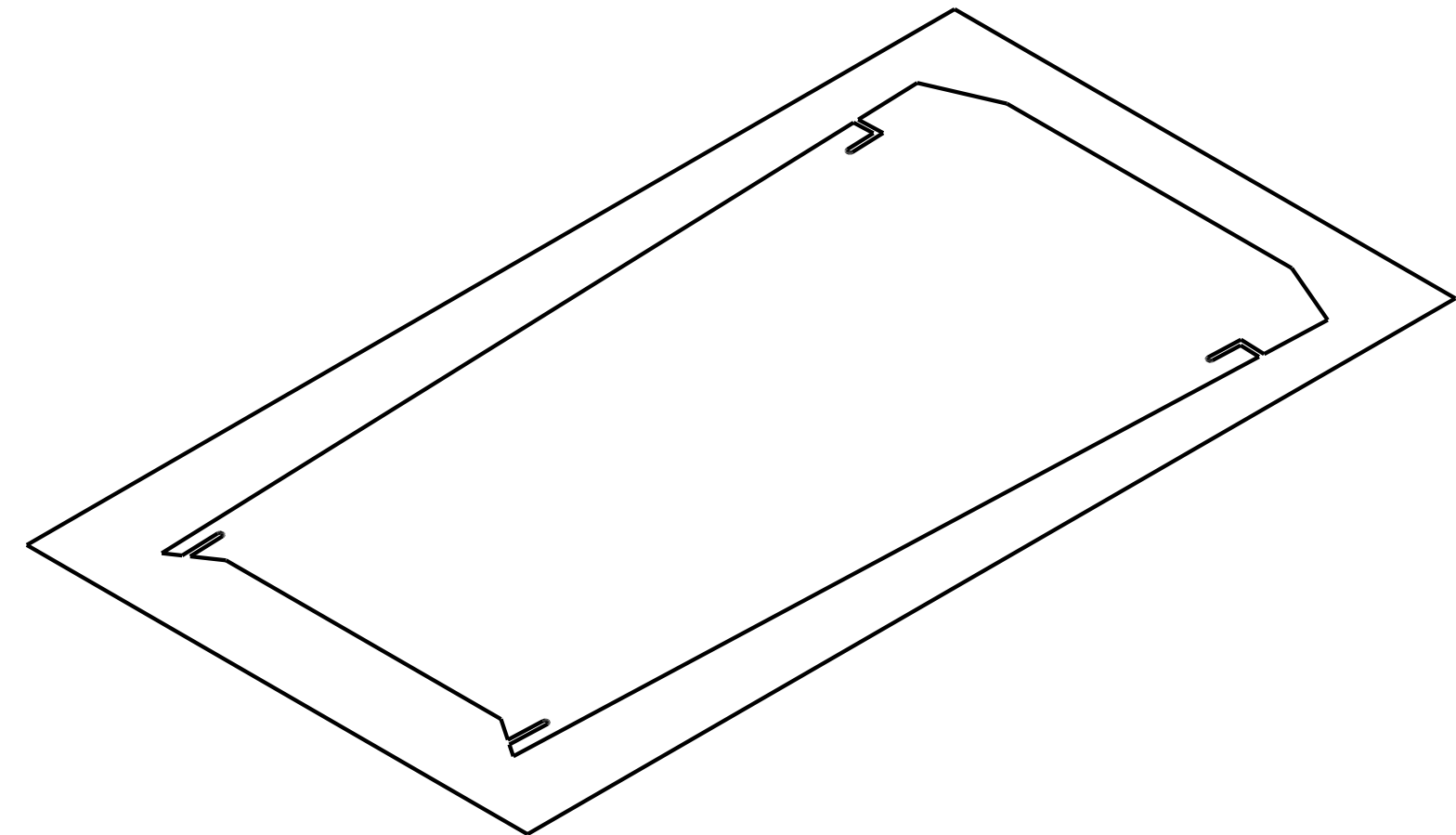


SPACE FOR
THERMAL EXPANSION

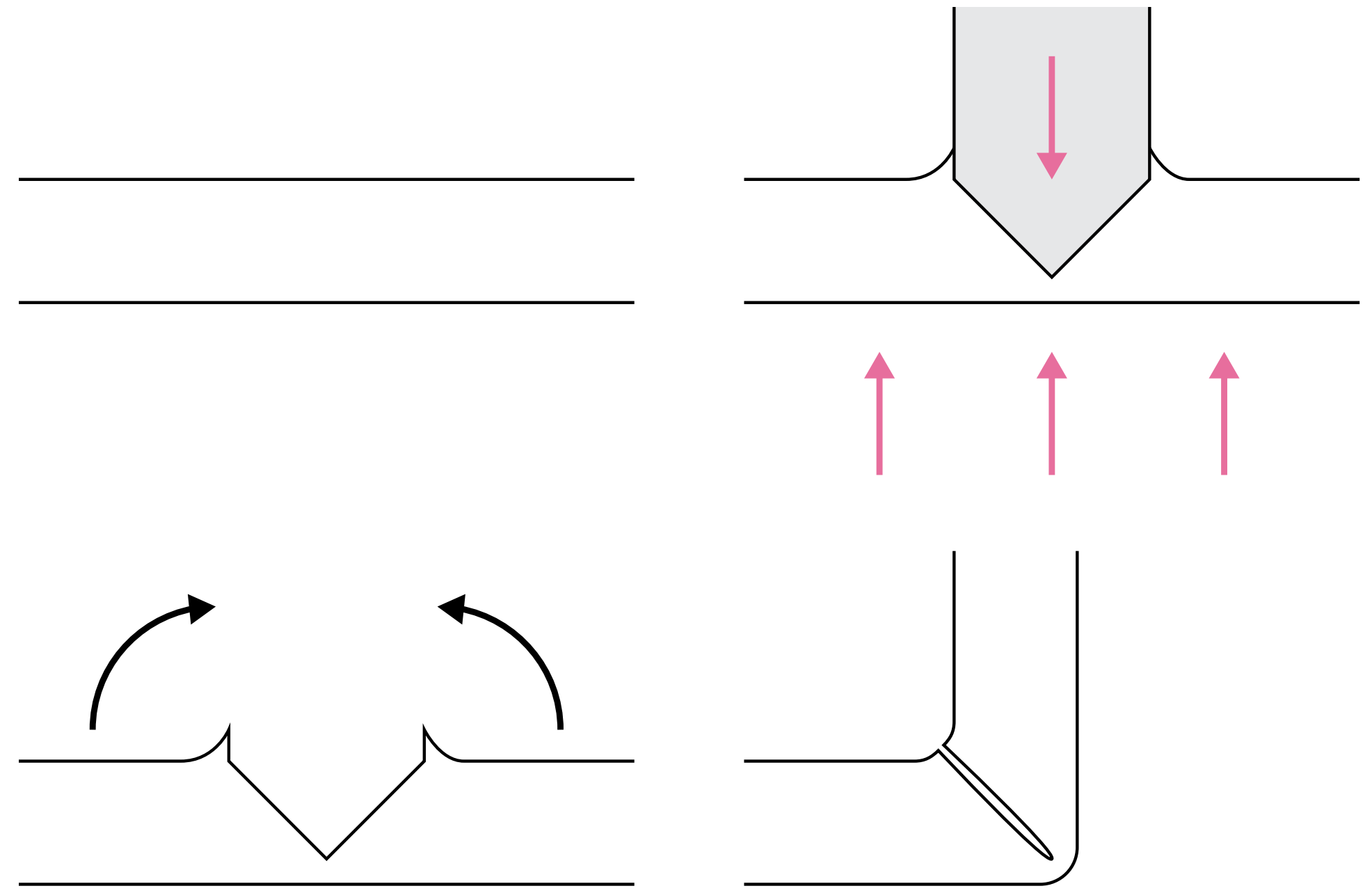
processing technique #1



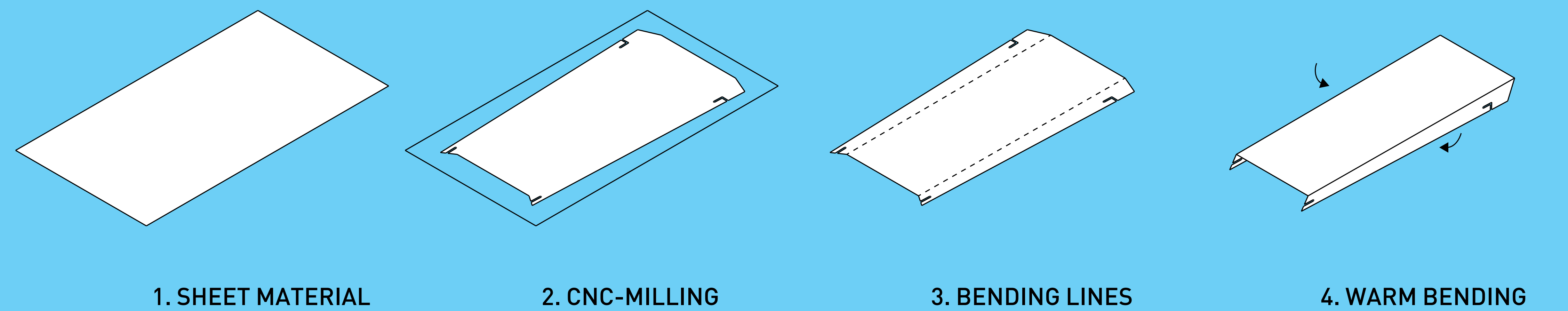
CNC-MILLING

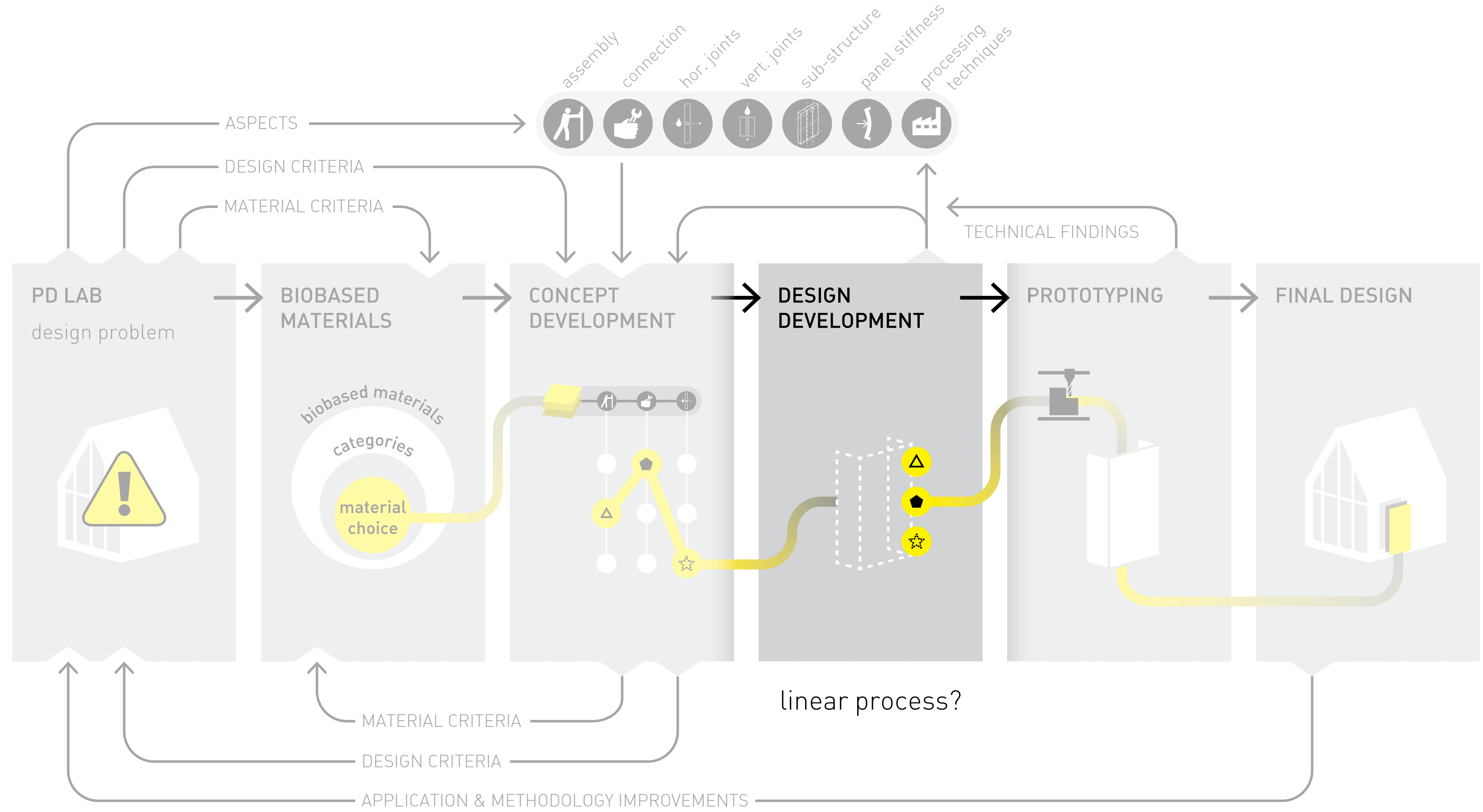


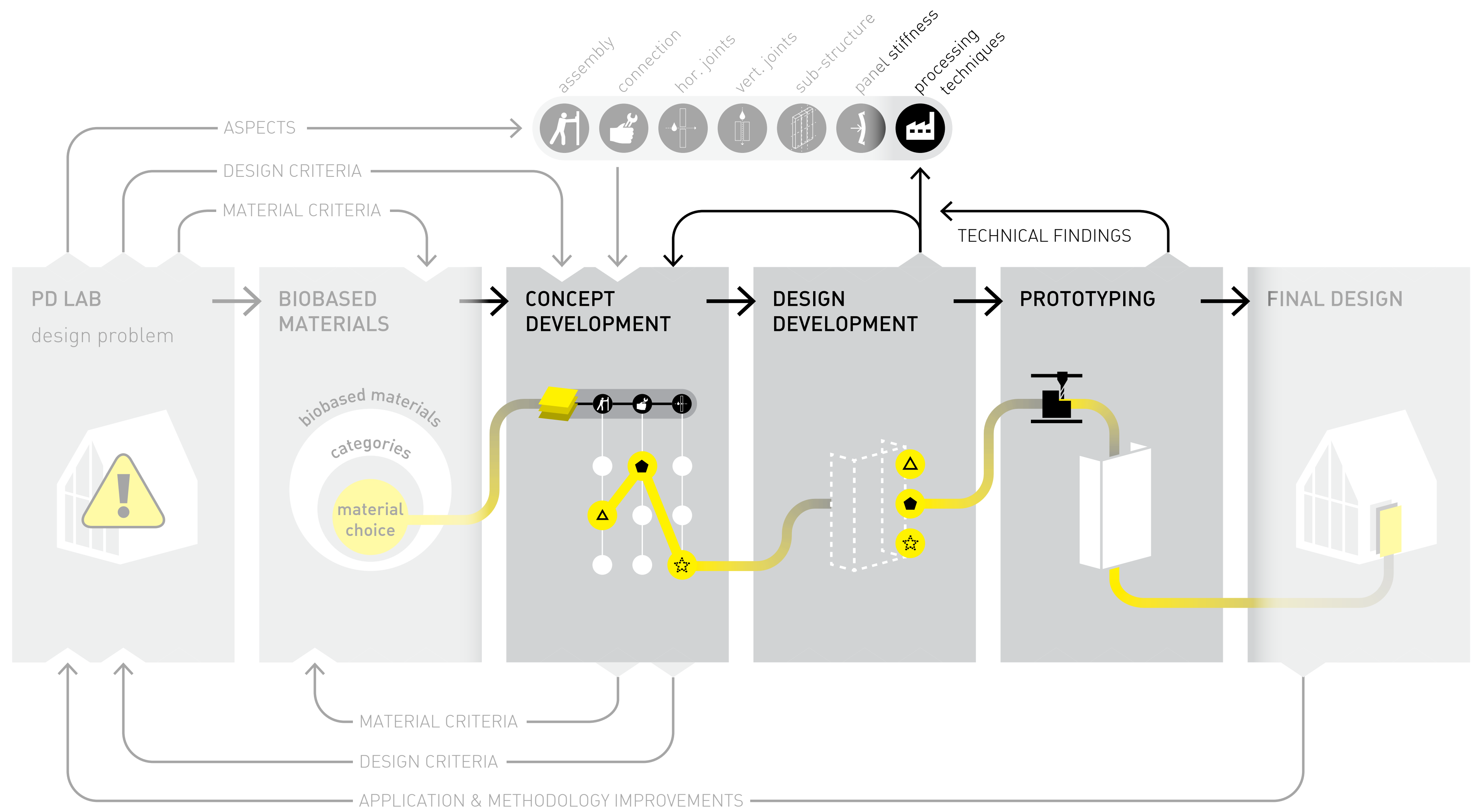
processing technique #2



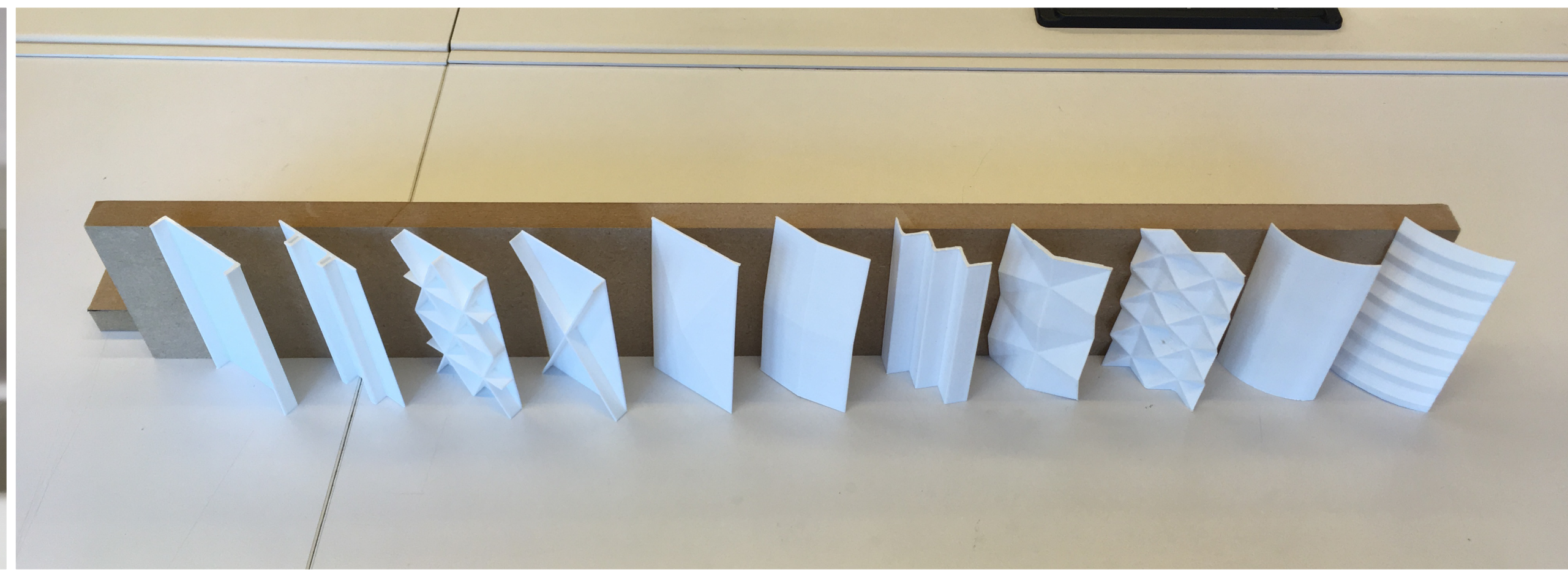
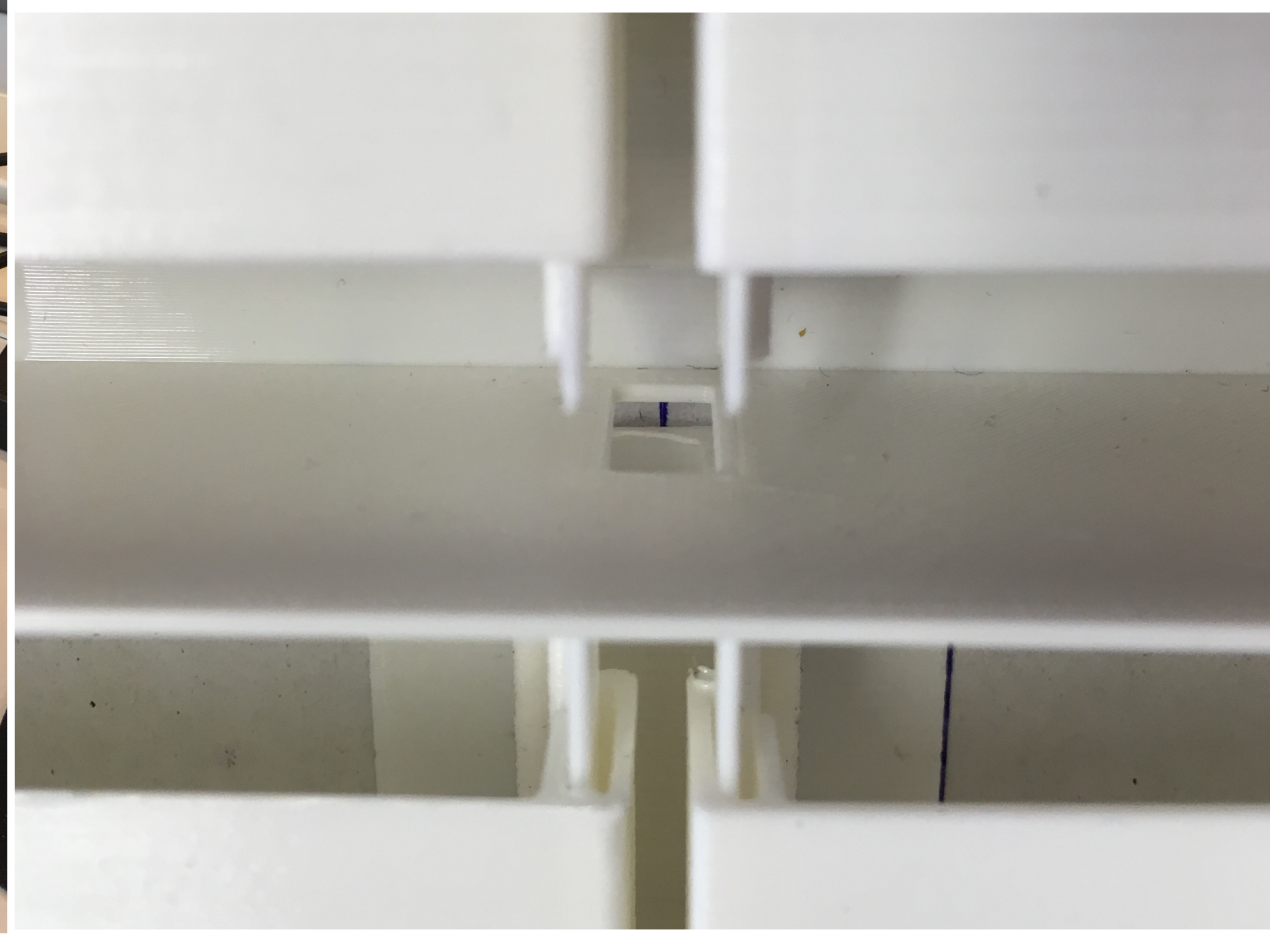
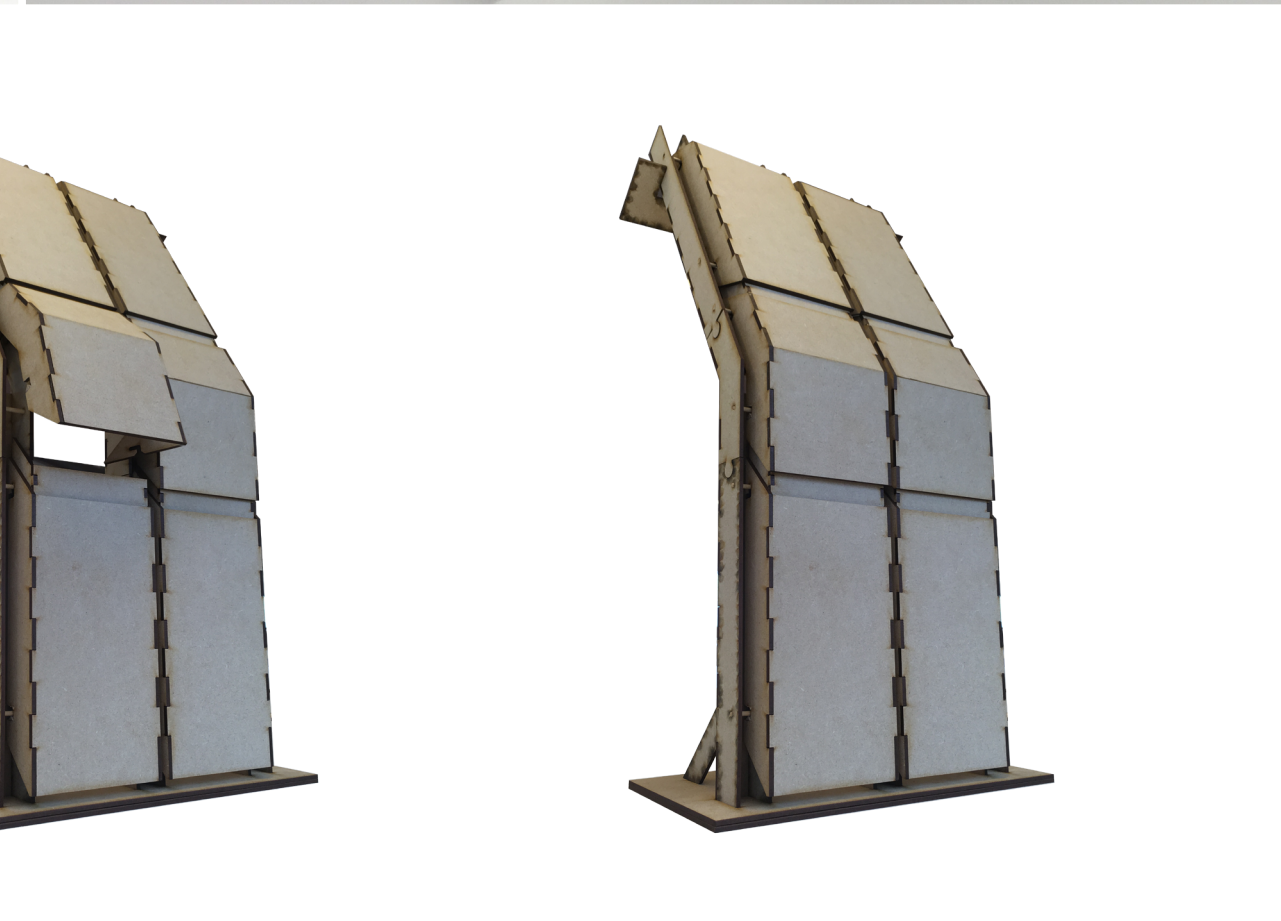
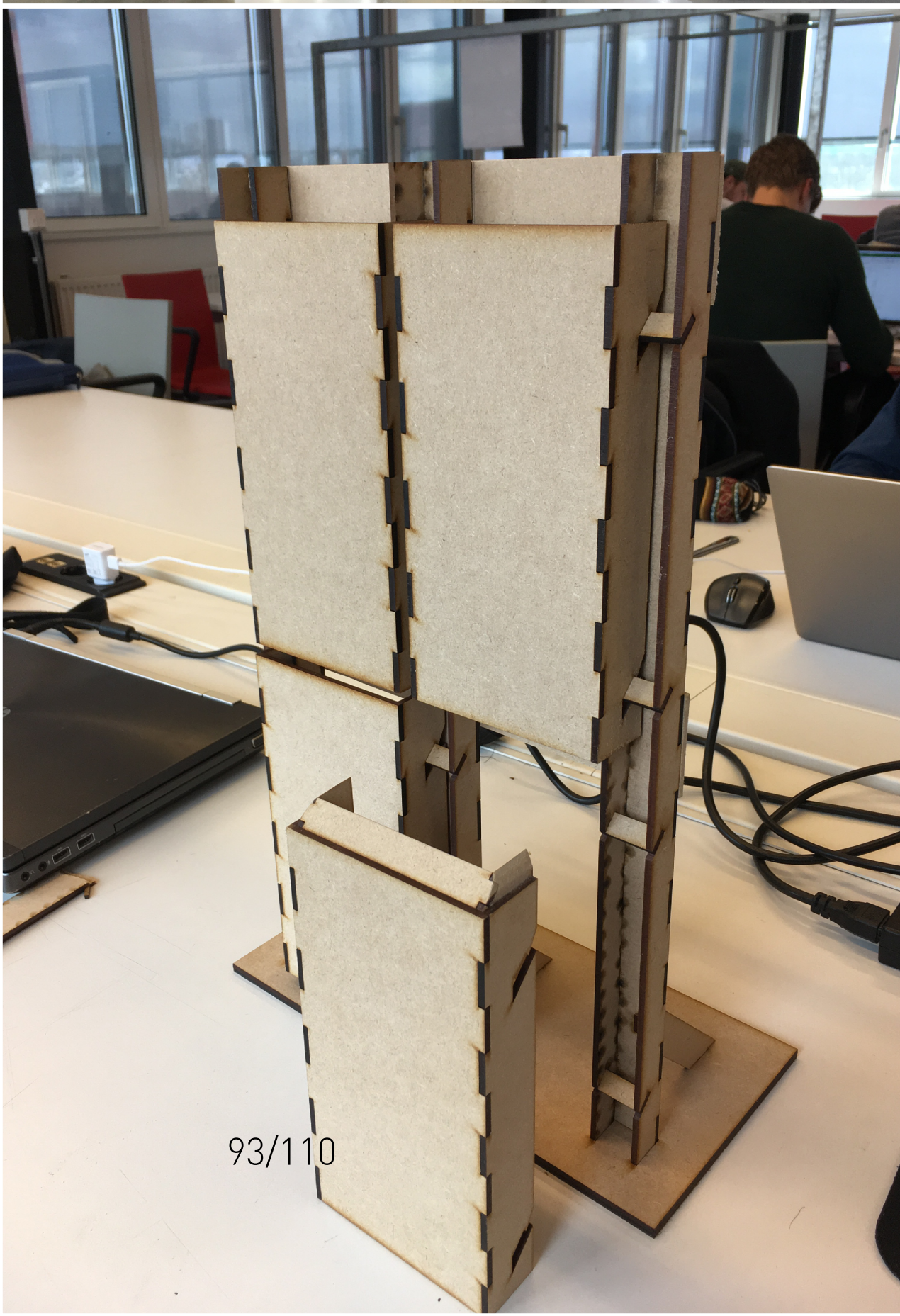
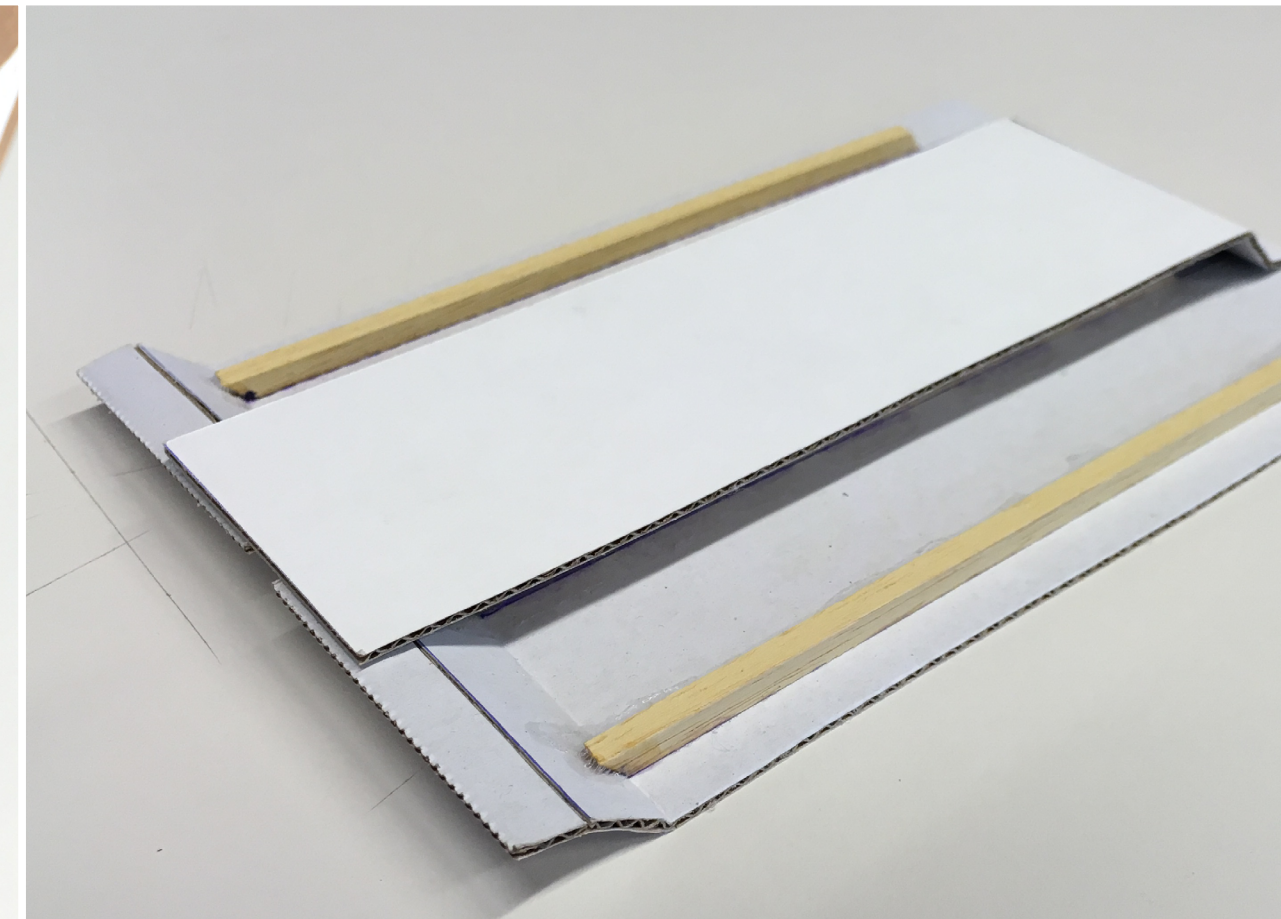
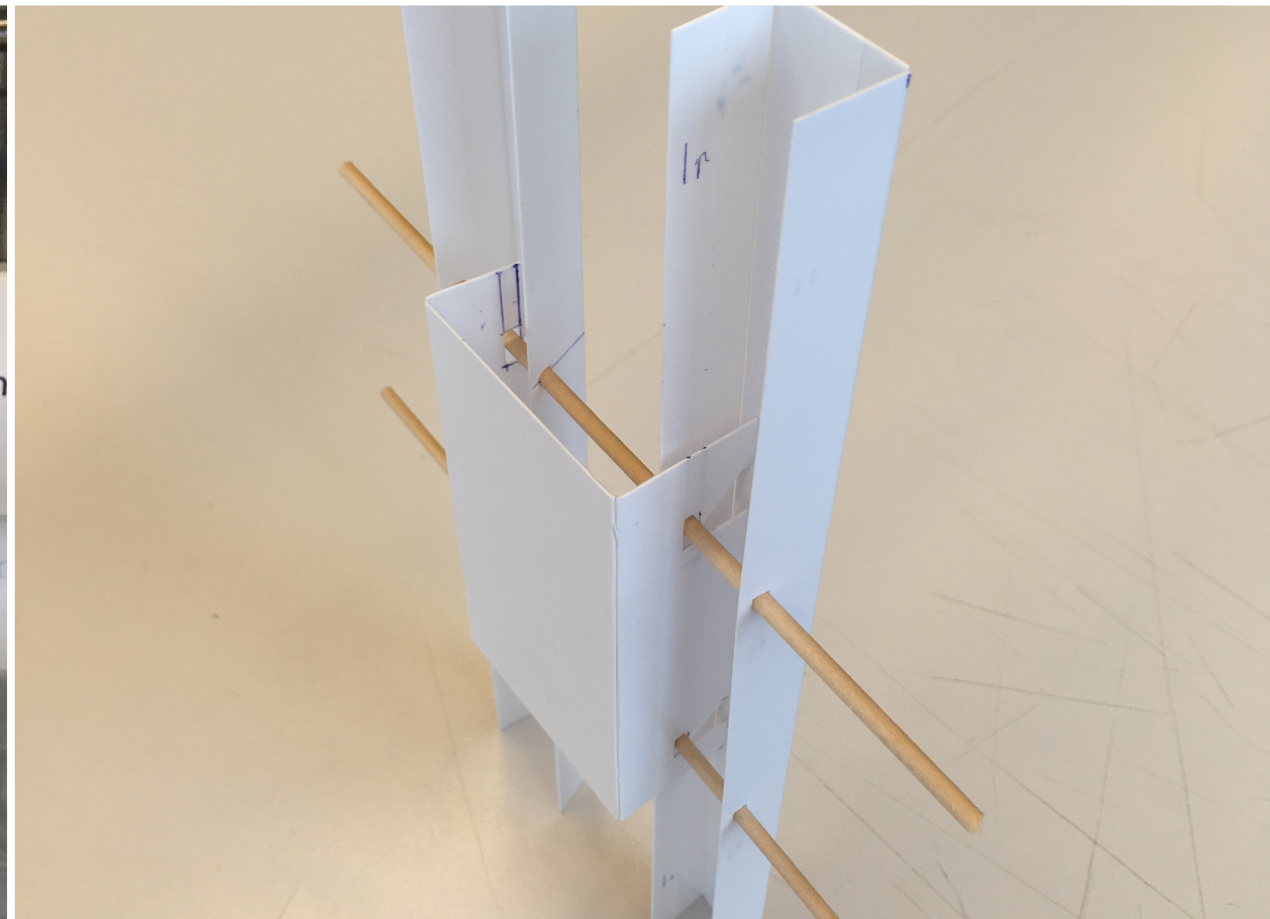
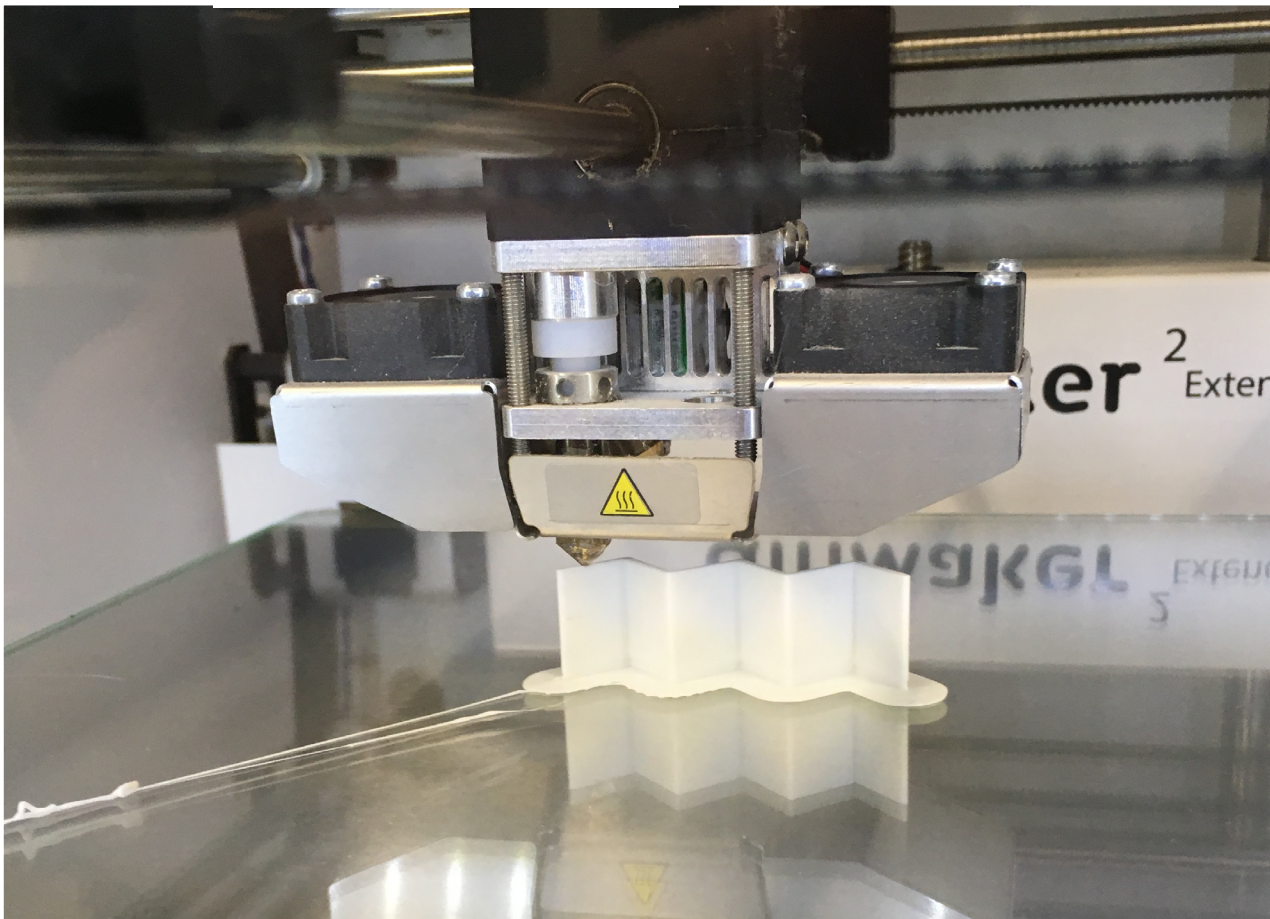
production steps

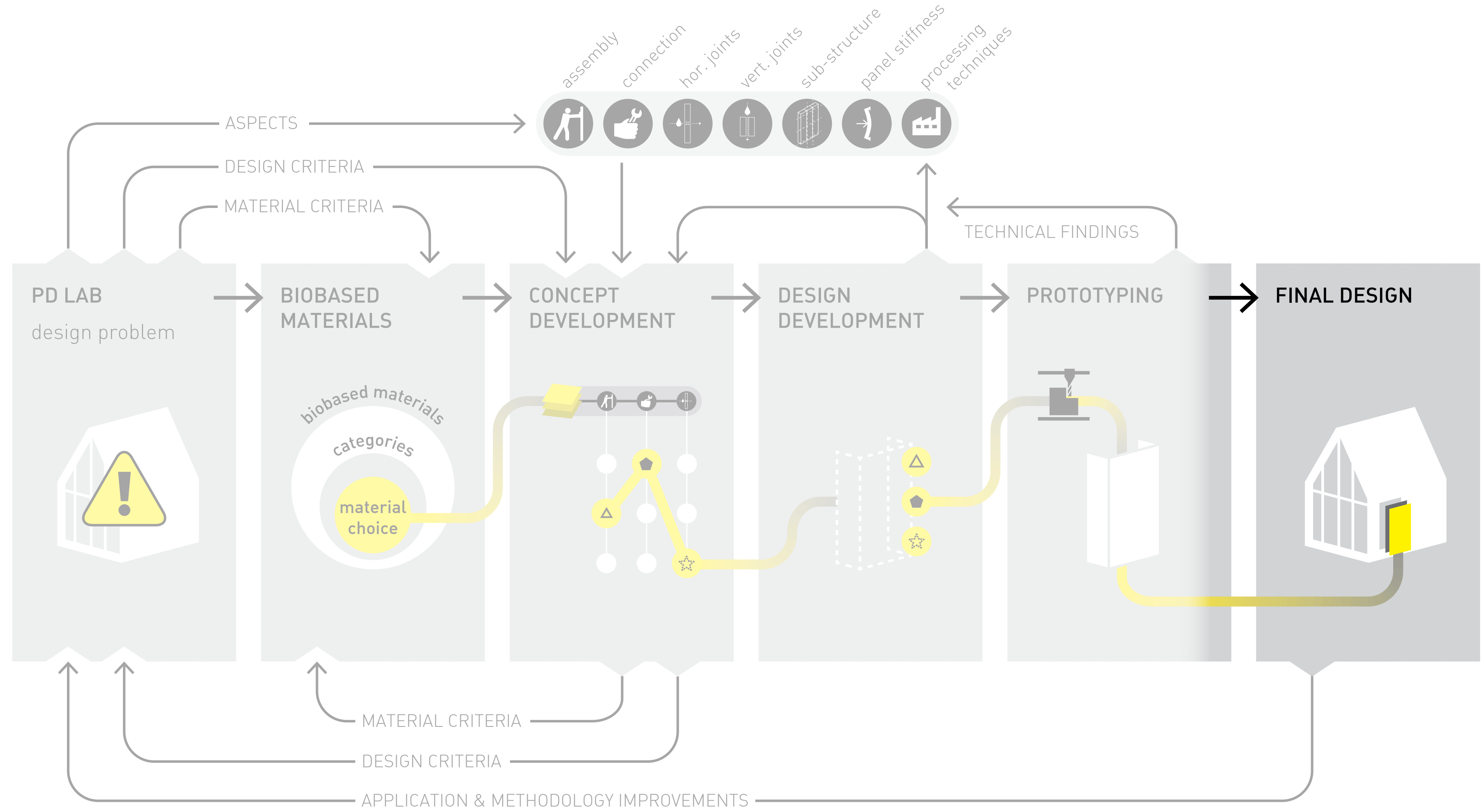






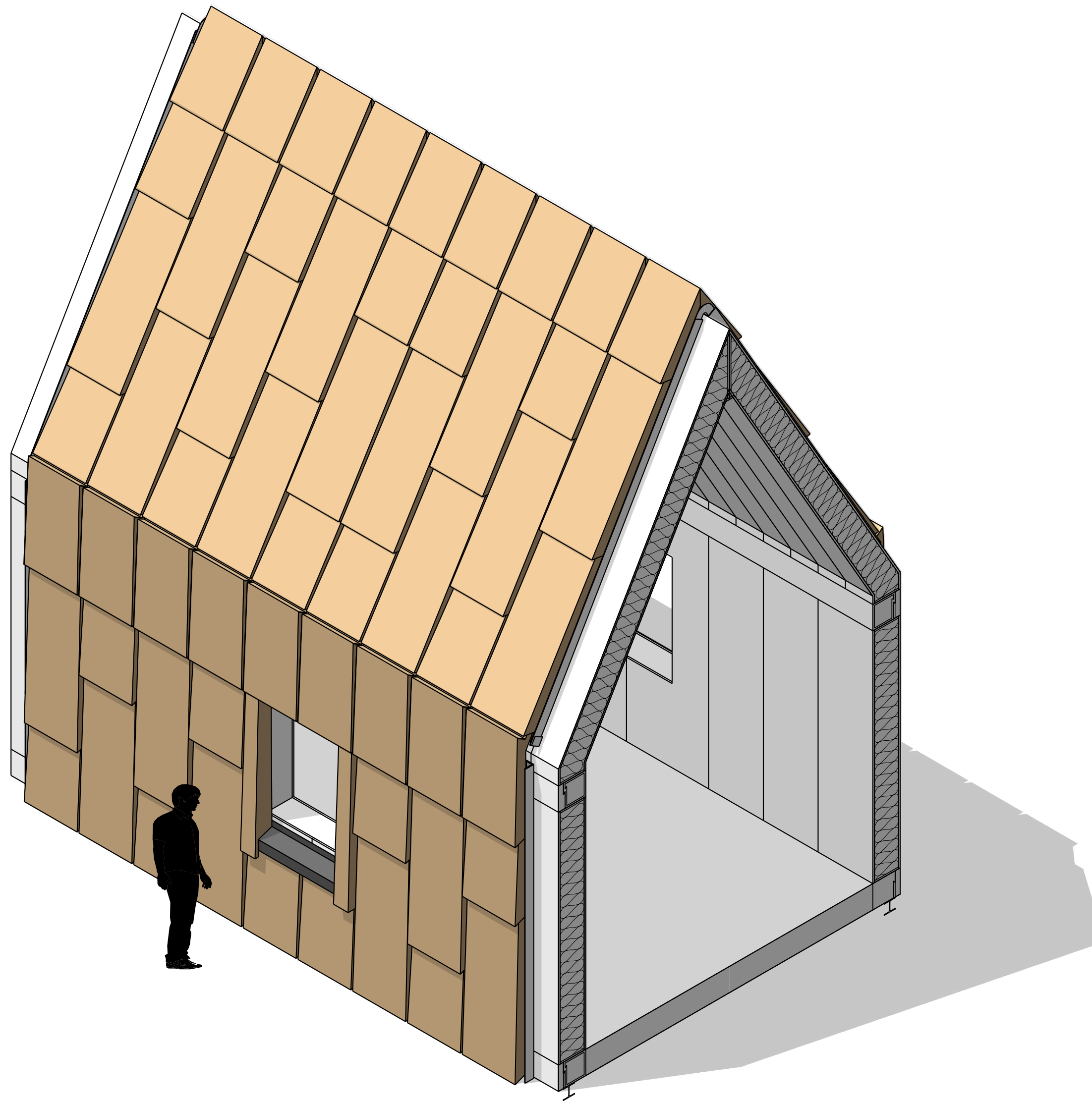
prototyping





final design

overview

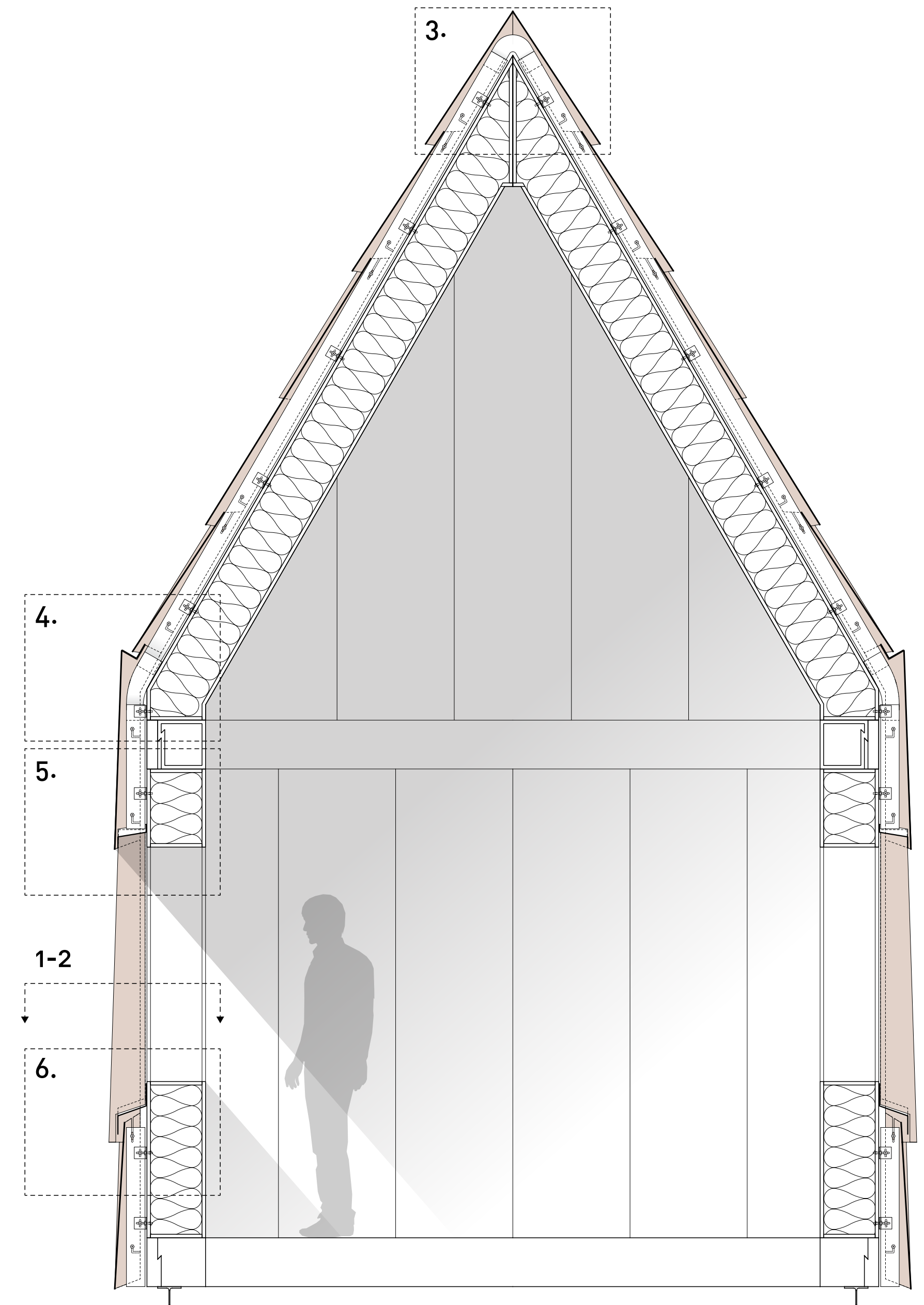
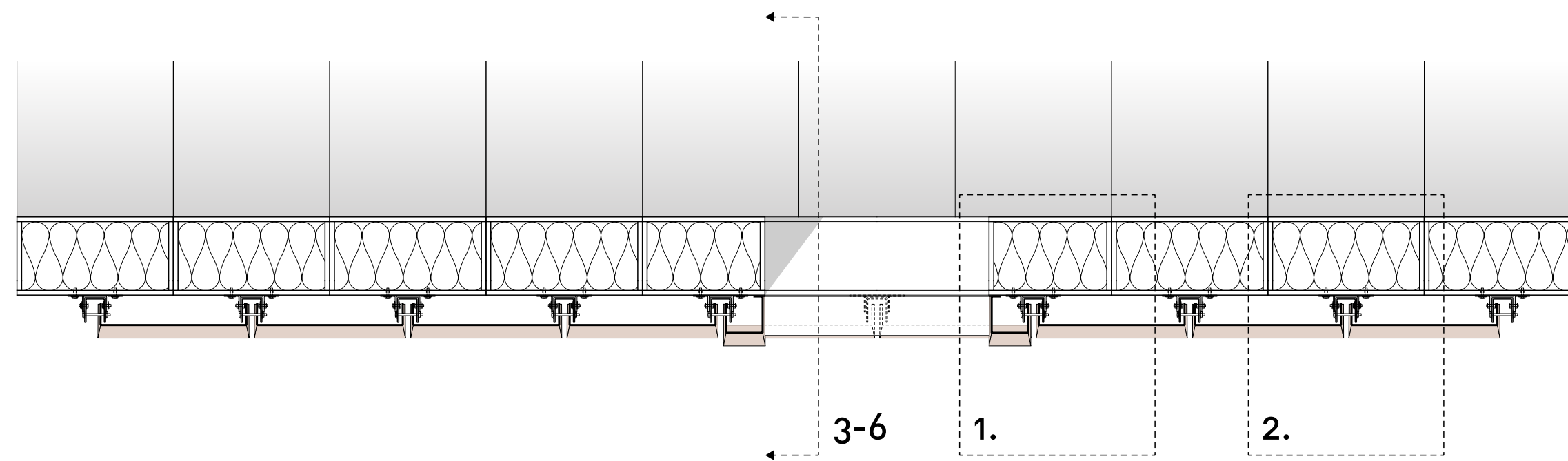


sectional
profile + window

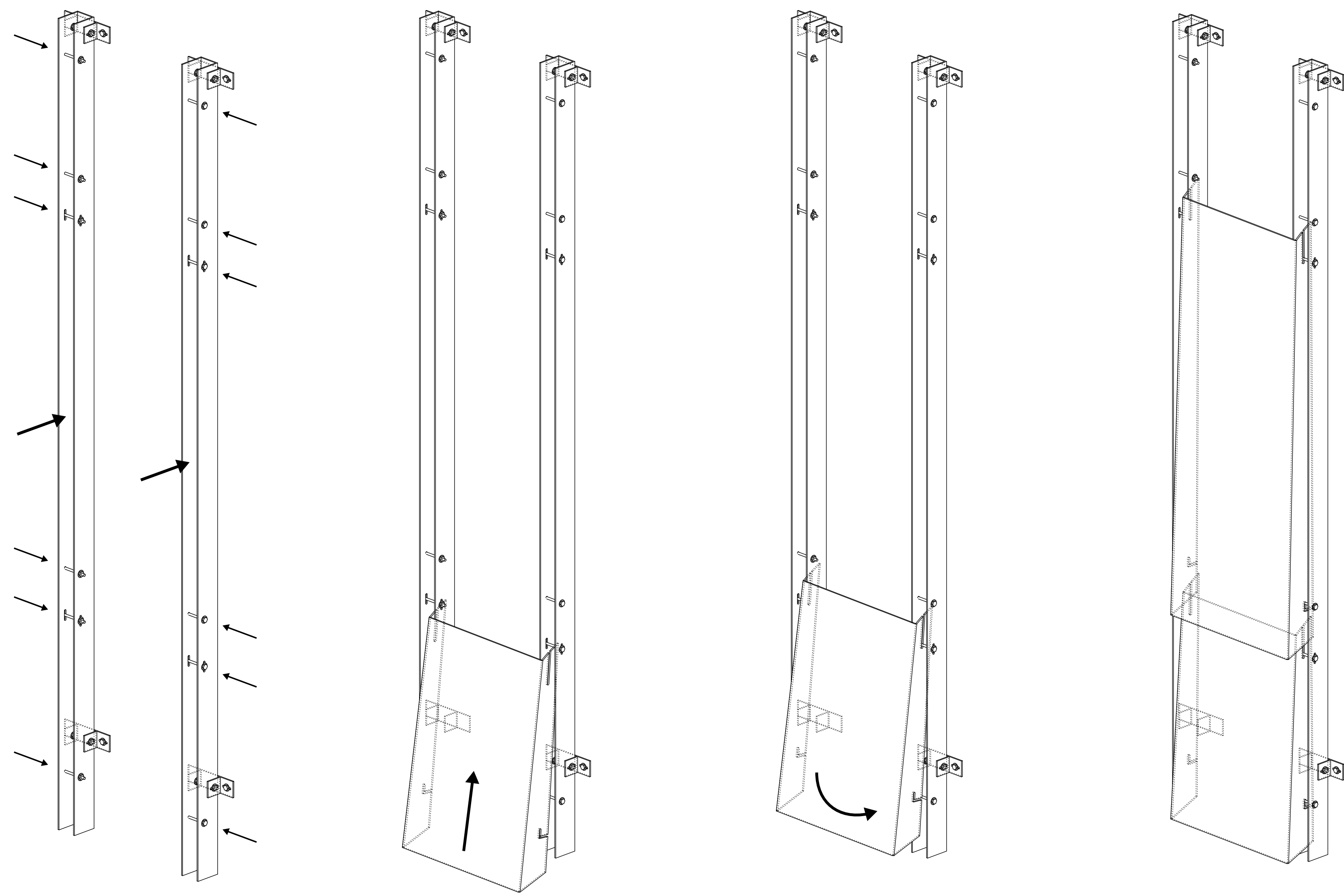
integrated
functions

drainage
aesthetics
assembly
space for adjustment

detailing



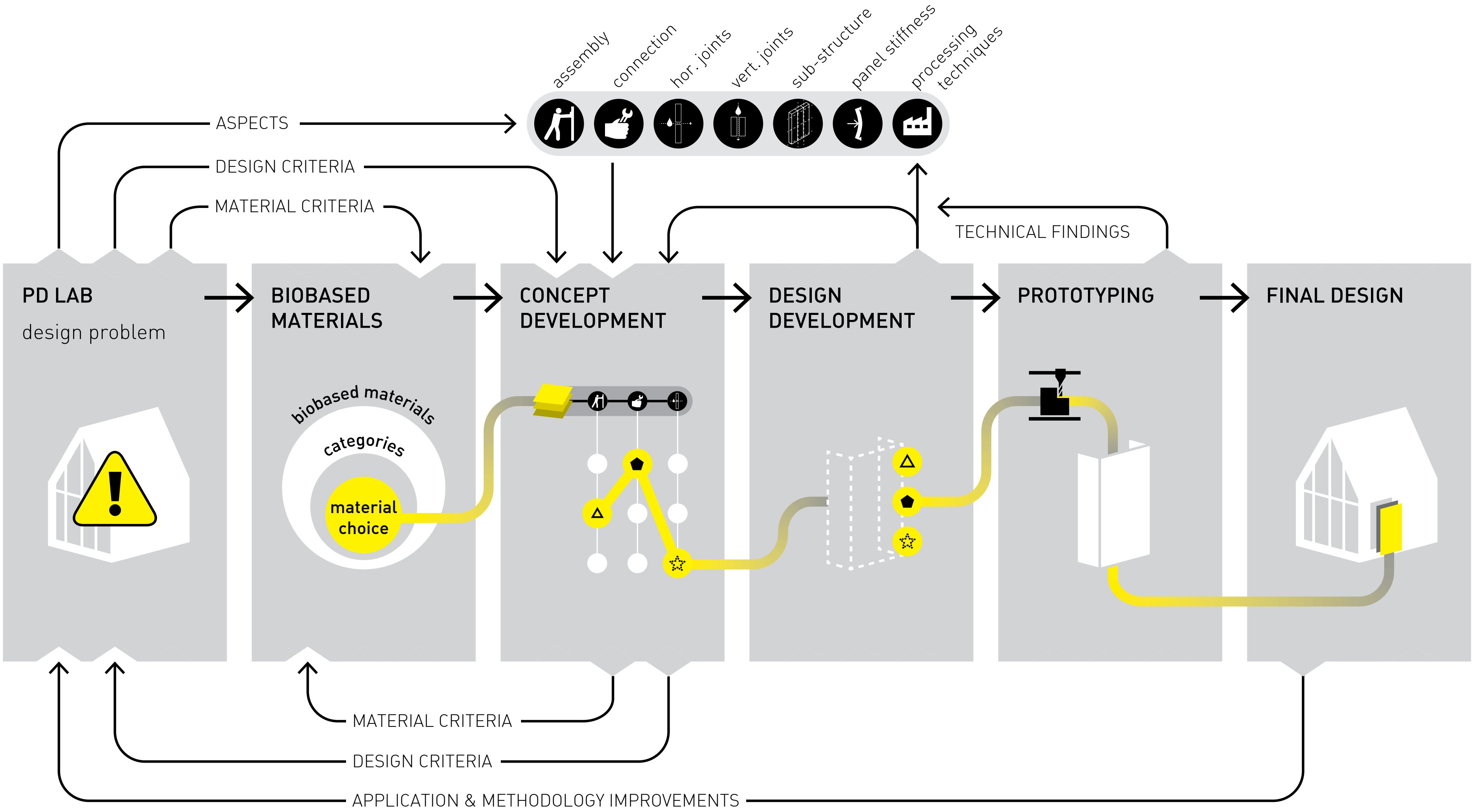
assembly



conclusions

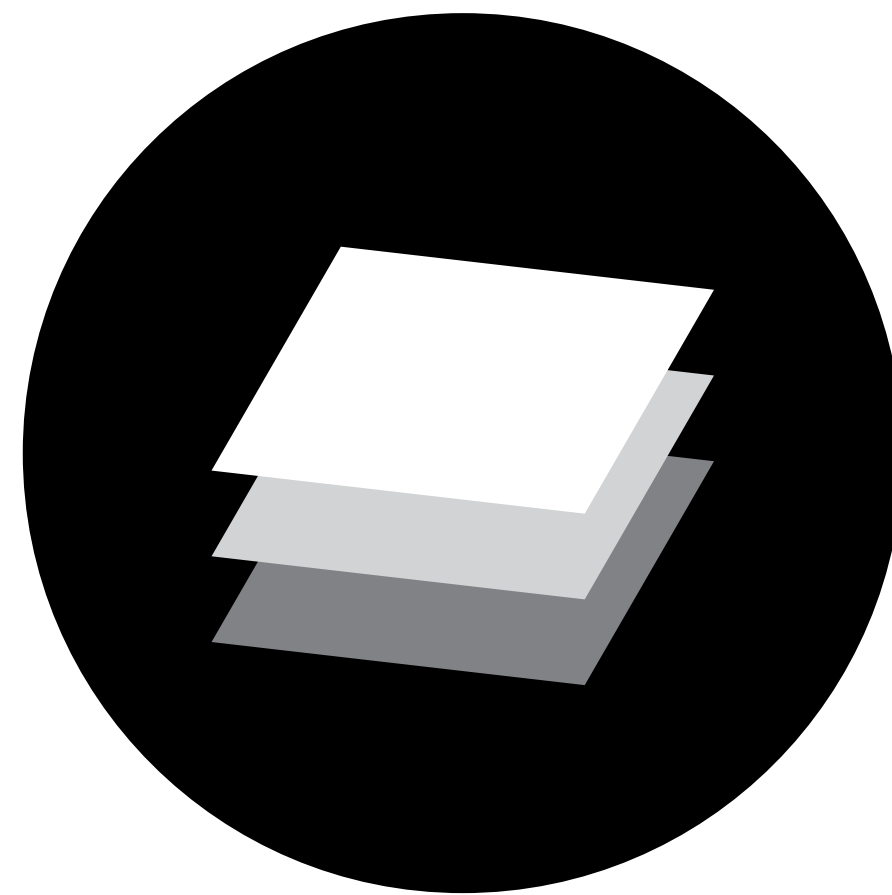
research question

**How can biobased materials be applied
to develop a modular and demountable
cladding system for the PD lab?**



reflection

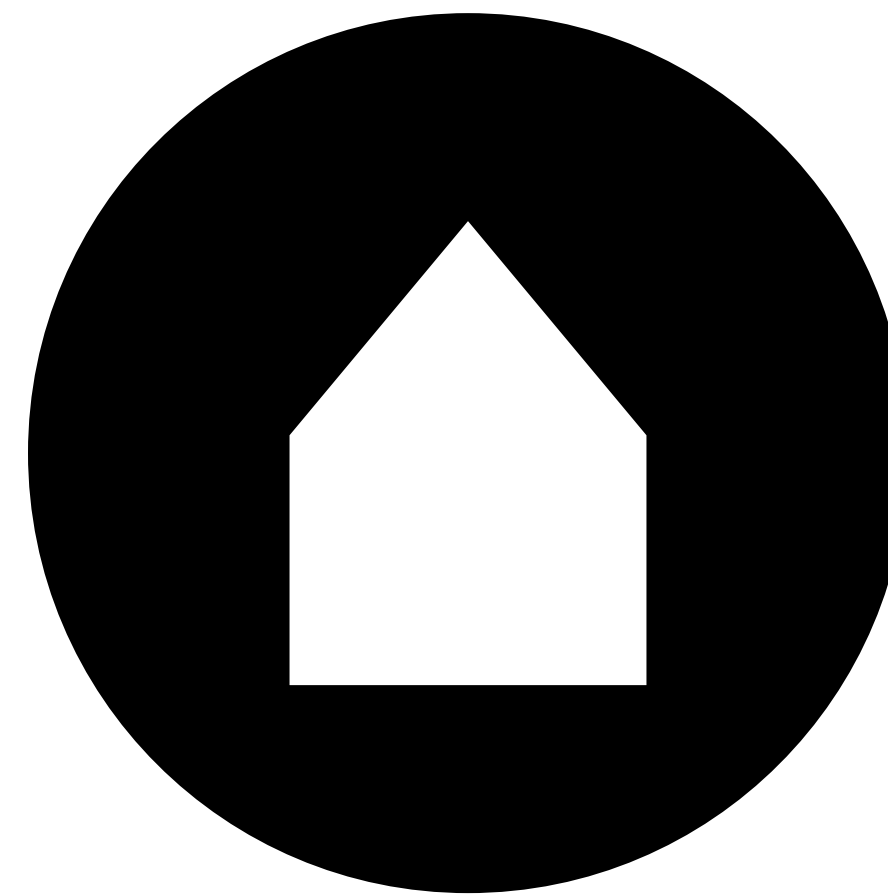
relevance



MATERIAL

biobased
materials

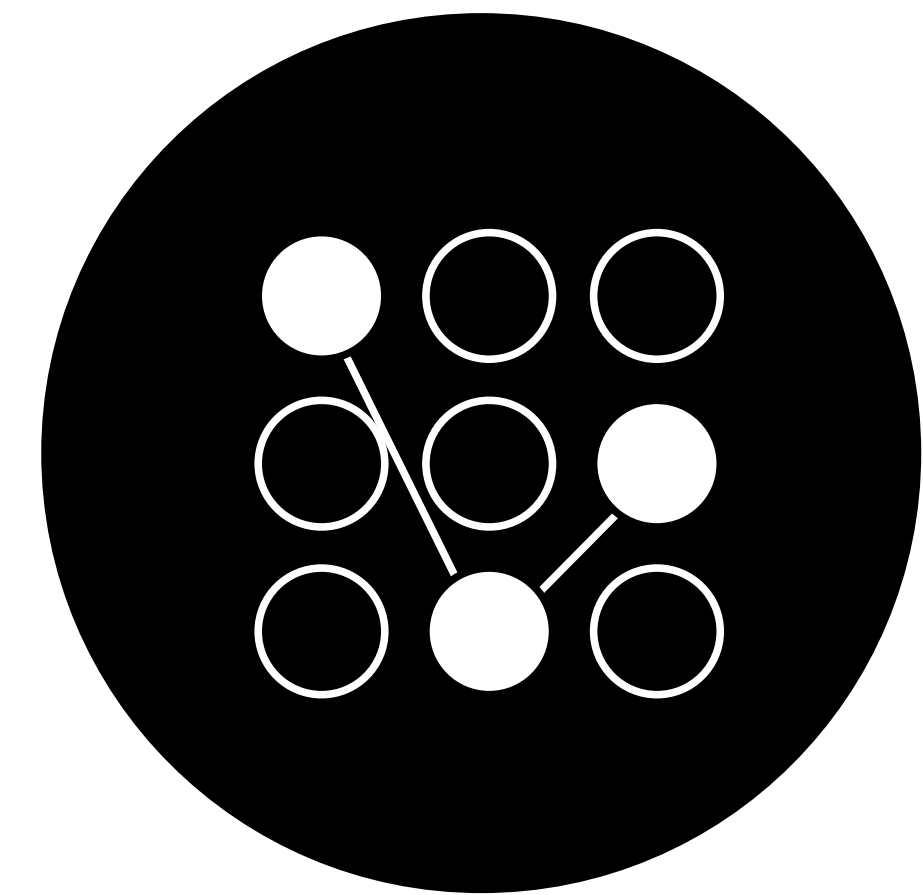
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DESIGN

PD lab
cladding system

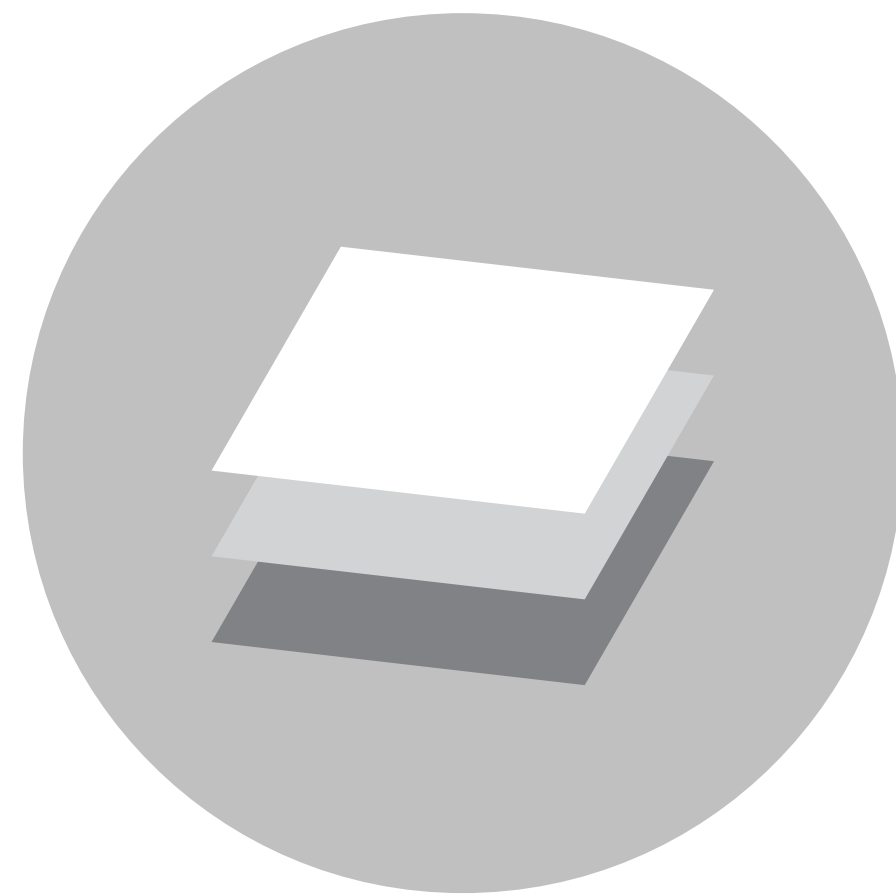
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METHODOLOGY

expanded (materials)
and improved (total concept)

relevance



MATERIAL

biobased
materials

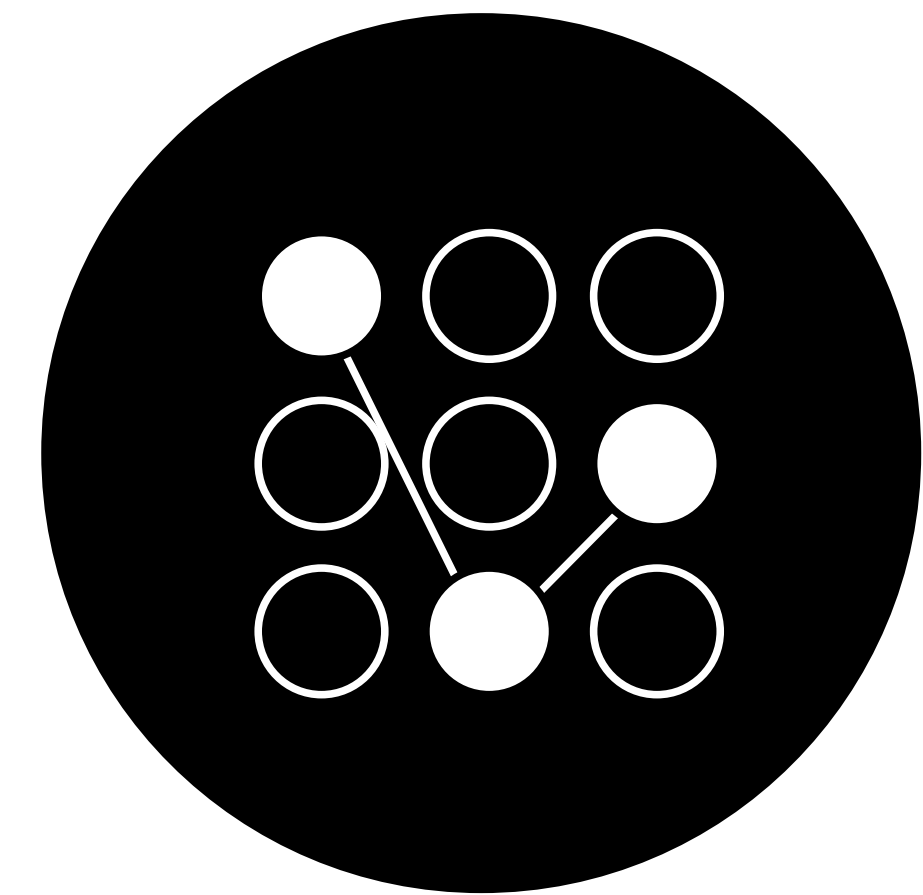
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DESIGN

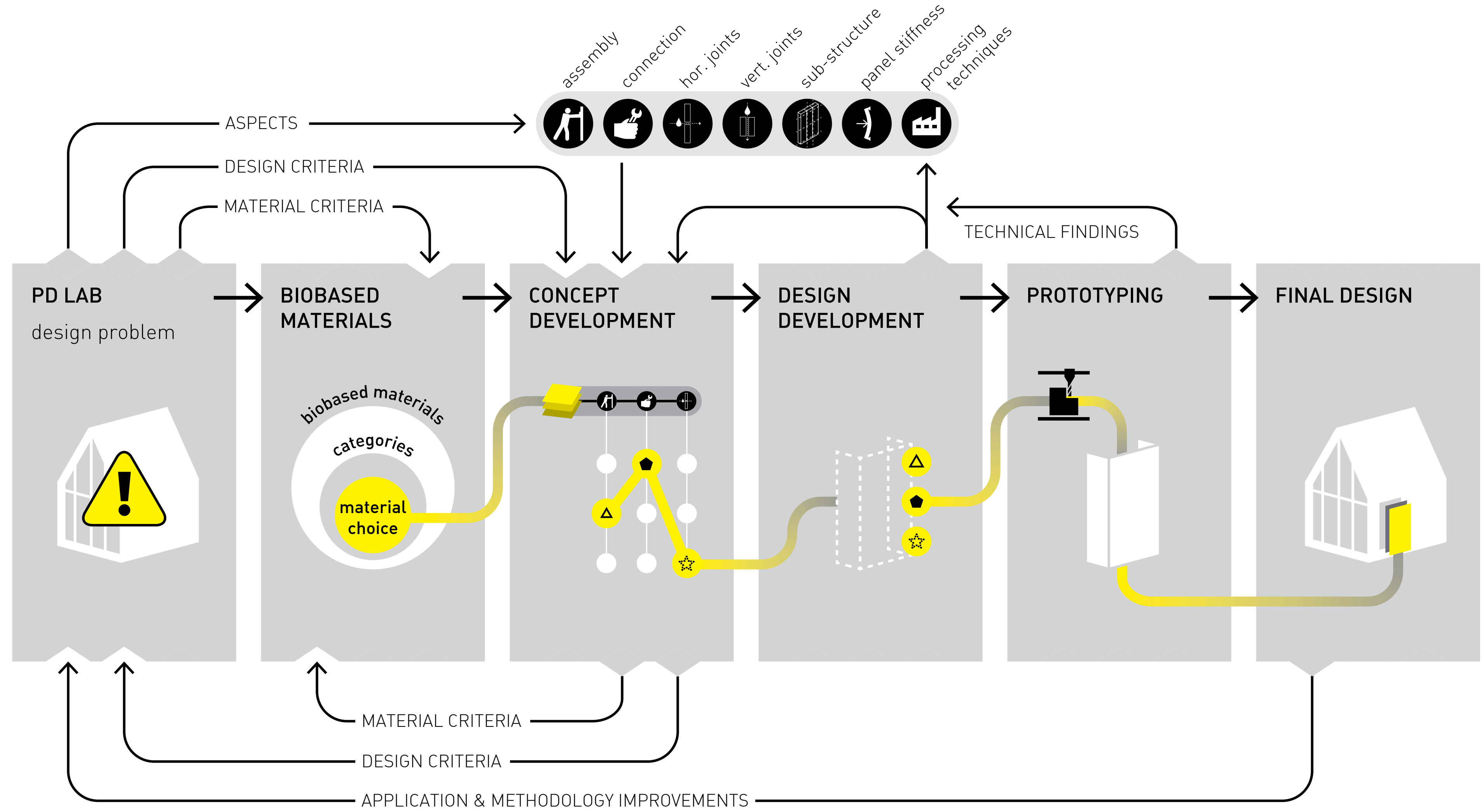
PD lab
cladding system

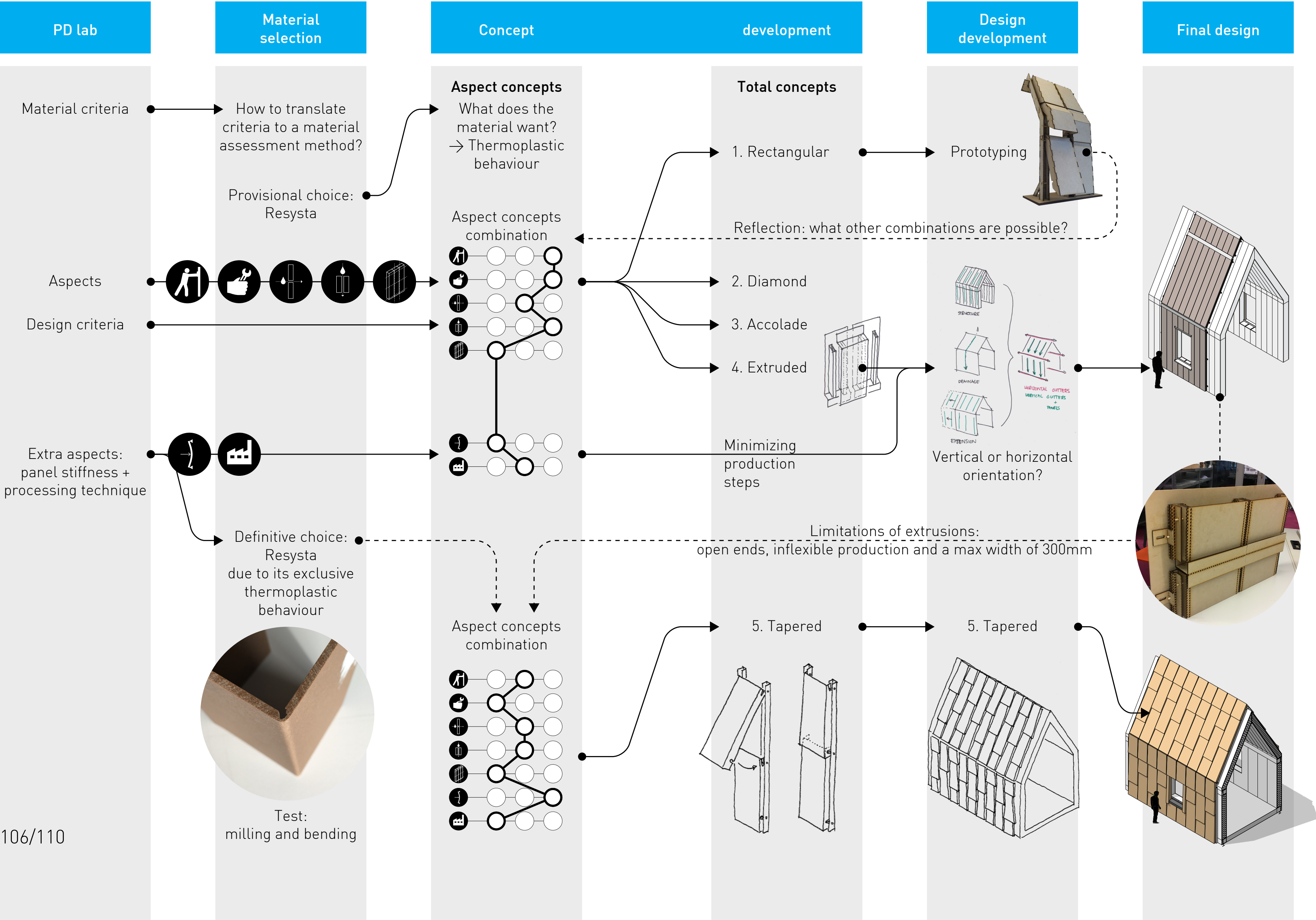
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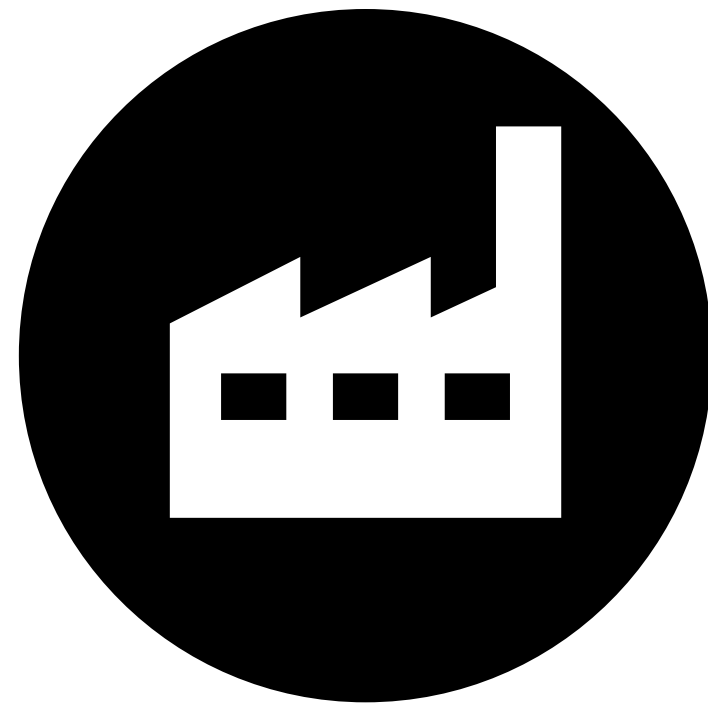
METHODOLOGY

expanded (materials)
and improved (total concept)



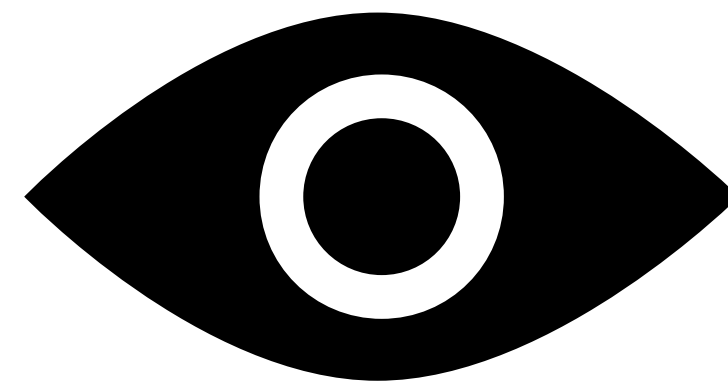


points of improvement



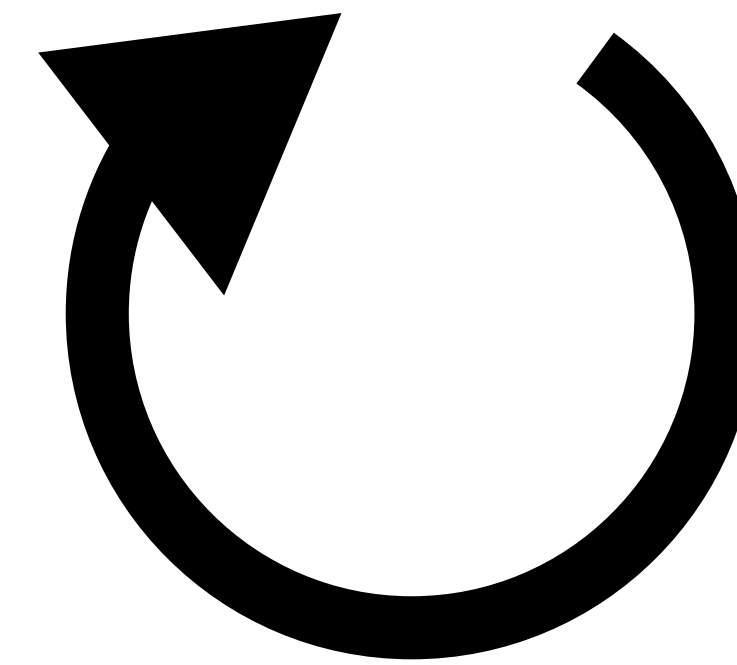
PROCESSING TECHNIQUES

Lack of knowledge
of limitations



DEFICIENT ASSESSMENT

Room for discussion
at concept assessment

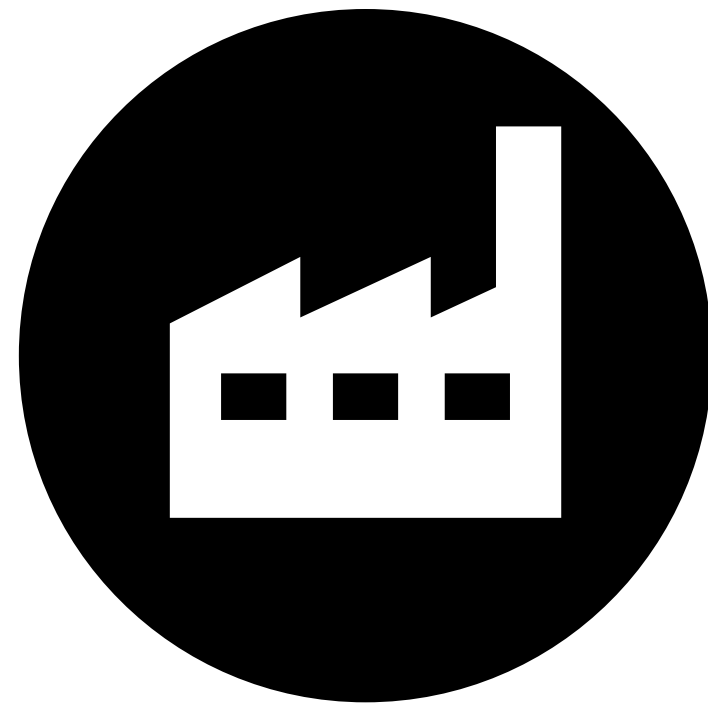


CIRCULAR ECONOMY

Focus on technological
implementation

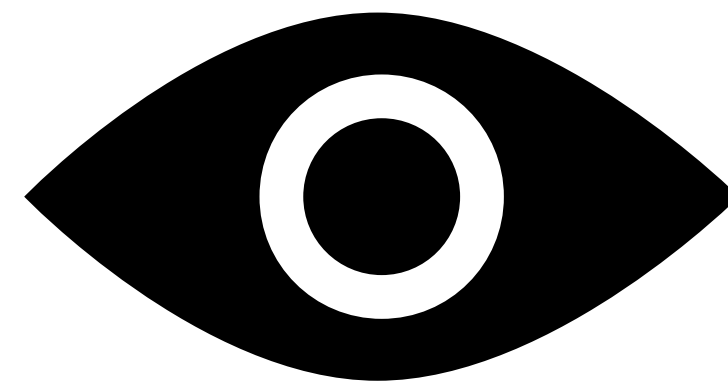
recommendations

possible improvements



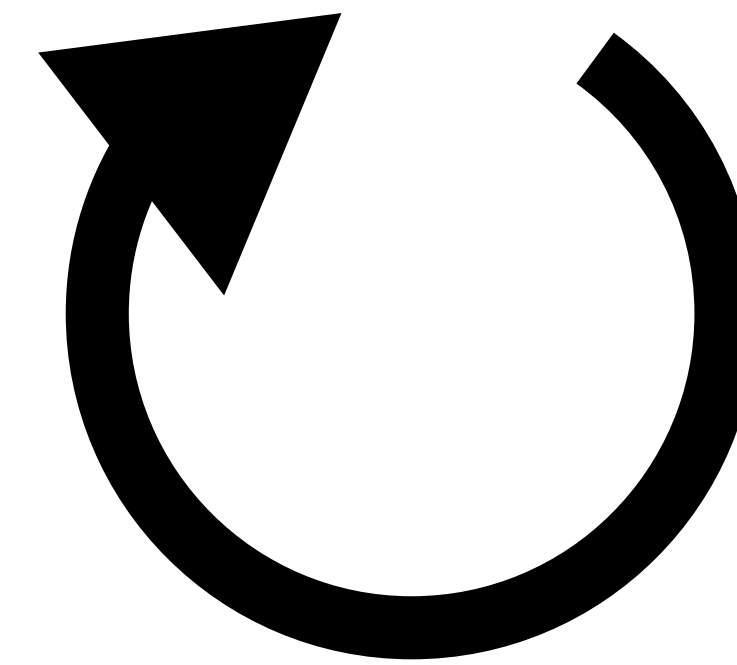
PROCESSING TECHNIQUES

Further research on
industrial production



DEFICIENT ASSESSMENT

Keep complete
system in sight



CIRCULAR ECONOMY

Also focus on:
Economy, environment,
behaviour, society
and government



thank you!