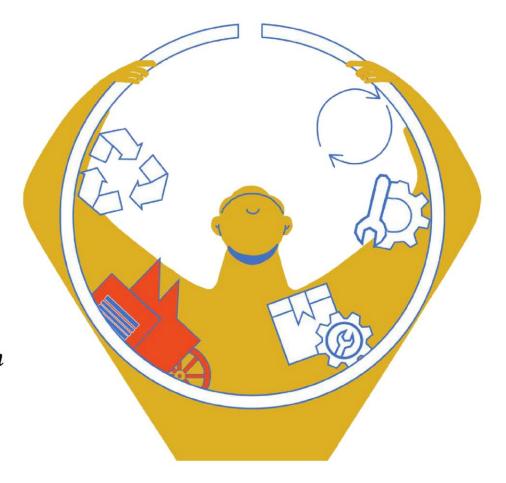
#### REMANUFACTURING AS A STRATEGY FOR A CIRCULAR BUILT ENVIRONMENT

An investigation into the potential of remanufacturing of EoL facade elements of De Satelliet, DNB Complex.

Rhea Ishani | 5315883

Together with Dr. Tillmann Klein, Dr. Michela Turrin & Martijn Veerman

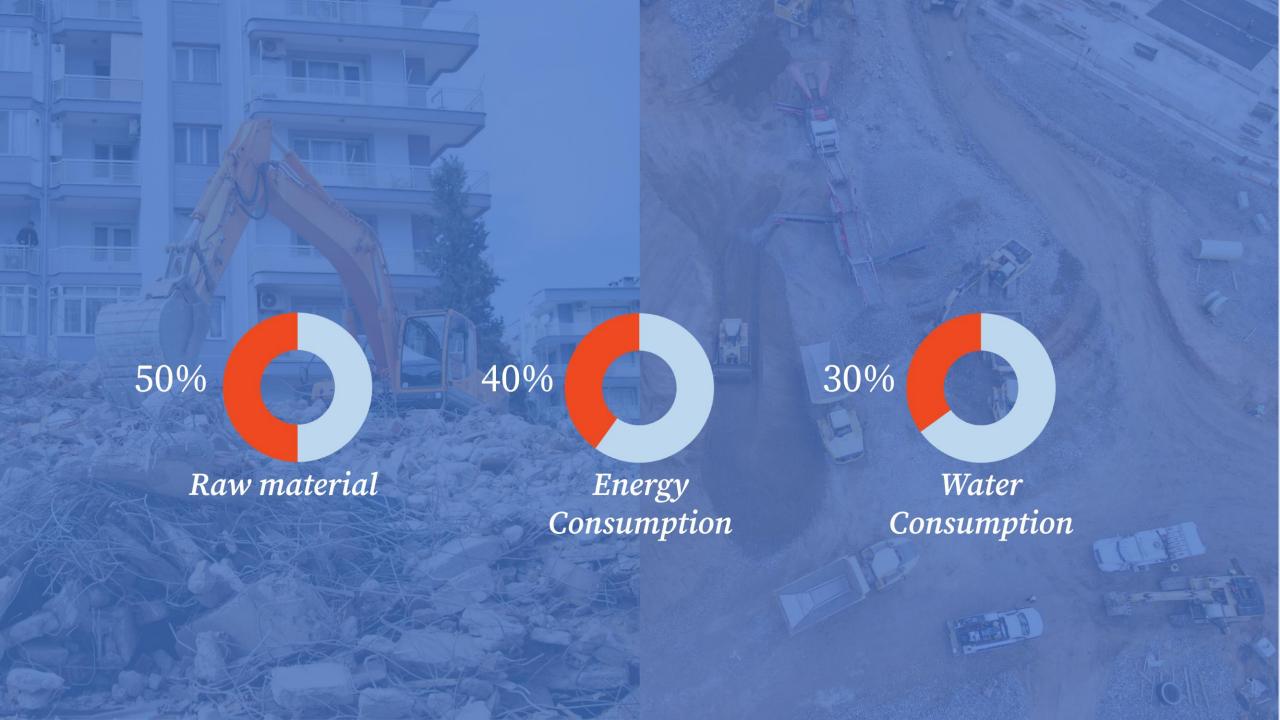
16 June 2022



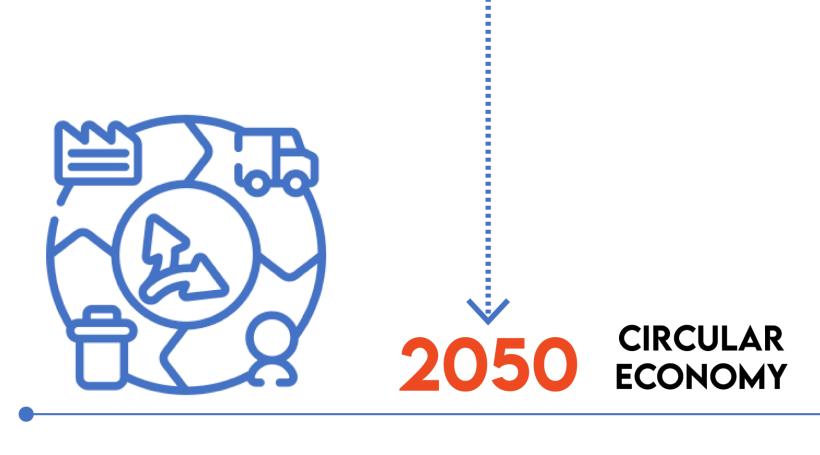








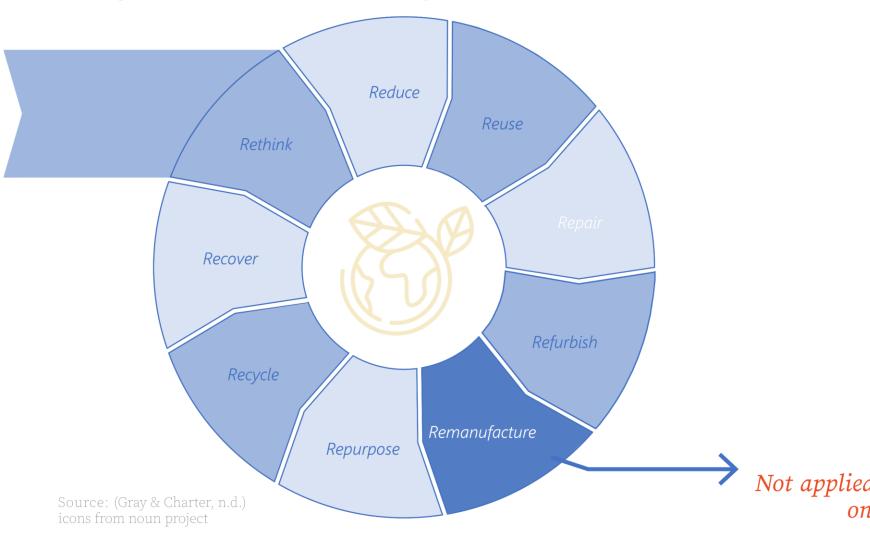




Source: (Gray & Charter, n.d.) icons from noun project

#### **9R Framework**

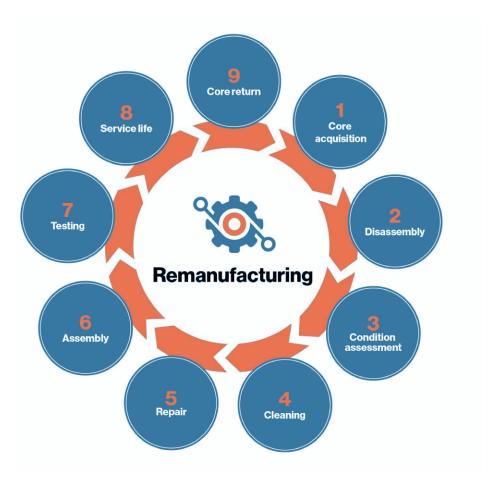
Strategies to achieve circular economy



Not applied to Building products on a large scale

#### Remanufacturing (Reman)

from literature review



- - QUALITY

- Return to original performance
- Warranty >= new
- You can't tell the difference!

Source: (Gray & Charter, n.d. icons from noun project



Standardized

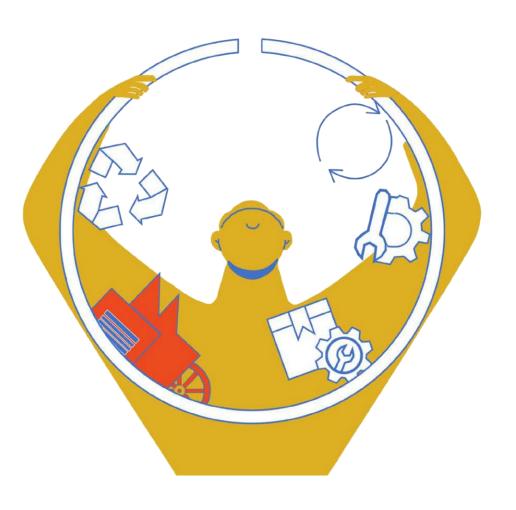
High value materials

@ fixed locations

Mass-produced

#### REMANUFACTURING AS A STRATEGY FOR A CIRCULAR BUILT ENVIRONMENT

An investigation into the potential of remanufacturing of EoL facade elements of De Satelliet, DNB Complex.



#### **Research Question**

Guiding the research



How can remanufacturing of building products be implemented as a strategy to accelerate the progress towards a Circular Built Environment?

#### **Order**

Chapters of the presentation

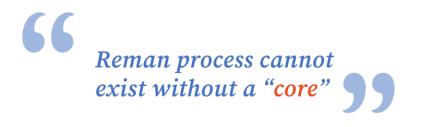
Literature Review & Case study Design for Reman Canvas De Satelliet - Live Case study Assessing value of Reman

Discussion & Conclusion

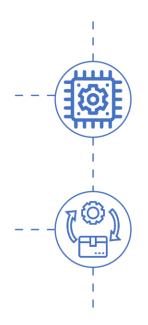


#### Core

#### from literature review







- Extracted from an EoL product
- Retained
- Re-introduced
- Composed of high value materials, DfX

Source: Nick Morley (2006), (Gray & Charter, n.d.) icons from Flaticon.com



Product Design

Design Product Specifications

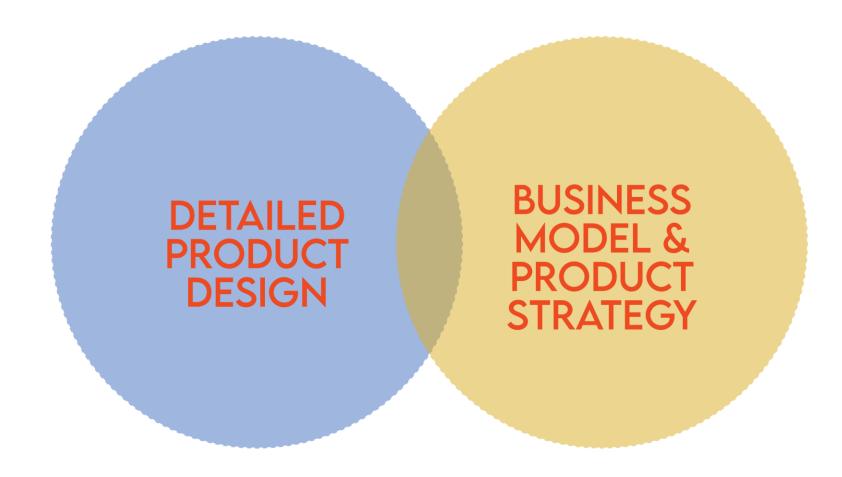


Product Strategy

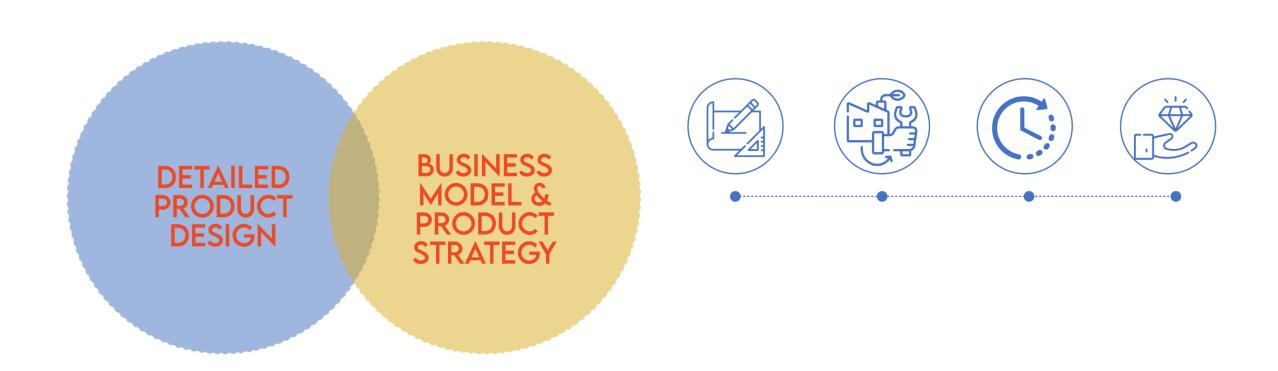
Business Collect cores at EoL

Source: Nick Morley (2006), (Gray & Charter, n.d.) icons from Flaticon.com

from literature review



from literature review





# 20 examples

Successful reman in other industries

Hitachi Construction Machiney Europe	Inrego AI	Xerox	Steelcase Orangebox	SCM Turbomotive Ltd.
Scandi-Toner AB	Desslo	Bülher Group	Davies Furniture	Edwards Vaccum Pump
Sony (SCEE)	Philips MRI Systems	BMW	The Bond Group	Caterpillar
Liebherr-Ettlingen GmbH	Canon EMEA	APD International	Autoelectro	Miliken Earth Square Carpets

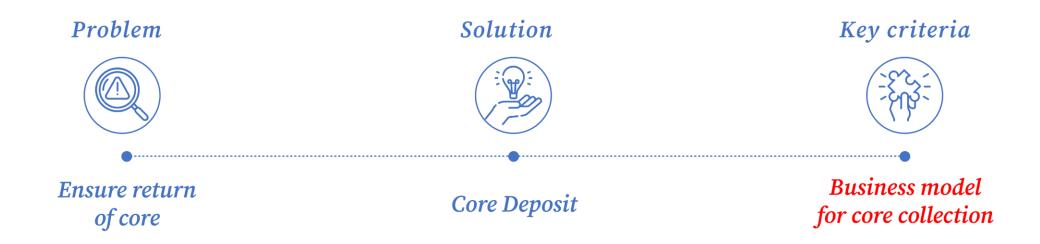
#### 20 examples

Successful reman in other industries



#### **Key problems & solution**

with respect to remanufacturing





### **Key problems & solution**

with respect to remanufacturing

**Problem** 



Ensure return of core

Solution



Core Deposit

Key criteria



Business model for core collection

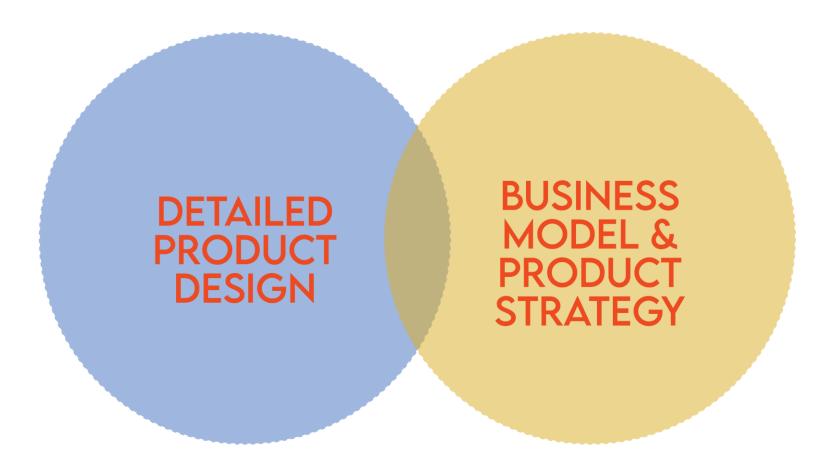
Reverse Logistics

Brand value

Design for X

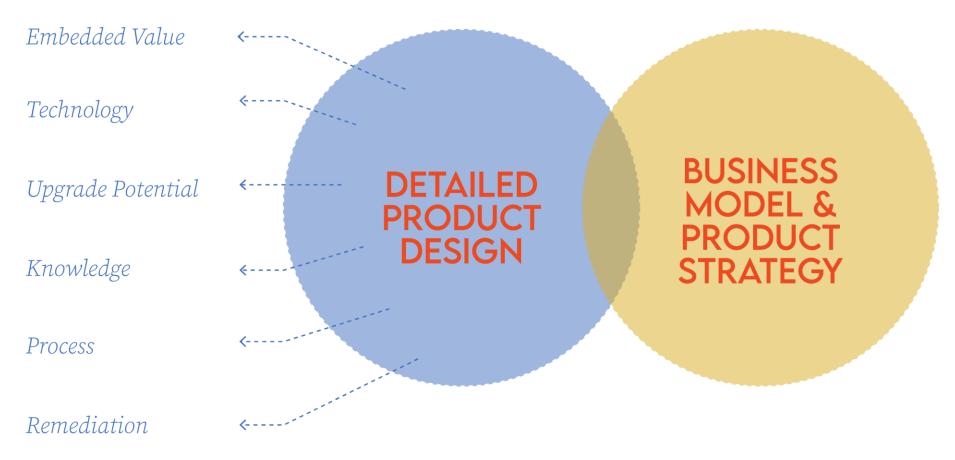


from literature review

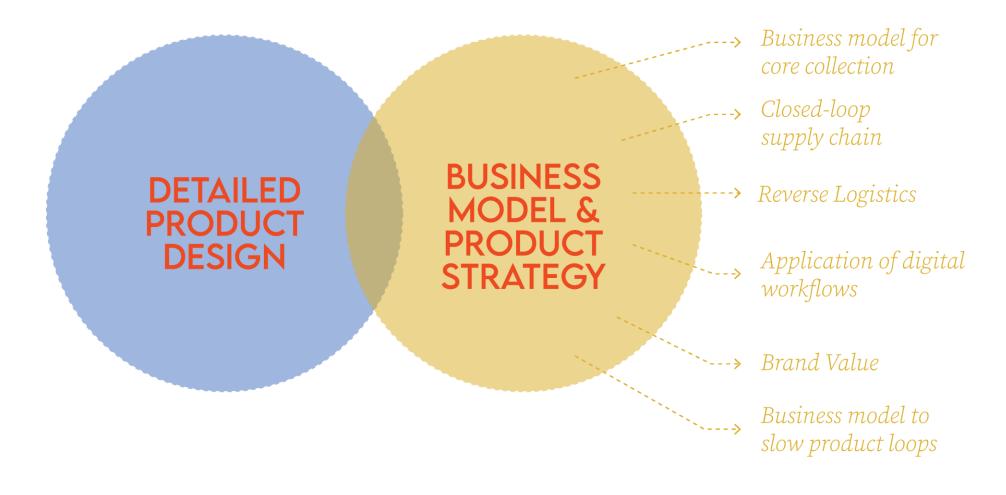


Source: (Gray & Charter, n.d.) icons from noun project

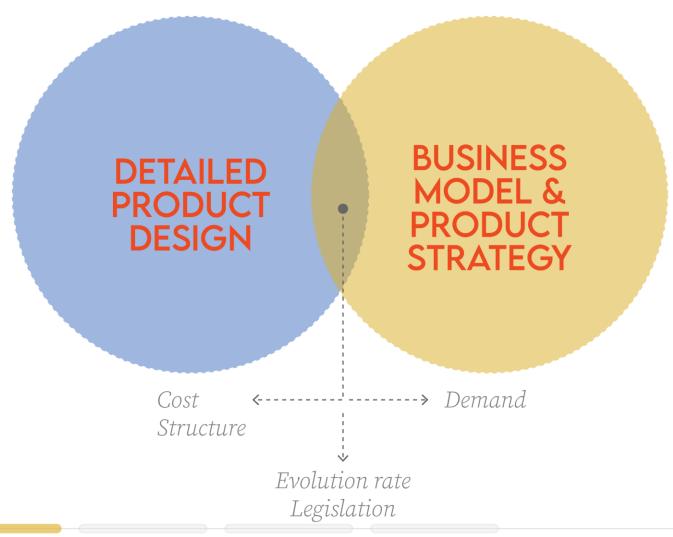
from literature review



from literature review



from literature review



from literature review

Embedded Value

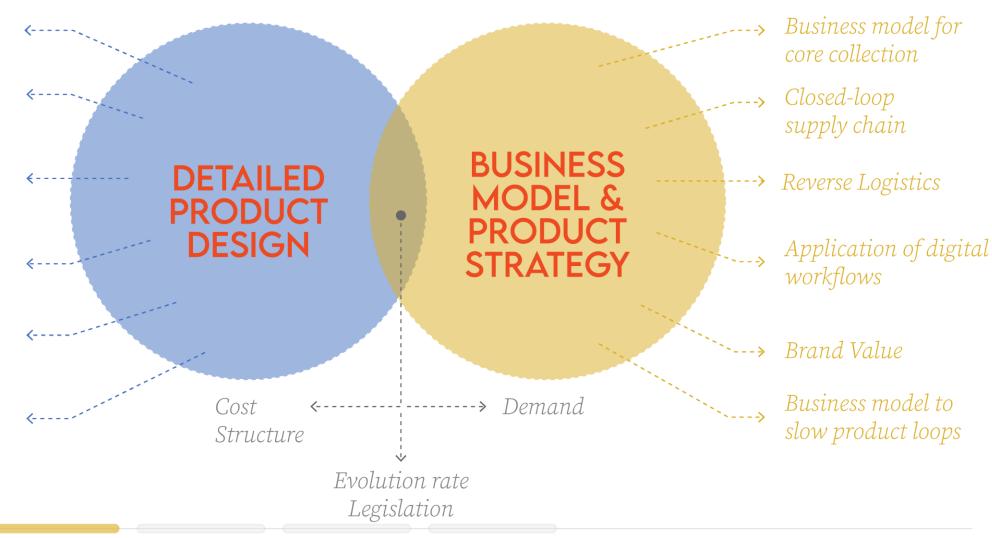
Evolution rate - Technology

Evolution rate -Upgrade Potential

Re-constructability Knowledge

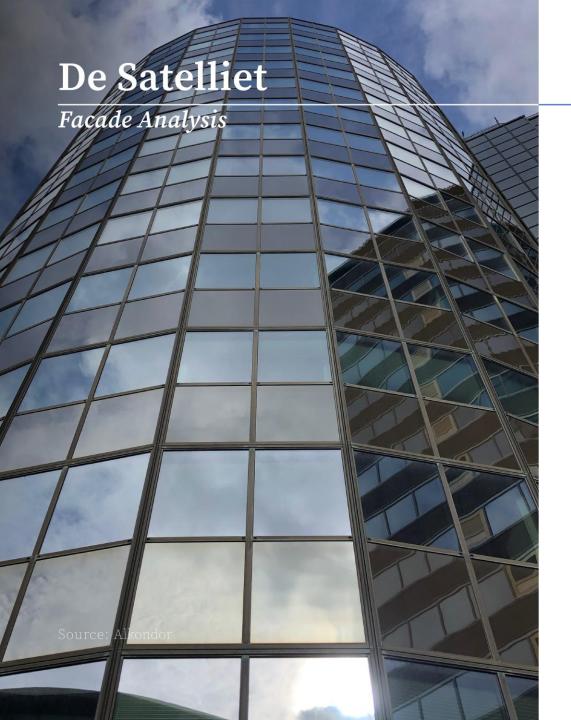
Re-constructability Process

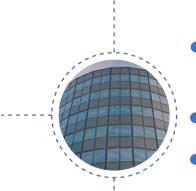
Re-constructability
Remediation











Designed as an extension by Jelle Abma

Built in 1921

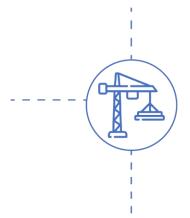
- Garden has replaced the tower
- No. of floors = 14 Total area = 8,000 sq.m

#### **De Satelliet**

#### from literature review







- 95 transports over the water (electric)
- 420 façade elements
- 210 collumns
- 395 wall elements
- 615 floor elements
- 140 concrete stair elements

Source: Alkondor

#### **De Satelliet**

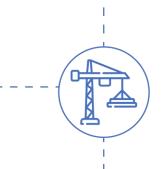
from literature review











- Placed horizontally on unequal wooden pegs
- Many units have been damaged

### **Risks**

Observations from on-site assessment



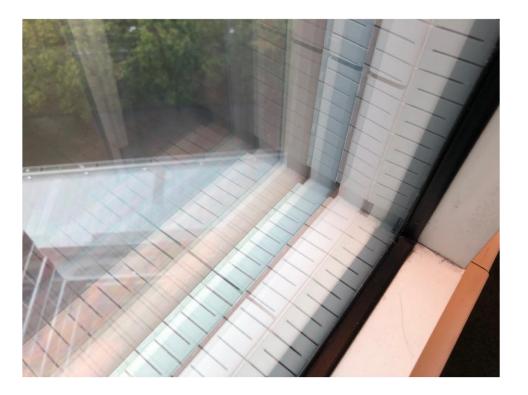




### **Potentials**

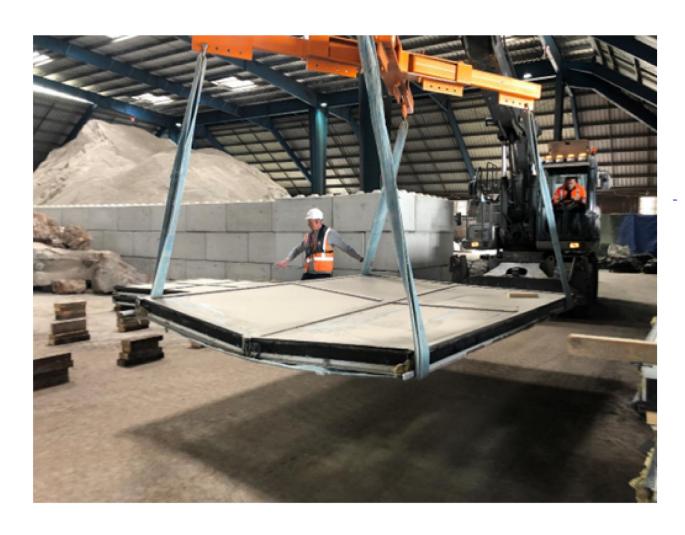
Observations from on-site assessment





# Advice on disassembly

Lessons from De Satelliet



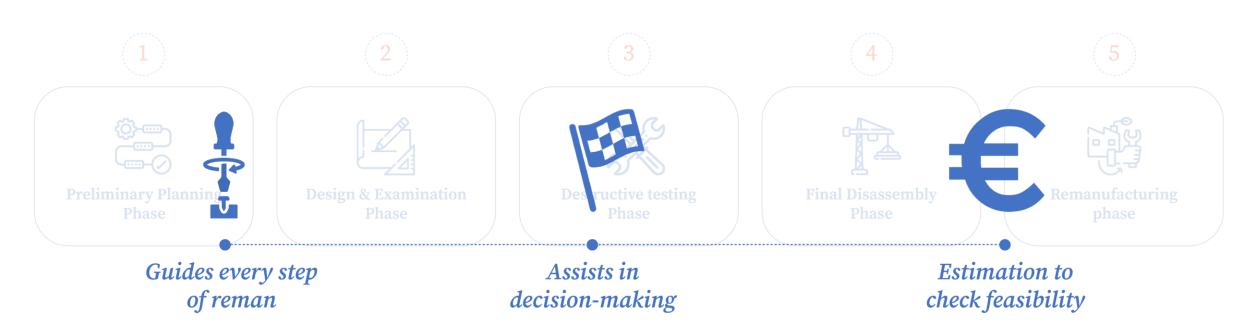


- lift, transport & store facade elements vertically
- transport vertically on 1-side
- Placing beam under elements lifting with straps
- --- 100 % flat & stored in a crate
- Innovative sprays glass protection

#### How can this damage be minimized in the future projects?

#### **Guidelines for reman**

for Architects, facade designers & builders



of EoL facade elements





Preliminary Planning Phase 2



Design & Examination Phase 3



Destructive testing Phase

4



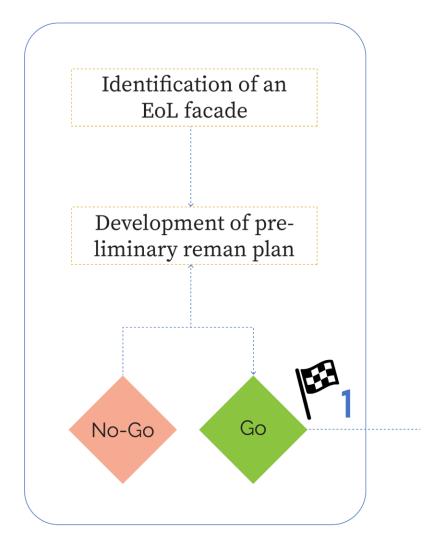
Final Disassembly
Phase



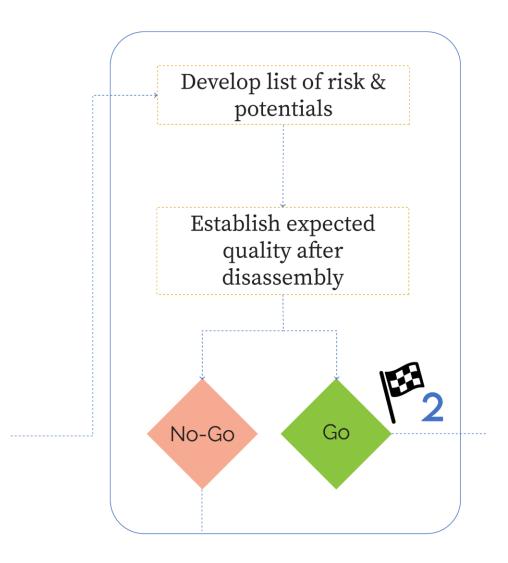


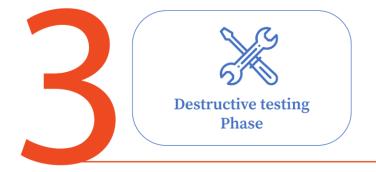
Remanufacturing phase

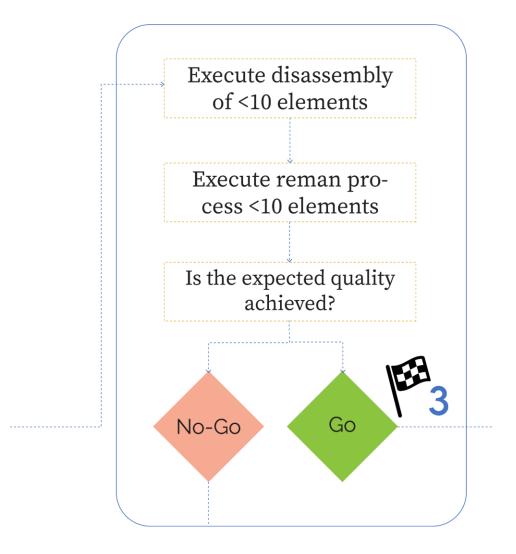




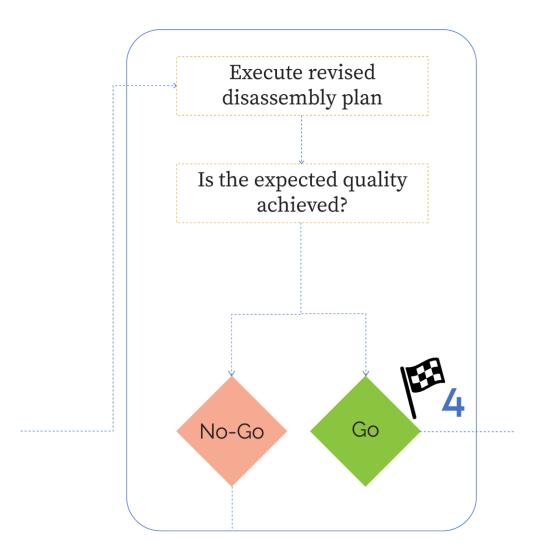


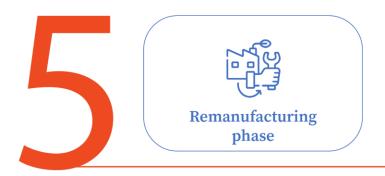


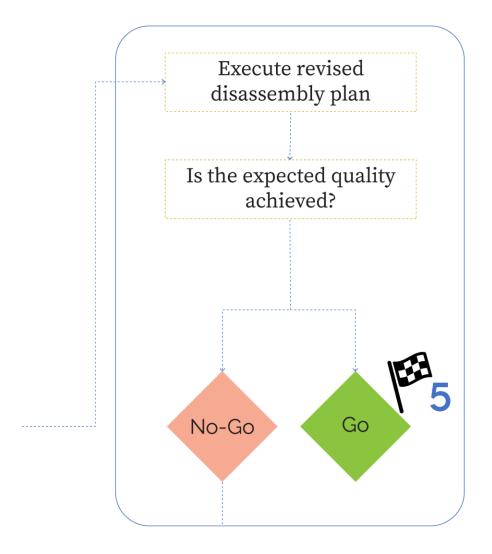












## Challenges to reman

of EoL facade elements













Preliminary Planning Phase



Design & Examination Phase



Destructive testing Phase



Final Disassembly Phase



Remanufacturing phase



**Lack of Product data** 



Lack of product data



Quality inspection & assessment



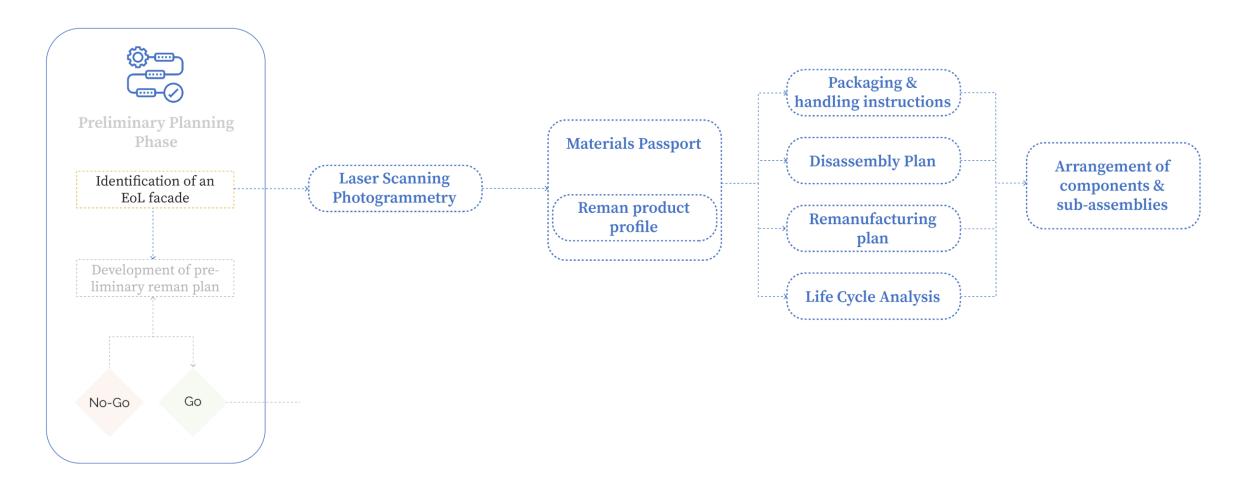
Monitoring the product



Information on remanufacturing

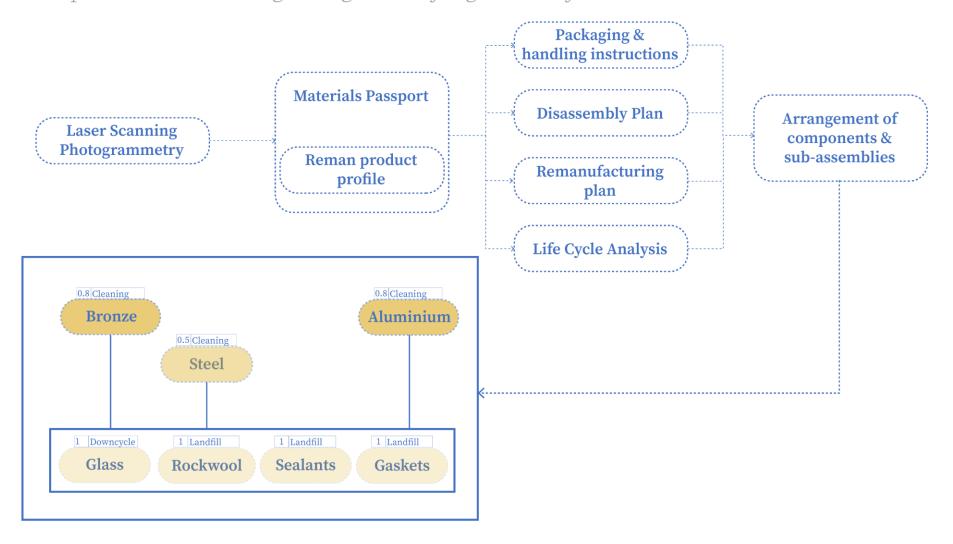
### **Proposed Solution - Lack of Product data**

Conceptual solution through integration of digital workflows



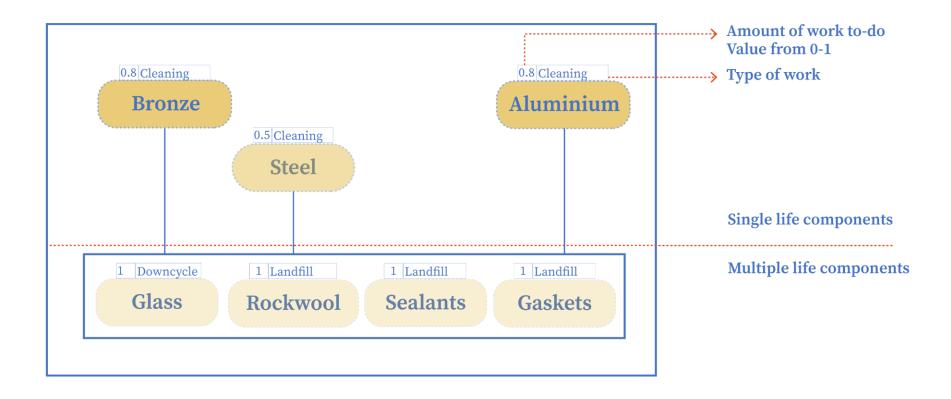
## **Proposed Solution - Lack of Product data**

Conceptual solution through integration of digital workflows



## **Proposed Solution - Lack of Product data**

Reman product profile



### Limitations in proposed solution

Conceptual solution









Lacks proof of concept

Complex and needs simplification

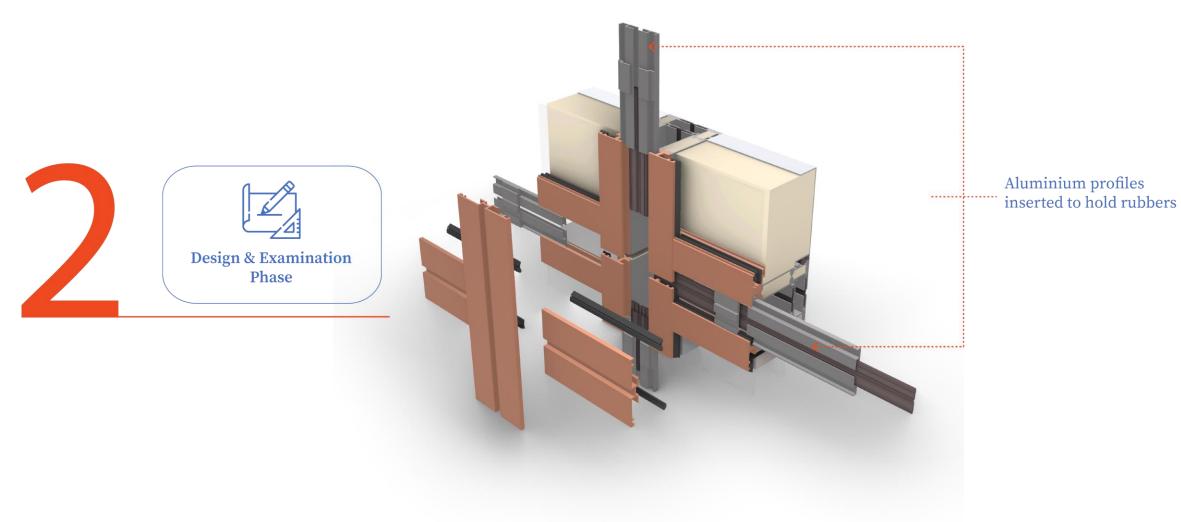
Does not take into account type of product

integration of workflows not explored



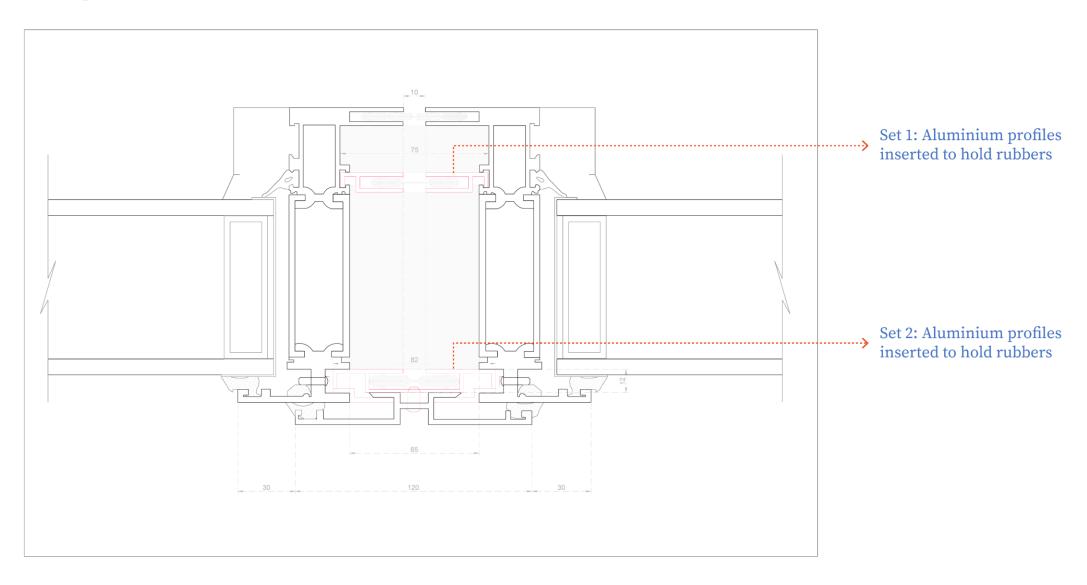
# Development of Water tightness & air permeability

A conceptual solution



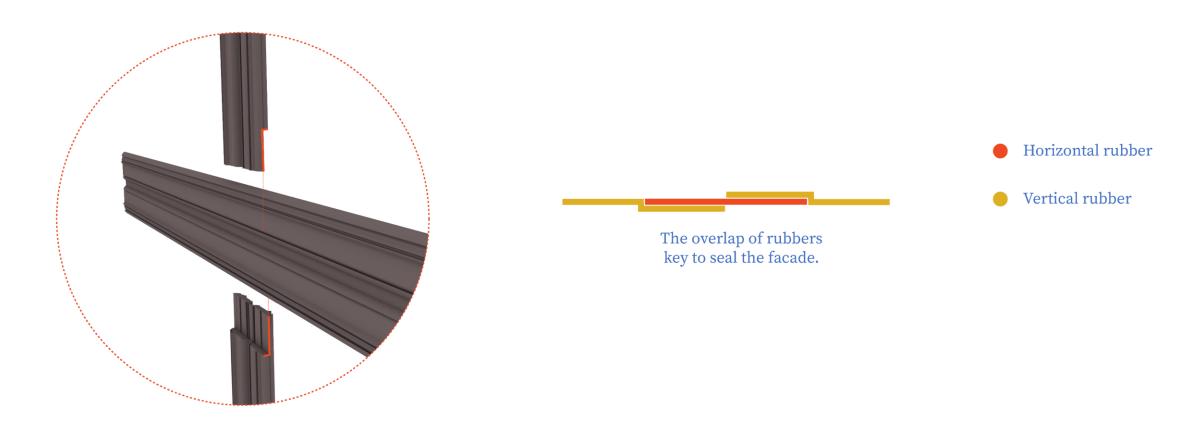
# Proposed Solution - Water tightness & air permeability

Conceptual solution



# Proposed Solution - Water tightness & air permeability

Conceptual solution



## Limitations - Water tightness & air permeability

Conceptual solution

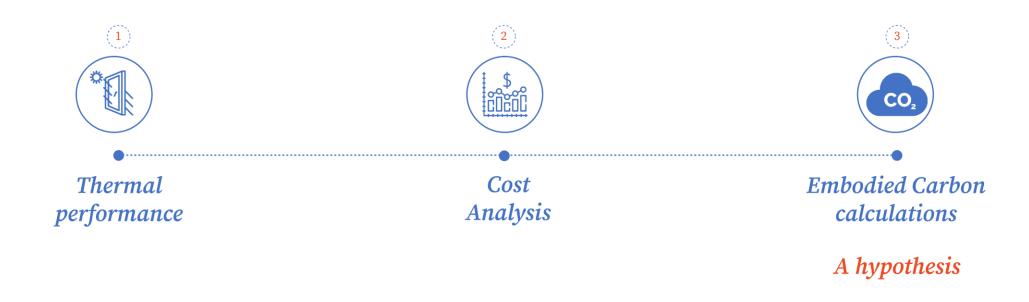


Will be tested and developed further by Alkondor



## **Assessments - Critically evaluate reman**

to understand value of reman



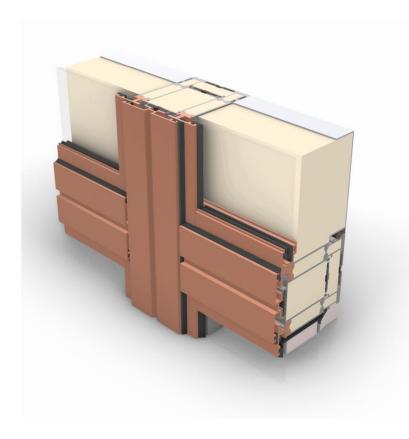
## **Assessments - Critically evaluate reman**

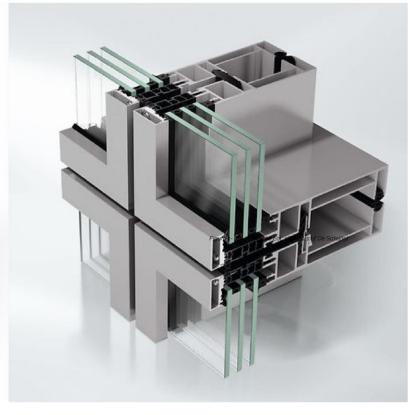
to understand value of reman



## **Assessments - Thermal performance**

Results





The EoL elements of De Satelliet, Source: Author

Schucö AF UDC 80 (Aluminium Façade Unitized Dynamic Construction). Source: Schucö

Comparison of properties		
Property	De Satelliet	Schucö
Uf value of frame		1.7
System U value	1.61	
Dimensions	2.8 x 3.75	3.0 x 4.0

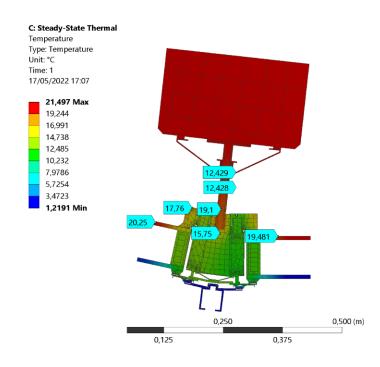


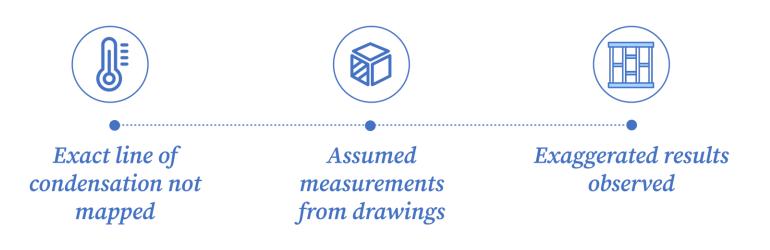
The calculated U value is acceptable according to Building Standards



#### **Limitations - Thermal performance**

Scope for future work





## **Assessments - Critically evaluate reman**

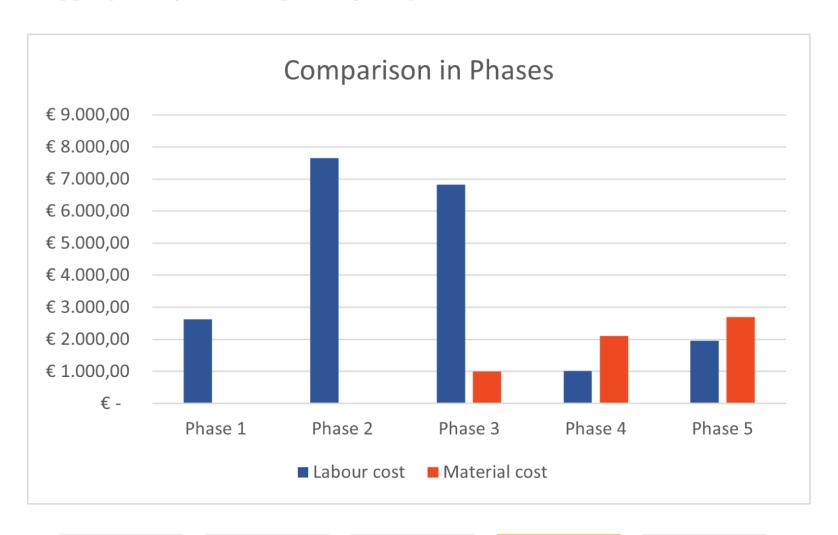
to understand value of reman



Mapping costs from each phase of the guidelines

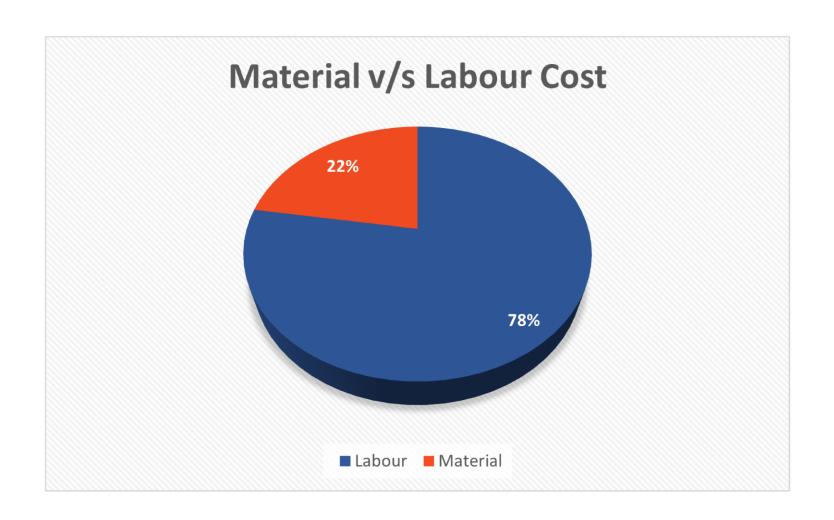


Mapping costs from each phase of the guidelines

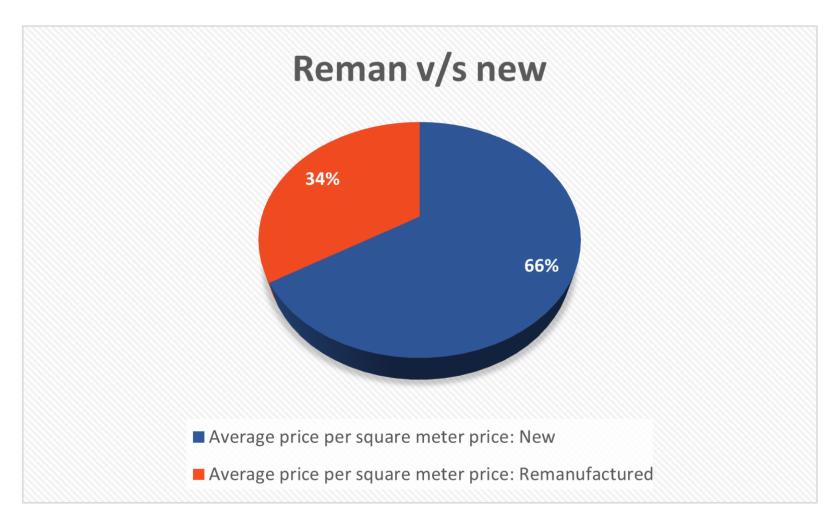


- 1 Preliminary Planning Phase
- Design & Examination
  Phase
- Destructive testing
  Phase
- Final Disassembly Phase
- Remanufacturing phase

Mapping costs from each phase of the guidelines



Mapping costs from each phase of the guidelines



#### Limitations in cost estimation

Scope for future work









costs are approximate

Labour for disassembly not mapped

changes with every project

Lack of predecessor to evaluate



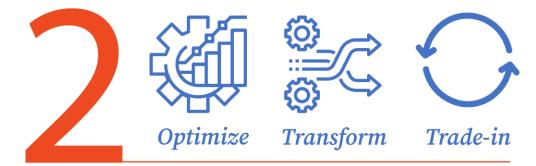
How can remanufacturing of building products be implemented as a strategy to accelerate the progress towards a Circular Built Environment?

& criteria

Answering RQ



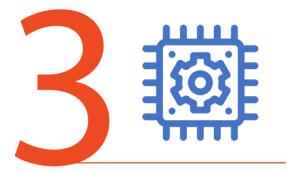
Answering RQ



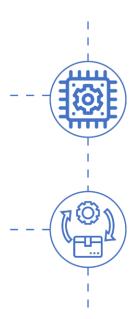
Introduction of product portfolio

- Close to assets
- Understands flaws in design w.r.t Reman
- New revenue streams

Answering RQ



Core (at product level)



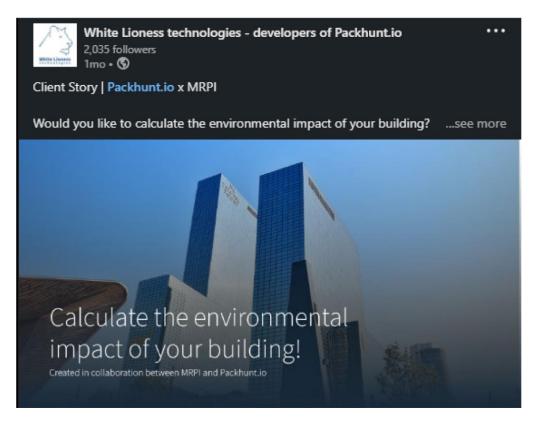
- High value materials
- Re-introduced
- DfD & Inspection
- Business model

Answering RQ

Single use - design
Reverse logistics
Reman not undestood



Discussion



MRPI-MPG tool by White Lioness & MRPI

#### MPG (Milieu Prestatie Gebouwen)

Indicates the environmental impact of materials used in a building. More MPG = More sustainable materials

### On Reman of other building products

Discussion

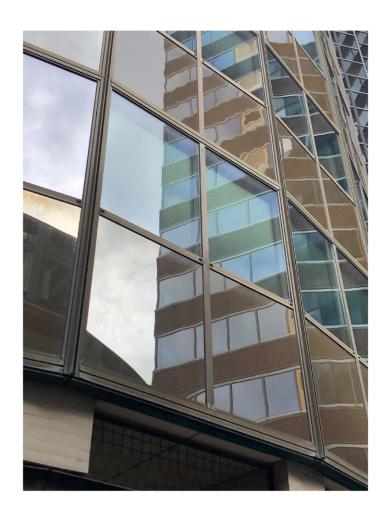




Fewer Layers Materials of similar lifespan

### On De Satelliet

#### Discussion



- High value materials
- Making Reman feasible
- A special case
- Valuable to recover than recycling



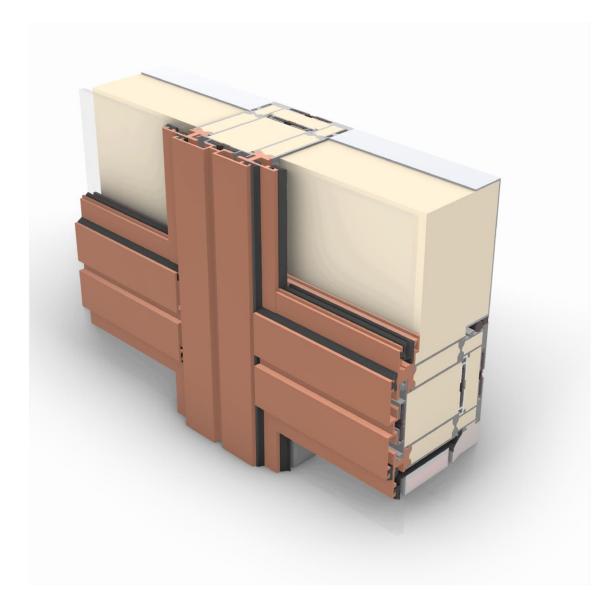
- Core & Business model
- Robust material |easy to clean
- Wear & tear | corrosion resistant
- Minimal connections
- Monitoring & tracking systems
- Follow guidelines to reman at EoL

## On barriers to Design for Remanufacture

- Absence of guidelines on lifecycle thinking
- Info. for design for reman not available at design phase
- EoL issues hinder reman
- Product must be retrieved and EoL scenario should be known

#### **On Reman Canvas**

Discussion



Embedded Value

Business model for core collection

Legislation

Application of digital workflows

Reverse Logistics

Brand value

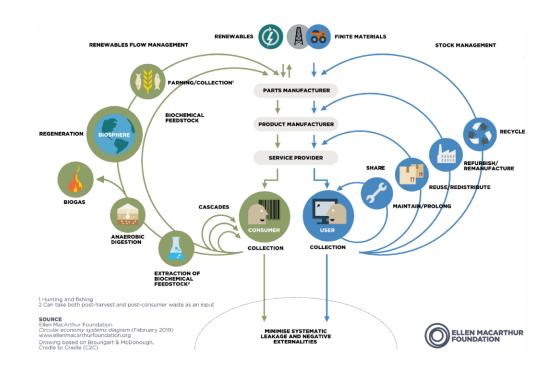
### **Limitations in List of Criteria**

Scope for future work



### On Remanufacturing

- Power of smaller loop by Walter Stahel
- Follows Thinking in systems
- Design out waste
- Think in cascades

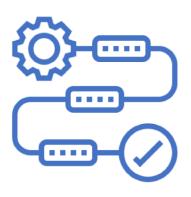




Risk of creating more impact than virgin production



transfer of enormous responsibility which was one's csutomers!



- Development of workflows
- Each criteria can be studied further
- Calculation of Embodied carbon for all modules
- Trace meaningful conclusions to design
- Map every lifecycle to check feasibility



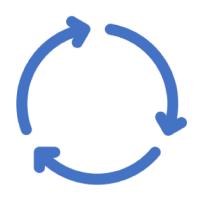
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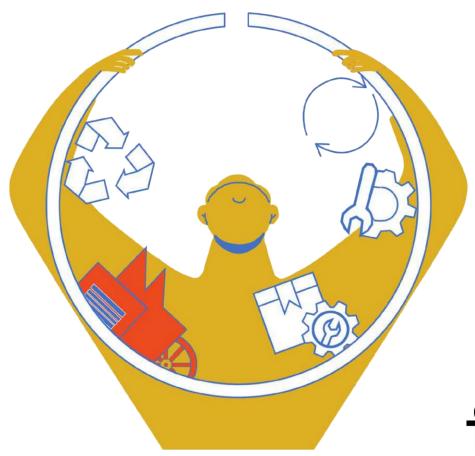
- Development of workflows
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- Trace meaningful conclusions to design
- Map every lifecycle to check feasibility



De Satelliet



Gelders office





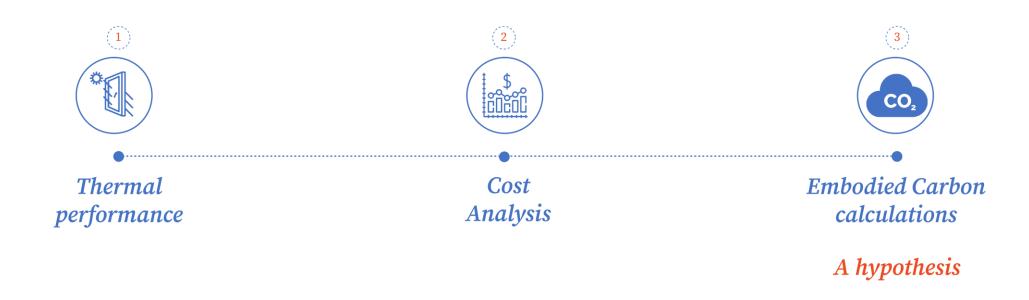




Thank you for your time!
Questions?

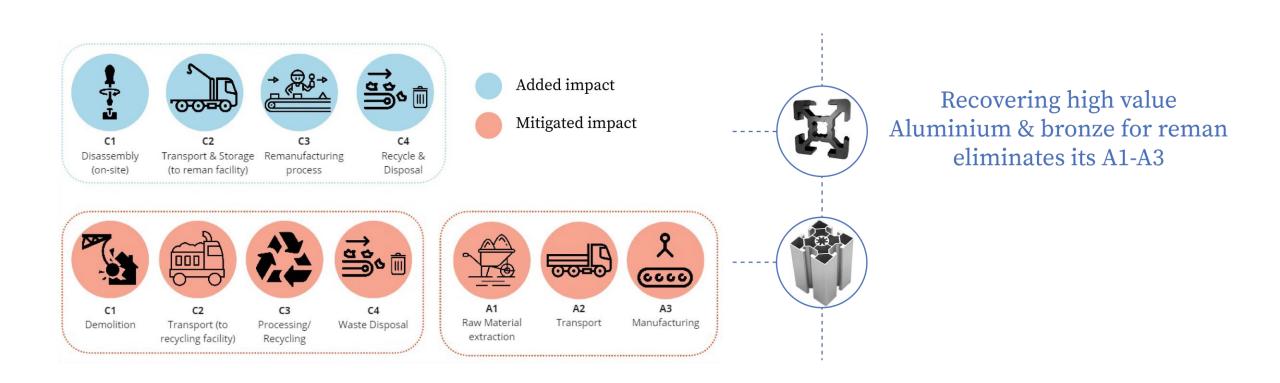
### **Assessments - Critically evaluate reman**

to understand value of reman



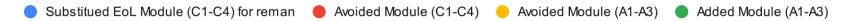
#### **Assessments - Embodied Carbon**

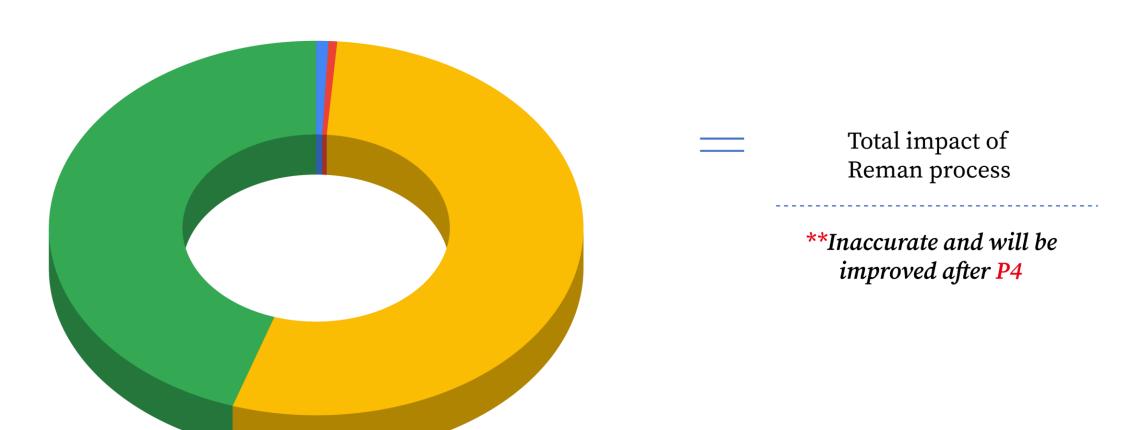
Assumed flows in the Reman process



#### **Assessments - Cost Estimation**

Assumed flows in the Reman process

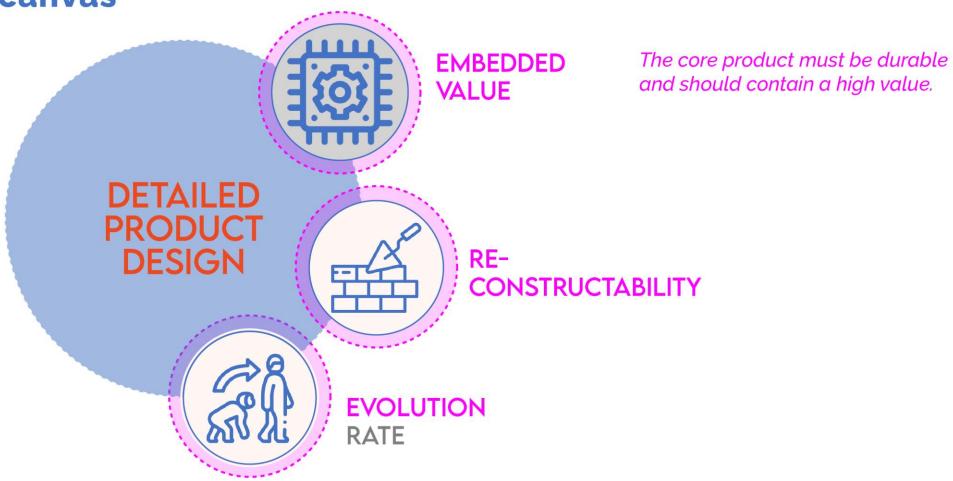




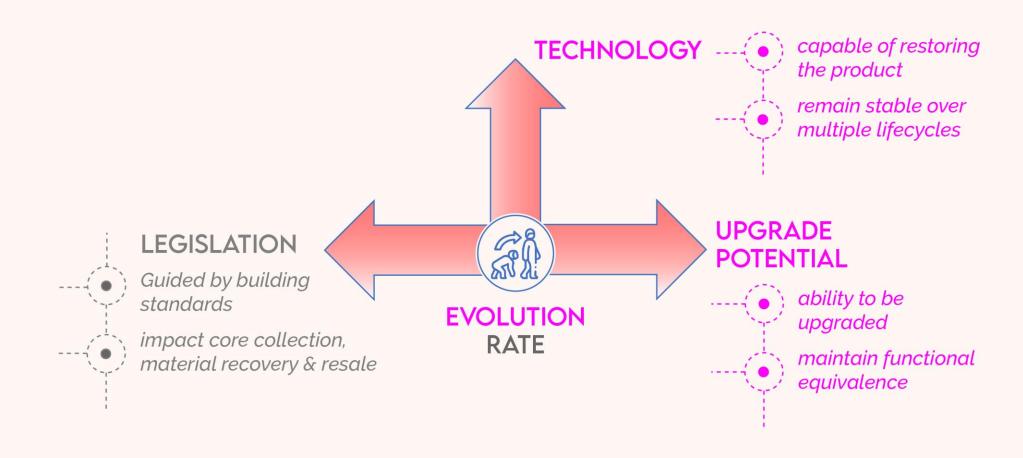
#### Limitations in cost estimation

Scope for future work

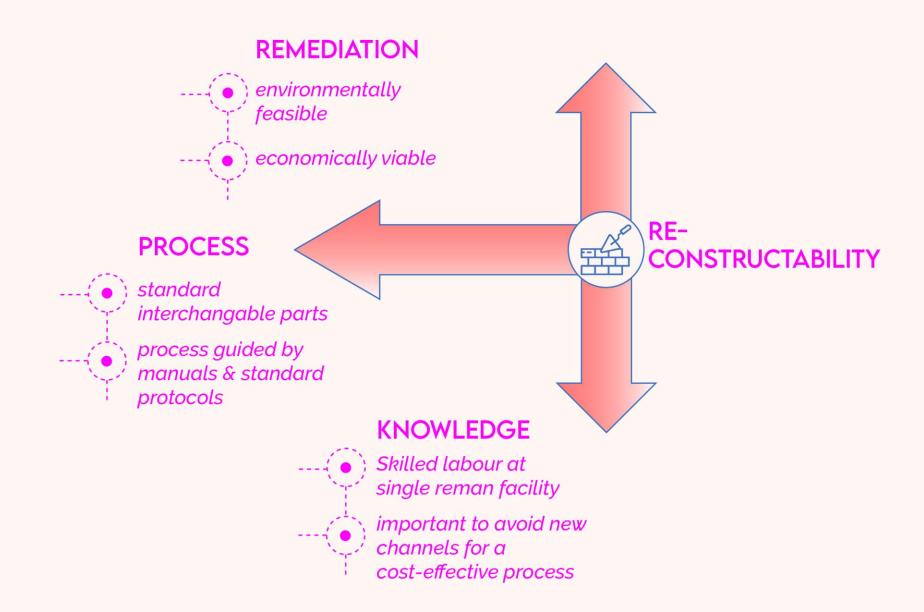




#### **Criterias**



#### **Criterias**



## BUSINESS MODEL FOR CORE COLLECTION

Ownership based

Buy back based

Voluntary based

Service contract based

Credit based

Deposit based

Direct order based

BUSINESS MODEL FOR SLOWING PRODUCT LOOPS

Access & Performance model

Encourage Sufficiency Extending
Producer value

BUSINESS MODEL & PRODUCT STRATEGY

CLOSED LOOP SUPPLY CHAIN



Viable resource stream consistent customer base

REVERSE LOGISTICS





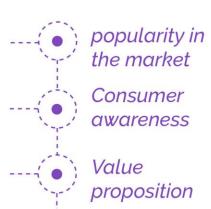
ICT & CUSTOMER SUPPORT

Digitalization key component of upgradebility

stay close to assets return at/before EoL

Sales & accounts team

BRAND VALUE





# Parameters important at Product level

