The Marinepassage

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

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Architectural Engineering Graduation  |  P5

01-02-2019

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Frits van Loon  |  examiner
Introduction

Project Context
Circular Economy
Graduation Project
Introduction

Project Context

Planet Earth
Introduction
Project Context

Planet Earth

Introduction

Planet Earth is a closed system.

There are only two possible long run fates for waste materials: recycling/reuse or dissipative loss.

Introduction

Circular Economy

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

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

Familiar sights in the building industry:

- **construction**
- **demolition**

input of resources

output of waste streams

Negative effects:
- resource depletion
- climate change
- pollution
- ...
Introduction

Circular Economy

Circular Economy (CE) model: “an industrial system that is restorative or regenerative by intention and design”

ultimate goal: to eliminate the concept of waste

achieved by circularity: restoration of resource flows

source:
4 Ellen MacArthur Foundation (2013), Towards the Circular Economy vol 1 - Economic and business rationale for an accelerated transition
6 Ellen MacArthur Foundation, Granta & LIFE (2015), Circularity Indicators: An Approach to Measuring Circularity; Project Overview
Introduction

Circular Economy

Circular Economy (CE) model: “an industrial system that is restorative or regenerative by intention and design”

ultimate goal: to eliminate the concept of waste

achieved by circularity: restoration of resource flows

transition to a CE model: new business models, new ownership models, new actor groups, new products, new design strategies, new material usage strategies

source: 4 Ellen MacArthur Foundation (2013), Towards the Circular Economy vol 1 - Economic and business rationale for an accelerated transition
6 Ellen MacArthur Foundation, Granta & LIFE (2015), Circularity Indicators; An Approach to Measuring Circularity; Project Overview
Introduction
Circular Economy

Circularity in the building industry:

circular building: “a building that is designed, planned, built, operated, maintained, and deconstructed in a manner consistent with CE principles”

construction / deconstruction

Introduction
Circular Economy

Circularity in the building industry:

circular building: “a building that is designed, planned, built, operated, maintained, and deconstructed in a manner consistent with CE principles”

Introduction

Graduation Project

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

Design: “Can architects, non-expert to the CE, be stimulated and systematically guided towards circular design using the ‘Guidance Tool for Circular Building Design’?”

literature study
reference project analysis

Guidance Tool for Circular Building Design

research paper

‘Marinepassage’
Research Circular Buildings

Key Principles
Guidance Tool
Research Circular Buildings

Key Principles

Circularity in diagrams:
Research Circular Buildings

Key Principles

Circularity is a combination of:

**lifecycle thinking** and **system thinking**

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source: 11 Balanay, R. & Halog, J. (2016), Charting Policy Directions for Mining’s Sustainability with Circular Economy, Recycling (1, 2)

Research Circular Buildings

Key Principles

Circularity is a combination of: lifecycle thinking and system thinking

‘Shearing Layers’: Each building ‘layer’ has its own lifespan

source:
11 Balanay, R. & Halog, J. (2016), Charting Policy Directions for Mining’s Sustainability with Circular Economy, Recycling (1, 2)
Circularity can be seen as a way of preserving value (of products, components and materials)  
System value consists of:  
material value and added value  

Circularity is achieved through a combination of:  
circular material usage and circular design  

source:  
14 Ellen MacArthur Foundation, Granta & LIFE (2015), Circularity Indicators; An Approach to Measuring Circularity; Methodology  
Research Circular Buildings

Key Principles

Circularity at material level makes a distinction between:

- **technical cycles**
- **biological cycles**

Research Circular Buildings

Guidance Tool

The **Guidance Tool** is developed in accordance with these principles

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<th>Building Level</th>
<th>Development</th>
<th>Utility</th>
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<td>Design for Refuse/Reduce Input</td>
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<td>Design for Prolong Use</td>
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<td>Design for Technical Cycle</td>
<td>Design for Biological Cycle</td>
<td>Design for Hybrid</td>
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<th>Technical Cycle</th>
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<td>Material Usage</td>
<td>Circular</td>
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1. Circular design

2. Circular material usage
Refuse / Reduce Input
Design for Refuse and Reduce is aimed to reduce the resource use of buildings, systems, products and components, while maintaining performance. This can be achieved in design by using regenerated inputs, by efficient design and by the increase of utility, through sharing economy and collaborative consumption.

Design for Light-Weigting / Miniaturising
Optimised design in order to save material through weight-saving strategies and size reduction strategies.

Building Systems Level Reference Project
RAU - Liander Headquarters (office building renovation)
The resource input for the steel roof structure over the existing buildings was reduced through clever engineering by rollercoaster engineers (lightweight structure experts).

Reuse Materials
Refuse and reduce the virgin material input by substituting it with recycled materials. In some cases, remining (gathering feedstocks from landfills) can be considered as a material source, but for this process human health has to be considered.

Technical Cycle Reference Project
Dirk Vander Kooij – Endless Chair (furniture design)
Using a self-engineered 3D printer, design furniture is manufactured from 96% recycled plastics (coming from old refrigerators). As this feedstock comes in different colours, every piece is an industrially produced ‘one-of-a-kind’ (dirkvanderkooij.com).

It contains information and inspirational reference projects.

Research Circular Buildings
Guidance Tool
Research Circular Buildings
Guidance Tool

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

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<td>Building Systems</td>
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<td>End-Of-Life</td>
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<td>Products/Component Level</td>
<td>Design for Refuse/Reduce Input</td>
<td>Design for Prolong Use</td>
<td>Design for Recover Output</td>
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</table>

1. **business model**
2. **ownership model**
3. **actor group**
4. **design strategies**
5. **material usage strategies**

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

- Business model
- Ownership model
- Actor group
- Design strategies
- Material usage strategies
Research Circular Buildings

Guidance Tool

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

Development
- Design for Longevity / Reliability / Durability
- Design for PSS (Product-Service-System) / Leasing
- Design for Resource Conservation
- Design for Disassembly / Reversibility / Reverse Logistics

Utility
- Durable Materials
- Recyclable / Renewable Materials
- Materials for Recycling Infrastructure / Separability

Product / Component Level
- Technical Cycle
- Biological Cycle
- Hybrid

Building Systems Level
- Design 
- Light-Weigting / Miniaturising
- Design for Reuse / Resell
- Design out of Waste
- Design for Reassemble / Redistribute
- Design for Eliminating Yield Losses
- Design for Repair / Maintenance
- Design for Refurbish / Restoration
- Design for Refuse / Reduce Input

Building Level
- Common / Generic Design
- Design for Production
- Design for Use
- Design for End-Of-Life

End-Of-Life
- Reuse / Redistribute
- Refurbish / Remanufacture
- Refuse / Reduce Input
- Recover Output
- Maintain / Prolong Use

### Research Circular Buildings

**Guidance Tool**

**Focus on narrowing resource loops**

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<td>Building Level</td>
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<td>Design for Refurbish / Restoration</td>
<td>Design for Disassembly / Reversibility / Reverse Logistics</td>
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<td>Product / Component Level</td>
<td>Design for Eliminating Waste</td>
<td>Design for Recycling / Separability</td>
<td>Design for Resource Conservation</td>
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</table>

1. Circular design

2. Circular material usage

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

Focus on **slowing** resource loops

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### 2. Circular material usage

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#### Source
## Research Circular Buildings

### Guidance Tool

**Focus on closing resource loops**

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

Guidance Tool

Possible to combine strategies

Program and Ambitions
Anchoring
Passage Canopy
Building Volumes
Marineterrein again part of the city after 360 years...

Design
Program and Ambitions

Design
Program and Ambitions

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

Municipality ambitions:
- frontrunner CE
- car-free waterpark
- innovation hub
- 2021 Amsterdam Biennial
Design
Program and Ambitions

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

Municipality ambitions:
- frontrunner CE
- car-free waterpark
- innovation hub
- 2021 Amsterdam Biennial

Ideal location for case study Circular Building

source:
21 Gemeente Amsterdam (2013), Strategienota Het Marineterrein
22 Gemeente Amsterdam (2017), Principenota Marineterrein Amsterdam
Marineterrein car-free waterpark

Design
Program and Ambitions
Design
Program and Ambitions

Marineterrein  car-free waterpark

parking space
Design
Program and Ambitions

Marineterrein  car-free waterpark
interrupted routing
Marineterrein  car-free waterpark  building volume between parks
Marineterrein: car-free waterpark

Proposal: continuous park and routing

Design
Program and Ambitions
Marineterrein car-free waterpark

Proposal: central location
Design
Program and Ambitions

Marineterrein innovation hub

MAKERVERSITY

AMS
AMSTERDAM INSTITUTE FOR ADVANCED METROPOLITAN SOLUTIONS

CODAM
CODING COLLEGE AMSTERDAM
innovation hub
Marineterrein
proposal: shared facilities

Design
Program and Ambitions

MAKERSVERSITY

shared facilities

AMS
AMSTERDAM
INSTITUTE FOR
ADVANCED
METROPOLITAN
SOLUTIONS

CO-DAM
CODING COLLEGE AMSTERDAM
innovation hub

Marineterrein

conferences
exhibitions
events
meetings
flex work
fabrication
relaxation

proposal:
shared facilities

Design
Program and Ambitions

MAKERSITY

CO-DESIGN

shared facilities
Marineterrein 2021 Amsterdam Biennial

Proposal: doubles as event space
Concept:

- Innovation hub
- Passage canopy
- Common facilities buildings
- 2021 Amsterdam Biennial

Design Program and Ambitions
Design

Anchoring

Shared facilities
Design

Anchoring

Main routing through passage
Design

Anchoring

Main routing through passage
Design
Program and Ambitions

Main routing through passage
Design
Program and Ambitions

Alternating open ‘pockets’
Design
Program and Ambitions

Alternating open ‘pockets’
Design
Program and Ambitions

Alternating open ‘pockets’
Design

Passage Canopy

Circularity strategy
Design
Passage Canopy

Starting point
Design
Passage Canopy

Reuse existing structure
Design

Passage Canopy

Cut-outs
Design
Passage Canopy

Raised plateau for placemaking
Design
Passage Canopy

Lightweight roofstructure

translucent ETFE

scaffolding structure
Design
Passage Canopy

Mobile furniture
Design

Passage Canopy

Design
Design
Common Facilities Buildings

Circularity strategy
Design
Common Facilities Buildings

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

- **Users**: tenents
  - pay for service
- **Managers**: BIM manager, tenant representative
  - for service
- **Owners**: pay interest
  - ownership/responsibility
  - service
  - maintenance
  - installation
  - take-back service
- **Financers**: finance

**Source:**

Design
Common Facilities Buildings

Manufacturer 1
(facade)

Manufacturer 2
(structure)

Manufacturer 3
(installations)

Manufacturer 4
(interior)
Design
Common Facilities Buildings

Space Plan: Design for Sharing
Design
Common Facilities Buildings

Space Plan: Design for Modularity / Adaptability
Design
Common Facilities Buildings

Space Plan: Design for Modularity / Adaptability
Design

Common Facilities Buildings

Services:
- Design for Modularity / Adaptability

Raised floor system (500mm):
- 220mm existing in situ concrete floor
- 270mm prefab concrete floor slab patches
- 460x75mm slotted wooden beams (450mm grid)
- 130mm hemp insulation boards (Rc=3.5)
- 440mm air cavity
- 2x 20mm PureGlue plywood flooring (1350x450mm grid)
- aluminium spacers
Design
Common Facilities Buildings

Structure:

Materials for Recycling Infrastructure / Separability

- Structural beam (27m, 5400mm grid):
  - 750-1500x250mm dowel laminated timber (DLT)
  - Hardwood dowels
  - Steel pull rod stability crosses

- Structural column (9m, 5400mm grid):
  - 750x250mm dowel laminated timber (DLT)
  - Hardwood dowels
  - Steel pull rod stability crosses
Skin: Design for Standardisation and Compatibility

- Design for Standardisation and Compatibility
- 3m 2.7m curtain wall panels (3000x2700mm)
  - Insulated aluminium mullions
  - HR++ glazing
- 50mm ThermoWood timber cladding
- 50mm ThermoWood slats
- Stainless steel brackets
- Rooftop finish: 50mm ThermoWood trapezoidal cladding
- Stainless steel brackets
- 50mm ThermoWood skids
- Stainless steel brackets
- Suspended facade column (9m; 270mm grid)
  - 100x150 wooden beam
  - Bolted stainless steel facade connections
Common Facilities Buildings

Skin: Design for Standardisation and Compatibility

- **Facade Component (5400x2700mm):**
  - 0.8mm zinc cladding
  - 20mm PureGlue plywood
  - Air cavity
  - Water barrier
  - 150mm sheep wool (R=4.5)
  - 180x100mm 'vuren' wooden beams
  - Vapour barrier
  - 20mm PureGlue plywood

- **Roof Component (2700x2700mm):**
  - Water barrier
  - 20mm PureGlue plywood
  - Air cavity
  - Water barrier
  - 250mm sheep wool (R=6.0)
  - 300x100mm 'vuren' wooden beams
  - Vapour barrier
  - 20mm PureGlue plywood

- **Facade Corner Element:**
  - 50mm ThermoWood timber cladding
  - 50mm ThermoWood slats
  - Stainless steel hinges

- **Suspended Facade Column (9m; 270mm grid):**
  - 300x150 wooden beam
  - Bolted stainless steel facade connections
Model making for Modularity/Adaptability
Model making for Recycling Infrastructure
Modelmaking
Modelmaking for Modularity/Adaptability
Modelmaking
Modelmaking for Modularity/Adaptability

designed for reuse
Modelmaking

Modelmaking for Modularity/Adaptability
Modelmaking
Modelmaking for Recycling Infrastructure
Modelmaking
Modelmaking for Recycling Infrastructure

biological materials
Modelmaking
Modelmaking for Recycling Infrastructure

technical materials
Conclusions and Reflection

Reflection Circular Design by Guidance Tool

Conclusions
Conclusions and Reflection

Reflection Circular Design by Guidance Tool

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

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

**Improvement:**
- overlap within strategies
- lack of definitive selection criteria
- limited scale levels
Conclusions and Reflection

Conclusions

Question: “Can architects, non-expert to the CE, be stimulated and systematically guided towards circular design using the ‘Guidance Tool for Circular Building Design’?”
Question: “Can architects, non-expert to the CE, be stimulated and systematically guided towards circular design using the ‘Guidance Tool for Circular Building Design’?”

stimulated: yes!
Question: “Can architects, non-expert to the CE, be stimulated and systematically guided towards circular design using the ‘Guidance Tool for Circular Building Design’?”

stimulated: yes!

systematically guided: to an extent...

...additional input required in:
- future scenario
- larger scale levels
Conclusions and Reflection

Conclusions

Question: “Can architects, non-expert to the CE, be stimulated and systematically guided towards circular design using the ‘Guidance Tool for Circular Building Design’?”

- stimulated: yes!
- systematically guided: to an extent...
  - additional input required in:
    - future scenario
    - larger scale levels

Advise: Use the framework for inspiration and as an overview of circular strategies
Thank you!

Jelmer Amory | 4209710
Architectural Engineering Graduation | P5

01-02-2019