Research Plan | aE Graduation Studio 2021

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Studio
AR3AE100 Architectural Engineering Graduation Studio
Studio Second Life
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Argumentations of choice of the studio

The studio 'Second Life 'especially focusses on the 'not so desirable buildings 'of the existing stock. The value for this kind of non-eloquent buildings is poor. Apart from their non-present architectural quality, most of them also cannot meet the current energy standard. Leaving the buildings vacant is a waste in form of material waste and energy consumption. This is a missed opportunity, however, and has not yet gained enough attention, especially from the architects because of its low esthetic value (Remøy et al., 2014).

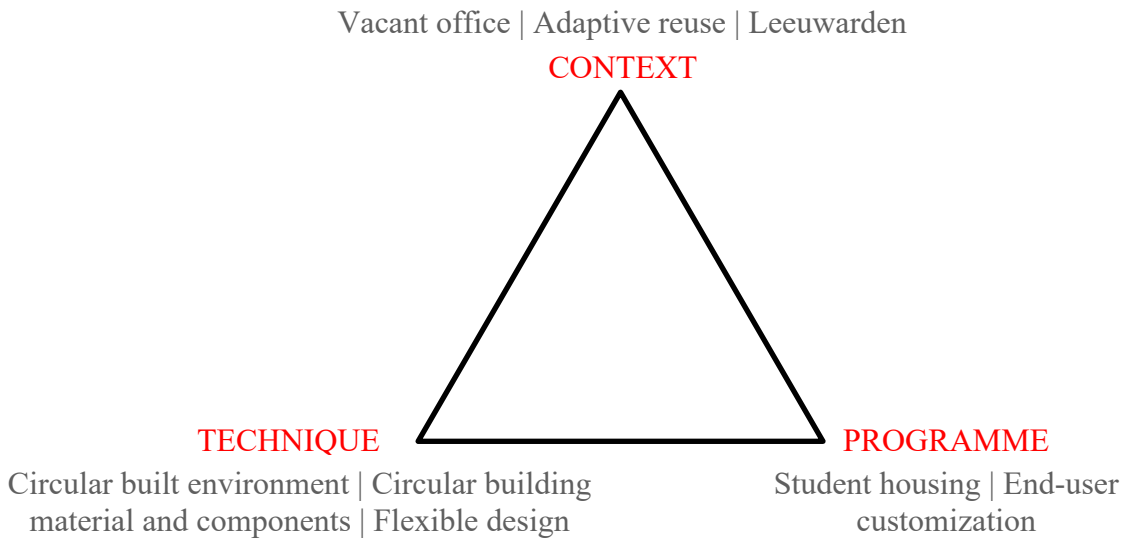
Furthermore, reuse is a complex issue. It brings together many aspects: the history of the building, the place in the city, architecture, the life cycle of buildings, management for planning, investing and organizing, and so on. An adaptive re-design of these buildings is a challenging subject that requires creativity, inventiveness and visionary thinking from a broad spectrum.

Overall, the studio second life subject is a missed opportunity regarding its architecture and material value. it requires challenging, exciting, multidisciplinary yet practical design approach that matches my personal interest well.

Title

Old Office Building Transformation: Circular-Flexible Student Housing

Adaptive re-use of Tax office, Tesselschadestraat 4, Leeuwarden, the Nederland



Keywords
Vacant office, adaptive refurbishment, student housing, circular built environment, customization, flexible design

Problem Statement

*(*For Overall design question)*

There is a huge stock of old office buildings in the Nederland that are currently vacant. These buildings often do not meet modern standards anymore: they have energy-label C or higher that will not meet EU regulation anymore by 2023(Netherlands Enterprise Agency RVO, 2021); they have low interior flexibility, while their external appearance is poor (Remøy et al., 2011). However, the conventional processes of demolition and new construction contradict the principle of reducing co2 emission. Moreover, they constitute 80% of the next 80 years' built environment (Climate Change, 2017). Therefore, the adaptive reuse of these buildings is of great importance and in urgent need.

Apart from large stock of vacant office buildings, the Netherlands will need 845,000 homes by 2030, especially student housing (Lalor, 2021). In addition to the ongoing developing solutions of fast assembling and modular buildings, ways to produce homes in an even faster way with lower co2 emission should be sought. As revealed by some case studies, office can possibly be transformed into housing (Remøy et al., 2007). This could be a potential sustainable solution to partially solve both the aforementioned problems. (Geraedts et al., 2016)

Yet, as study showed (Wilkinson et al., 2014), housing project transformed from office buildings often give priority to *'generic-uniform- rather than specific-pluriform-design'* (Geldermans et al., 2019a), they are often built with fixed walls, furniture and limited room types. Lack of adaptability, flexibility and the users' ability to influence their own dwelling according to changing needs and requirements is criticized. (Remoy et al.,2011) The concept of **circular building (CB)** might provide leverage for change in this respect. (Geldermans et al., 2019b)

Building industry need to act on the **Sustainable Development Goals (SDGs)** call to reach the goal by 2030 (United Nations, 2020). Built environment need to transform into a resource-effective one to address these challenges (Çetin et al., 2021). Contrary to the current **Linear Economy** business model (take-make-waste) that use material in an ineffective way, **Circular Economy (CE)** and **Circular Built Environment (CBE)** approach support **SDGs** goal through minimizing waste and avoiding downcycling. (BAMB2020, 2017) The adaptive re-use of the abandoned office buildings and sites can represent a substantial contribution to **CBE** and **CE,** they can be used more circular through retrofitting. (Bosone et al., 2021).

One of the **CBE** approaches is to look **Building as Material Bank (BAMB)**, as buildings are temporal and dynamic storage of materials and components. They can easily be changed in response to changing demand and preferences. It calls for collaboration involved not only building professionals and finances, but also end-users. (BAMB2020, 2017) These characters coincide with the demand of **Flexible Building (FB)** and end-user influence in current housing market. (Schneider & Till, 2005) In other word, **circular building (CB)** and **flexible building (FB)** are essentially two sides of the same coin. (Geldermans et al., 2019a) Therefore, a circular transformation of office building into student housing is not only environmental responsible but also matches market demand.

However, very few of the reviewed studies explicitly examines the circular transition of the housing sector (Eikelenboom et al., 2021). Therefore, the design question of **how to**

transform vacant office building into flexible student housing following circular design principles becomes a challenging and important topic.

Objective

The Programme *(will be defined further based on research findings)*
To answer the question, former tax office building, Leeuwarden is chosen as a case study. The former tax office building will be transformed into a student housing building. It aims to offer a highly flexible and customizable floor plan (interior space) for its tenants, which (hypothetically) will be realized through the use of circular building components that can be disassembled and reassembled easily.

A platform will be developed for its future tenants (students)for end-user customization. The floor plan (interior) of the building will be constructed according to the tenant's demand. By choosing from a selection of various circular building components, tenants make their own customized 'best room' in the same building. All components can be disassembled and re-used(re-customized) by the next group of tenants. In this way, every tenant's living experience is tailored to maximum and materials waste after the tenant have left is reduced to minimum. Therefore, leads to a more circular and environmental responsible customization.

Overall Design Objective *(building circularity)*
- Refurbishment of the building following circular design principles.
- To create a site/context-specific taxonomy of (interior)circular(dfd) building components that will be installed in the building later according to tenants' need.
- Introducing end-user(students) to the design process. Provide students a platform where they can participate in the designing of their own room and public area.

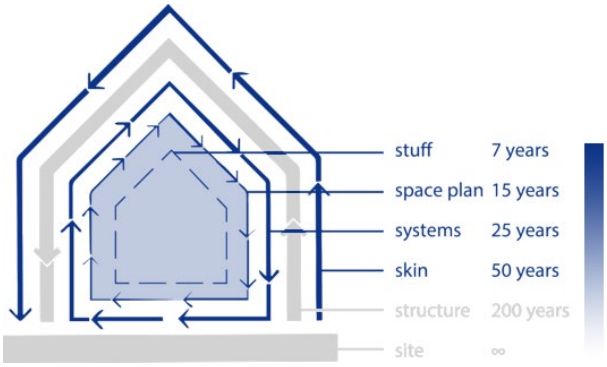
Thematic Research Objective *(circular building product)*
-To provide technical insights on building material and component for the design.
  a. What existing materials/components is reusable in this case.
  b. What additional materials can be found and used in the building.
  c. How will they be used in the building. (r strategies)
  d. How can these materials be (re-)designed for disassembly.

Relation between design question and thematic research question
The thematic research focusses on the technical part of the design, it is a study on technology and design of building materials and components(figure). Other conceptual-contextual research such as interviews and study on student housing typology will also be conducted during the research phase of the design. Based on the result from both technical and conceptual-contextual research, the design afterwards can be developed well-founded.

Overall Design Question

How to transform vacant office building *(Tax office, Tesselschadestraat 4, Leeuwarden, the Nederland)* into flexible student housing following circular design principles?

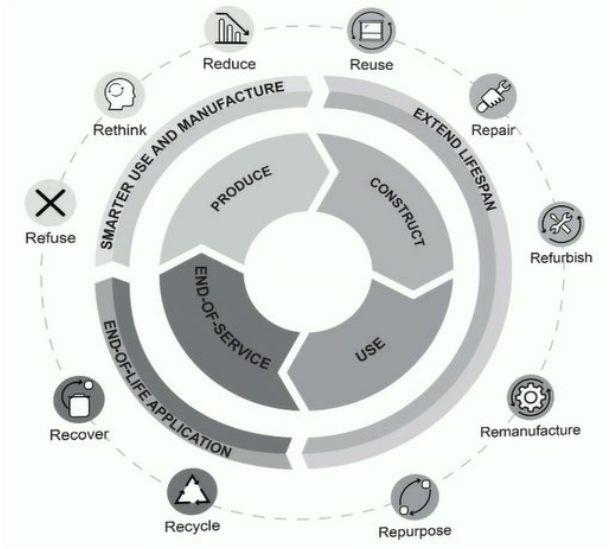
Subquestions:
- What is the current status of the building?
- On what extent (which **shearing layer**) should the building be refurbished?(figure)
- What are the needs of the target group (students)?
- On what extent (which **shearing layer**) should(could) the building be customizable for end-users?(figure)
- How do **circular design principles** affect the material strategy of the transformation? *(The thematic research question)*
- How to find the balance between the relatively low-budget of student housing and current 'expensive' **circular built environment**?



Thematic(technical) Research Question

How do circular design principles affect the material strategies of building transformation?

Subquestions:
- What are the circular design principles?
- How to deal with the existing materials following **circular design principles**?
  a. What kind of materials are there in the current tax office building?
  b. What is the quantity of each material?
  c. What are the ways to deal with these materials in a circular way? (R strategy) (figure retrieved from MOOC)
- How does **circular design principle** affect the choice of additional material?
  a. How much additional material is needed for the transformation?
  b. What kind of materials could they be?
  c. where to find these materials?



Methodology

1. Research about design

Literature study
read relevant academic literature and scientific articles, providing an overview of existing acknowledge regarding: the risks and potential of building transformed into housing, retrofit of office building into housing.

Case study on building adaptive reuse

① Kleiburg Klusflat, Amsterdam (*low-budget housing conversion, DIY housing*)
② 'Westplantsoen' in Delft (*same floor layout, adaptability of the structure*)
③ 'Eendrachtskade' in Groningen (*same problematic pre-fab concrete slab floor*)

2. Research for design

Literature study
read relevant academic literature and scientific articles, providing an overview of existing acknowledge regarding: what is **circular built environment**, what are **circular design principles**, why does it matter, what is **design for disassembly** for built environment, different strategies to deal with existing material, building code such as fire safety/façade insulation/noise level/air pollution level, building code, rules and regulations hinder reusing building materials.

Case study on using circular building material and components

① The temporary court house in Amsterdam (*life-cycles, change functionality*)
② The Circl Pavilion in Amsterdam (*material bank, dfd*)
③ Substrate Factory Ayase (*adaptability*)

Site visit
To assess current building performance (structural stability, noise level, airtightness, service system, necessary material accounting)

Questionaries+ creating tenant profile
A questionnaire hands out to students regarding their preferred living environment: room size/ shared facilities/ location of the room in the building/partition walls in the room/ kitchen/ bathroom facilities.
the data of each questionnaire will be used to create a tenant profile(database).

Material inventory+ data analysis
Translating the original drawing of the building via BIM into a 3D model, which will help to create an inventory of the existing building components and also after the transformation, makes the accounting for material feasible and controllable.
After accounting existing materials, the amount of new material can be estimated.

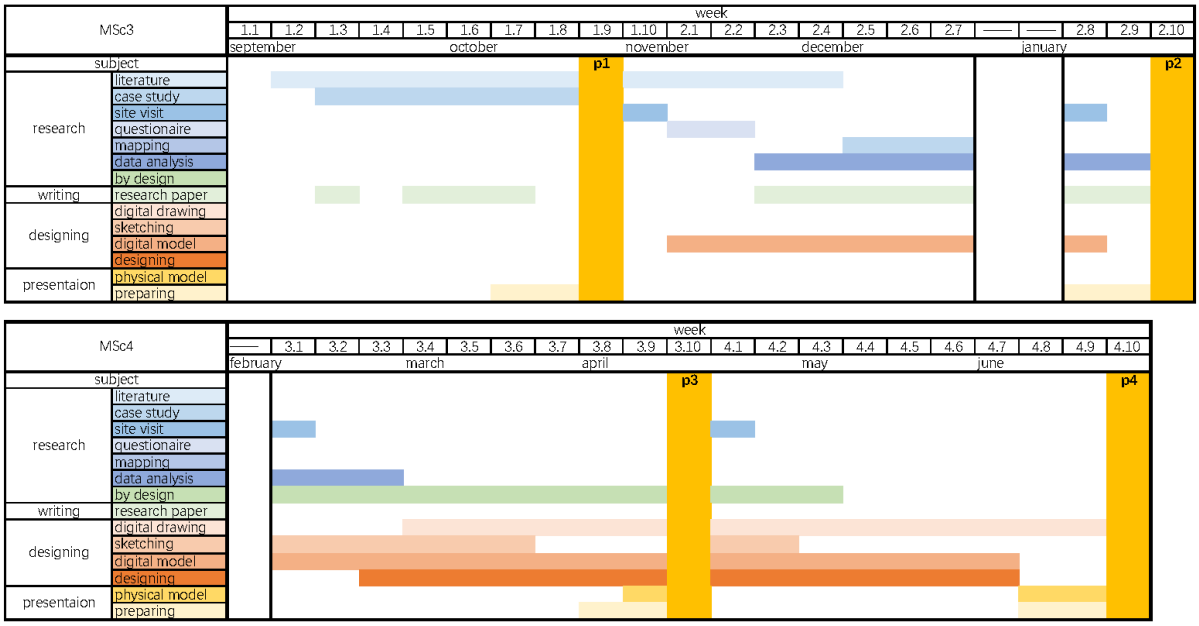
Mapping
-The possible transportation 'flow' of the existing material
-Possible resource of other material(steel/timber/furniture)

To help on the decision making on materials in the MSc4 design phase

3. Research through(by) design

Platform design
Digital model
Physical model
Digital drawing

Planning



Relevance

With a big building portfolio offered by studio 'second life' and a nearing deadline of 2023 (Ministerie van Economische Zaken, Landbouw en Innovatie, 2020) there will be many office buildings vacant. Together with the problem of material scarcity and the depletion of scarce sources, the problems are piling up. We are living on the edge. These problems are threatening the benefits of local community and other stakeholders. Developing a strategy and implementing this strategy into design, is a solution for the aforementioned problem.

This research is a supplement for the research field that needs more attention from the designers: conversion from non-residential to residential buildings. The result of this research is case-specific yet widely applicable, since the construction materials used in buildings in the Nederland are similar during a certain time period (1960-1990). They are now facing the similar transformation challenge, especially in aspects of dealing with non-circular built environment and extending lifespan of old mediocre buildings. Meanwhile, CE needs to be "brought down" from the macro to the meso-micro level. CE literature rarely focuses on the strategies and actions at the micro level. (Foster, 2020) Moreover, it shows a way of how can architect contribute to a more circular world.

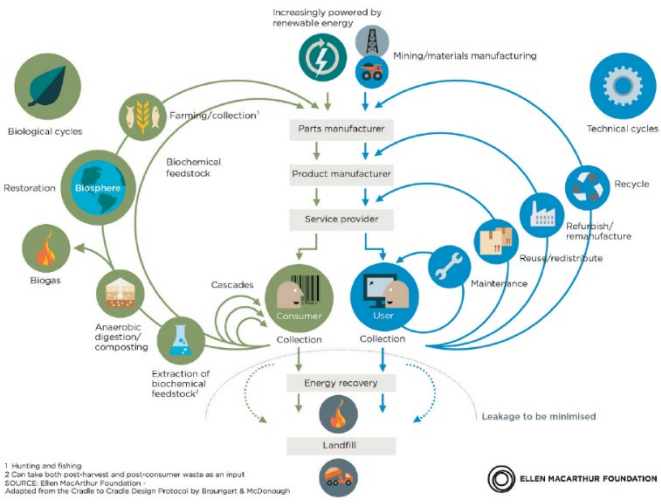
Glossary of Key Terms

Adaptive reuse
Is defined as “any building work and intervention to change its capacity, function or performance to adjust, reuse or upgrade a building to suit new conditions or requirements” (Douglas, 2006)

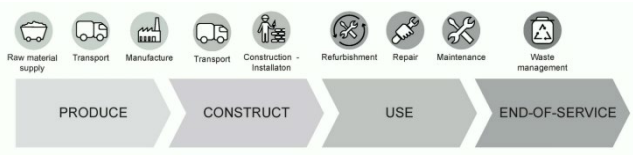
Circular Economy
The Ellen MacArthur Foundation proposed five principles on which to base a circular economy:

1. Design out waste. Waste does not exist when the biological and technical components (or ‘materials’) of a product are designed by intention to fit within a biological or technical materials cycle, designed for disassembly and repurposing.
2. Build resilience through diversity. Modularity, versatility and adaptivity are prized features need to be prioritized in an uncertain and fast-evolving world.
3. Work towards using energy from renewable sources. Any circular story should start by looking into the energy involved in the production process.
4. Think in ‘systems’. The ability to understand how parts influence one another within a whole, and the relationship of the whole to the parts, is crucial.
5. Think in cascades. For biological materials, the essence of value creation lies in the opportunity to extract additional value from products and materials by cascading them through other applications. The complete biological entity should be considered. (Ellen MacArthur Foundation, 2015)

The Butterfly Diagram
The Circular Economy concept is illustrated by the "butterfly diagram". Both sides of the diagram are relevant to the built environment: the right side illustrates the technical cycle and closing the loops of resources facilitated by circularity strategies; the left side of the diagram shows the biological cycle and the loops and cascades assuring the sustainable management of biological resources and creating renewable flows and stocks. The ultimate aim of this economic model is to minimize the extraction of raw materials and waste generation. (figure retrieved from ellen mac arthur fouandation)



Linear Economy
follows the prevalent material flow: take-make-waste. In the linear economy, there are three options to handle waste: recycling, incineration and landfilling. In all options, a lot of the value that was introduced in the

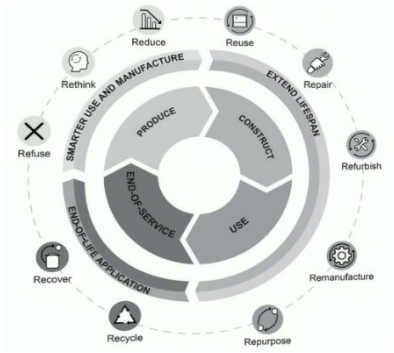


creation of products and building components is lost. (Figure retrieved from Delft University of Technology - TU Delft, 2021)

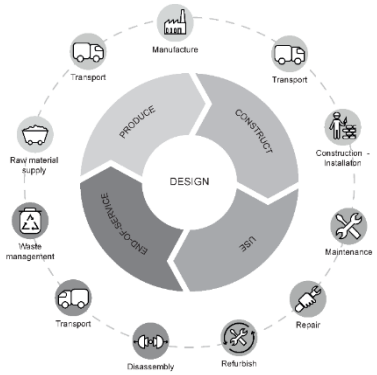
Design for Disassembly (DfD)
Design for Disassembly is the design of buildings to facilitate future changes and dismantlement (in part or whole) for recovery of systems, components and materials, thus ensuring the building can be recycled as efficiently as possible at the end of its lifespan. (Cutieru, 2020)

Circular Built Environment
"The Circular Built Environment (CBE) is a system designed for closing resource loops at different spatial-temporal levels by transitioning cultural, environmental, economic & social values towards a sustainable way of living (thus enabling society to live within the planetary boundaries)"(CBE hub, TU Delft)

Life-cycle of Building Product
Understanding the life-cycle of building products and the impact that each stage has on the environment is the first step towards the development of a circular built environment. There are four main life-cycle phases of a building product: production, construction, usage, and end-of-service. (Figure retrieved from Delft University of Technology - TU Delft, 2021)

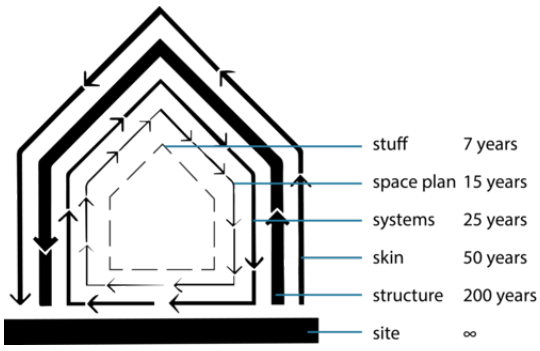


Circular Design Principle
Include three approaches:
1. Smarter Material and Product Use and Manufacture is the most circular level of strategies. 2. Extend the Life-Span of components, buildings and closing the loop. 3. Useful End-Of-Life Application of Materials and Components is the lowest level of circular strategies. Some circular principles are assumed to be known already to the construction sector, particularly, the R principles (Cetin et al., 2021). (Figure retrieved from Delft University of Technology - TU Delft, 2021)



Building as Material Bank
BAMB is creating ways to increase the value of building materials. Dynamically and flexibly designed buildings can be incorporated into a circular economy – where materials in buildings sustain their value. That will lead to waste reduction and the use of fewer virgin resources. (BAMB, 2019)

Shearing Layer
the "Shearing Layers" concept of architect Frank Duffy, which was later elaborated by Stewart Brand in his book How Buildings Learn: What Happens After They're Built (1994), which refers to buildings as composed of several layers of change. There are six shearing layers: Site, structure, skin, services, space plan, and stuff. (Figure retrieved from openbuilding, 2021)



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