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Circular Façade Systems and Construction Design for Remanufacturing Window Systems

## Reflection: Graduation process

**1. How is your graduation topic positioned in the studio:**

The Built Environment, being a high material intensive sector, is one of the ve key sectors that need to transition to circularity by 2050, as required by the Dutch government. The supply of crucial raw materials is limited, and additionally, energy consumption and carbon emissions have increased dramatically. The Circular Built Environment Studio aims to tackle these problems through the ap- plication of CE principles. Waste prevention, eco design, reuse, and remanufacturing imply not only positive environmental impacts, but also in the economy.

Remanufacturing is considered a highly important process in the manufacturing industry that uses resources ef ciently. Additionally, it follows the Ellen MacArthur Foundation key principles of a circular economy (2013): "think in systems", "design out of waste", "think in cascades".

**2. How did the research approach work out (and why or why not) and did it lead to the results you aimed for?**

The results of the literature review were divided into ve different parts: circular economy, circular built environment, remanufacturing, window systems, and the case study of the RT 82 HI +.

Strengths: The results are after reviewing some of the most important authors, by interviewing stakeholder, and by understanding the latest discussions on circularity. Weaknesses: Because of the time of the graduation project, the research was limited to a component level. Many other façade sys- tems were excluded.

Opportunities: Further studies on reverse logistics, remanufacturing business models, warranties, serial numbers.

**3. How are research and design related**

To start designing, I rst had to do an extensive research on different topics, from general to more detailed: circularity, circular built environment, circular façades, components, elements. After gathering so much information, and making connections between different authors, I was able to start de ning the requirements for a circular façade. This initial foundation served as the starting point for design considerations and criteria.

## Societal impact

### 1. To what extent are the results applicable in practice?

There are already some few examples of circular façade systems in the Netherlands. The design is still quite conceptual, it was intended to also analyse remanufacturing business models, understand- ing case studies, and through interviews with stakeholders involved in circularity, to make it closer to practice.

### 2. Does the project contribute to sustainable development?

One of the most important problems of sustainable development is the highly demanding mate- rial construction industry. This industry follows a linear model: 'take-toss-dispose'. The project aims to tackle this problem through the application of the CE principles in façade construction. Façades can make up to 20-30% of the embodied energy of a building. If the embodied energy, and the material value is retained, there can be an alternative to demolition, and thus is a way of tackling the scarcity of resources.

### 3. What is the socio-cultural and ethical impact?

The 'make-take-toss' system from a linear economy has caused several important impacts in soci- ety. Shifting to a circular economy implies a more responsible use of resources, and understanding the value on them. However, the transition to it seems to be highly complex, as it needs a lot of research, money, and efforts which will be seen in a long-term. According to some researchers, developing countries might have a harder time transitioning.

### 4. How does the project affect architecture / the built environment?

There seem to be a lot of risks on transitioning to a CBE. The whole supply chain should be iden- ti ed to understand the different barriers and opportunities. For example, a contractor might under- stand the bene ts of CE, but it might also see a lot of risks. In a CBE, buildings and infrastructure are designed for a whole life cycle, and not only for an end use. Different technological tools such as BIM should enable material passports, and document the service life of the building components. Design for disassembly and design for adaptability are two of the key tools for transitioning. This would enable the design of buildings that are not just structures that provide shelters, but are also able to adapt and change, through refurbishment, expansion or disassembly.