Reflection paper

Master of Architecture, Urbanism and Building Sciences

AR3AE100 Architectural Engineering Graduation Studio (2021/22).
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From the very beginning of my graduation phase, it was clear to me that the current way of building residential architecture – glued, welded, and cast – was too rigid to cope with the requirements that are placed on it. Designing in this way, would lead to buildings that are hard to adjust in the future and where materials are hard to reuse. This means that demographic changes and changes in residents' lifestyles inevitably lead to demolition, and this leads to Construction and Demolition Waste (CDW).

This is a problem, because CDW pollutes the environment, its processing contributes to climate change, and it has negative health implications. One third of all waste produced in the EU stems from the construction industry. Although, the Netherlands claim to recycle close to 100% of CDW, only 3% are retracted to the built environment, while the rest is downcycled as landscaping filler, in road construction, or otherwise – a waste of valuable materials. So, with 1M homes to be built in the Netherlands in the coming years, we are facing a severe waste problem if we do not manage to make most new residential projects CDW redundant.

My project site in Arnhem is a focus location, where the regional government plans to develop a new neighborhood. Hereby, they tackle the increased local housing demand in relation to the 1M homes shortage in the Netherlands. Once I had a site, I saw my opportunity to create something that could be an inspiration for practicing architects and have an impact on design in the real world. A building system that is easy to implement, flexible, and spatially rich. In the design phase, I came to the realization that a balance between spatially rich and flexible is not easily achieved.

Technical design research

As a starting point for my research, I knew that I wanted make "Transit Village" circular, by using appropriate materials, making it remountable, and by creating a sandbox of components that would make it flexible.

So, I commenced my research phase by reading about N.J. Habrakens "support" and "infill", with participation as a design driver. This led me to the Shearing Layer concept and Open Building ideas. I really liked these approaches of dealing with change in architecture, but following my goal of eliminating CDW, I had to go the step further and think about how to subdivide Shearing Layers into a system of modules that could be disassembled and reassembled.

First, I researched the potentials of different biobased or reclaimed materials within this concept, regarding their application in different Shearing Layers – including structural steel components, reclaimed window glass, mycelium insulation, etc.

In consultation with my tutors, I decided to use timber for most purposes, because no other material delivered the same lightness, workability, environmental and climatic performance, and friendliness in haptic. Sustainably harvested Japanese Larch from the closeby Veluwe area is used for structural applications and facades, while the softly textured Populus wood from the site is used for visible interior surfaces. I make use of the whole tree by working leaves, branches, and other offcut into wood-wool insulation.

Second, I researched timber framing joints from European and Asian carpentry. I also revisited research I had collected over the years about timber construction systems. Ger Warries helped me to in my decision for a hybrid post and beam structure with prefabricated CLT-cores. The cores host wet cells, technical installations such as ventilation and elevators. System ceilings from Lignotrend-style "Rippe" slabs host electrical cables, power sockets, infrared floor heating panels, and a lighting system. Ceiling slabs can be taken out in designated spots to make space for interior stairs that facilitate duplex apartments. A modular reCO2ver concrete foundation creates a crawling space underneath the building to make piping accessible. The skin consists of interchangeable and prefabricated façade panels and a green roof on base of Citumen (Circular bitumen) sheeting. Interior walls are transportable modules that can be fitted into designated locations in the apartments. This allows for an easy expansion or downsizing of apartments within the boundaries of structural shear walls.

"Service Trust"

Towards the end of this rather straightforward design research phase, I went down a road, that I partly regret taking – that of Affordability. I was convinced that my apartments had to be affordable regarding the skyrocketing rental prices in the wake of the housing crisis. But I learned that architectural design has considerably less influence on rental prices than ground value. Also, this did not connect very well to my main topic of circularity and CDW reduction.

If I could not make the homes affordable, I thought that I might use the residual value of materials and components to create a financial incentive to disassemble instead of to demolish. This was inspired by the TU Delft Leasing Façade project and a Residual Value calculator, envisioned by TNO. Now, there was suddenly a strong connection between affordability research and my main goal of facilitating circular design in housing.

Around P2, while researching reclaimed materials, I read the book Material Matters by T. Rau and S. Oberhuber. The authors present a financial model that promises to make designing circular profitable, thereby creating a financial incentive for designers. The concept of "As a Service", which can eliminate planned obsolescence in everyday products, is expanded to the realm of building products. This is demonstrated with the circular lighting project by Turntoo/ Philips at Schiphol Airport.

Here, the client would merely pay for light instead of for lamps. This implies the use of a service contract and the design of longer lasting lamps. The provider profits from increased customer loyalty and a constant cash influx, while the client has no extra costs or effort and can be sure that everything is always working correctly.

I got fascinated by the idea of organizing an entire building process "As a Service". So, I started researching and found that there would be some parts of the "Turntoo model" that needed adjustment. In the case of the circular lighting project, Philips is the service provider. They have the goal to direct designers to design in a circular way. In the planning process of an entire building, there are many parties at play. So, I had to find a way to make architects themselves profit from this model.

This is where I came up with the "Service Trust". All planning and executing firms – including the architects – hold shares of this trust, which is filled up monthly with rental income. It is used to maintain, adjust, and modify the building. This is organized with service contracts. The trust becomes a financial incentive to facilitate circular design and material management.

In short: if architects want to profit, they have no other choice than to design in a circular way, because this is what drives the maintenance costs down. If façade builders want to profit, they have no other choice than to implement the architects' design in a remountable way, because this again drives down service costs.

This redistribution of responsibility can eventually motivate all parties involved to work together on circular buildings and a much-needed transition towards a Circular Economy.

Thematic Research: Low service-cost components.

To find out, what leads to low service costs, I looked at how car leasing firms choose their vehicles. In the case of leasing firms, it is not about choosing just some vehicle, but one that creates the least cost during maintenance and can be resold at a high price. I found that how leasing firms choose vehicles is like how architects should choose circular building components.

Leasing firms use a method known as Residual Value Forecasting. These are mostly deep learning algorithms that evaluate training data in respect to car design characteristics. I checked the datasets for relevant parameters that could also apply for serviced interior walls. I chose interior partition walls for the analysis because metal stud plaster board walls – the most common interior wall system - are a large CDW contributor.

With this information from the datasets, I was able to create an evaluation tool that can be used by architects to determine the longevity of building components. The tool is based on the method of Multi Criteria Decision Analysis. There are several parameters a product is tested against. These can range from quantitative to qualitative and are assigned an individual relevance to the matter. This test results in a scoring stated in percent. By testing multiple products, their overall performance across

different parameters can be measured and compared. This can be used as decision support by architects.

I want to thank Pieter Stoutjesdijk for his guidance throughout my Thematic Research Paper. I felt like this research was important for me and I think that it could become interesting for further elaboration in real world project-organization. Although, my thematic and technical research had a large impact on the technical scale of my design, I still needed to find a fitting architectural concept.

"Happy City"

I learned that Circularity in the built environment requires action by different parties – this includes residents as well. In his lectures and 2013 book "Happy City", Charles Montgomery argues that places that make us feel good, can change our behavior in a positive way. Not only will they make us more optimistic, healthy, and social, but they can also make us care more about our living environment itself. And if residents take care of apartments, buildings, and neighborhoods, they will last longer. I would argue, that creating a Happy City, is just as Important for circular building design as material choice, remountability and facilitating a circular process.

There are many aspects that lead to a Happy City. In relation to my planning area and technical design goals I chose walkability and cyclability, nature inclusivity, and interaction as my focus areas.

On the urban scale I created a bicycle highway that establishes a connection between eastern residential districts and the city center of Arnhem across my site. Furthermore, I created a green recreational belt around Transit Village that connects it to a trail network around the Rijn-Ijssel delta. This belt is a recreational zone that is used by all citizens of Arnhem. The new Al-Fath Mosque creates a meeting point for multiple Muslim communities with different backgrounds, a Creativity Hub provides space for creatives to meet and learn, and a Music School tackles the deficit of musical education in the surrounding.

Transit Village is built around a network of axes and squares, that allow for different types of pedestrian and cyclist movement across the site. In between buildings there are different types of courtyards with various grades of privacy (market square - community garden – small sports fields - house community benches). Depending on the courtyard, interaction between residents of the city and Transit Village occurs and new friendships are made. The courtyards are designed include green in the form of grass patches and trees that contribute to pleasant microclimates.

The buildings form clusters that are connected to each other in terms of accessibility by bridges. All roofs are accessible and belong to the residents of the buildings. Here they can meet, recreate, garden, build. A "Happy City" also includes spaces that are not occupied with a function. In this way, people have space to build something that is their own and that can become an identification point with their environment. Ultimately, this is aimed at strengthening the house community into something that lasts. If in the future density is growing or shrinking, whole clusters can be stacked up, or a storey can be taken away.

A Material Management Hub in a former car dealership building on site handles the remounting of Transit Villages buildings and the remaining of materials. Therefore, it has an interim storage that retains components for a timespan several months before selling them as base materials. In this timespan, components such as interior walls can be picked up upon request. Depending on how much demand there is, the material Management Hub also handles the management of recovered materials from construction sites around Transit Village.

At this point, I would also like to thank my design mentor for his patience and guidance throughout this graduation period.

Towards P5

For the final part of my graduation, I am planning to revisit and enhance critical aspects of my design with the feedback from P4. Especially on 1:5/10 scale there needs to be more testing in form of details. Furthermore, I want to show floorplans of function types that exceed what I show at P4. I also had in mind, to build a sectional model of an interior wall. Finally, I would like to work on drawings, visualizations, diagrams, and my use of colors to create a hierarchy in the façade and across the urban scale of Transit Village.