REFLECTION

Reuse of waste wood for an exterior wall element

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GRADUATION TOPIC

The beginning of my graduation started with the desire to learn Python and implement it into my graduation project. Before this thesis, I had zero knowledge of Python. I wanted to know if Python would be something that I will continue to use in the future. This graduation topic was an excellent opportunity to find this out.

In my graduation thesis, an exterior wall element tool is developed. This tool connects a digital database with a parametric model of an exterior wall element that can be constructed with waste wood. Connecting the parametric model to a digital database and apply a script that finds the most suitable wood and minimizes any additional waste overlaps with the domain of Design Informatics.

Developing a design for an exterior wall element that can work with the changing dimensions and availability of waste wood is within the domain of Building product innovation.

The two mentors that are involved in my graduation project have expertise within these fields.

RESEARCH APPROACH

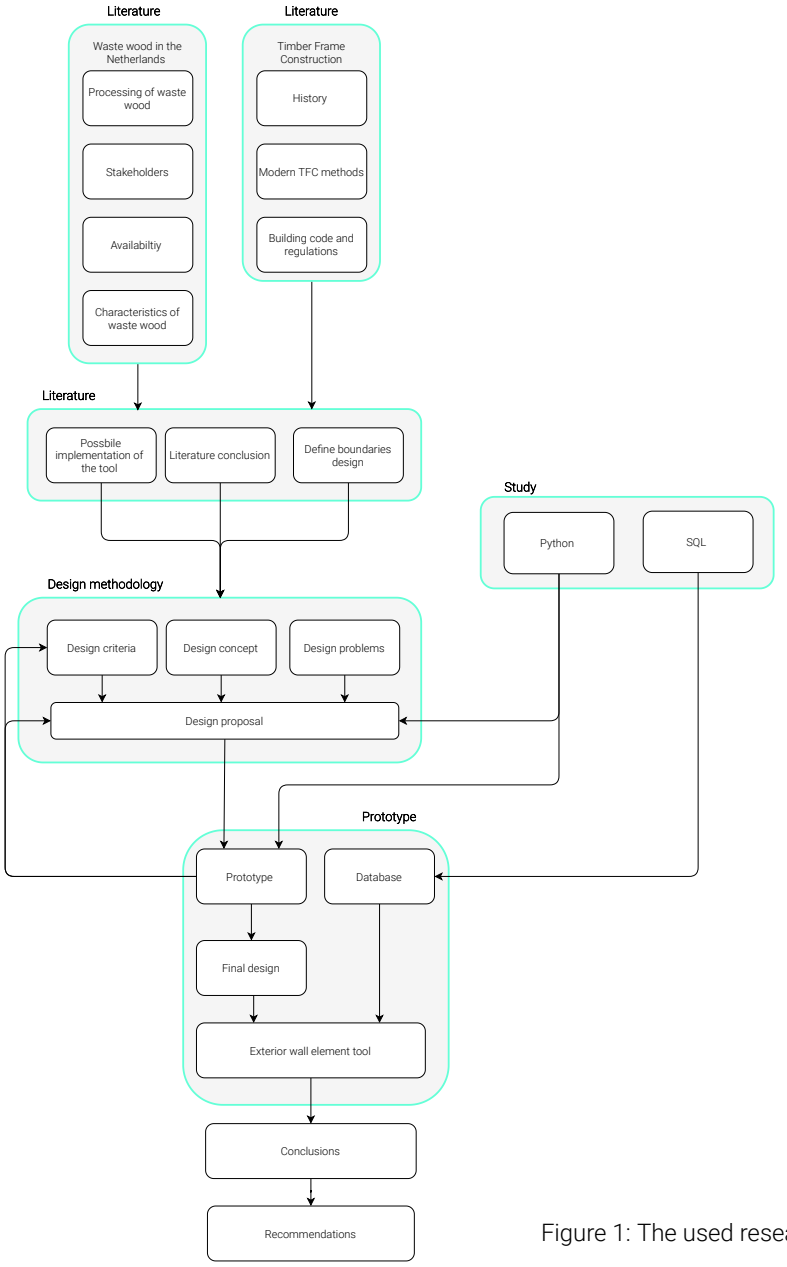

Figure 1: The used research methodology

To develop an exterior wall element tool that could be implemented in the Dutch waste wood market, research was performed. The research can be divided into four phases: the literature phase, the study phase, the designing phase, and the prototyping phase. During the literature phase, a solid foundation was created. With the study phase, an online course was followed in PostgreSQL and Python. Before this thesis, I had zero knowledge of these programs. The designing phase consists of following a design methodology supported by the knowledge obtained from the literature and study phases. The design methodology's result was some design principles that are compatible with building with waste wood and a final design.

A design methodology can guide the designer in finding the most suitable design for the given design problem. Following a design methodology is quite common in the product design industry but lesser-known in the architecture and construction industry. However, following a design methodology can be a subjective process where the designer's decisions are substantiated by background knowledge and experience. In this thesis, the designer had to distribute points for each criterion for every design solution. These points range from one up to four and are based on a subjective scale. The existing methodology was altered, and scripting was implemented to study if the quantified output can help the designer in the design process.

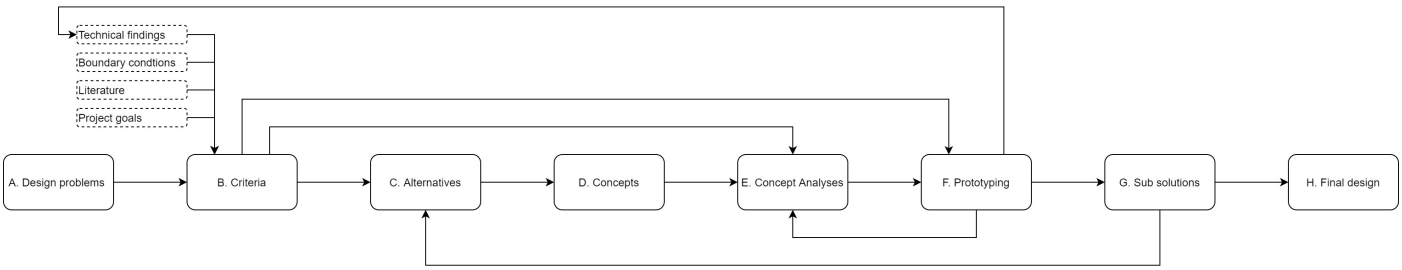

Figure 2: The design methodology by van Veen and van der knaap

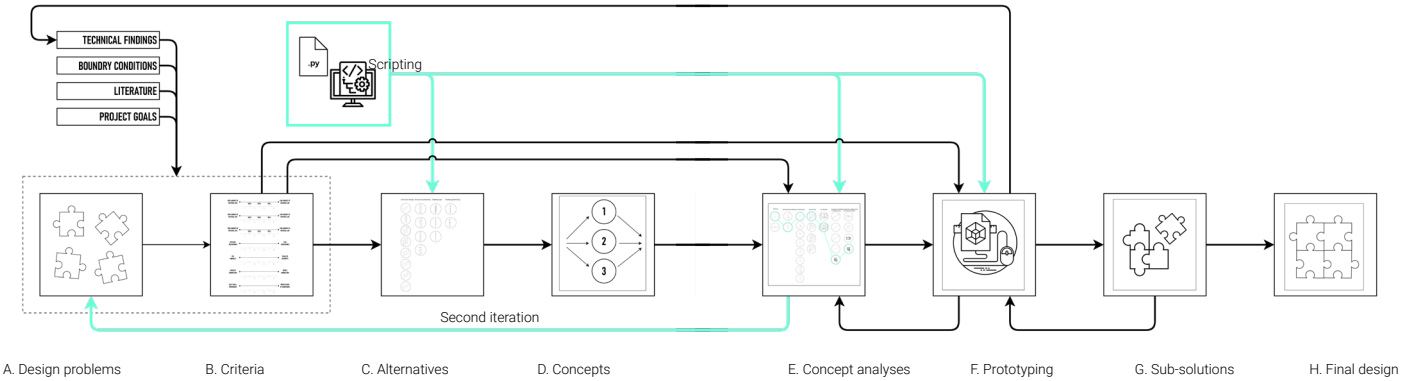

Figure 3: The altered design methodology

Adding scripting to the methodology was less effective than expected, especially in the earlier phases of the design process. Implementing scripting costs too much time for what the designer gains in benefit. Later in the design process, the value of the scripting increased. However, the implementation of the scripts did result in particular insights that positively impacted the design. The goal was to design an exterior wall element that can work with waste wood and minimize any additional waste created in this process. It helped me as a designer knowing how certain design decisions impacted the created waste and how much. Before the scripts, this was just an estimation. However, the true effectiveness of seeing the additional waste was during the prototyping phase.

The biggest problem I encountered with the design methodology is that I stayed too long in the design process trying to force an innovative design and waited too long with implementing the script. When this was realized, the focus shifted more on the scripting aspect of the design and implementing it within the methodology. The methodology was used in finding a design that can work with the challenges of waste wood rather than reinventing the wheel.

In hindsight, it would be better to change the focus on only the façade and create a more in-depth design. It became clear that the cladding and substructure make up for 74% of the waste wood used while dealing with the least requirements.

New research can be done by focusing on the connection between the cladding and the substructure and allow for a new façade system. Here the script can create a design that is not restricted by structural calculations. Without these restrictions, the selection procedure were the scripts selects the waste wood to be used for the façade can also be more efficient and minimizing waste.

SOCIETAL IMPACT

In 2015, 1610 million kg of waste wood was collected in the Netherlands. The building and demolition industry was, and still is, the most significant contributor. The estimation is made that in 2015, 23% of this wood, 370 million kg, consisted of solid waste wood. This solid waste wood has the potential to be reused as a building material without having to shred it. To this day, with the current waste wood processing methods, this high potential waste wood ends up being shredded for the engineered board industry or incinerated for bioenergy. The process results in additional carbon emissions and therefore have a negative impact on the climate. Besides this process, the Netherlands is facing two significant challenges:

1. There need to be one million additional houses before 2030 to challenge the increasing shortage.
2. The Dutch government stated that the building economy needs to be completely circular by 2050. This circular goal is to stop the significant impact the building industry has on the climate. Recycling waste wood into engineered boards is not considered circular. The engineered boards cannot be recycled again into engineered boards and can only be incinerated for bio energy. This is not in line with the circular economy.

The exterior wall element tool can contribute to the realization of the one million additional houses before 2030 while stimulating the circular economy and preventing the unnecessary incineration and downcycling of reusable waste wood. However, with the current timber frame construction methods, it is not possible to create an exterior wall element in a feasible way from waste wood. Combing the developed design principle with a parametric model can offer a solution to this problem. Here the parametric model can work with the constantly changing availability and dimensions of the waste wood. Adding digital manufacturing prevents a carpenter from having to manually modify every piece of wood. This can be a problem in the Netherlands, where manual labour is expensive. With digital fabrication, it does not matter that every piece of waste wood is unique because the modifications are all computer-controlled.

Another problem is the current registration of waste wood stream in the Netherlands. The estimation was made that 23% of the B-wood consisted of solid B-wood; this is not a fact. It is not required by law to separate B-wood in solid B-wood and non-solid B-wood. Therefore, it is also not possible to estimate the percentage of solid B-wood that is suitable for reuse.

The developed exterior wall element tool combined with the government's circular goal can create an additional incentive for the waste wood processors and demolishers to separate the reusable waste wood from the waste wood stream.

By analyzing and understanding the Dutch waste wood market, the developed tool can be integrated realistically. By doing this I wanted to prevent that the idea could never be implemented because it is too futuristic.

On a lower scale, the idea of having a database where waste wood can be sold on a national level can already be applied. This is already happening on a more fragmented level. Demolishers sell their dismantled products in their physical shop or online. Expending this to a national database only requires the online shops and demolisher to register the dimensions of each piece of wood. If the database works in combination with the exterior wall element, additional building components can be added to the tool. This process can result in a positive spiral. More parametric building components that are integrated with the database can create more motivation for the demolisher to dismantle more products instead of demolishing them. This can result in more contractors wanting to use the tool because the available wood increases. This process can lead to a more sustainable future where the circular economy plays an important role.