

Thesis Reflection

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Master track: Building Technology

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Project description

In this reflection paper, I will reflect on the process and design of the graduation year.

As a part of the “Adjustable, circular prefabricated system for Sustainable Building Renovation” general topic, my thesis intended to identify the contribution of the BIM software and, more specifically, the BIM components library. The main focus was on how the BIM library can facilitate the design process of a circular façade system for energy renovation.

This research was driven by my strong interest in circular economy and the aim to find a way to facilitate the application of circular design in renovation projects. Additionally, BIM software is a promising tool that can solve several practical and technical problems in the design and application of circularity and energy renovation.

Based on the observations, questions, and the goal of the project, the proposed research was focused on:

- The energy renovation needs and design principles.
- The circular economy in the built environment, how we can achieve a circular design, and how standardization and flexibility contribute to this goal.
- The BIM software and especially the function of a BIM library and its possibilities to the designer regarding the design process for a more circular and energy-efficient façade renovation result.

The general planning of the thesis can be divided into two parts, the first research phase, followed by the design phase. However, both parts should be categorized as research due to the exploring and experimental character of the design phase, where the investigation of relevant information never stops.

This journey of researching and exploring the potentials of BIM technology and the need for circular design and energy renovation allowed me to gain experience and knowledge, further enhance my interest in circularity, and grow my curiosity for BIM software.

Answer to the research question

The main research question of the thesis was:

“How can a BIM components library facilitate the design of a circular standardized facade renovation system that meets the energy-saving measures, and it is adjustable?”

After the thesis development and the extracted results throughout the process, the research question can be adequately answered.

A BIM components library can facilitate the design of a circular façade system for energy renovation in three different ways:

1. Group and organize the components in families in the library according to their function and their relevance with other components of the system. This can help the designer have a clear idea of the system he is developing and the adjustments that need to be done according to each project’s needs.

2. Data attached to the components of the library. Each component will have certain attached information that shows how circular and energy efficient it is. The designer should use this information to compare the different components and component configurations and make the most efficient design choice in terms of circularity and energy performance.
3. Quantification of the different components of the system and their different configurations in tables. This can effectively contribute to the higher standardization of the system, the minimization of material waste and time, and its overall circularity level.

The approach of the thesis did work to a certain extent. Certain limitations of the BIM software reduce the flexibility of the final design and the automation of the designing process that was the goal. The selected scope of the thesis and methodology influenced the final results. The decision to focus on the component level led to the final solutions and functions of the BIM library. If the scope were different, the extracted result would probably be different.

Final part framework

The final part of the graduation period will be filled in with the application of the different panel configurations at the selected case study building. With this process, I will be able to analyze how the actual design process will be with the use of the library and maybe identify any additional functions of the BIM library that can further facilitate the design.

Relationship between research and design

My research was about the three different topics, as presented above that are directly connected to the aim of the design. Before diving into the design phase of the thesis, I had to fully grasp the needs for an energy façade renovation, e.g., the façade system, the significance of each component, and the relationship with circular design. Additionally, I had to identify the design principles of circularity and the design part in general, the possibilities and limitations of a circular façade system, the standardization potential, and the level of adjustability needed. Then, in combination with the above, I had to clarify and explore the aspects and possibilities of a BIM library and what it means to design using BIM software and a BIM library.

The design methodology was decided based on the analysis of the above topics and by trying to identify their common points. Moreover, the thesis followed the research by design methodology. Thus the research and the design part are strongly related.

Relationship between the graduation (project) topic, the studio topic, the master track, and the master program

- Graduation topic: A BIM Components Library for Circular Energy Renovation Design
- Studio topic: Adjustable, circular prefabricated system for Sustainable Building Renovation
- Master track: Building Technology (BT)
- Master program: Master of Science Architecture, Urbanism and Building Sciences (AUBS)

The BT master track focuses on the sustainability of the built environment and explores how it can be achieved and maximized. Circularity and energy renovation are part of this process. Moreover, in this master's track, I got more technical and technology knowledge that I can use to maximize the sustainability of the design projects. This knowledge led me to select my thesis topic, explore the possibilities of the BIM software and have a more technical and digital design result without leaving out the importance of the analog design.

In my thesis, I focus on energy renovation, circularity, and BIM, which are all included as categories in the BT master track and are constantly being researched and explored. The thesis is a specific part of the more general studio topic that focuses on the use of BIM software to achieve the aim of the studio topic.

Elaboration on the relationship between the graduation project and the broader social, professional, and scientific framework, touching upon the transferability of the project results.

The graduation project touches on the current energy renovation and circularity methods and goals. It goes one step further by combining these two topics into one solution using a BIM library with the necessary components and attached data to facilitate the renovation process.

In the future, nZEB renovations and the expansion of circular design applications will be the main focus of the building industry. This thesis has a significant contribution to this extent. It can be used as a starting point for further research to feel the gaps in BIM software and extend the possibilities of the BIM components library.

Societal relevance: Many people can be benefitted from this project. The energy renovation will reduce the buildings' energy demands. Residents of buildings that will be refurbished will benefit from the energy retrofit of the building, which will result in a better quality of living. Engineers and architects are also aided since there are a lot of residential buildings that need to be refurbished. The circularity approach helps the overall environmental situation, and the standardization of the façade components and façade system helps the design application by reducing the time and the materials needed for the renovation. The manufacturing and construction phase can be more efficient and have fewer waste materials. BIM makes the design process easier, keeps the design choices up to date, and makes the stakeholders involved in the renovation from the early stage, which is crucial for the high quality of the end result. More precisely, this thesis project clarifies all the available solutions that the BIM library can provide the designers with to extract a more efficient façade system design regarding the level of circularity in combination with the energy performance.

Scientific relevance: This project is about identifying how a BIM components library can facilitate the energy façade renovation design by creating a circular standardized façade system with a certain level of flexibility. With the potential options of this design tool, the energy façade renovation projects can be optimized and simplified to an extent. The implementation of the circular design principles can be achieved. Circular design can be supported effectively and applied to renovation projects with various energy and design needs. This BIM library will contribute to creating a more sustainable and circular building environment and helping Europe achieve its goals for 2050.

Ethical issues and dilemmas

During the thesis, I encountered ethical issues and dilemmas during the research and design phases.

The solutions for an efficient energy renovation design often come in contrast with some circularity principles, especially regarding materiality and the need for customization. Thus, the key points that fulfill both requirements were intended to be identified. Also, the definition of circularity is challenging due to the multiple aspects and different levels of circular design and the various ways it can be applied.

Additionally, due to my lack of theoretical and practical experience with the BIM software, I encountered difficulties identifying how BIM can contribute to and facilitate the design process. In my opinion, that was the most challenging part of the process. Moreover, I had difficulty finding the balance between the 'traditional,' analog design process and designing with BIM and to what extent BIM design should and can influence the design process. I got lost and found several times trying to understand where I should invest more time and focus on answering the research question efficiently.

Throughout the entire process, the focus has been slightly shifted from designing the BIM library to finding the methods and tools that this library has or can potentially have to facilitate the design process of the energy renovation façade system. The scope was narrowed to the component level to identify and fully understand the solutions that the BIM library can offer.

Although my original ambition for this research was to come up with definitive answers and more efficient and automated solutions regarding the BIM library, the result was proved not to be attainable based on the current possibilities of the software. Nonetheless, the findings show several aspects of BIM that if they are evolved and automated, the application of circular design will be simplified throughout the entire renovation process, from design to construction. The results of this thesis should be tested and applied to different projects to identify the possibilities and limitations of the digital system to its full extent. Additionally, based on the findings of this thesis, a complete BIM components library should be created with all the necessary circular components for an energy façade renovation and all their different possible types and configurations.

Even if the final result of this research was not the desired, I hope that I have contributed to the knowledge of the BIM aspects towards circularity and that I have helped the designers and the other stakeholders of a renovation project to aim for circular solutions.