

# INNOVATION IN RENOVATION

Optimizing interior insulation application workflow

## Reflection

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**Aspect 1** the relationship between research and design.

The graduation project researches into the topic of energy friendly renovation process for protected and monumental house in the Netherlands and how the new insulation material and production technologies can help in a wider acceptance of interior renovations. A research to design approach is adopted as there are not many example cases of the material and technologies in use in the built environment.

The literature research led to identifying the drawbacks of current renovation strategies and challenges with using conventional insulation material. In the first phase, an extensive research was conducted to find super insulation material that perform better than conventional ones. A database is created that lists the properties of all material suitable for interior application. The production companies of the insulation (Va-Q-tec, St. Middelkoop, BZW Holland) were contacted to understand the practical challenges in application. Their inputs helped formulate the desired characteristics of the final design.

The second phase covers optimization of the workflow of the renovation process to reduce the time taken on site and the disturbance to owners/occupants. Literature research revealed the project reports of various research programs which focus of process and product innovation. Faro, a laser scanner manufacturing company were contacted for a demonstration to scan a room at the Faculty of Architecture at TU Delft. Starting from the measurement of interior spaces, the design evolves from the thought of streamlining the process by integrating digital data capture with a prefabricated system for an accurately dimensioned integrated wall insulation solution finished in the factories and assembled on site.

**Aspect 2** the relationship between your graduation (project) topic, the studio topic (if applicable), your master track (A,U,BT,LA,MBE), and your master programme (MSc AUBS).

The graduation topic on energy renovation of the interior envelope looks into different specialities of the master program. Disciplines from renovation of heritage buildings, material science, design informatics, facade design and building physics are integrated into the research. As a building technology student, the research aims to first analyse the current practices, identify the challenges barriers, find possible solutions to overcome the challenges and suggest steps to take in order to achieve the desired results. The outcome of the research is a workflow that includes typical construction details that can be adopted with little modification for any special case study .

**Aspect 3** Elaboration on research method and approach chosen by the student in relation to the graduation studio methodical line of inquiry, reflecting thereby upon the scientific relevance of the work.

The thesis research question is 'How can the advancements in insulation material and production technologies help to optimize the energy renovation process of interior envelope?' with a vision to create a insulation application workflow that will be digitalized to reduce on-site interference.

To achieve this vision, extensive research has been conducted in field of insulation material, digital data capture and product design solutions. The findings are documented to compare results and find the best fit solution for each situation.

Considering advance materials and production technologies, information was limited and hard to come by. Due to uncertainty of the way forward, It was unwise to narrow the research at an early stage. The methodology evolved as the research progressed. A fall back plan B was required in case things did not go as planned.

The method presented with a unique chance of interacting with pioneers in the fields. Top laser scanner producing company, Faro agreed to do a demonstration which helped to first hand experience the technology and understand the principles.

The methodology relies on market research and interaction. In some cases technical data sheets could not be accessed. The post processing of the laser scan point cloud turned out to be complex and required specialised software skills which could not be learnt in the time frame. The research spans into multi-disciplinary fields and makes it easy to get lost in literature and start walking on a track that is not the focus of the project. Mentors critiques were helpful in not losing sight of the goal. Multi tasking on different steps simultaneously proved to be an unsuccessful and confusing venture leading to fragmented data that took time to sort and order.

**Aspect 4** Elaboration on the relationship between the graduation project and the wider social, professional and scientific framework, touching upon the transferability of the project results.

**Social relevance :** Homes come with a lot personalized spaces that holds an emotional value and can make the renovation process very sensitive in nature. Energy efficient renovation are probably last on their list of works to do outed by kitchen and toilet tile upgradation. Therefore, It becomes important to make people believe that investing in energy saving measures will have a positive impact on their lifestyle, comfort and energy bills.

Home renovations are centric to the occupants and every decision has a direct impact on their lives. The approach to design is based on the People, Planet and Profit (PPP) model with identifying the interest of people, then address their interest using measures that also represent the interest of planet and lastly plan financial models to invest in such measures. The thesis proposes an optimized workflow of the renovation process to reduce the impact on occupants by reducing the time spent on site and streamlining the production process such that no work would be done on site in a bid to make energy renovations more accepted in the society.

**Scientific relevance :** The graduation project plays a role in the bigger picture of tackling climate change by making existing protected homes energy efficient with adding insulation. In the Netherlands, as with other European countries, a large stock of the existing buildings have the status of protected building or as monuments. As a result these buildings can not undergo any renovation that will alter or impact the facade aesthetics and are therefore not required by the

law to meet with the energy performance requirements. Renovating the envelope from the interior can be the key to solving the problem.

Technological advancements with machine learning provide the means to automate process. Technologies such as 3D laser scanning and photogrammetry makes it easier to get accurate dimensions hence aiding in industrialising the production process in turn reducing the onsite time. Production techniques such as prefabrication, modularity, plug-and-play decrease the onsite assembly risk and human error. The advancements in insulation material data sheets are helpful in providing consolidated knowledge and design choice without compromising the energy performance.

Aspect 5 Discuss the ethical issues and dilemmas you may have encountered in (i) doing the research, (ii, if applicable) elaborating the design and (iii) potential applications of the results in practice.

The potential ethical dilemma that might be faced in practice would be cost versus performance. The current market prices of the insulation material is significantly higher than the common insulations. A digital data capture equipment is better suited for very complex spaces where manual measurement is not possible. Convincing home owners to spend extra money to save space and/or improve comfort would be a challenge.

Another ethical dilemma faced while researching materials was defining the material selection criteria. The bar was kept only at thermal performance and section thickness. There was a dilemma to consider bio-based products for their environmental performance but sustainability of insulation does not seem to be a pressing challenge for interior renovation.