Graduation Plan P2

18 January 2013

PERSONAL INFORMATION

Name: Paressa Loussos

Student number: 1373528

STUDIO

Master: Architecture, Urbanism & Building Sciences

Studio: Building Technology, Design & Technology Graduation Laboratory

Theme: Increase the energy performance of residential buildings by refurbishment, while keeping the total life cycle energy low and considering the environmental impact.

Argumentation choice of studio: In the studio of Building Technology it is possible to concentrate not only on the design of a building skin, but also to do more research into the possibilities of materials and their properties. I find it important to do more research into materials and their environmental influence before using them in a design.

Mentors: First mentor: Arie Bergsma

Second mentor: Andy van den Dobbelsteen

Third mentor: Thaleia Konstantinou

TITLE

Life cycle façade refurbishment for post-war residential buildings

PRODUCT

Problem statement

Greenhouse gas emissions, due to excessive use of fossil fuels, have recently led to global warming. The building sector is a large consumer of these fossil-fuel-based energy systems.
For some older residential buildings the energy consumption is very high, especially buildings made before 1975. By refurbishment the energy performance of these homes can be improved, to lower the operation energy.
To lower the complete life cycle energy, the operation energy needs to be considered together with the embodied energy (measured in Joule). The environmental impact also needs to be considered. This includes the embodied energy use, but also considers for example global warming and ozone depletion potential. To lower the environmental impact as much as possible, reusing and recycling of materials might be taken into consideration as well.

Goal

An approach will be developed that can be used for a residential building to improve the energy performance (operation energy), while also considering the embodied energy and other factors that influence the environmental impact. Also the effect of using recycled and reused materials on the environmental impact will be researched.
By literature study and example studies in different aspects (refurbishment, energy performance, materials and reusing and recycling), knowledge can be gained to develop this approach.
By this literature study an overview can be made of materials that are good for the environment, while also improving the energy performance. By using the approach that was developed, this knowledge of materials will be implemented into a case study, which represents a certain part of the residential building stock.
A design for the case study will be made with this approach, and calculations will be made to try make the total life cycle energy and environmental impact as low as possible, compared to the old situation. Also the influence of using reused and recycled materials on these factors can be concluded. This way, recommendations can be given for other designers to use certain materials for building components for a façade refurbishment.

Boundary conditions

The research will focus on the following aspects:

-Refurbishment of residential buildings. A choice will be made for a certain type of building from a certain period for the case study to focus on, but the results and recommendations may also be applicable to other building types.

-Design for one case study, for the façade specifically, with a focus on the energy performance. Installations, heating/cooling and ventilation will be taken into consideration, but this will not be the main focal point.

-Assessment of possible building materials for certain components of the façade, considering material properties, energy performance and environmental impact, applicable for that specific case study.

-A lifetime of the building and façade of at least 20 years.

-EPC calculations for the energy use.

-Greencalc+ for the environmental impact and possibly also hand calculations for the embodied energy specifically if needed.

-Thermal comfort can be considered (for example by a survey or by complaints of the residents) to see what improvements need to be made for the case study, but the comfort will not necessarily be assessed in the final design.

Main research question

How can the façade of a post-war residential building be refurbished, to make the operation energy and embodied energy (life cycle energy) as low as possible, while also considering other factors that influence the environmental impact?

Sub questions

Refurbishment	1. What measures can be taken to improve the façade of a (residential) building with refurbishment?
Energy performance	2. How can the façade be upgraded to increase the energy performance of a (residential) building?
Materials	3. What materials can best be used in the façade (for refurbishment) to lower the environmental impact, with a focus on the embodied energy?
Reusing/recycling	4. How can reusing and recycling of (façade) materials contribute to lower the environmental impact, with a focus on the embodied energy?
Component overview	5. What are the best materials to use for different components of the façade, to lower the energy use and environmental impact?
Case study design	6. What approach can be used to lower the energy use and environmental impact in façade refurbishment of a residential building, (and how can this be implemented onto the case study)?

PROCESS

Method description

In figure 1 the structure of the thesis is shown. The numbered parts represent the different chapters of the thesis, organised in four sections: introduction, literature research, case study design and conclusions. In the first section an introduction will be given, together with the graduation plan.

For the second section a study will be made on the different parts of this research, namely refurbishment, energy performance, materials and reusing and recycling. This is to get a theoretical background of these different aspects, but also to make a choice for a case study building and to be able to develop the approach to be used for the chosen type of building.

Concerning *refurbishment* and *energy performance* a literature study will be done. Different strategies and principles to refurbish will be examined. Also a study will be made of different components and materials used to increase the energy performance by refurbishment. Finally a study will be made in different residential building periods and types, also to find the type that is to be examined in this thesis by the case study. For the two parts, refurbishment and energy performance, example buildings will be analysed, to help answer some questions. With the help of this research a residential building type will be chosen, and certain tools to use in the approach will be assessed.

Another part of the research is the environmental impact of the *materials* used in refurbishment, with a focus on embodied energy. Here also a literature study will be done, to see what tools can be best used to answer the research questions. Also LCA will be examined further, to see in what way this approach can help in this thesis. Example buildings and other case studies will be examined for this part.

Also for the 6th part, *reuse and recycling*, a literature study will be done, together with examples and other case studies.
In part 7, an approach will be developed with the help of the previous gained knowledge, to best handle the refurbishment design. The literature study will help to make an overview of building materials (part 8), which can be used for the case study.
This approach will be implemented into a case study, to make a refurbishment design with as low operation energy, embodied energy and other factors that have a bad influence on the environment as possible (part 9). The approach also depends on the type of building, so these two parts need to be adjusted to each other. Also during the development of the approach and case study design, the literature study needs to be evaluated and adjusted again, together with the overview of materials possibilities.
In this research an emphasis will be put on different materials for different building components. This way, recommendations can be given in the last chapter that also can be used in other projects.

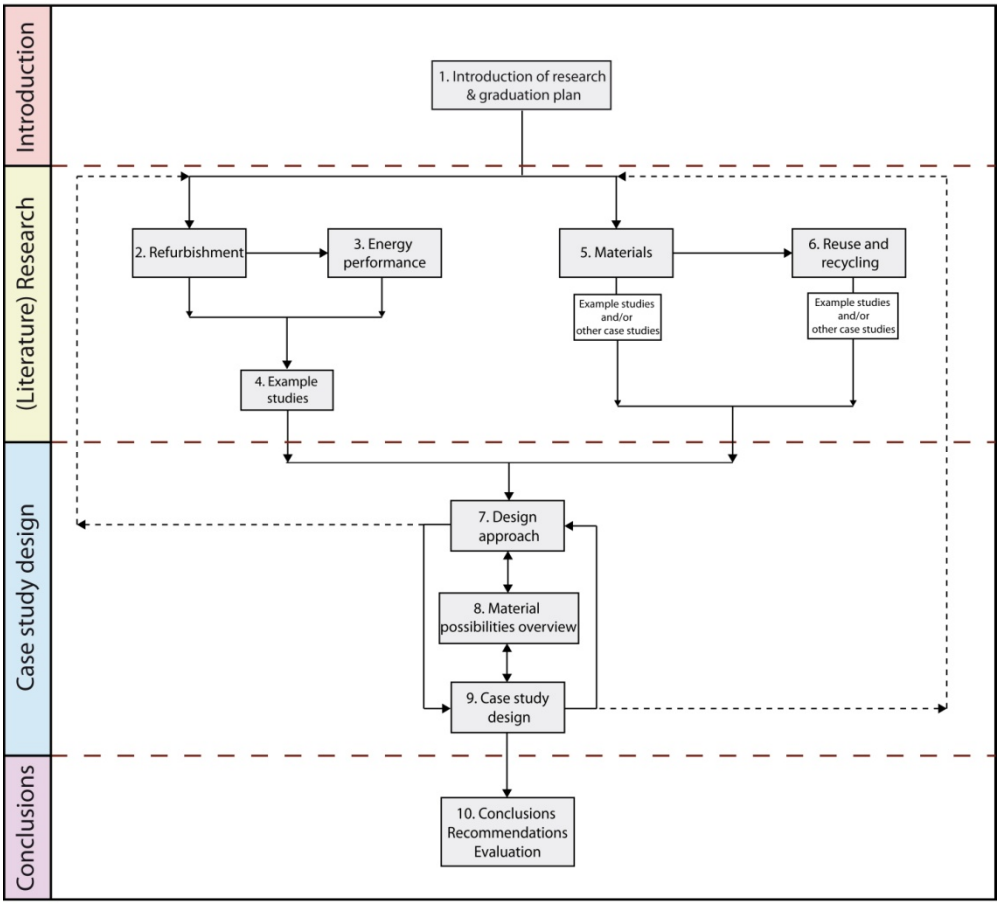

Figure 1: Research structure of the thesis

Literature

Already studied or used in preliminary research

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Yudelson, J. (2010). *Greening existing buildings*. New York: McGraw-Hill.

Still to be studied:

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Hendriks, C. F. (1999). *Duurzame bouwmaterialen*. Best: Aeneas.

Hendriks, C. F., Nijkerk, A. A., & Van Koppen, A. E. (1999). *De bouwcyclus*. Best: Aeneas.

McDonough, W., & Braungart, M. (2002). *Cradle to cradle: remaking the way we make things*. New York: North Point Press.

REFLECTION

Relevance

Improving the energy performance of the existing residential building stock is an important issue, due global warming and depletion of fossil resources. But apart from this also the impact of the materials on the environment and energy use need to be considered, from the beginning of the design process.
Specifically for a case study (which represents a certain part of the existing building stock) the total life cycle energy will be made as low as possible by using an own developed approach. By this design of the case study and the rest of the research, recommendations can be given for other designers, to use certain materials for building components in general.

Time planning

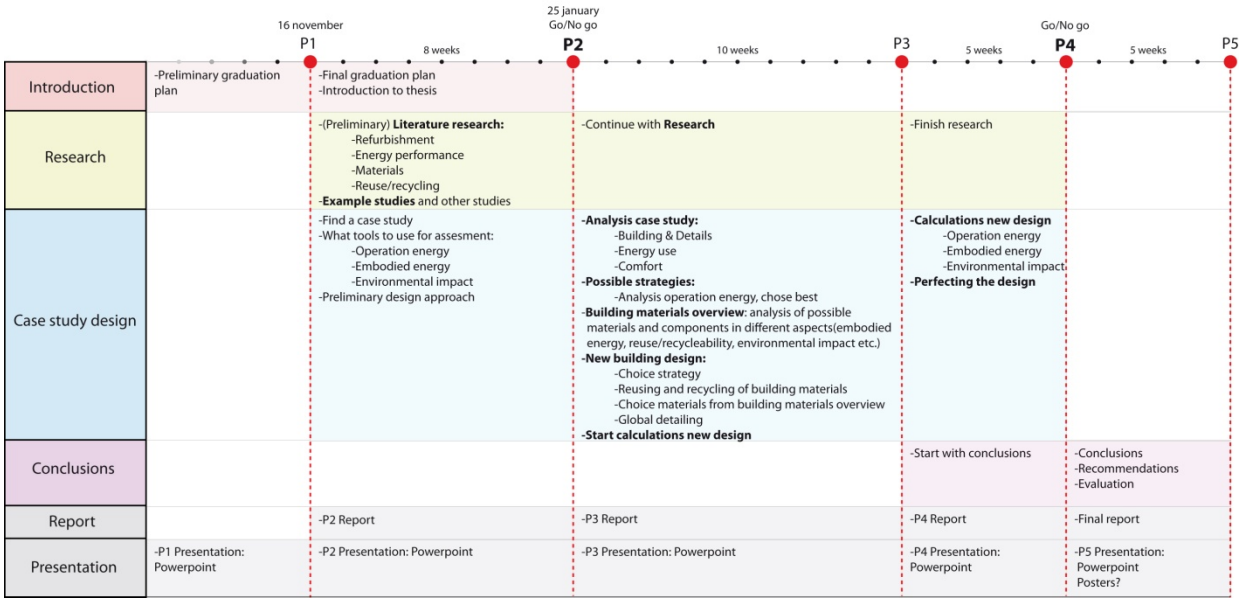

Figure 2: Time planning of the thesis