Building Transformation by Reuse and Recycling

Creating an inventory for reusing and recycling building materials from an existing building for a change of function

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Argumentations of choice of the studio
The choice for this studio, Architectural Engineering was made, because it is very open and gives free possibility of design and research direction. Designing with the focus on an technical aspect of the architectural world that is the theme of the project makes it interesting.

Keywords
Building components, Reuse, Recycle, Transformation, Circular building, TU Delft

Introduction

There are a few aspects that led to the idea for the project and associated research. The general theme for the project will be the reusing of waste, in this case waste being on a large scale a building itself or on a small scale the individual building materials. Important is that the chosen site is the Campus of the TU Delft, mainly because it can be the perfect place to showcase new ideas of treating buildings in new or not commonly used ways. Following are the stated problems, opportunities and ambitions that are the basis for the upcoming project.

Problem Statement

Outdated building on TU Delft Campus

The Campus of the TU Delft contains some buildings that are getting outdated and correspond therefore no longer to todays standards. Furthermore, the TU Delft has the ambitions to become CO2-neutral before 2030 (T. Blom & A. van den Dobbelsteen, 2019). In order to achieve this goal, amongst other things, some of the buildings on the campus need changes to comply with the set standards of 2030. One by one buildings are renovated. Building 22 is one of the buildings on the campus that is in relatively bad conditions. It is currently the faculty for technical sciences (TNW). The TU Delft already decided to move the faculty to a new building that will be build in the upcoming years. This building, Physics, will be build in the southern part of the Campus. This leaves the current building unoccupied. Currently the building gets improvements to keep it usable until the Physics building will be finished. The problem is that this building will no longer serve it's purpose in the future and can therefore be a waste of space, material and potential if it will not be used for a good purpose.

Campus needs

In figure 1 is shown how the problem statement leads to the objective and the field of research for the research paper. The main problem is the outdated building 22 on the campus. Three possible options to handle the situation are proposed. The first one is demolishing the current building and replace it with a new design. However, this option is counted out, because the TU Delft has the ambition to not demolish any building on the campus, since demolishing and building a new building always leads to a less sustainable outcome than renovating or transforming. The most sustainable option is to renovate the building, because less interventions are needed for this than transforming the building. However, there are reasons to choose for choosing for transformation in the case of building 22.

First of all, the current faculty that is based in this building, will move to a new building that will be build very soon. That means that the current function of the building will expire. Of course the building can be of educational use, but there might be a need for changes anyways, if another field of study will occupy the building.

Secondly, the TU Delft has some ambitions that might fit very well at the location of building 22.

The TU Delft recently announced that they want to expand with 40% on the number of students (Schouten, 2022). They want to grow from 28.000 students to about 40.000 students. The shortage of housing in the Netherlands has been a problem for a while and will continue to be a problem in the coming years ("'Woningtekort Wordt Komende Jaren Alleen Erger'," 2022). Furthermore, an housing agreement has been made to provide a million more houses between 2021 and 2030. This proclaims the general need for housing. This poses the challenge to provide the students with housing, if they want to attract students to study at the TU Delft, besides enlarging the campus on educational functions.

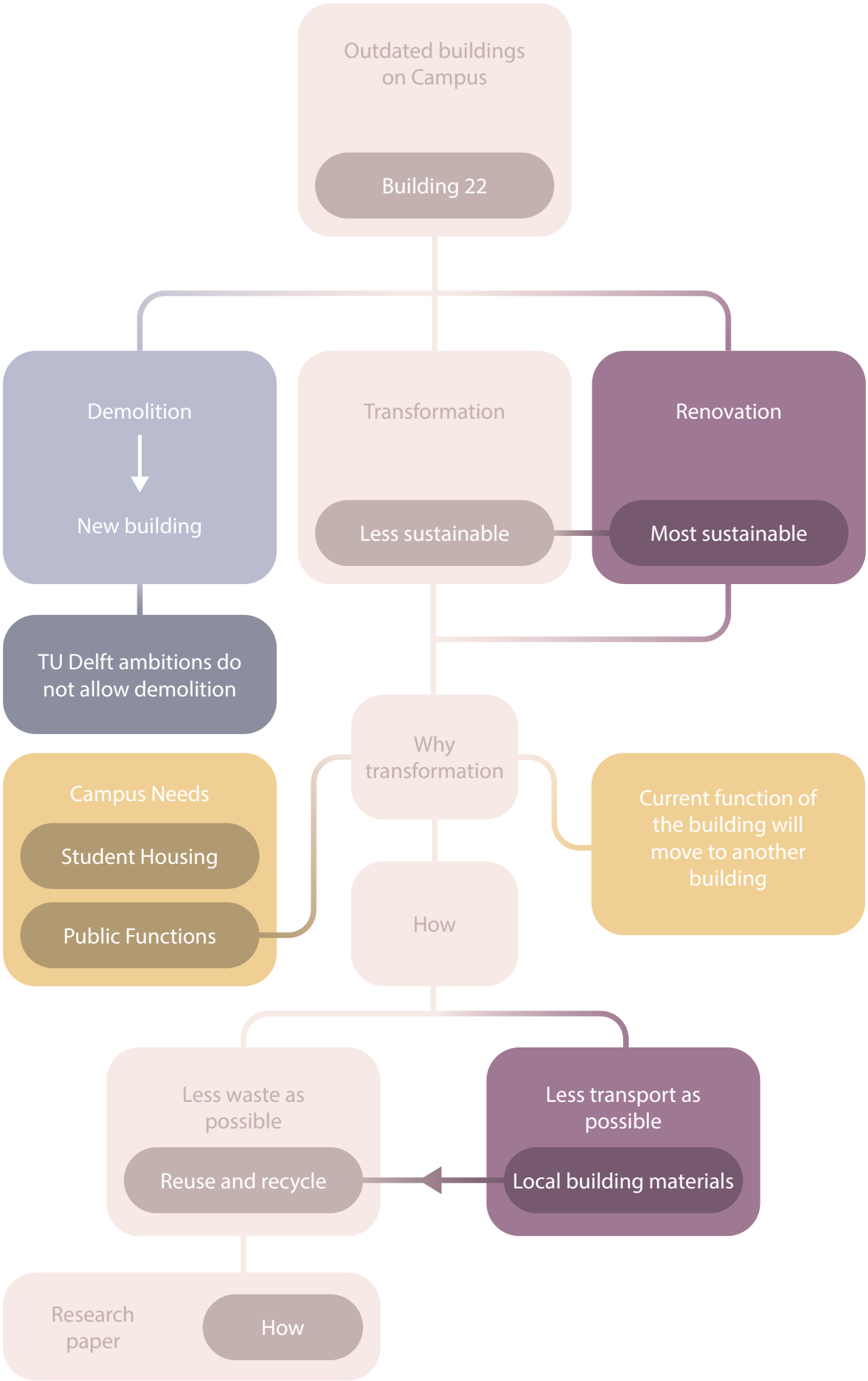

Figure 1 - Scheme of Problem statement and field of research

It's needless to say that the Campus of the TU Delft is focused on educational buildings. As shown in figure 2, most of the buildings on the Campus are educational. Besides that, housing and some (TU Delft related) companies are on the Campus as well. The TU Delft has the ambition to add more non-educational functions as well. By doing so, the Campus would get a stronger relation with the city itself, commuting gets reduced and energy use more balanced (T. Blom & A. van den Dobbelsteen, 2019). During the day, the campus can be very lively and busy, but as soon as the educational hours are over, the campus turns empty. In order to change this and make the campus an area that is lively also after educational hours are over, other functions are needed to keep people make use of the campus.

Figure 2 - Building functions in radius of building 22

Waste of building Industry

Waste is usually seen as a negative result of everything we create or do. It doesn't have to be something negative, as long as we use it and give it a purpose. The largest waste producing industry is the building industry. In the Netherlands the amount of waste produced by the building industry is almost a quarter of all produced waste (Centraal Bureau voor de Statistiek, 2019). Although the Netherlands recycles relatively a lot of it's produced waste, the effectuation of it is not ideal. A lot of the recycled materials from building waste is used for things like roads. In this way the material loses it's potential value and the building industry most likely still ends up producing building components from raw materials. The way we deal with waste, as well as the way most of waste gets processed and recycled is unsustainable and should change.

Waste process transportation

The emissions of transportation are rising and are expected to increase (Mathur & Farouq, 2021). Furthermore, The construction industry takes up a lot of transportation. Therefore, the carbon footprint left behind by construction is not only found in construction itself, but also in the transportation

of building materials. Recycling waste from demolished buildings instead of using new materials is a good way to lower the carbon footprint. However, usually waste is collected at several places per region or city, gets sorted and send off to a landfill, or in case of recycling, brought to a factory that uses the waste to turn it into something useful again. This process includes still a lot of transport, causing impact on the carbon footprint of transportation, which is maybe not always taken into account, but absolutely of importance in the building industry.

Summary of the Problem Statement (figure 3)
Building 22 (Physics) is in terms of technical properties outdated. The location has opportunities for other functions in the building like public functions and student housing. In order to transform the building and do this as sustainable as possible, the production of waste and emissions of transport as a general problem should be taken into account.

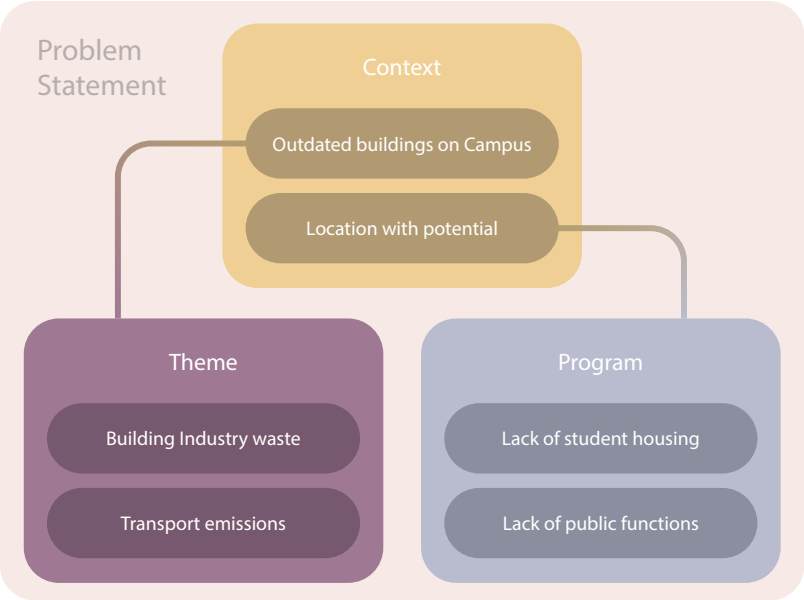

Figure 3 - Schematic overview of the problem statement

Objective

The proposed strategy is to use all the retrieved materials from the building by directly reusing them and otherwise recycle them. This will most likely not produce enough or the exact needed building materials for the new building. In that case other buildings, that are up for demolishing, in the vicinity will be explored to retrieve the needed materials. The last option will be to use new materials, but preferably as less as possible. Using this strategy will also reduce the need for transport considering the building material supply. The retrieved materials from the old building can be sorted on location. Components that can be directly reused can stay on the location, while recyclable materials can be brought to local facilities that can turn it into new building materials. If more building materials are to be retrieved from other buildings, the distance of transport can be kept down by looking for buildings within a close range of the project.
Building 22 (Physics) has an educational function. To be able to expand, the Campus needs to expand and build new buildings. A new building will be developed for the faculty of Applied Physics. Therefore the current building will lose its function as soon as they move the faculty to the new building. By keeping the educational function, the building might need changes anyway to serve another field of study. That, in combination with the prominent location of this building, which has potential to make the campus more lively since it's located central are reasons to transform the building.
Regarding the functions, the campus needs student housing and other public functions that broaden the activities on the campus during the whole day. Therefore the ground floor of the building can be used for functions focused on campus activity, while the levels above can be used for student housing.

Summary of the Objective (Figure 3)
The main objective of the project is to transform building 22 (Applied Physics) into a building with public functions and student housing and therefore fulfilling the contextual needs, by reusing and recycling as much of the original building materials to keep it a sustainable option as much as possible.

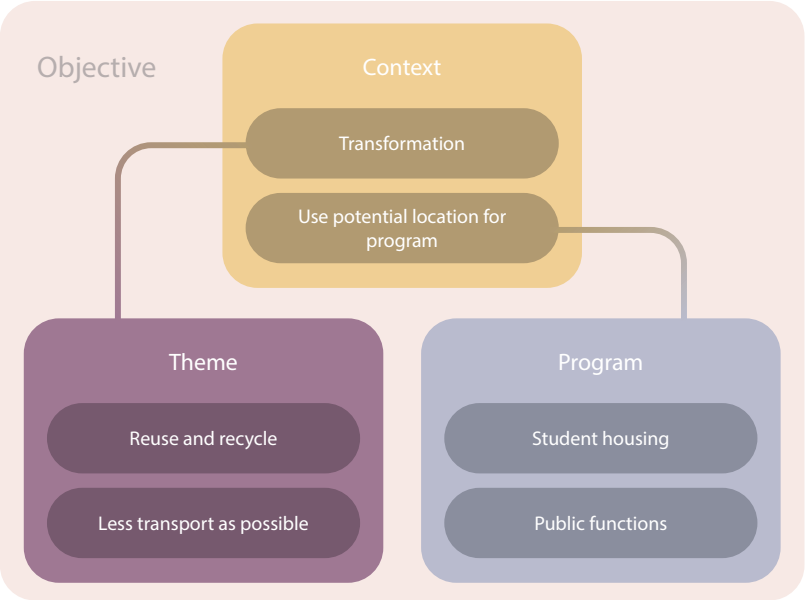

Figure 4 - Schematic overview of the Objective

Design Question

The design question is:
How can building 22 Applied Physics be transformed from educational function to public functions and student housing by keeping the existing building structure, and reusing and recycling building components of the existing building?

The design question will be the basis for the project of transforming the current building of Applied Physics. As explained earlier, the building will have public functions and student housing. The ratio of these two functions will be a point of interest within the research for the design of the building. Reusing and recycling the building components of the existing building will most likely not provide enough building materials for the whole new building. Therefore other buildings in the vicinity that are up for demolition can be explored to use as well.

Research Question

There has already been research conducted by Nienke Scheenaart (Scheenaart, 2021) into the reuse of reclaimed building components of the Applied Physics building. She focused on the materials of the building envelope. Therefore this research will be about the interior materials that, apart from the structure, can be reused or recycled. Together, this will provide a more complete overview of reusable building materials from both inside and outside. Furthermore, the transformation plays a role in the project, for which other ways of reusing and recycling might be more convenient. Accordingly the thematic research question is:
How can reclaimed building materials from the interior of building 22 Applied Physics be reused or recycled for the transformation from educational function to public function and student housing?

Sub questions are:
1. In what ways can interior building materials be reused and recycled?
2. What repetitive building materials or components can be reclaimed from the interior of building 22 Applied Physics?

3. What interventions are needed to change the building from educational function to public functions and student housing?
4. How can these building materials or components be reused in order to fit the needed interventions?
5. How can the not reusable materials or components be recycled to fit the interventions that are needed?

The research creates an inventory for the design project of what building materials are available from reclamation from the existing building. Besides that, it will lead to a methodology to find out how reclaimed building materials can be reused and recycled from existing buildings.

Methodologies

As shown in the diagram of the research plan (figure 5), the first sub question will be answered by literature review into methods and examples of how building components can be reused and recycled into what. For the second question the site will be visited and drawings of the building will be explored to discover de availability of interior building materials. Literature review and, if needed, case studies will be used to answer the third sub question. The accumulation of all this gathered information will be the basis to answer the third and fourth sub question. This will create an inventory for the design and be a tool to answer the design question.

Planning

The planning can be found in the appendix.

Relevance

There is a lot of information available about reuse and recycling building materials and the strategy of urban mining. So in that area, the research will most likely not add on more information. The research is case specific, because building 22, Applied Physics, will be explored. Existing information on reuse and recycling in combination with case specific information will lead to an inventory for the upcoming design of the project. Therefore, the outcome of the research is relevant for the future of the building in question. However, the research will hopefully also produce a methodology for inventory of reuse and recycling, which would be applicable on other buildings as well, as a by-product. This can be relevant in a larger scope of the building industry, making it more accessible to reuse and recycle building materials and therefore working towards a more sustainable future.

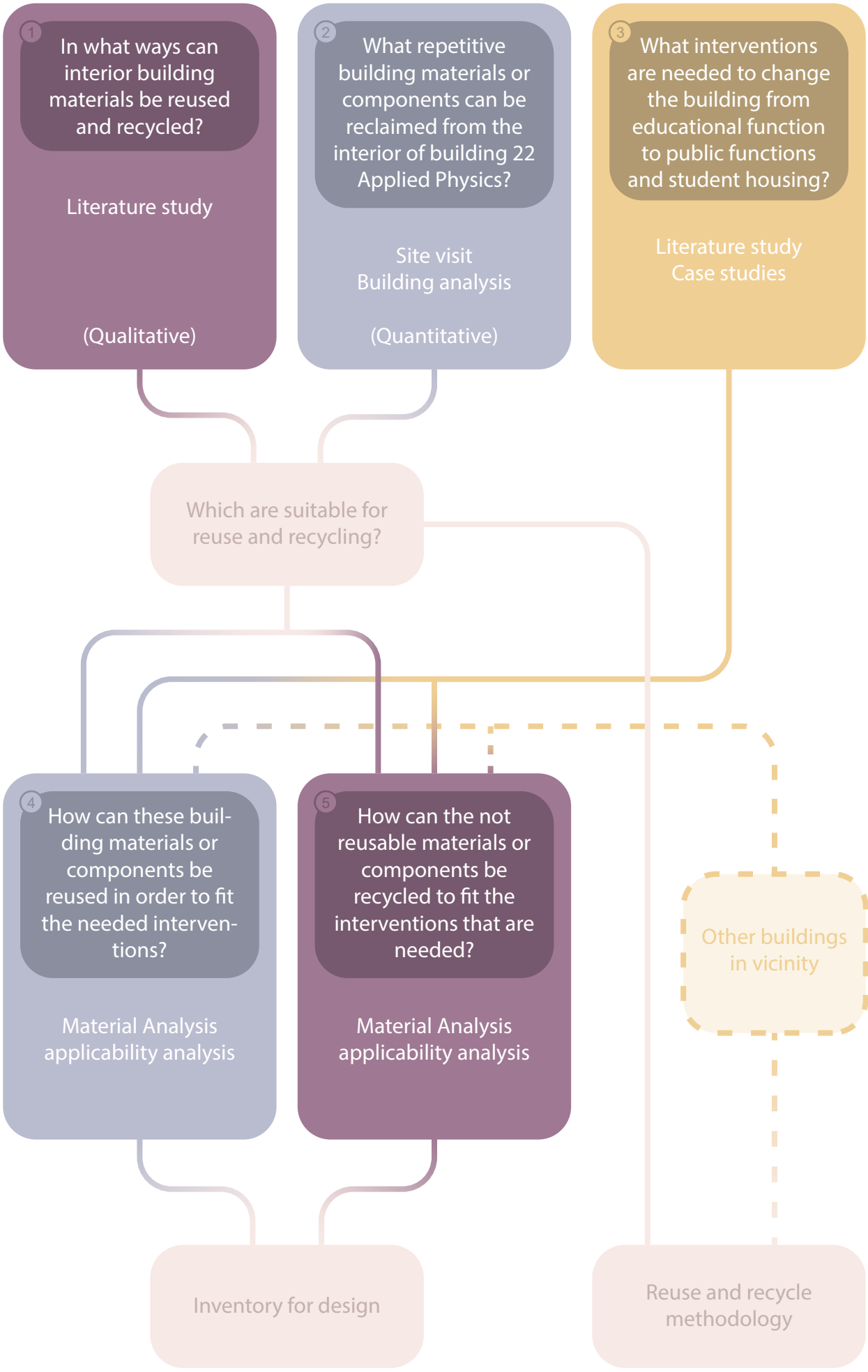

Figure 5 - Schematic overview the research and methodologies

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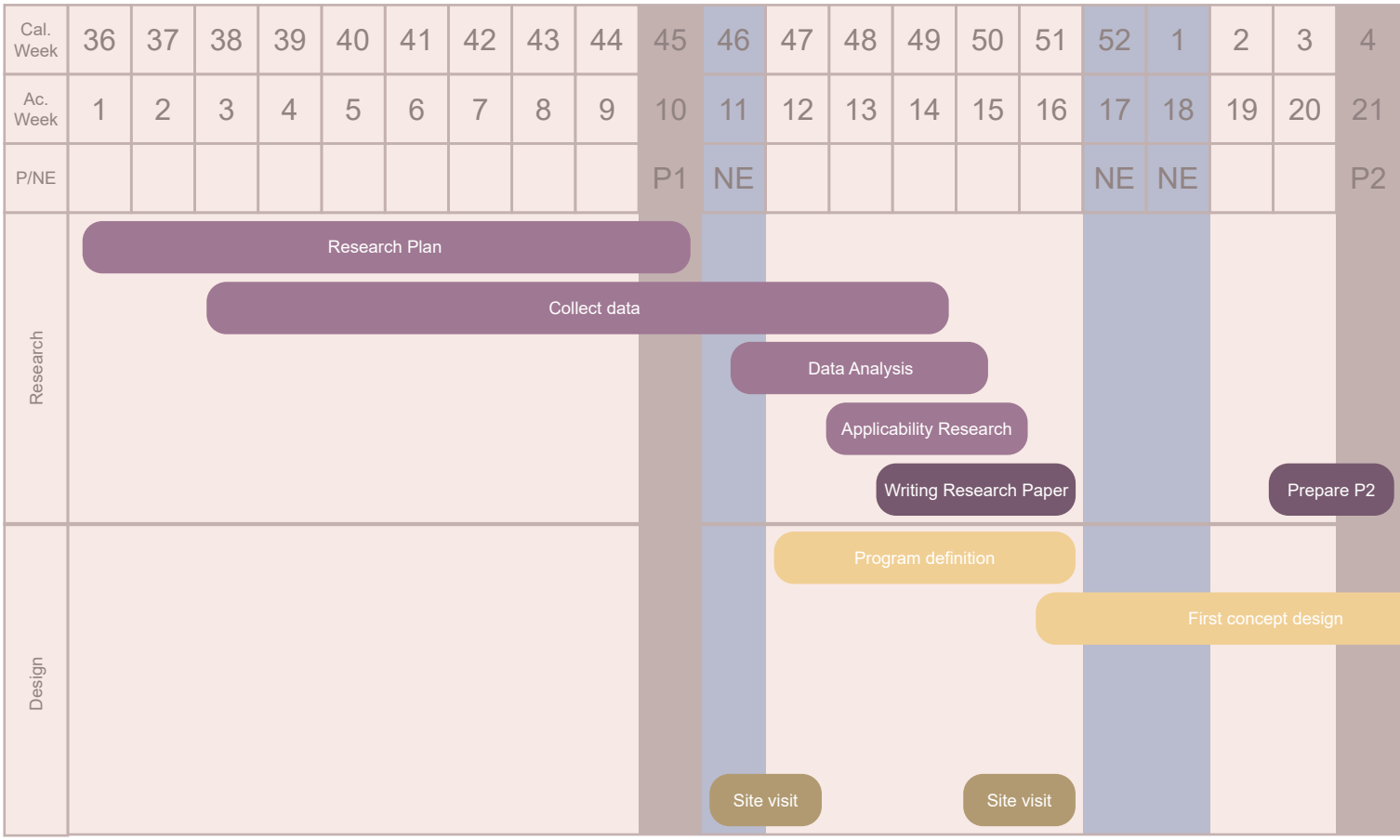
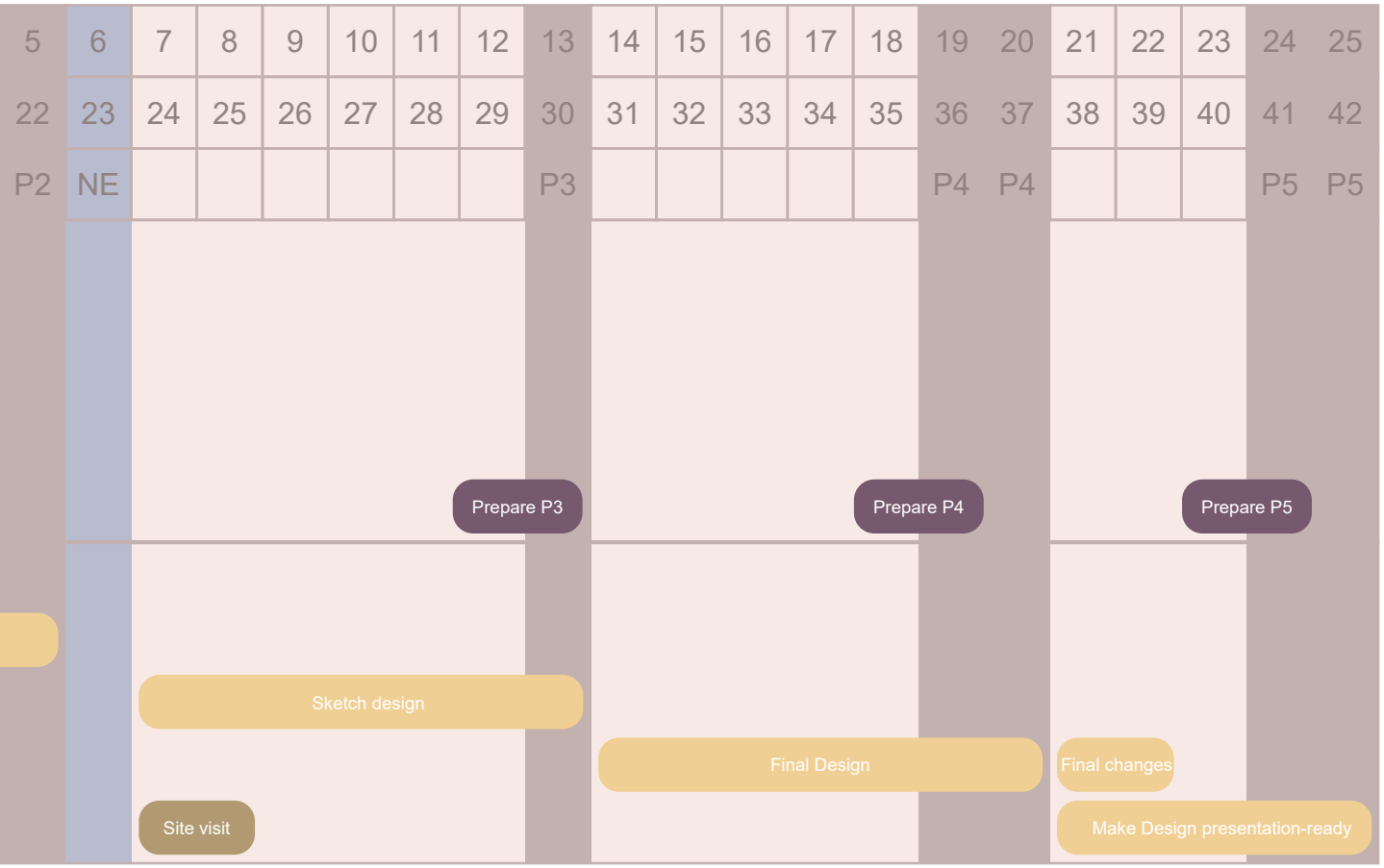
Appendix

1. Graduation Planning

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P2 NE P3 P4 P4 P5 P5
Prepare P3
Prepare P4
Prepare P5
Sketch design
Final Design
Final changes
Site visit
Make Design presentation-ready