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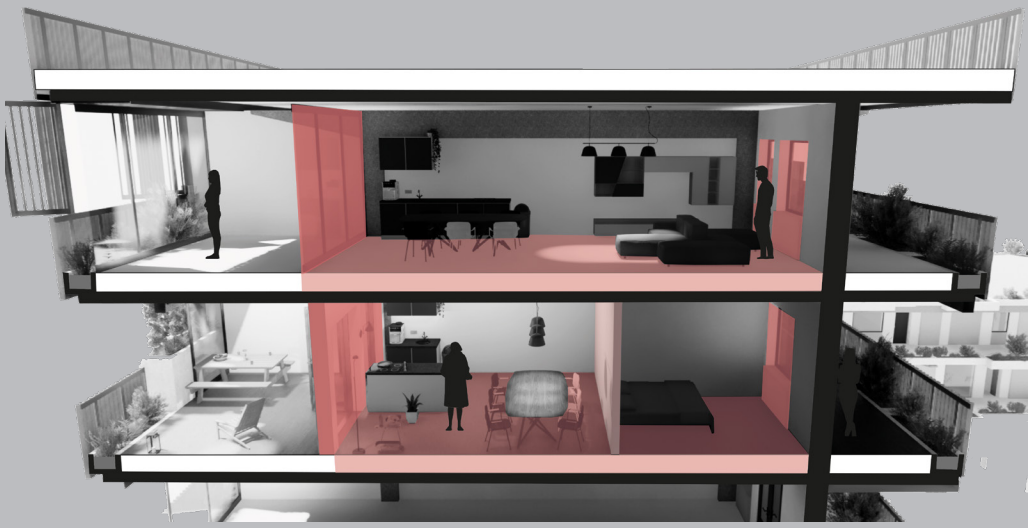

Adaptability as a means to create more social and environmental sustainability

Graduation booklet *Advanced Housing Design*

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Preface

Acknowledgements

For the graduation studio Ecology of Inclusion this booklet is created as a final showing of the process I went through this year. For the successful completion of this graduation course i would like to thank my first mentor Olv Klijn, whose insights about architecture and the process of the course helped me immensly. Also I would like to thank Anne Kockelkorn for steering the incoherent thoughts about modularity, flexibility and much more into a complete and coherent research paper. I would like to thank Ferry Adema for his optimism and passionate thoughts about building technology and the project as a whole. For helping me by listening to my rambling about my design and research I thank my parents. And my dad for helping me finish the model together.

This project was not without struggle, and as I create this booklet I am once again stressed and worried about a million things. For keeping my head secured on my body and keeping me focused throughout this stressfull time I want to thank Machteld. Without you I'm afraid I would not have finished this in the same way that I have now.

Introduction to the Booklet

This Booklet is a complete view on a year filled with research and design. It is divided into a few parts that all are presented seperately, but work together to create a cohesive and well argumented graduation project.

I start with the research I conducted in, after, and around the christmas break. This is the startingpoint of my design, and gave me a view of possible solutions that I use in the design. As wel as teaching me how to best implement these solutions.

The research is followed by the design. In this part a complete view on my design is presented. All explained mostly by drawings, sometimes in combination with text. The design shows a dive into the creation of adaptable housing solutions that are not only flexible, but also are actually adaptable throughout time.

After the design a short graphic novel is shown that gives the building life. For a project that is so intertwined with use and user-control the novel gives a perspective on how life works in the building. The graphic novel uses a visual story to show the realisation of adaptability in the built environment.

I will end the booklet with a look back at how the process went the last year. This reflection will be a view into how i personally experienced this year. Also it gives some insights into the relevance and placement into the scientific discourse of the TU Delft and the Faculty of Architecture and the Built Environment.

Research

Problem Statement

Concerns about the housing stock are growing. You only have to turn on the news and chances are that the term 'housing crisis' will pass the revue. Issues linked to the housing crisis include: the commodification of the housing stock, high demand for houses, and rising land prices.

According to Tatjana Schneider and Jeremy Till[1] these issues create a tendency of conformity in dwellings, because houses tend to sell very easily, therefore developers and sellers have no incentive to innovate or add extra value to the objects they are selling. (Schneider & Till, 2005)

These non-innovative dwellings are inherently inflexible and hard to adapt. Flexibility costs more to implement, if the focus is only on monetary value, it is not "valuable" to make flexible dwellings. Schneider and Till argue that this inflexibility leads to "the housing sector [..] building in obsolescence". (Schneider & Till, 2005, p. 164)

Before Schneider and Till, scholars like John Habraken[2] took notice of rising problems in the housing stock. More than 50 years ago in 1961 Habraken wrote about the so-called "natural relationship", which he describes as the connection an individual and society has with its urban surroundings. The "natural" part of this concept is not about nature perse, but refers to the "relationship" being present by itself, meaning it happens without effort from humankind. This relationship is a necessary component of living according to Habraken. To live is to act in and with one's surroundings. He argues that after the rise of 'mass housing' this relationship is diminishing. Mass housing strips the dwellings of their personality and is built for the masses, instead of for individuals, therefore removing the possibility of the individuals to act with their surroundings. Habraken explains the necessity of this relationship between the individual and their surroundings as follows: "This relationship therefore is the basis for all that has to be done in the matter of human habitation. It is the outcome of human nature," (Habraken, 2019, p. 29). To bring back the natural relationship he argues that the individual must become the central player in the creation of their surroundings. (Habraken, 2019)

To understand the problems plaguing the housing market today I believe it is necessary to start with the writings of Habraken. The relationship Habraken says is so instrumental for the well-being of society has a lot of parallels with the contemporary definition of social and environmental ecology. Which is why Habraken's writings are so relevant for this thesis as they are the topics of the graduation studio. Social ecology is about the way users and residents live together and create connections to each other and their surroundings. The environmental ecology is about the connections the materials and nature make with each other.

The lack of acting with and in ones surrounding Habraken speaks of is a good starting point for the problems in social ecology in the contemporary context . People who live in the contemporary urban fabric feel more and more separated from society and become increasingly lonely and individualistic. This diminishes the socio ecological relationships in the urban tissue. The added strain the construction industry has on the environmental e cology has only become more and more stressed nowadays. In the last decennia the impact the construction industry has on the environment has become very clear, with nonrenewable building materials being the most prevalent in constructing contemporary housing.

1 I will use Tatjana Schneider and Jeremy Till as a reference throughout this thesis, beginning at this problem statement. Schneider and Till are two architects and academic researchers. Schneider is professor for History and Theory of Architecture and the City, and Till is head of Central St Martins, University of the Arts London and a practicing architect.

2 John Habraken is one of the frontrunners of the flexible housing movement in the 60s. In his book 'Supports, an alternative to mass housing' (next referred to as Supports) he explains the problems in the housing practices of the Netherlands after the second world war. Mainly how these practices eliminate the wishes of the individual.

Introduction

Hypothesis & Goal

As a result of my readings of the works of Schneider and Till, and Habraken I believe that more adaptability of the housing stock and more user-participation in the design process will lead to more focus on the user, and therefore strengthen the social and environmental ecology in the neighborhood.
Schneider and Till argue that flexibility in dwellings can be a solution for four major domains of constructing dwellings. First the financial cost, flexibility gives more long term economic gains. Secondly, participation in society, adaptability encourages users to engage with the design process. Thirdly, technological advancements, flexible solutions can better anticipate and make use of new technological advances and solutions. And lastly, more efficient use of the building, the use in flexible dwellings can be changed over time. (Schneider & Till, 2005, p. 164) These improvements in the four domains of dwellings will lead to more social and environmental ecology.

The goal of this research is to gain a deeper understanding of the impact that adaptability and user-inclusivity have on the social and environmental sustainability of urban living. To find out if adaptable strategies and bottom-up power dynamics in dwelling design can create a better social and environmental ecology.

Research Questions

To find out if hypothetically adaptability and user-inclusivity is correlated with social and environmental ecology I will try to answer the following research question:
How can the inclusion of the user in the design of their dwelling and more adaptability in these homes help to create greater environmental and social sustainability?
This question does not only point towards if the relation between adaptability and sustainability is there, it also goes into the practical solutions that could be used to gain this larger sustainability.

There are two parts to this question. First, there are the two different proposed solutions: inclusion of users, and adaptability in dwellings. Second, there is environmental and social sustainability. These two sides of sustainability are a reference to the grander theme of the research studio Ecology of inclusion. This part of the question alludes to the goal of the studio: to design a building that creates a more inclusive and sustainable urban fabric.
To address the different parts that the research question proposes, various sub-questions have been created.

At the start of the first chapter I will answer the question Why is adaptability and user-inclusivity a necessary solution for present problems in the housing market? to create a strong case for the use of adaptable dwellings and user-inclusive design. After this, the answer to the question How can adaptability and user-inclusion be defined to a well-balanced theory? will result in a synthesis of existing theories of adaptability and user-inclusivity. This way the framework be used to create a method to analyze the existing design solutions in adaptable and user-inclusive dwellings.
In chapter two the sub-question What are working design solutions in adaptable and inclusive dwellings and how do they help strengthen the social and environmental sustainability of their surroundings? will be answered by analyzing a number of case-studies based on the insights gained in the first chapter.

Methodology

This thesis works towards building a greater understanding of adaptability and user-inclusivity from the perspective of social and environmental sustainability. An attempt will be made to do this by combining the researched theories discussed in chapter one and the design strategies that will be analyzed in the case-studies in chapter two. This will create a combination of theory and practice that will hopefully create a broad understanding of the why, how, and what of adaptability and user-inclusion.

To create the framework f or analysis I will start my research by gaining a theoretical understanding of adaptability, adaptability, and flexibility. To get to a framework for adaptability with a good basis I will use a few pivotal works in the architectural field of flexibility and adaptability. One of these pivotal works is the book Supports, an alternative to mass housing by John Habraken. Part of the theory in this book was already put forth earlier in this introduction, and I will continue to use it throughout my research. The version I will be using an English edition from 2019, this new edition gives a contemporary urgency and relevancy to the theories proposed by John Habraken, which makes the book very important for my research and in shaping my thoughts about adaptability and adaptability.

Furthermore, I will be using works from Tatjana Schneider and Jeremy Till. They have a large output of papers, articles, and books about the connection of social and political views on architecture and the built environment. Their works give a well argumented view on the importance of flexibility.
More specifically, I will be using a pair of papers Schneider and Till wrote on flexibility: Flexible housing: opportunities and limits and Flexible housing: the means to the end. They answer the question of for which problems flexible housing can be the solution, and how flexibility has been used or can be used to get to these solutions. Beyond these papers I will use their book Flexible Housing as a more general source of knowledge on flexibility and adaptability.

To give the synthesis of the theories on flexibility and adaptability a connection to the praxis three cases will be analyzed. The case studies used are chosen to analyze possible solutions and how they relate to social and environmental sustainability. The cases where chosen because they all seem to make use of different kinds of adaptability and user-inclusion. This way I can get different perspectives on how adaptability and user-inclusion can be implemented.

The first case is La Mémé, a student-housing building in Saint Lambrechts-Woluwe, Belgium. It was designed by Lucien Kroll in 1976. The building is built with and (partly) by the residents themselves. This created a strong sense of community in the building.

Secondly, I will discuss Diagoonwoningen in Delft, The Netherlands. This group of dwellings was built according to the structuralist architecture style. The dwellings were designed by Hertzberger in 1968-1970 according to the ideas of 'unfinished design.' This means that certain spaces in the objects are not completely determined in function and finishing when they were given over to the buyers.

Thirdly, I will analyze Patch22 in Amsterdam, The Netherlands. This is an apartment building that uses adaptability as a means to get a more environmentally sustainable building.

In chapter 3, I will try to apply the design solutions used in the case studies to describe how my own design uses the adaptable solutions. Here I will also use the gained insights to describe what kinds of adaptability and inclusion are more impactful and at what stages of the design they can best be implemented.

Why Adaptability and user-inclusion are necessary solutions

In this first part of the chapter I will explore the opportunities and solutions for adaptability and user-inclusivity. These solutions will act as a foundation and starting point for the rest of the research and design. To start I will therefore try to answer my first sub-question: Why is adaptability and user-inclusivity a necessary solution for present problems in the housing market?

The question is divided into the two themes of the studio I am writing this thesis for, Ecology of Inclusion. This division gives the research the direction that is necessary to get an image of the problems present. Not only in the problems associated with the contemporary housing market, also within the looming importance of climate change.

Social sustainability

When reading the book Flexible housing by Schneider and Till I saw a link between adaptability/user-inclusion and social sustainability:
"[t]he users choice, and hence satisfaction, that flexible housing provides has far more than financial benefits: it also has social and political benefits." (Schneider & Till, 2007, p. 46)
In this quote flexible housing is said to provide more user-choice, and with it user-satisfaction. This means according to the authors that it will increase social benefits.

Schneider and Till go further expand upon this topic further as they argue that adaptability and inclusivity is about empowerment of the user. They explain that this is done in three ways. First through giving residents the opportunity to customize. Second, as a result of the potential to adapt the design before the building is in use (not as customization but as involvement of future residents in participatory capacity) and third, it empowers the user after the building has been completed, by enabling them to make changes on their own at a later time. (Schneider & Till, 2007)

This is in line with my preliminary thoughts about how adaptability and user-inclusion are linked and how they can increase the control residents have over their surroundings when those surroundings are adaptable and inclusive.

The notion of control over one's surroundings comes together with the idea that when people have more control over something, they feel more morally responsible for it. Philospher John Fisher writes about this notion in his article about responsibility and control in the Journal of Philosophy. At the beginning of his article he states: "MOST philosophers have held that a person is morally responsible for what he has done only if he could have done otherwise. If responsibility requires freedom to do otherwise and this freedom is incompatible with causal determinism, then responsibility is incompatible with determinism." (Fischer, 1982, p. 24) Fisher talks about control as only present when one has the freedom to choose over something they have done. Next, he logically states that if this is the case then this responsibility is incompatible with determinism. When looked at through an architectural lens, one can see that this determinism is the opposite of adaptable housing and user-inclusion.

As a result of this reasoning I would like to make a case for adaptability and user-inclusion as an integral part to social sustainability. Adaptability and user-inclusion give users more control over their surroundings. Control over something gives greater feelings of responsibility, which breeds more inclusivity in the social community.

Environmental sustainability

From the perspective of environmental sustainability adaptable and inclusive housing can work as a sustainable alternative to standard housing practices focused on profit and turnover. As Jon Broome states in the book Architecture and Participation: "In my view, involving people in the housing process is a necessary precondition for a sustainable housing process." (Broome J., 2005, p. 65).

Schneider and Till explain in their interpretation of the quote that flexibility is a 'inherent part' of the sustainable housing process.They expand on this by saying that flexible housing inherently makes the housing market capable of adapting to future needs and changes. (Schneider & Till, 2007)

The fact that adaptability and user-inclusivity seem inherently sustainable does not (yet) explain why they would be or for what reason. In their book Adaptable Architecture Robert Schmidt III and Simon Austin further analyze this notion. They summarize sustainability in adaptable architecture as follows: "Adaptability can be viewed as a means to decrease the amount of new construction (reduce), (re)activate underused or vacant building stock (reuse) and enhance disassembly/deconstruction of components (reuse, recycle) – prolonging the useful life of buildings (sustainability)." (Schmidt III & Austin, 2016, p. 6)

Here Schmidt and Austin introduce reduce, reuse, and recycle as part of lengthening the life cycles of buildings. They believe that because of adaptability buildings do not get abandoned because of changes in users' lifestyles or preferences. Beyond that with the correct adaptable solutions we can make it easier to reuse changeable modules or parts of the buildings.

How to achieve adaptability and user-inclusivity

Buildings as Layers

When thinking about adaptability we should also be considering its role over time. In order to do this a different perspective on buildings is necessary. In the 'normal' way of building the process of creation stops when construction ends. This forgoes an entire dimension of life in buildings, namely what happens to them over time. Francis Duffy explained this in his keynote and later article Measuring building performance. He says: "Buildings are too important to be left to builders. In fact, I would like to begin by objecting to the word 'building.'" (Duffy, 1990, p. 17). He explains that buildings are about more than just 'building' (constructing), they are primarily about use.

The shift in perspective on what buildings are, makes a different definition of buildings necessary. Duffy proposes four different aspects of buildings that all have a different lifespan. These four aspects make a complete building. They are: Shell, Services, Scenery, and Sets. The Shell entails the structural elements of the building together with the facades. Services encompass everything from electrical or ventilation systems, to the central circulation spaces. The Scenery are all the parts that define spaces, interior walls for example. The sets are the people and furniture in the spaces. (Duffy, 1990)

Stewart Brand goes even further in the division of buildings in aspects. He uses the theory of Duffy as a starting point in his book How buildings learn: What happens after they're built. Duffy's four 'S' are mostly applicable on office buildings. Brand changes the four into six 'S' to make it applicable on more general buildings. The new aspects (or layers) of buildings according to Brand are:

Site
The cadastral border of the property on which the building sits.

Structure
The loadbearing structure of the building. Columns, floors, trusses, or loadbearing walls.

Skin
The facades of the building. This is the layer that divides the space in inside and outside spaces.

Services
The layer that facilitates the flow and transport of physical things through the building like water, gas, or energy.

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Space Plan
The components that divide and create the spaces in the building.

Stuff
The objects that are put into the spaces created by the space plan.
(Brand, 1994, p. 13)

These layers all have a different expected lifespan. The Site is the most fixed. The effort to change the cadastral borders or geological footprint of the site is enormous. Thus it can be expected it will not change from the perspective of the building. The Structure is expected to last from thirty to around three hundred years. The Skin, Services, and Space Plan all have a lifespan of three to thirty years. The Stuff layer is the layer with the shortest lifespan of around one month according to Brand. (Brand, 1994)

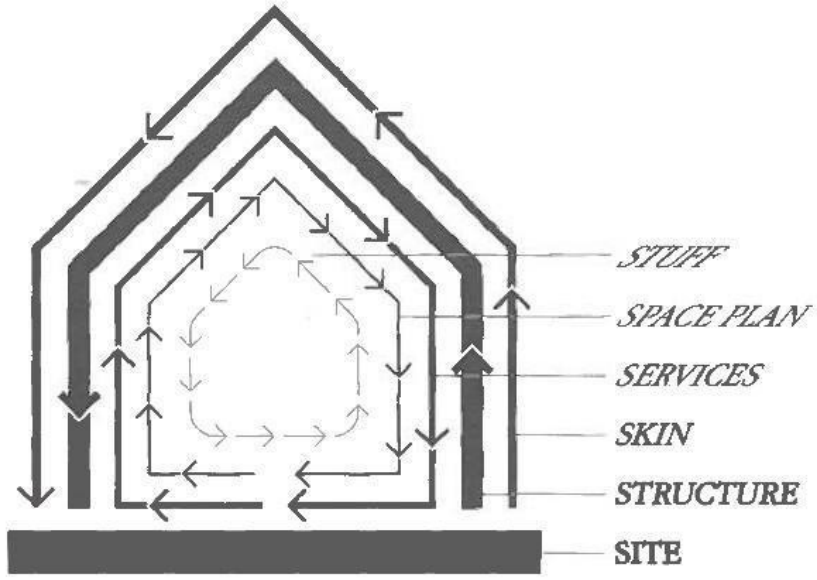

Fig. 2: Brands model of Building Layers (Brand, 1994, p. 13)

The important part to take away from this theory is the new perspective on 'buildings.' I believe that to re-use buildings and create adaptable buildings it is important to view them as made of different aspects that work together to create a machine-like object. In this machine all 'layers' work in unison to together create a working building.

The more layers in a building are intertwined the harder it is to make changes in the building. If a building has the skin and structural layers combined, like in a brick cavity wall, an adaptation like an extra opening is very hard to do. A structural portal has to be made, as well as breaking down several layers of brick. On the other hand, if layers are separated, with a column structure and a lightweight façade for example the adaptation is a lot easier.

Schmidt III & Austin's Adaptable Architecture

While Duffy and Brand go more into why it is important to view buildings as objects that are used through time, Robert Schmidt III and Simon Austin go into how this can be implemented in a more praxiological way. They call this adaptability in architecture. Their book Adaptable Architecture. theory and practice sets out to show connections and relations between types of adaptability and design solutions. They start with explaining different types of adaptability as they see them:

Adjustable

The adjustable adaptability type is about the change of task/user in a building. It is a type that is focussed on the reconfiguration of the 'stuff' in the building and is therefore more prevalent in utility buildings.
In dwellings an example that comes to mind is the Tiny house trend. In these small spaces it is practical to be able to for example adjust the dining table so that it becomes a bed.

Versatile

The Versatile type is about the change of spaces. This type is one of the most common adaptability types. It is mostly used in offices and contemporary museums. It is characterized by a lack of load bearing walls and a simple column grid-structure. This way new spaces can be easily created by adding or moving cheap, easy to construct interior walls.
This is relevant for dwellings in a few ways. Mainly in the transformation of old office buildings to dwellings. It can also be used in loft style housing by creating a large hall, in which the spaces can be placed freely.

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Refitable

Refitable adaptability means that the performance of the building can change. This can happen in different layers of a building, but is more easy if the layers are separate. It is a quite technical form of adaptability and mainly focuses on implementing new techniques or systems in buildings. For example the addition of new insulation in an existing hollow wall to lengthen the functional life of the building.

Convertible

Convertible is the type of adaptability that is about the change of the use of a building. Convertible adaptability is mainly done in transformations from offices to dwellings. This change does not necessarily have to be designed in the original building. But it can be practical to do so, to make the transition to a new function easier.

Scalable

Scalable adaptability is the change in size of a building. This means adding or taking away horizontally or vertically. This type of adaptability has more to do with the surroundings of the original building. The borders of the plan site define how far the extensions can go. Within the connection with the existing, the ability to easily take out the exterior walls is an important notion. For the horizontal additions the load bearing capacity is a limiting factor. An example is an extension in the back of a terraced house.

Movable

This type is less likely to be implemented than the others and is used more as a temporary structure. Even though it can be practical to change the location of certain buildings as the cities and demographics that surround the building change. Examples of movable buildings are festival tents, theater sets, or research stations. In dwellings the structures that come to my mind are trailers and campervans for example. (Schmidt III & Austin, 2016)

The kinds of adaptability Schmidt and Austin describe are based on all different types of buildings, from public to residential. For my research I have chosen the three most applicable to dwelling-design. These are: Versatile, Refitable, and Convertible, or the adaptability of space, performance, and use.

The aforementioned six forms of adaptability are subsequently linked to different adaptable design strategies. Schmidt and Austin define these as Physical, Spatial, Character, and Context. It is noteworthy that the different design strategies can be a part of multiple forms of adaptability.

Physical
The Physical design strategy comprises Modular, Design in time, Long life, and Simplicity & Legibility. This strategy is primarily about implementing adaptability in the physical parts and materials of the building. Secondarily, it is about the lengthening of the lifespan of these parts and materials.

Spatial
The Spatial strategies consists of Loose fit, Spatial planning, Passive techniques, Unfinished design, Maximize building use, and Increase interactivity. The spatial strategy is mostly about the use, users, and user-inclusion.

Character
The character design strategy has only one sub strategy. This is the aesthetical strategy, which is about the use of the image and narrative of the building to create an appreciation for it. It is for example about using color to highlight certain design features or routes through the building.

Context
The contextual design strategy also consists of one sub design strategy, the multiple scales. This strategy is the consideration beyond the building itself. Including the site and context of the building but also the user-context.

(Schmidt III & Austin, 2016)

These four strategies are all ways to create more adaptable buildings. They can include multiple types of adaptability (Adjustable, Versatile, Refitable, Convertible, Scalable, and Movable) and each consists of different building characteristics.

The strategies are a way of connecting the theory of adaptability to the praxis of creating the built environment. Therefore these strategies will be useful for analyzing existing cases of adaptable architecture in the next chapter.

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Schneider & Till's Flexible Housing
Schneider and Till start out their book Flexible Housing by giving a short historical overview of flexible housing. They talk about the 1920 and 30s as the time where the deterministic design of the use of spaces in a plan design started. This is called "hard" housing design.

The housing stock before industrialisation consisted of two types of houses. The 'special' object (palaces, town houses, and villa's) and the vernacular houses. This vernacular building culture shifted in the modern age (from the 1920s on) to special housing objects and mass housing. The simple way Schneider and Till argue to include flexibility in housing is to go back to a less deterministic design in housing (more toward the vernacular culture), or a more "soft" approach. (Schneider & Till, 2007)

Schneider and Till divide housing design into two aspects, Construction and Use. On the one hand the very physical and concrete Construction, about the ways flexibility can be implemented in the building process itself. And next to that, what is often forgotten about by designers, Use. The way flexibility can be achieved by including the user in the design of their house. (Schneider & Till, 2007)

Use
The flexibility in Use is divided into three aspects. Indeterminacy, Circulation, and Movable elements. After which it is linked to the notions of 'hard' and 'soft' flexibility.

Indeterminacy
Indeterminacy is the design of change and taking changes into account.. Indeterminate designing begins with making spaces whose functions are not predefined. However, just creating spaces that are open plan and neutral in function is not enough, this only creates ineffective spaces. Schneider and Till say that:
"The most successful raw spaces are those that act as armatures for future occupation in an anticipatory manner, providing a set of clues that are suggestive rather than determining. " (Schneider & Till, 2007, p. 135)
In this quote the "raw" spaces reference a spaces that are not yet fully designed (or determined). It is not only about creating these raw spaces. It is about anticipating future change.

Schneider and Till go on to describe different strategies with which indeterminacy can be accomplished (beyond "raw spaces"): Excess space, slack space, adding-on, expanding within, joining together, switching, dividing, moving

inside, and rooms without labels.

Circulation
Aside from the layout of dwellings it is important to look at circulation spaces. Circulation space is often thought of as something to reduce in size. But if handled creatively the circulation space can be much more than just a place to move through. In circulation outside of the dwellings themselves, the vertical circulation can function as an extension of the street. These "galleries" can be used as spaces to appropriate by the residents, by making the landings and walkways wide enough to put tables, chairs or plants on them. These circulation spaces don't have to be a hallway. They don't have to exist at all. All the movement can go directly through the spaces themselves, thereby eliminating the need for special circulation spaces. (Schneider & Till, 2007, pp. 148-151)

Movable Elements
Movable Elements are a more literal version of flexibility, where partitions or walls can slide or fold to create a fluid space that can change throughout the day. The Rietveld-Schröderhuis in Utrecht, the Netherlands is a good example of this. The top floor of this famous dwelling is made with sliding walls. These walls create two distinct layouts and uses. There is also a long history of sliding partitions in Japan, where rooms are divided by sliding doors made of ricepaper. In the Netherlands the curtained beds of the seventeenth century in the Netherlands come to mind.

The flipside of this way of designing is that it is still very determined. The use is still not completely flexible, but determined by the walls and partitions in two different states. (Schneider & Till, 2007, pp. 151-155)

Hard and Soft flexibility
In the three paragraphs above Schneider and Till seem to go from a quite "soft" stance on flexibility to explaining the "hard" stance. They begin with the strategy to create a blank canvas that the users can fill in themselves (soft) and move towards an approach that is more determined by the architect (hard).

Construction
On the topic of construction of dwellings Schneider and Till start by looking at inflexible ways of building. They do this to create an understanding of the construction types that are available and how to implement more flexibility. After looking into inflexible building they go deeper into principles of construction that

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are flexible and how to implement those.
The construction principles start with the concept of a frame in which all parts of the buildingcan be placed. The frame is a basic structure that can be adapted by the users and is therefore intrinsically empowering. The non-load bearing partitions can be placed, removed, and moved to whatever place the user wants.

A second way of implementing the frame concept is by the bottle rack principle. This principle is to create a column structure, where in the units (just like bottles) are placed completely independently of the supporting 'rack.'

In this part of their book Schneider and Till also make use of the building layers of Brand. They link it to their concept of the frame, by describing the way the construction is handled in this concept. The layers of buildings come back in their theory as the non-adaptable 'frames' and adaptable parts within the frame. Schneider and Till do note that this layer system can lead to more determinism. The seperation of the layers in buildings gives way to very detailed design per separate layer. (Schneider & Till, 2007, pp. 164-171)

Synthesis of theories
To make the acquired knowledge on the theories of 'adaptable architecture' and 'flexible housing' discussed above applicable to the analysis of the case studies I hope to combine them to create a new and encompassing framework of adaptability and user-inclusivity. Although the respective approaches to adaptability and flexibility of the two works are quite different, there are also a lot of connections to be made.

To begin I will use the theory of building layers by Steward Brand. This gives the framework the dimension of time, as it forces me to see buildings in more than just a design.

I want to divide my model of adaptability and user-inclusivity into the two ends of the flexibility spectrum that Schneider & Till use, the Hard and Soft sides. This will work as a sort of scale of adaptability. Where soft is more user-inclusive, and hard is more 'designed.'

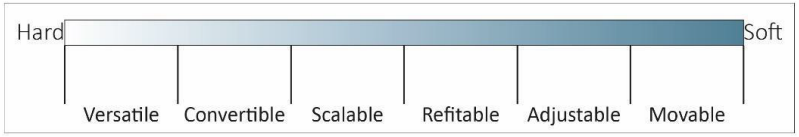

Fig. 2: Model for combining kinds of Adaptability and the Hard-Soft scale.

This spectrum will be filled with the classification of different kinds of adaptability that Schmidt III & Austin use. Schmidt III and Austin already touch upon this idea of hard and soft adaptability, they use them as spatial and physical. Where spatial is the soft, more passive approach to adaptability. The Physical is the hard, more active kind of adaptability.

For dwellings specifically and the task of transformation of an existing building some kinds of adaptability are more applicable than others. I will focus on Versatile, Refitable and Convertible. These three kinds of adaptability center around the change of spaces, the change of performance, and the change of use (or functions).

An important concept that keeps coming back throughout my research is the 'easyness' of change. Adaptability means, in my opinion, making change in buildings as easy as possible. However, this easyness is not that well defined. As was mentioned in the part about Building Layers, the more layers a change links to, the more difficult said change is. This means that I can link this 'easyness' to the building layers as described by Brand.

Each of the case studies will be discussed according to the following structure. First, a general description will be given of the objects and its users. Second, the three types of adaptability of Versatility, Refitability, and Convertability that I have introduced in chapter 1 will be analyzed.

La Mémé

The first case I would like to discuss is La Mémé in Woluwé Saint Lamberts in Belgium, a student housing complex and faculty. It was designed by Lucien Kroll in 1970. It is part of the medical faculty of the University of Louvain la Neuve (the new campus of the French speaking part of the Catholic university of Leuven), this is also where it got its name: La Maison Médicale (La Mémé).

The story of this building begins in 1968, when students of the medical faculty started to distance themselves from the faculty staff and management. They wanted more control and less authoritarian oversight by the planners and university. (Kroll, 1997)

The students themselves found an architect, Atelier Kroll, and helped create a more free and less structured campus. The building is designed in the opposite way than the way the management of the university wanted. It is made "in the direction of diversity, everyday culture, de-colonization, the subjective, in the direction of an image that could be compatible with the idea of self-management,..."[1] (Kroll, 1997, p. 208)

The anti-establishment sentiment of the future users take center stage in the design of the campus. Dieter Besch calls this style "Anarchitecture"(Besch, 1997, p. 216). The building is built in a way that encourages individual expression, but at the same time a collective sense of community within the users (and therefore against the established management of the university). This style of anarchitecture got an organic expression in all facets of the building.

The columns are at the same time part of a grid ánd are seemingly never placed on the same grid-lines. Lucien Kroll says about this himself: "in regards to the influence of architecture on behavior: regularly placed columns create conformistic residents, irregularly placed columns stimulate the imagination."[2] (Kroll, 1990, p.38)

1 Translated from: "in de richting van diversiteit, alledaagse cultuur, dekolonisatie, het subjek tieve, in de richting van een image dat verenigbaar zou zijn met het idee van zelfbestuur," (Kroll, 1997, p. 208)

2 Translated from: "ten aanzien van de invloed van de architektuur op het gedrag: regelmatige kolommen maken conformistische bewoners, onregelmatige kolommen stimuleren de verbeelding" (Kroll, 1990, p.38)

Testing the model of Adaptability and user-inclusion

The building is constructed with brick load bearing walls that are combined with a freeform column structure. The column structure gives future users the opportunity to shift the inner walls around to create new spaces. The seemingly random placement of the columns prevents all the movable walls from getting placed along these columns. Instead the inside walls are placed with an idea of 'randomness' within the 90cm grid of the building. (fig. 3 & 4)

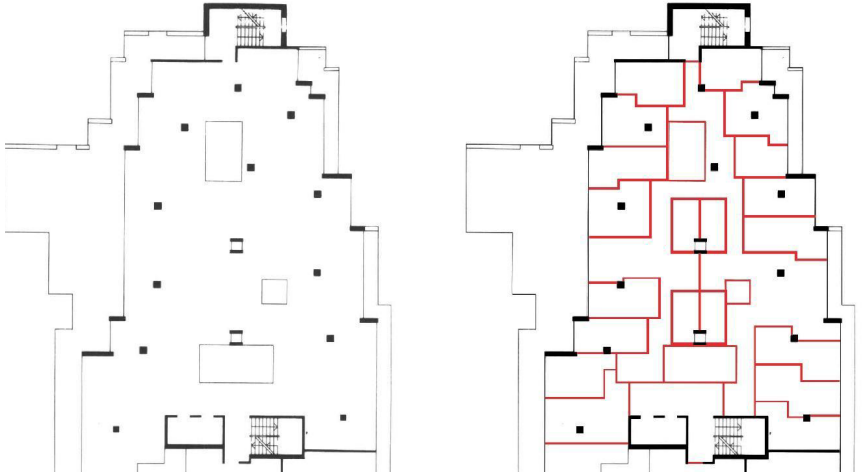

Fig. 3: Floorplan of La Mémé. With and without adaptable parts. (underlay from: Kroll, 1990, p. 37)

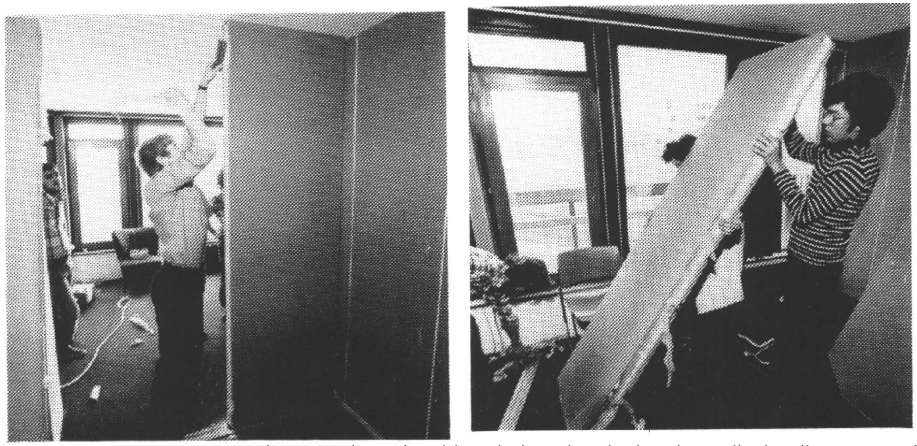

Fig. 4: Students (Residents) changing the interior walls. (Kroll, 1990, p. 44)

The facades are not loadbearing, and made out of a plethora of different 'modules'. These were picked out by the students themselves. For instance, some students wanted big window others preferred small. The framework could then eventually also be remade and redesigned if and when the users wanted. (fig. 5) (Kroll, 1990)

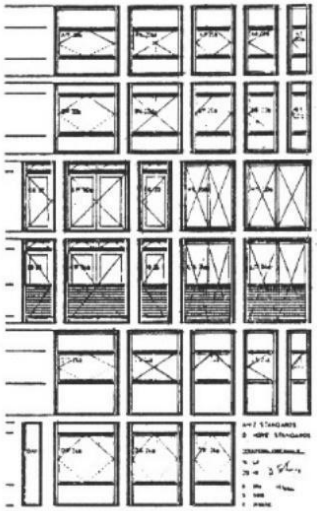

Fig. 5: facade-elements as stickers (Kroll, 1990, p. 49)

The theory of Support and Infill by Habraken was consciously used in the design. In his book Components I Kroll describes the opportunities this theory gives the building. He talks about ownership or use.

Kroll describes two notions of ownership that give two different insights into decision-making power. The first notion is applicable on the vertical and horizontal Supports. Kroll says about this: "In the same way as a natural terrain it encompasses in one way the entire structural system of the building: foundation, columns, load-bearing walls, floor parts; in another way the circulation system and different installations: communal staircases and elevators, cold and hot water, gas, electricity, heating, information networks, water drainage, trash, chimneys, ventilation, etc."[3] (Kroll, 1990, pp. 44-45)

3 Translated from: "Op dezelfde manier als een natuurlijk terrein omvat het enerzijds de gehele draagconstructie: funderingen, kolommen, draagmuren, vloerplaten; anderzijds het ontsluitingssysteem en de verschillende installaties: gemeenschappelijke trappen en liften, koud en water, gas, elektriciteit, verwarming, informatienetwerken en afwatering, stortkokers, schoorstenen, kunstmatige luchtbehandeling, enz."(Kroll, 1990, pp. 44-45)

He explains that basically all the parts of the building that are part of the communal ownership fall under this Support system.

The second notion relates to the Infill of a building: the interior that can be created in factories, by craftsperson, or by the users themselves. It is important according to Kroll that the Support of the building can permit these three options in unison or separate. Also the Support needs to stimulate the initiative of the residents to change their surroundings. (Kroll, 1990)

Versatility

Within the building the residents able to change the spaces easily. This versatility stems from the ability to shift and easily (de-)mount the interior walls. When the first residents came to the building they could do this themselves. This fits well with the bottom up perspective of the designer and community. (fig. 7)

The separation of different building layers that Brand describes also plays into the ease with which the spaces can change. None of the interior walls are load bearing (with the exception of the shafts and vertical circulation-walls). This creates the opportunity to move these interior walls around and create different spaces.

This separation of "Structure" and "Space plan" does not continue to the floors. The floors are separations between the different levels of the building, also they are loadbearing as there is no beam-structure. Because the layers in this part of the building are not separated, any change on this part is very hard. Creating holes in the floors is practically impossible to do. (Kroll,)

Refitability

The adaptability of the building from the perspective of the change of performance mainly comes from the exterior walls. The exterior walls are made of different "stickers" that encompass windows, closed wallboards and door parts (fig. 5). These "stickers" have been chosen by the original residents.

The stickers give the residents the possibility to change the amount of windows and openings in the facades later on as well. This will change the performance of the spaces behind those facades as new and better insulating parts can be placed back. With that the technical performance of the building will be changed.

Beside this refitable character the buildings vertical circulation system and electrical and plumbing shafts are not changeable at all. The walls of these voids are made of brickwork that is an entanglement of the two building layers of

Skin and Structure.

Convertibility

The use of the building is made easier by the free form column structure. This makes the transformation to a new function (like office space) easier. On a smaller scale as said in the Versatility paragraph the layout is adaptable. This creates the opportunity to change for example the private rooms into communal spaces.

Because the different spaces in the building are imagined to be quite conventional mono-functional it seems harder to switch between different functions throughout the day. The apartments are not switchable to communal spaces in the day, and then change back into apartments in a moment's notice.

More ambiguity in the functionality of the spaces could have resulted in larger convertibility. The question here is if this was wanted in this case. The whole layout of the dwellings was created by the students themselves. The fact that the students chose this mono functionality in the spaces gives the impression that this was what they wanted to accomplish. Another hypothesis could be that they didn't know better than to create monofunctional spaces.

Testing the model of Adaptability and user-inclusion

Diagoonwoningen

The second case study I would like to discuss are the famous experimental dwellings in Delft, the 'Diagoonwoningen' by Herman Hertzberger. These dwellings were built in 1972 as a part of an experiment on how to divert from standardized residences in the post-war period.

The dwellings are organized around a central void with split level "rooms" around the void. The central space consists of balcony-like spaces that flow into the "rooms". The residents themselves choose to close the rooms off or keep them open. The functions of the different rooms are also completely free, except for the kitchen and bathrooms.

The organization of the loosely designated functions can be seen in the middle of figure 8. Here indicated in yellow the living areas are shown. These are all organized around the central void in the house. The rest of the functions are envisioned in the extremities of the dwellings. On the bottom of fig. 8 the future extensions are shown. The terrace on the roof is built up to an extra bedroom. The garage is transformed into a new master bedroom and en-suite bathroom.

The extensions are not without reason. The places of these new rooms were already designed by Hertzberger as potential expansion places. (Knudsen, 2015)

The different functions are not defined by traditional interior walls. The possibility to place dividing walls is there though, and it is used by the present residents. For example; where the living area on the 1st floor borders the sleeping area on the top of the plan, a wall can be placed to create a more private room. (Knudsen, 2015)

Even with all the positives that the adaptability in the Diagoonwoningen makes possible, living in it is not for everybody. One of the original residents (an architect himself) said about live in the dwellings:
"Even with all the space in the living area, the use is quite limited. With straightforward rooms the possibilities are way larger. In this room there are weird jumps that work spatially limiting. Most of the people use these houses the same way because of this."[1] (Eilander, 1978, p. 15)
The argument he makes is that because of the non-standard shape of the spaces the dwelling is paradoxically less user-inclusive, by forcing a certain use on the dwellers.

1 Translated from: "Ondanks de ruimte in de woonkamer is het gebruik eigenlijk heel beperkt. Met rechttoe rechtaan kamer kun je veel meer doen. In deze kamer zitten sprongen die ruimtebeperkend werken. De meeste mensen gebruiken deze huizen dan ook op dezelfde wijze."(oud bewoner Diagoonwoning. Source: Eilander, 1978, p. 15)

His opinion on dwellings in general is:
"The house is too complicated and too present. Always. A house should also be able to not be there for a time."[2] (Eilander, 1978, p. 15)
In other words, a house should work as a blank canvas that can be painted on and therefore gain the personality of the residents. Not the other way around. He argues that the Diagoonwoningen have such an outspoken personality themselves, that it forces this personality on its residents.

2 Translated from: "Het huis is te gekompliceerd en teveel aanwezig. Altijd. Het huis moet er ook eens een keer niet kunnen zijn." (oud bewoner Diagoonwoning. Source: Eilander, 1978, p. 15)

Testing the model of Adaptability and user-inclusion

Fig. 8: Designed floorplans (top), functions in the 1970s (middle), and present expansions and functions (bottom). (drawings based on floorplans from https://www.architectuur.nl/project/diagoonwoning/

Versatility
Versatility is the adaptability-type that is the most present in the diagoonwoningen. The spaces are all quite fluid and loose. They can all be separated into smaller closed-off rooms, or kept open to create a singular loft-like space across the whole dwelling.

The ability to create new inside spaces on the semi-outside spaces like the garage and roof terrace show that the spaces in and around the dwelling can change. As seen by the fact that all but one of the dwellings has undergone these extensions, it seems that this change of space is quite easy to do. (Knudsen, 2015)

Refitability
The ability to change the performance of the Diagoonwoningen is not that great. The materialization of the dwellings halts the refitability. The walls are constructed with B2-concreteblocks that are not only quite hard to break through (to create new windows for example) but also are constructed in a bad way. The contractor constructed the walls with cement that was too wet. This created a lot of thermal bridges in the cavity of the walls that make insulating the exterior walls impossible.

The idea of Herzberger was that the b2-concreteblocks would be finished by the residents themselves. This however did not happen. Most of the residents kept the bare concrete. Painting or plastering over the concrete was also non reversible, because of the roughness of the concrete. Once painted, it can never be reversed.

Convertibility
The different functions throughout the dwellings can be easily shifted around. The sleeping areas can be changed to living areas and vice versa. This gives the Diagoonwoningen much convertibility. Adding sliding walls between the 'rooms' and central void-area can also lead to different uses throughout the day.

On a larger scale the dwellings are difficult to transform into something other than houses. The very specific shapes and organization of the dwellings are difficult to imagine as another function than housing. The spaces inside of the dwellings themselves are very convertible, however the dwellings themselves are hard to convert to another function.

Testing the model of Adaptability and user-inclusion

Patch22

The last case study is Patch22 in Amsterdam. This wooden building has been, with its 30 meters, the highest wooden building in the Netherlands. It is designed by Frantzen et al architects. It was a joint venture of Frantzen and the developer Claus Oussoren. They started a business especially for this project, this way they had more freedom over the outcome of the development.

The building consists of a tower with apartments and an arm with row houses. All the dwellings are built with adaptability and inclusion in mind. The dwellings are designed by the residents themselves, they did the interior themselves or together with an interior architect. The building is completely constructed with wood to make the building more sustainable. (Frantzen, 2016)
Because the dwellings are all personally designed by the residents they have unique layouts. Some have a more stereotypical loft layout. While others have a more traditional room-based layout. This is made possible by the lack of load bearing walls and floors. (Frantzen, 2016)

The wooden structure is completely visible from the outside and inside of the building (see fig. 7). The structure is over-dimensioned to take the fire-resistance into account. The esthetic that this gives the building played into the fact that the location was not an area for dwelling. The expressiveness of the wooden facades was used to entice future residents to live in the atypical neighborhood. (Frantzen, 2016)

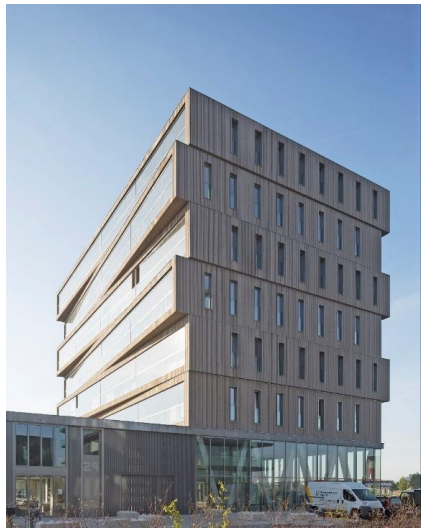

Fig. 7: Photograph exterior of Patch22 (photographer: Luuk Kramer)

Versatility

The versatility of Patch22 mainly comes from the lack of loadbearing walls. The dwellings stay versatile even after initial construction and division. The diversity of all the dwellings is shown in the floorplan views of the design (fig. 8). All the dwelling-separating walls can be taken away or moved. As well as the interior of the dwellings.

Another part of the changeability of the spaces in the dwellings is linked to the refitability. The pipework and cabling are completely adaptable, which makes the placement of bathrooms or kitchens also versatile.

Fig. 8: Floorplan Patch22 (edited from: FRANTZEN et al. 2016)

Refitability

The change of performance is the main focus of Patch22. Refitability is used to create more sustainability in the building. The argument used by the developer is: "Our installations, on a basis of renewable energy, are especially understandable and operable by the residents. Technique doesn't have to be a nuisance. The space has to be freely divisible for our buyers, but also or the residents after that..."[1] (Claus Oussoren, 2017)

1 Translated from: "Onze installaties, op basis van hernieuwbare energie, zijn vooral te begrijpen en te bedienen door de bewoners. Techniek moet geen last zijn. De ruimte moet vrij indeelbaar blijven voor onze kopers, maar ook voor de bewoners daarna..." (Claus Oussoren, 2017)

Testing the model of Adaptability and user-inclusion

Oussoren says that by creating the opportunity for adaptable installations you can create a better dwelling experience for not only the first, but also future residents.

The Refitability is most clear in the principle of the floor construction (fig. 9). Here the removable raised floor is shown that makes the vertical moving of the pipework and cabling possible. The heating is placed in the individual underfloor panels, this means that repairs or changes are also possible for this part of the performance of the dwellings.

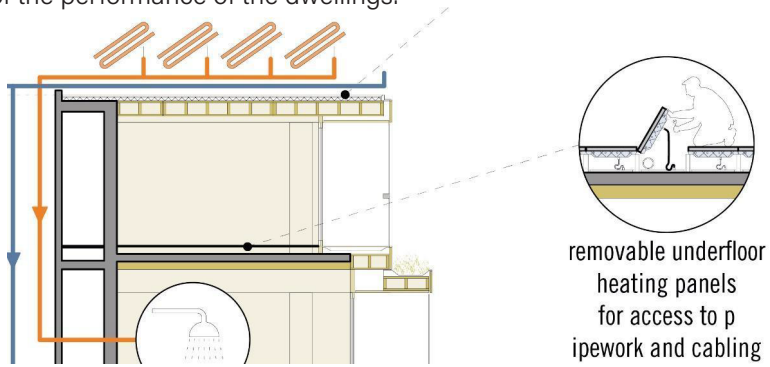

Fig. 9: Excerpt of the installation scheme. (edited from: FRANTZEN et al. 2016)

Convertibility

The change of use is a kind of adaptability that the architect specifically kept in mind when designing. The future transformation to a different function was important in the project from the perspective of sustainability. Making it easier to transform the building leads to a smaller chance of the building becoming obsolete in the future.

The design enables the convertibility by making the floor to ceiling height larger than is necessary for dwellings. The gross floor height is four meters. This large height makes the transformation to office space possible.

To make this transformation possible from the perspective of the municipality a new kind of land lease contract was made in cooperation with the city of Amsterdam. This way the convertibility of Patch22 is not only technically but also administratively possible. (Frantzen, 2016)

Conclusions

To conclude this exploration into the practical applications of adaptability and user-inclusion it seems there is a trend across the three cases I researched. In all three cases there seems to be a hierarchy between the three kinds of adaptability.

They all take the more general kind of 'versatility' as a starting point for the adaptability. Versatility also has the strongest link to the user-inclusion in the three cases. In my opinion, the focus on the change of spaces is not surprising, as the focus of architectural design is mainly and primarily how spaces relate to each other and how the spaces are designed.

The 'refitability' seems to come next. It also has the strongest link to the versatility of the three kinds. The way in which the building is versatile directly affects the way the refitability is implemented.

The last kind of adaptability, 'Convertibility', seems to be the most separate one of the three. From a design perspective the change of use in the three analyzed cases almost seems an afterthought (with the exception of Patch22).

It seems to be a good design strategy to use this hierarchy to streamline the design process and integrate the adaptability in the architecture.

The scale of Hard to Soft adaptability and user-inclusion seems linked to this hierarchy in a different way. If I look into the characteristics of adaptability versus user-inclusion it seems that user-inclusion is more in line with the soft side of the scale I made in my synthesis. Adaptability is mostly created by hard solutions. User-inclusive solutions are the ones that seem to not change after the initial user-inclusive construction. For example the La Mémé is the most user-inclusive building of the three that I analyzed, but it also has not changed after the original residents left.

Design brief and context

Before I explain how the solutions and strategies are implemented in practice I will describe the context in which these solutions and strategies will be used.

For the master-studio Advanced Housing Design: Ecology of Inclusion together with a group of other master students I had to create an urban master-plan for the Walenburgerhof in Blijdorp, Rotterdam. This is an area just north of the train tracks, 300 meters west of the Central Station. The location is divided in two by the 'tunneltrace' a busy road that connects Rotterdam North to the center and the Southern parts.

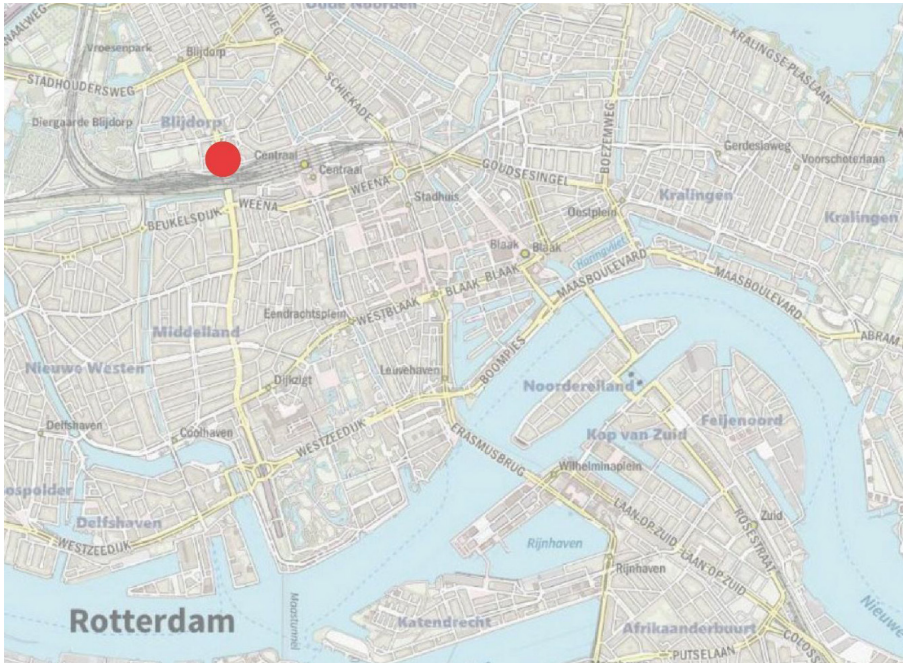

Fig. 10: Location within Rotterdam (Underlay from: OpenTopo)

Masterplan

The masterplan that we, the 'Social group', created is built on the principles of connection and social interaction. A connection between the two halves of the area itself, but also to the 'Walenburgerhof' and the rest of Rotterdam.

In the existing situation the site has large buildings that are seemingly placed in the urban tissue randomly. Beyond just their placement these buildings are very large in scale, making it harder to identify with them when walking

Connecting the strategy of adaptability and user-inclusion to the design

through the area. In our plan this scale has been made smaller, to add a human scale to the plan, which will create a better social climate in the public spaces by creating opportunities for the residents to meet and interact in their own scale.

Fig. 11: Masterplan ground floors (Social group Ecology of Inclusion 2022)

Individual site

Within the urban masterplan I have chosen a plot to make an architectural design. The site consists of an existing building that is now functioning as student housing and originally functioned as a municipal office building. The existing L-shaped building is completed into a block with two new 'arms' to create a closed structure. I have chosen to focus most of my design to the transformation of the student housing to an apartment building.

The existing building consists of a concrete structure, with concrete columns and beams that carry the in-situ concrete floors. The previous use as offices make the floor to floor heights quite tall. From the first floor onwards the height is three and a half meters, on the ground floor this is even higher with four meters twenty. This floor-to-floor height combined with the column structure create a lot of opportunities for an adaptable conversion to apartments.

Connecting the strategy of adaptability and user-inclusion to the design

The placement of the building with on the southside the train tracks and on the west the busy road makes for a challenge that has had a lot of influence on the design. More specifically on the orientation of the dwellings. Because the train tracks not only create a lot of noise-pollution, the tracks also are used by freight and are therefor also a source of air-pollution. The same is the case with the busy road, albeit less than on the train tracks. This means that the dwellings cannot have normal outside spaces on those sides.

Specific design solutions

Building Layers
In my design the main concept revolves around the division of the different building layers. The service layer is separated as much as possible from the structure and skin layers. This is most apparent in the south façade of the building. Here the wooden lamella shading is separated from the glass sliding sound blocking layer by mounting them separately on a steel structure. This makes sure that the different layers can be changed easily and without disturbing the other layers.

With every design solution this separation is the first thing I took into account. This is the first step and foundation of the adaptability in my design. It is the main aspect that allows for the three different types of adaptability that I implement in the building.

Versatility
The use of the existing structure gives the building its main versatility. The concrete column structure makes the placement of interior and space-defining elements completely free and reversible. This not only allows for every apartment to have a different layout, it also makes it possible for the layout of the dwellings to change over time or with different users.

By adding a void in the middle of the floorplans, the connection between the top and bottom floor becomes stronger. It also gives the user the opportunity to change the spaces in a three dimensional way. Not only can the staircases be placed in whatever orientation is wanted, the void can also be kept as a vide to link the first and top floors to each other. This is also done in the Diagoonwoningen that I analyzed.

The layout of the dwellings is completely user-inclusive, as they are delivered to the residents without any interior. The wall to the gallery is modular, and is made of two zones where doors or windows can be placed as stickers, like in La Mémé. This inclusivity means that the layouts might not necessarily be very conventional.

Connecting the strategy of adaptability and user-inclusion to the design

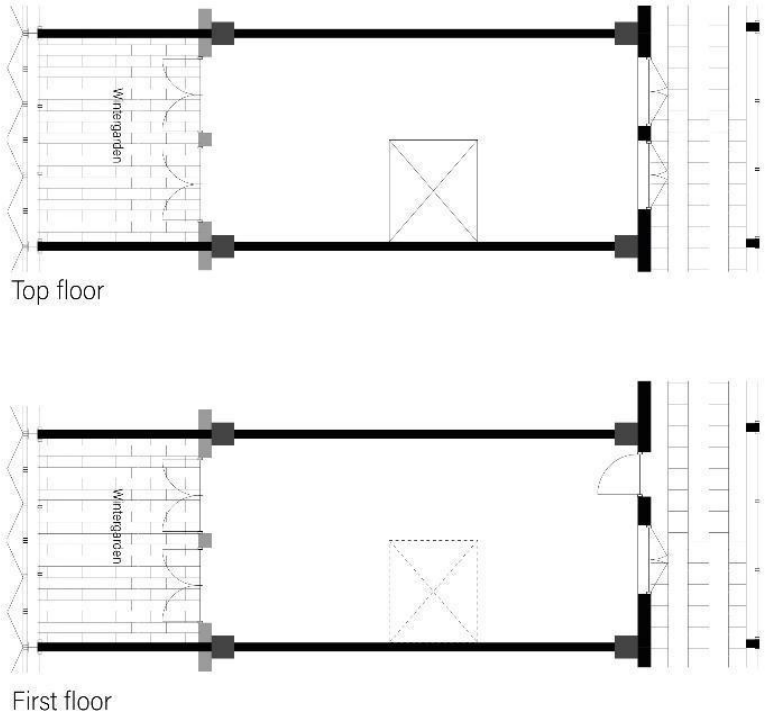

Fig. 12: Void placement in empty apartment floorplan

Refitability
The technical performance of the building is changeable in a few ways. Because of the modular exterior wall on one side of the apartments the technical performance can be improved easily, by changing the different parts of the wall. The separation of the façade by the wintergardens, the glass and shading can also easily be changed. This is further enabled by using mostly dry connections. The steel structure, and wooden lamellas are bolted together which creates an easier change of parts.

The technical systems are also very refitable. They are all fitted under the raised floor, which leads to the shafts located in the modular wall. This system is also used in Patch22. In this raised floor the plumbing and electricity is placed as well as the mechanical ventilation. To finish the system with the raised floor, the heating is put in the flooring panels on top of the void. The integrated floor hea-

ting panels make the replacement of any of the pipework or wiring very easy. The panels are simply removed by lifting them, after which the void can be reached easily. This flooring system gives the residents the possibility to put the functions in whatever place they want, and to not be held back by shaft placement and water drainage points. This together with the complete freedom in the placement of inside partitions gives the users full individual control over what functions go where and how they want those functions look.

Convertibility

The act of transforming the existing building to another use, from student housing to an apartment building is convertible in and of itself. It not only makes the building adaptable, but it also is a more sustainable solution for the construction of dwellings.

In the dwellings the use of a raised floor, in which all the wiring and pipework is located, gives complete changeability of functions like where the kitchens or bathrooms go. The placement of functions is completely free this way.

Because the original building has an extraordinary floor to floor height of three and a half meters the convertible from the original use is easier. This excess size is a very important foundation for convertible buildings. It allows for the opportunity to use the space as the user sees fit.

The choice to place voids in the existing structure gives the dwellings the next measure of convertibility. The placement of the void in the middle of the floorplan makes the division of the dwelling into separate rooms easier. It also enables more efficient use of the space in the dwellings, which in turn creates more adaptable placement of different functions.

The combination of these three types of adaptability and the different uses of hard and soft solutions gives the design a well rounded and completely integrated way of giving the users the control over their surroundings. This will create an ecology in and around the building that will be socially and environmentally better.

Connecting the strategy of adaptability and user-inclusion to the design

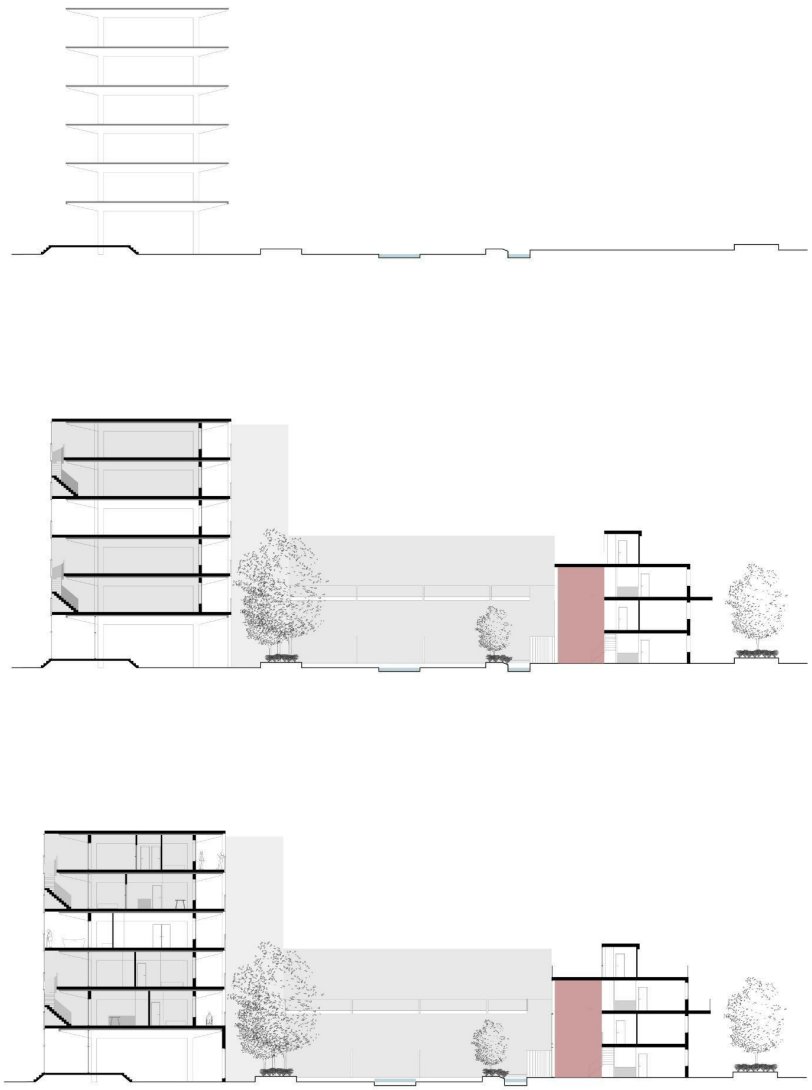

Fig. 13: Section. Top: Existing re used structure. Middle: Non-adaptable elements. Bottom: Adaptable infill.

By analyzing different design solutions and opportunities, this research has shown how adaptability and user-inclusion can be implemented. If adaptability is seen as a spectrum of different aspects of a building three relevant types emerge, Versatility, Refitability, and Convertibility, or: the change of space, performance, and use. Between these types Versatility is a good place to start. After which the changeability of the performance has to be integrated into the spaces. More important in the building over all is the change of use. Convertibility has implications for the smaller scale of individual dwellings, but also for the future uses of the whole building.

The theoretical basis in flexible housing and building in layers discussed in this thesis gave me a new perspective on dwelling design and how to view architecture. Making dwellings adaptable and user-inclusive is better for social and environmental sustainability. Adaptability and user-inclusion shifts the power-dynamics of the housing-market towards the users. This gives the users the opportunity to make their surroundings which creates values besides the monetary value the developers and builders want. This non-economic value creates more social sustainability.

The challenge seems to be to not only make the dwelling, but to also keep that control in the future, when the original users have left. To make sure that a house is not only user-inclusive, but also adaptable after the first user leaves, it is important to make the changeability easy and logical. This can be done by implementing the theory of buildings as layers and also by constructing with as many reversible connections as possible.

By combining the methodology of adaptability and user-inclusion with a design assignment the research gets anchored in the architectural praxis. This way the research can function as a guide on how adaptable and user-inclusive dwellings can be designed. Where the adaptability does not function merely as an afterthought or buzzword, but is an integral part of the design process and creates a future focused and socially inclusive building. The research gained relevance for the architectural profession by using existing theories to get to a personal understanding of adaptability and inclusion and consequently linking this understanding to the practical application in case studies.

When designing an adaptable and inclusive residential building it is important to see the building as an object that gets used throughout time. This makes it a necessity to think about the life of the building and how it can react to changes in society. By dividing and ordering different types of adaptability an all-encompassing adaptability and user-inclusion can be reached within the design and the building itself.

Conclusion

This research can be expanded by going deeper into the ways adaptable re-use can be used to make a more circular and adaptable building stock. Adaptive Re-use is a theory about transforming existing buildings into a new use. The idea is that by already integrating the re-use in the design phase the future transformation gets easier and more likely. This could give even more insight into adaptability and why to implement adaptability in buildings. Even with these unexplored avenues this research gave me a well-balanced view on adaptable and inclusive living.

By focusing the research on adaptability and user-inclusion from the perspective of social and environmental ecology it has become clear to me that it has become more and more important to start thinking of buildings as more than just commodities. A home is far to important to only be viewed as a money making machine. I believe that this can be achieved by implementing adaptability and user-inclusivity in an integral way in the design and construction of dwellings. I believe after doing this research that the users are the most important aspect of architecture, especially in design of dwellings. It seems logical that the most important aspects are given the most power over the things they inhabit.

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Introduction

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Design

This part of the booklet is a complete view on my design. This design comes forth from the conclusions and findings in the research. The design further acts as a laboratory for the ideas about adaptability and inclusion described in the research. It shows how this can be implemented in praxis.

The design begins with the urban context. In my case the urban masterplan 'social exchange.' Where the plot I chose consists of the existing building that presently functions as studenthousing.

The beginning as an existing building is already the first act of adaptability. The old building is adapted to a new use. This is a continuation of history as the building was originally built as a municipal office building, and transformed in the 90s to the present function of studenthousing.

Within this existing building the loadbearing structure is used as a starting point for the new building and as part of the "Support" system for the design. This "Support" is the part of the building that will function as the secured non-adaptable backbone on which all the adaptable solutions can be placed.

The support system is completed with the circulation spaces and the placement of the different dwellingtypes. These three systems work together to give the building a simple starting point for the adaptable solutions.

The adaptable solutions all are designed differently. They can be placed on the "Hard to Soft scale" that I introduced in my research. From the quite ridgetely designed harmonica facade, that is not inclusively created, to the completely self built facade towards the wintergardens.

The Harmonica facades adaptability lies in the choice the users have on the open or closed states that the facade offers. This way the users have control over privacy and shading in their dwellings.

The Modular facade towards the gallery space is slightly more inclusive as the users have control over the function of the openings in their wall. This also facilitates change over time if the dwellings get changed. The modules can then be changed accordingly.

The Raised floor system I implement in all the dwellings is adaptable in itself by making the construction with 'dry' connections. The floor also enables the adaptability in the layout of the dwelling itself by making all the necessary plumbing and instalations changable.

In the existing loadbearing floors a Void is created in every multi story dwelling. This void opens up the dwelling to different staircase designes. Also it gives the users even more choice about the connections between spaces in their home. It creates a adaptability in the vertical axis of the dwellings.

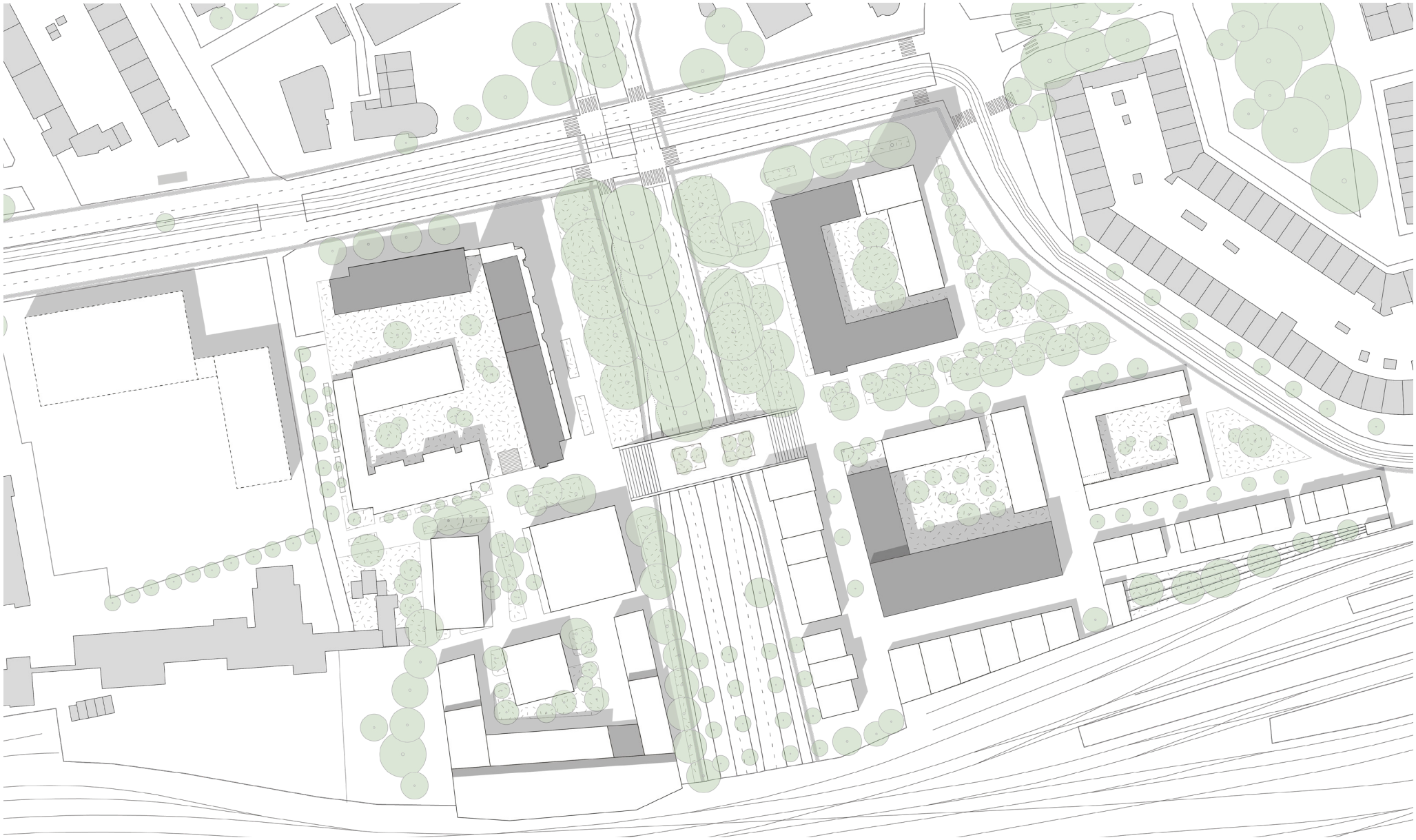
The DIY facade is the most inclusive adaptable solution as the only designed part about it is the placement. This is necessary to create a non broken thermal line trough the building. The rest of the facade is all designed and built by the users.

Lastly the Layout of the dwelling is also completely inclusive. The dwellings are finished completely empty, this in combination with the other adaptable and inclusive solutions gives the users the control and power to create the perfect dwelling for themselves. The floorplan layouts in this booklet function more as examples then as fixed designes. They show what is possible, not what is necissary.

Urban context

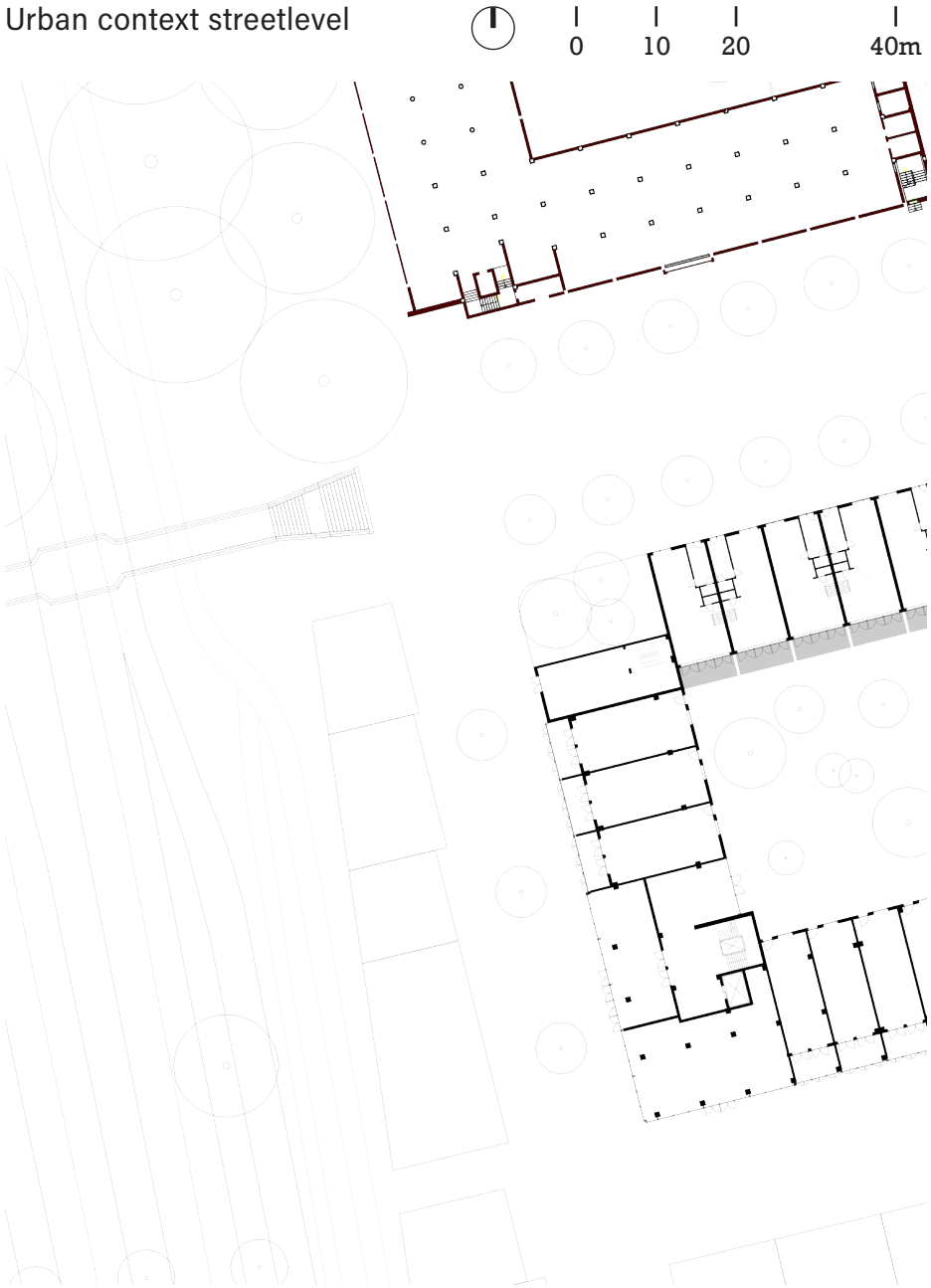
Masterplan Social Exchange

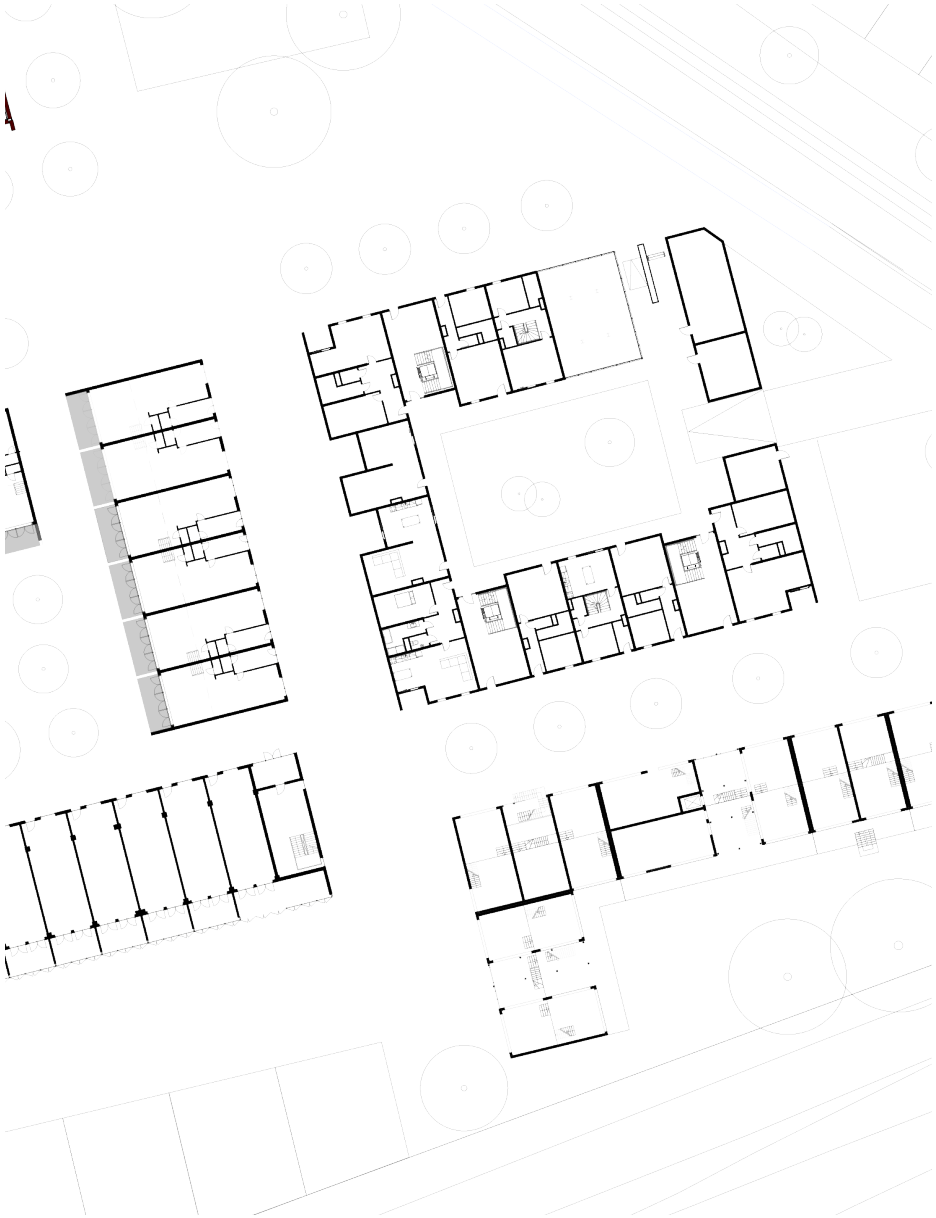
0 20 40 80m



Urban context

Urban context streetlevel





Historic situation

These are historic photographs of the site. The existing building originates from the 1960s. It was built as the municipal administration office for Rotterdam. Being an office building it has a collumn-grid structure and heigh floor to ceiling heights.

The traintracks and 'Tunneltracé' road are both already visible. The arm of the building located next to the tracks is 6 floors high, the part next to the road just 3. The visible facades all are almost completely glass, other than the part of the building that functions as the circulation core.

On the next pages the existing situation is visible. The building has got a different and less open facade, and was extended vertically with 2 floors. The current function is studenthousing.

Urban context

Urban context

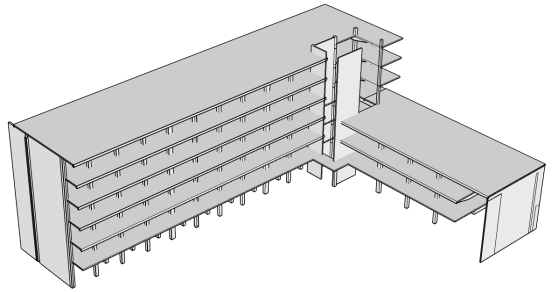
Current situation

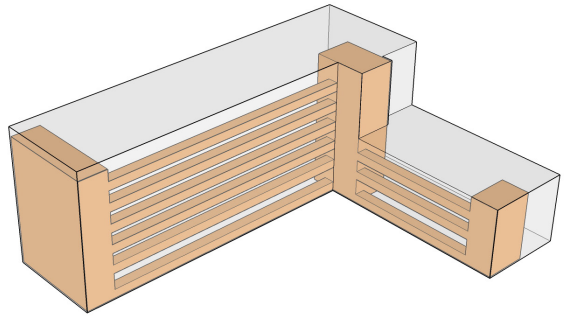
On the right side are the three principles of my support-system. The photograph is for reference to the existing building.

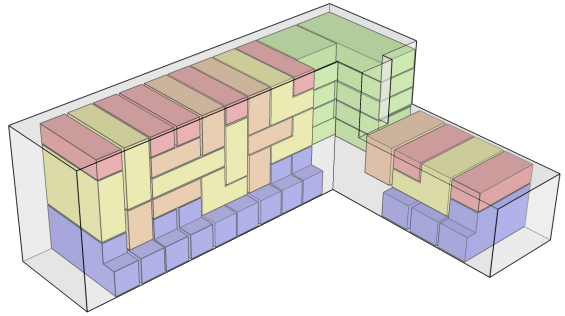
The existing loadbearingstructure is the beginning of my system. The high floor to ceiling heights and grid structure are ideal for transformation. I use this as the startingpoint to my design.

The circulationsystem is the next step. It is placed on the north and east sides of the building, thus exposing the south and west sides to more light and sun. I reuse the existing vertical circulation aswell. These cores get connected by exterior galleries placed on the existing loadbearing floors.

The last supportsystem is the placement of the dwellings. The dwelling-seperating walls are secured and show the users the edges of their domains. The placement of the different types is done in a workshop setting together with the future users of the building.



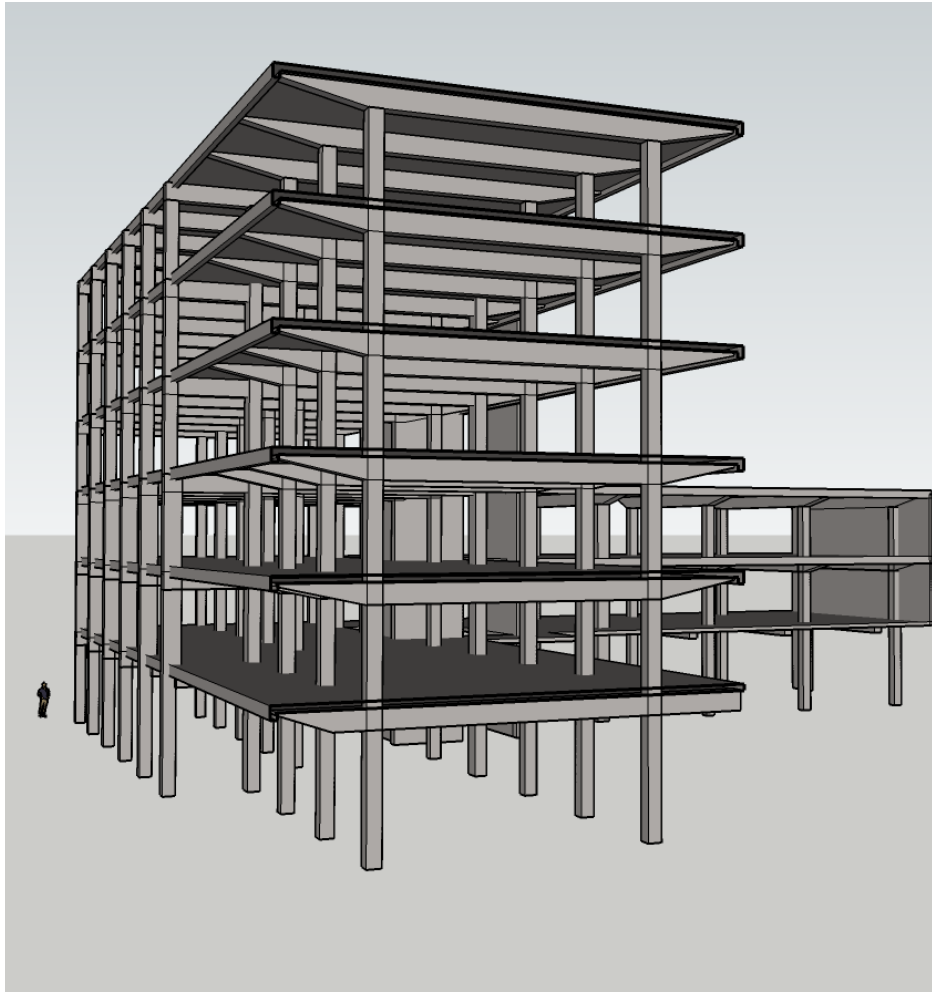




In this 3D section the existing loadbearing structure is visible. The collumns are placed set back from the outer facades of the building, creating a cantilever on both sides. This cantilever space is used for the galleries on the one side, and wintergardens on the other.

The floors are carried by large cantilevered beams that span the entire building. The floors themselves are concrete cast-in-situ structural floors.

Visible in this 3D image and also on the following pages in plan view is that the grid changes in the corner of the building. The two arms of the buiding have two columns every grid line with the cantilevered beams I described. The corner of the building bridges the two arms with three columns every gridline. In the inner corner the circulation core that acts as a stabilizer is placed.

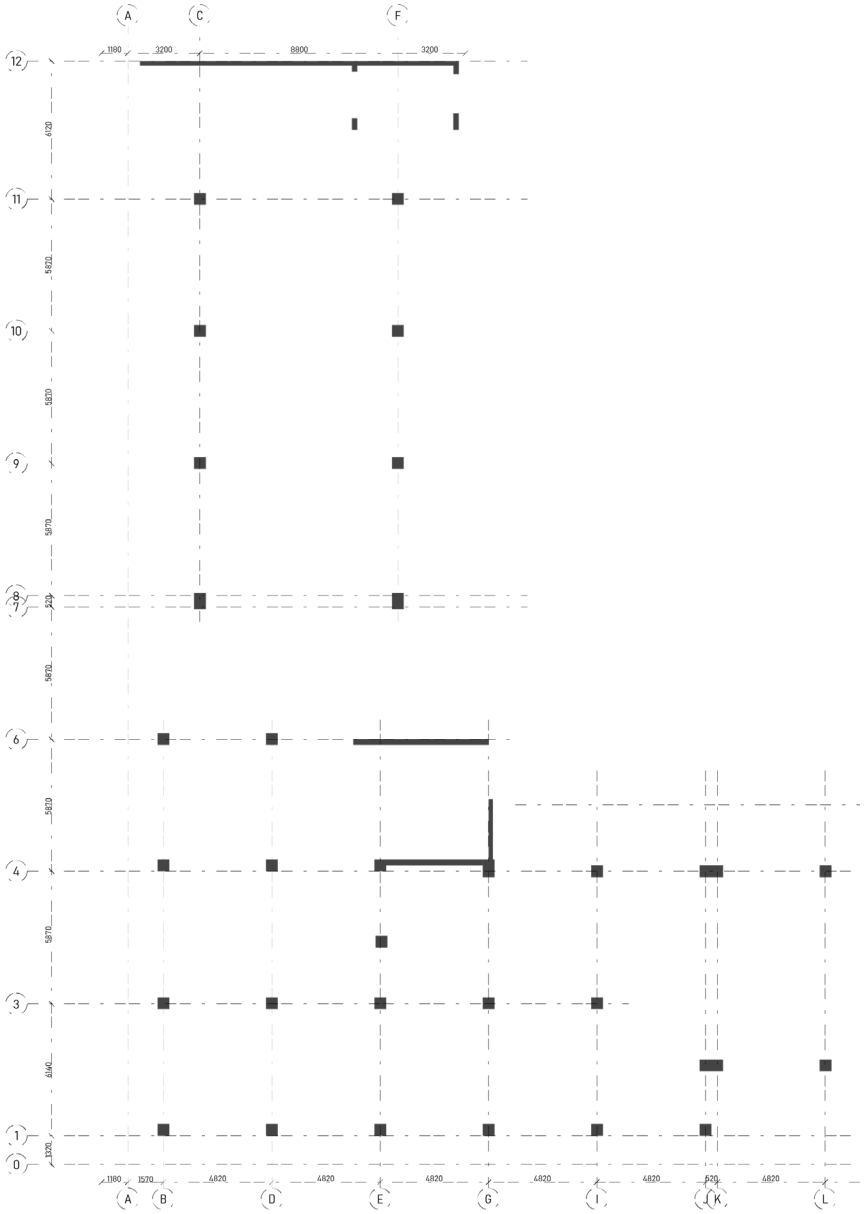


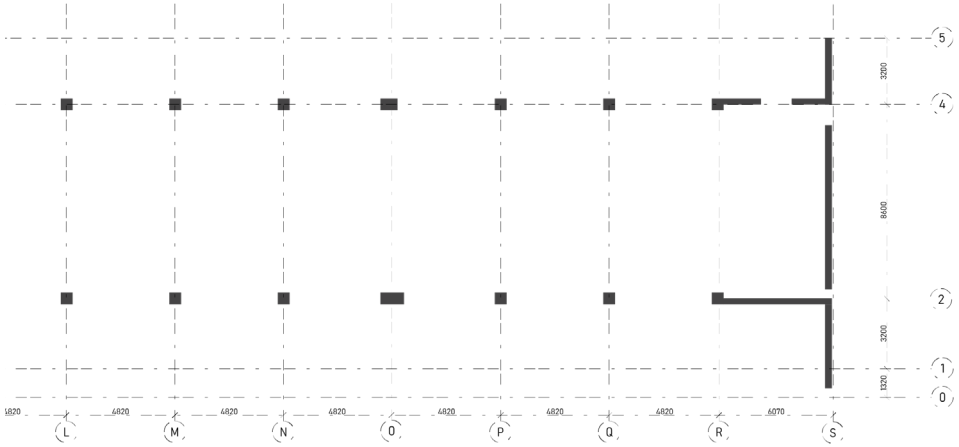
Principles

Principles

Existing structural elements

0 10 20 40m





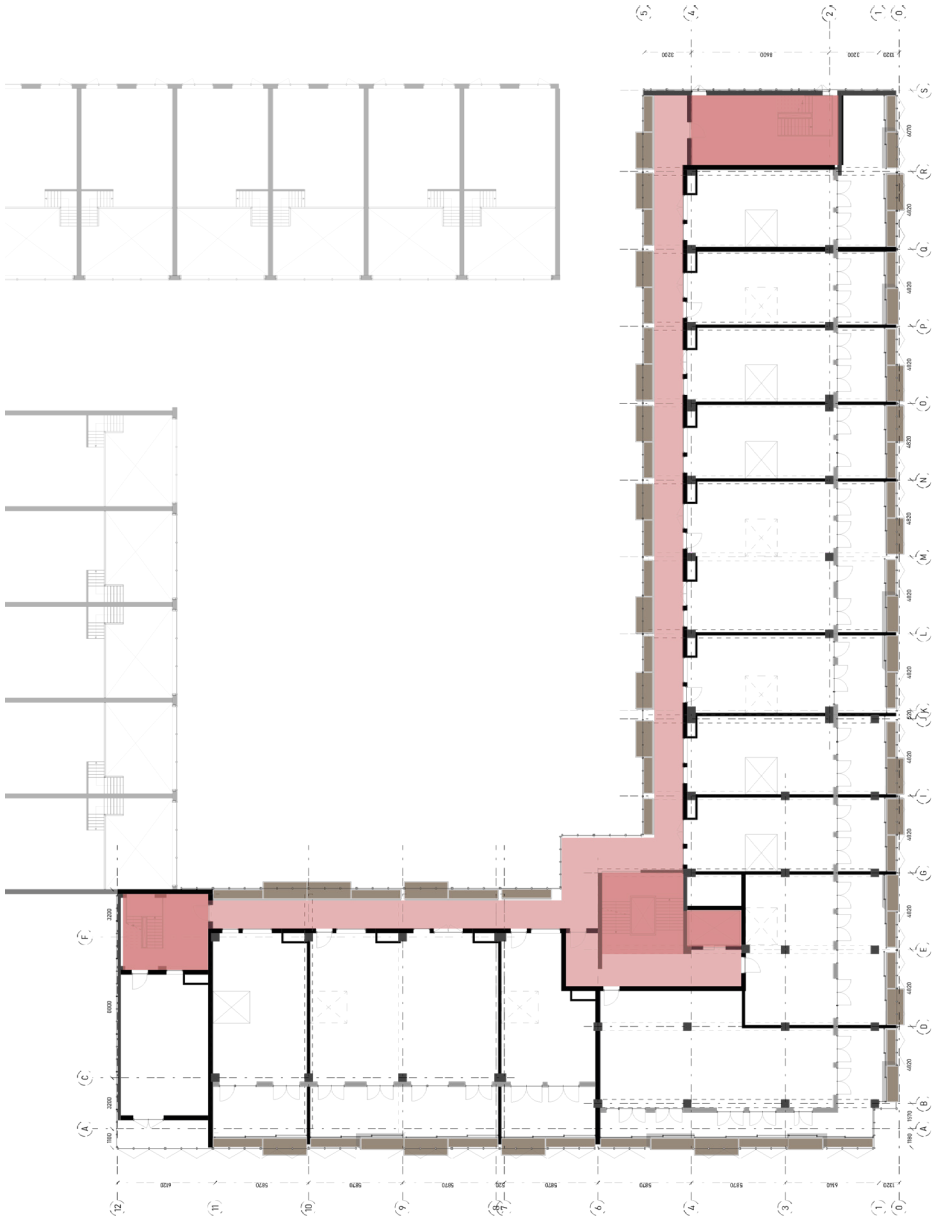
Ground floor circulation scheme

0 5 10 20m

Principles

Upper floors circulation scheme

0 5 10 20m

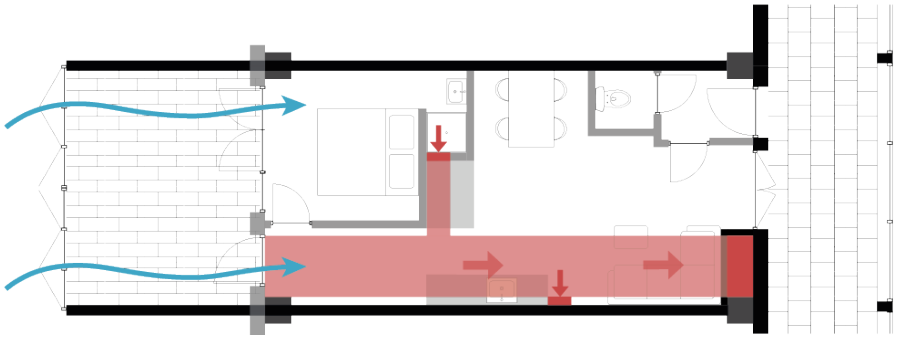


Ventilation scheme plan

0 2 4 8m

The ventilationsystem of the dwellings consists of natural intake and mechanical outtake. The mechanical outtake vents are located in the raised floorsystem, here they lie on one side of the dwellings and are connected to the vertical shaft on the gallery side. The sub-ventilation for inside the dwelling itself branches out from this 'main' pipe and is completely adaptable.

The warm used air is led to the roof of the building where an air to water heat transfer unit is situated. From here the air is pumped out of the building, but not before a lot of the heat is saved and transferred to water.



Ventilation scheme section

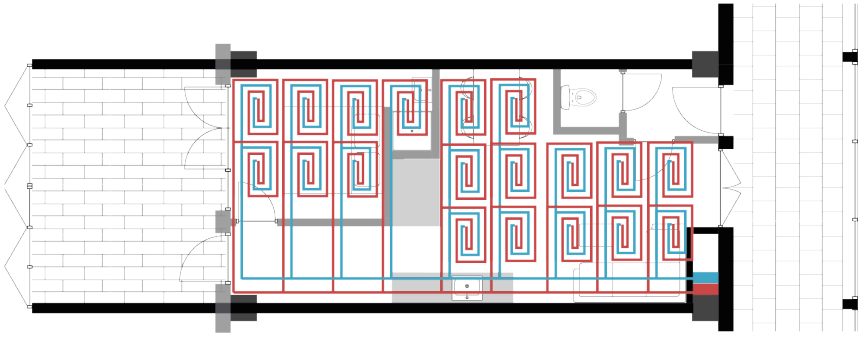
0 2,5 5 10m

Heating scheme plan

0 2 4 8m

The heated water from the air to water heat transfer unit is then led towards the basement of the building. Here the existing municipal heating system is located. The warm water is combined with this existing heating system and pumped back up through the vertical shafts.

In the dwellings the hot water is pumped through a main pipe and divided between the individual floor-heating tiles and finally when it expelled all the heat pumped back down to the basement.



Heating scheme section

0 2,5 5 10m

In the following pages the complete building floorplans are shown.

First the basement plan, which consists mainly of the external storage units of the residents. Also the existing municipal heating system is located here.[1] In this heating room a new system is added that combines the existing system with the new heated water system that comes from the roof.

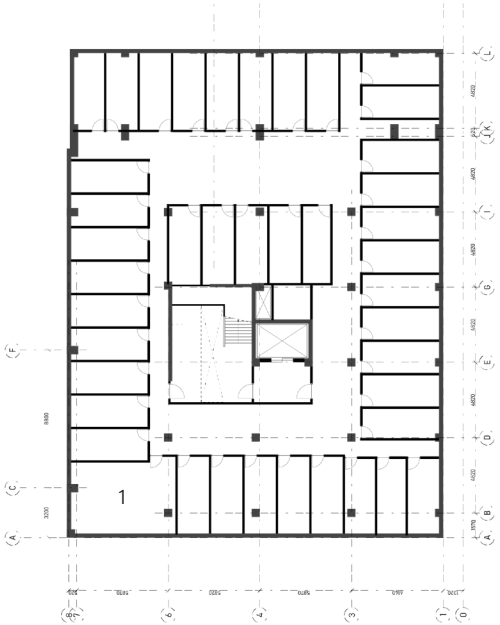
Secondly, in the ground floor plan the courtyard is shown. This courtyard is accesible via the main stairwell as well as the emergency stairwells. It is also externally accesible through two small doorways between the different buildings. The bicyclestorage is also visible. This storage gives space to at least four bikes for every dwelling, which is more than enough. The internal bicycle storage adds security for the residents and keeps the street free of a lot of bicycles.

Then the first and second floor plans are shown. Here the different dwellings are visible, aswell as the fact that they remain almost completely empty. The inner stair voids are also visible.

Lastly the third and above floorplans. They add a view of the roofgarden on top of the lower arm of the building. This adds a communal space for the entire building. Also it makes the view out of the higher surrounding buildings calmer and greener.

Basement floorplan

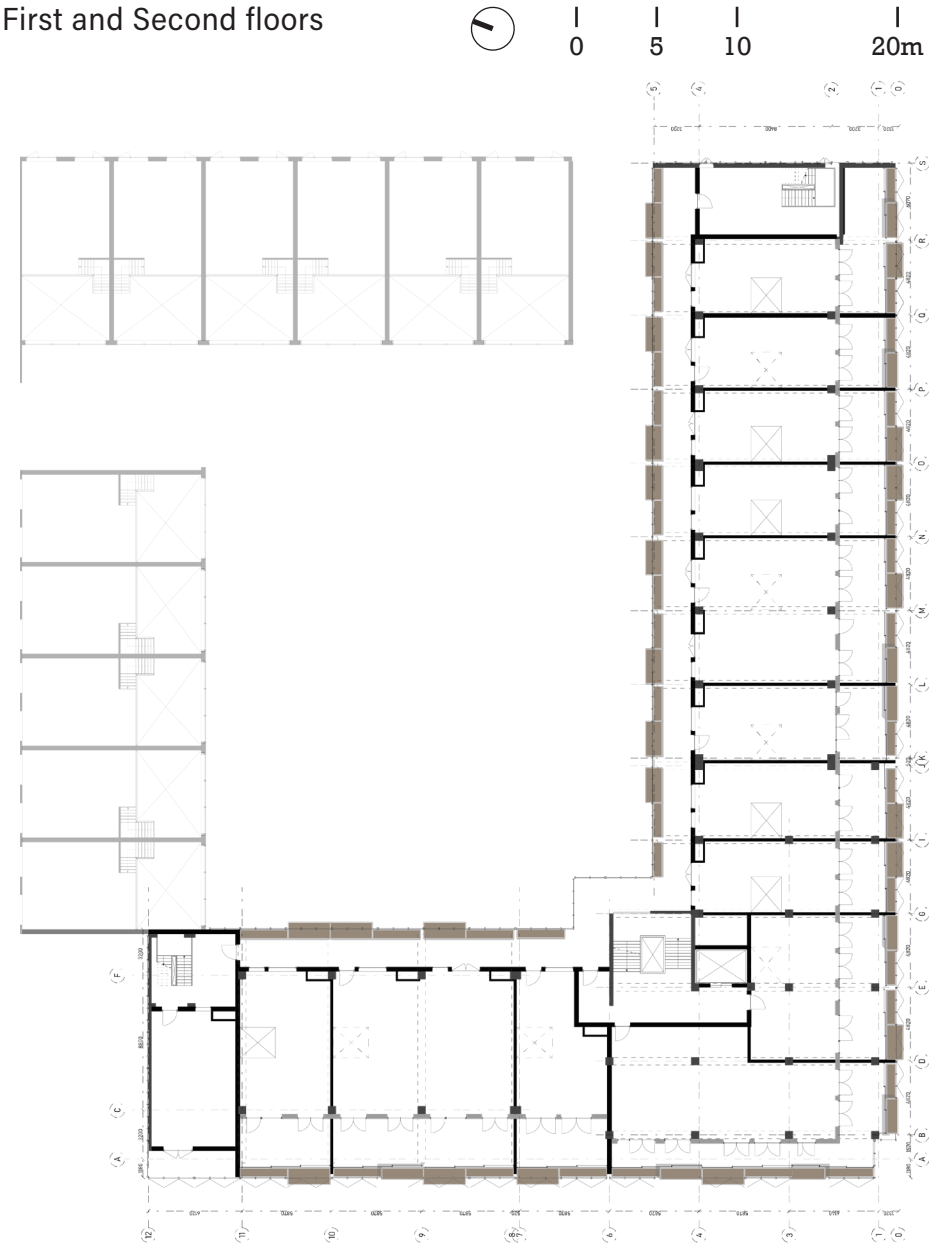
0 5 10 20m



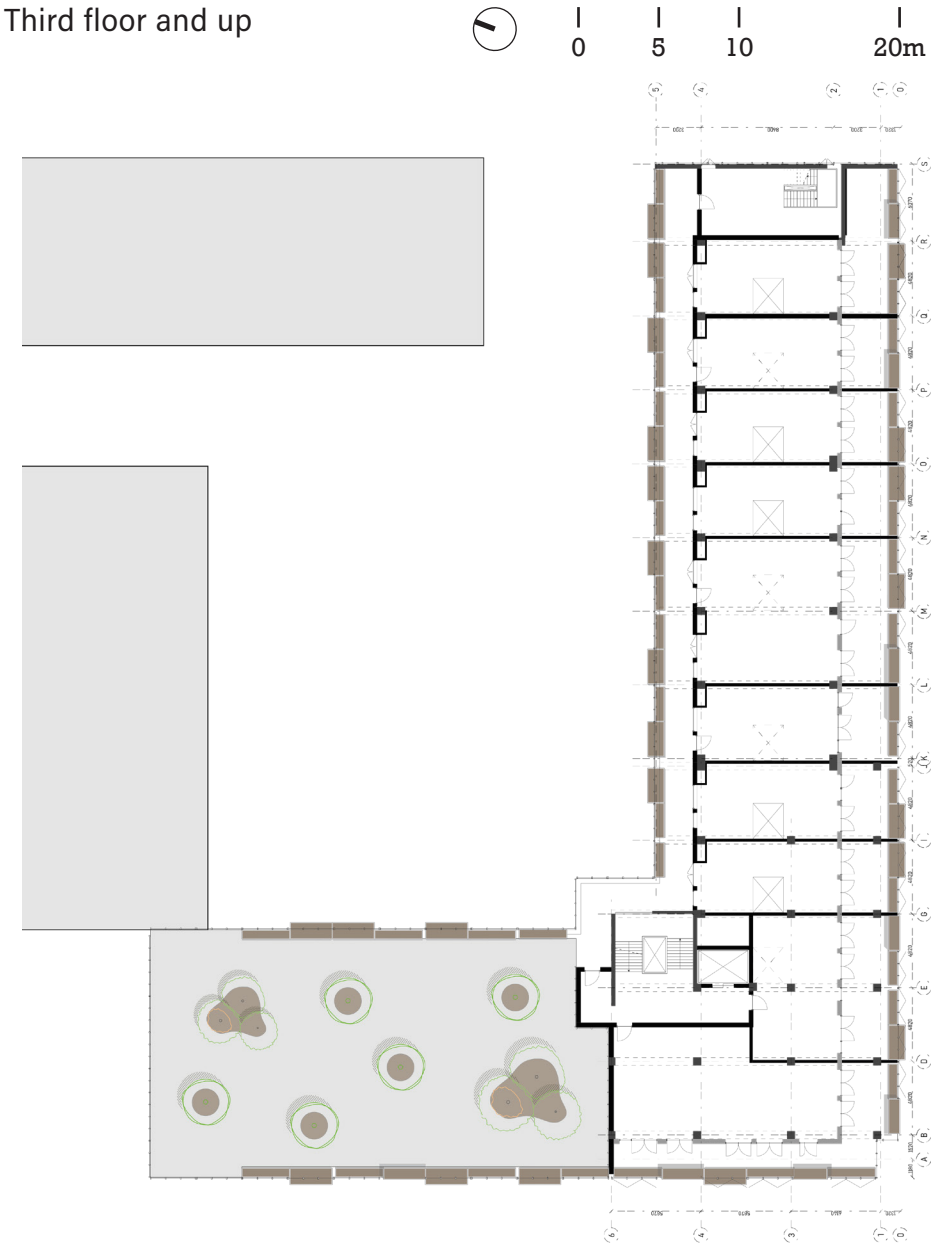
Ground floor

Building plans

First and Second floors



Third floor and up



Building section

Section

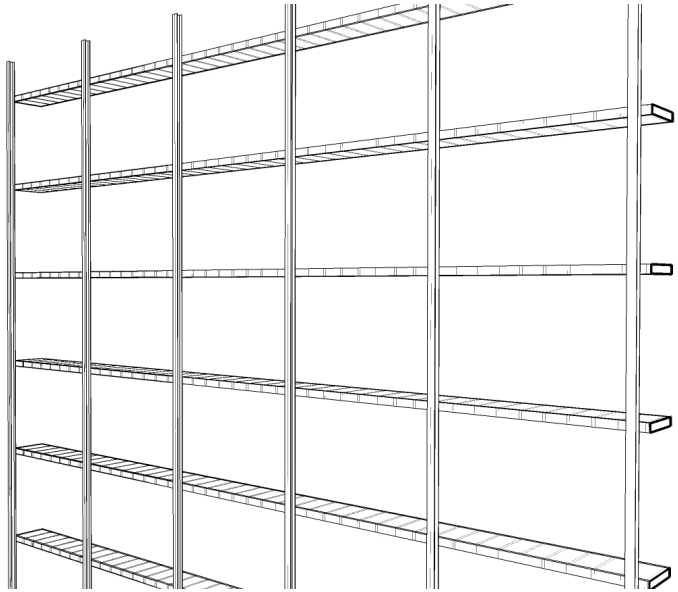
0 5 10 20m

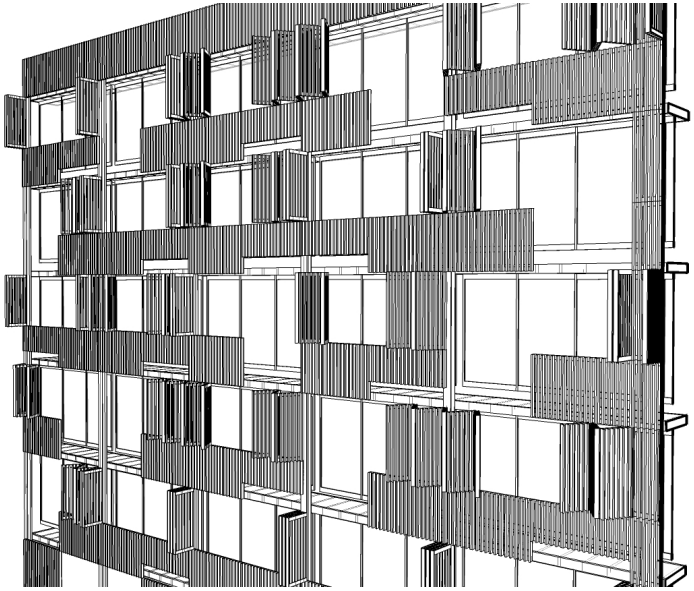
Principle new facade

The Harmonica facade is the most 'Hard' (or strictly designed) adaptable design solution. The facade is placed on a new steel construction that is self bearing and connected to the existing concrete structural floors.
The facade consists of steel frames on which wooden lamelas are bolted. The bottom panels function as a railing. The top ones on every floor act as a harmonica wall that can be opened and closed completely.

To break the monotomy of the facade concrete planters are placed behind the lamelas. Some of the planters stick through and some are high enough to replace the railing panels.
This adds an inclusive element as well, as the users get to decide how green and what plants are put in the planters. These plants also create extra shade and privacy in the dwellings.

On the inside of the facade, in the wintergardens, a glass sliding facade is placed to keep out the noice and air pollution from the traintracks and road next to the building. This also enables the space to be used when the weather is not great.





Facades

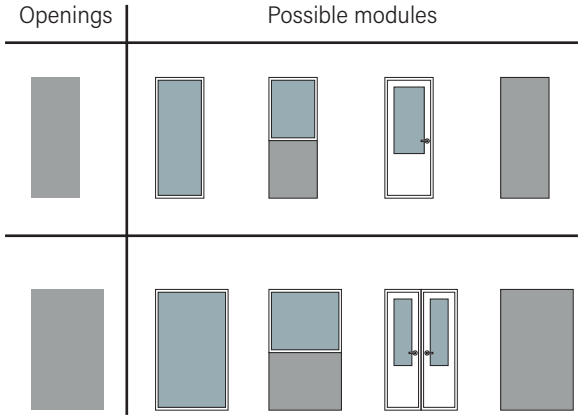
Principle Modular facade

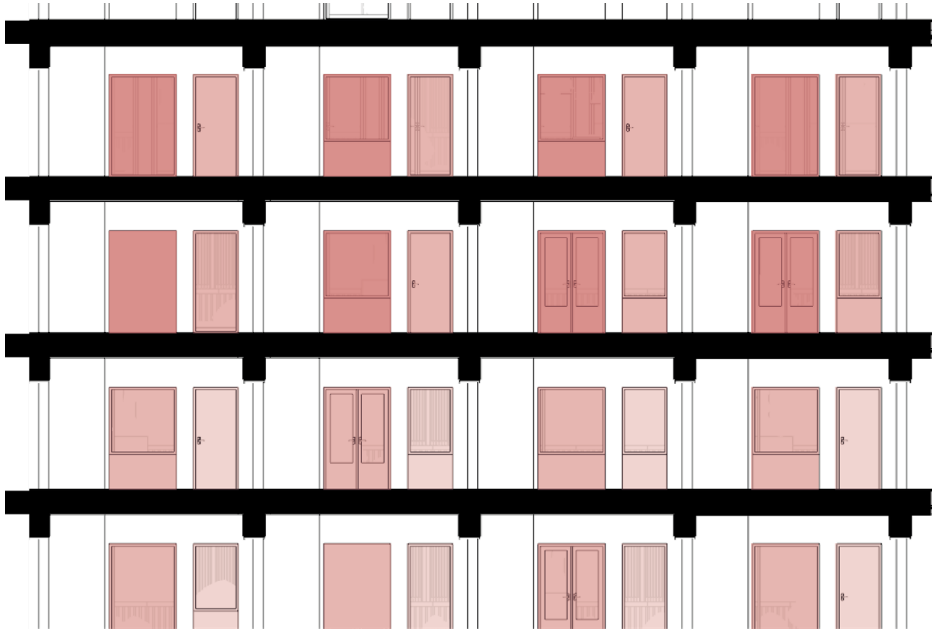
The Modular facade is built up of the same openings every grid measure. Every time it is a zone where the vertical shaft is located, and a big and small opening next to this.

The openings each have four kinds of infill. A big window to the floor for a more public side of the dwelling. A smaller window that gives slightly more privacy. A door, that can be used as front door or secondary entry. And lastly a closed panel, that creates a more closed-off side to the dwelling.

These regular openings and small amount of different infills create a uniform and calm facade no matter the choices. This is important in this facade as it is located directly on the gallery of the building.

Facades





Facades

Elevations

0 5 10 20m

The dwellings in the building are seperated into five types, these types are categorized by size.

Type A is the smallest type and measures one grid-size.

Type B is two grid-sizes and can be oriented horizontally or vertically.

Type C is three grid-sizes and can be oriented horizontally, vertically, or as a L shape.

Types D and E are the corner sollutions and are medium sized. D is between A and B in size. E is between B and C in size.

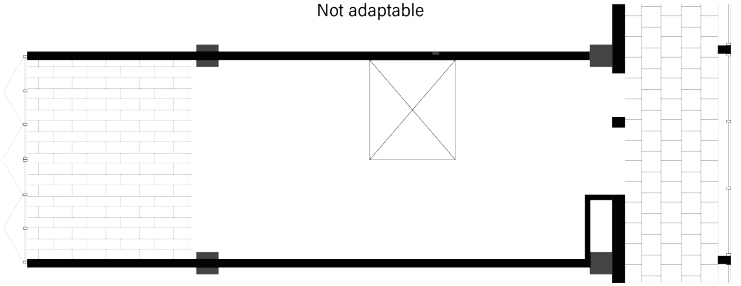
The floorplan layouts are all user-inclusive and are therefore decided by the residents themselves. The given layouts in my project function more as examples and experiments into if regular and less regular dwelling layouts are possible in the building.

Dwelling floorplans

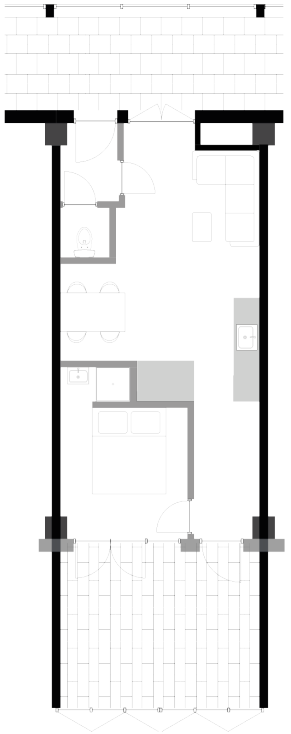
0 2 4 8m

Type A: 43 m2

Not adaptable



First Floor

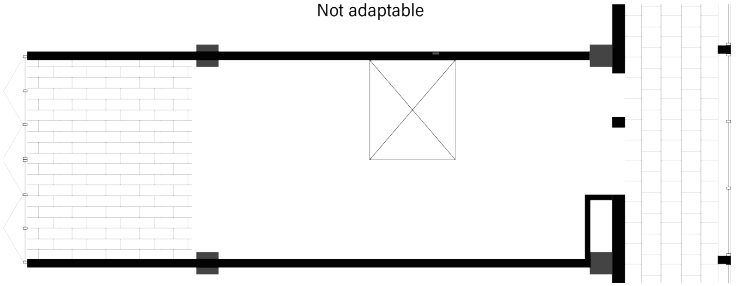


Dwelling floorplans

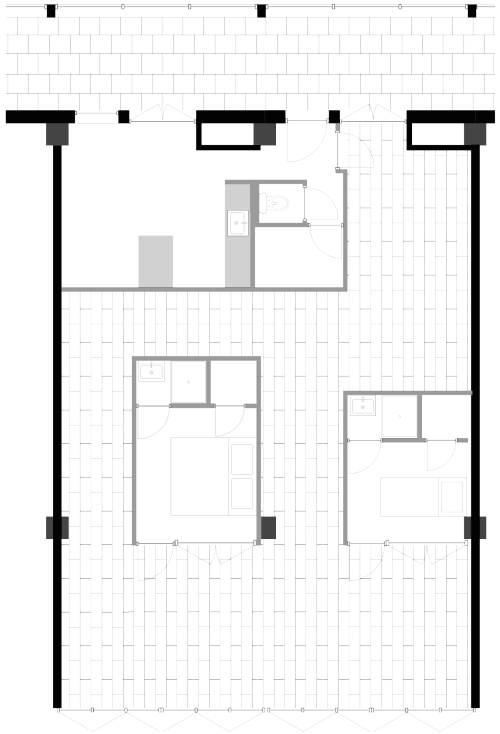
0 2 4 8m

Type B1: 87 m2 BVO

Not adaptable



First Floor

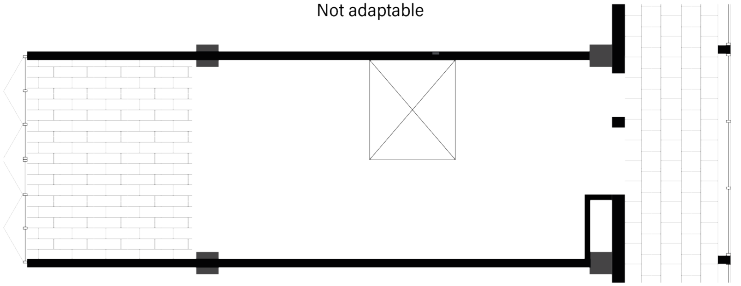


Dwelling floorplans

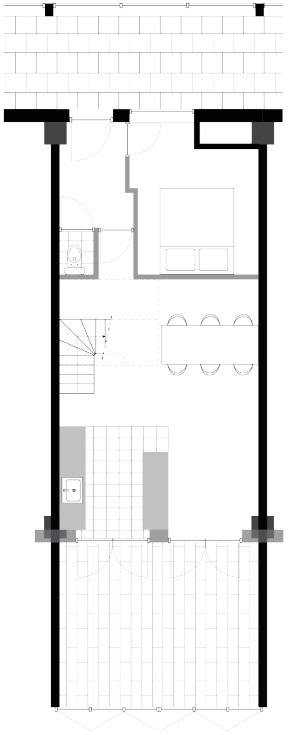
0 2 4 8m

Type B2: 87 m2 BVO

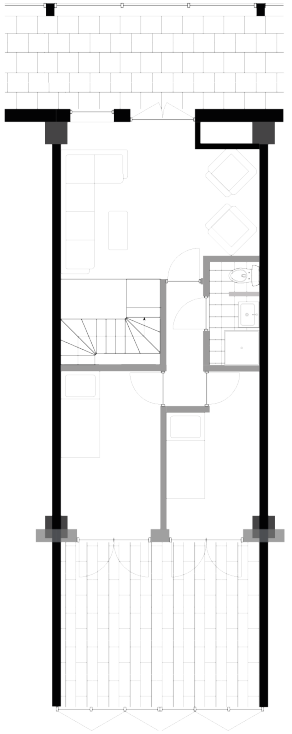
Not adaptable



First Floor



Second Floor

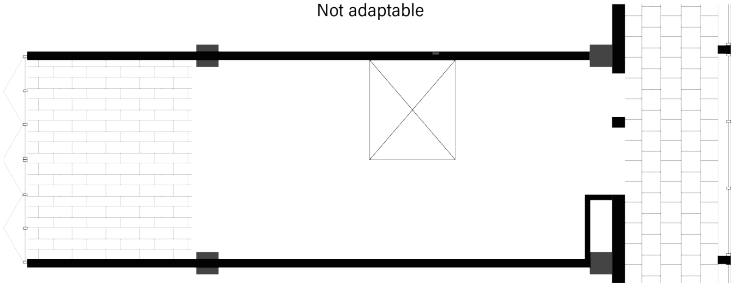


Dwelling floorplans

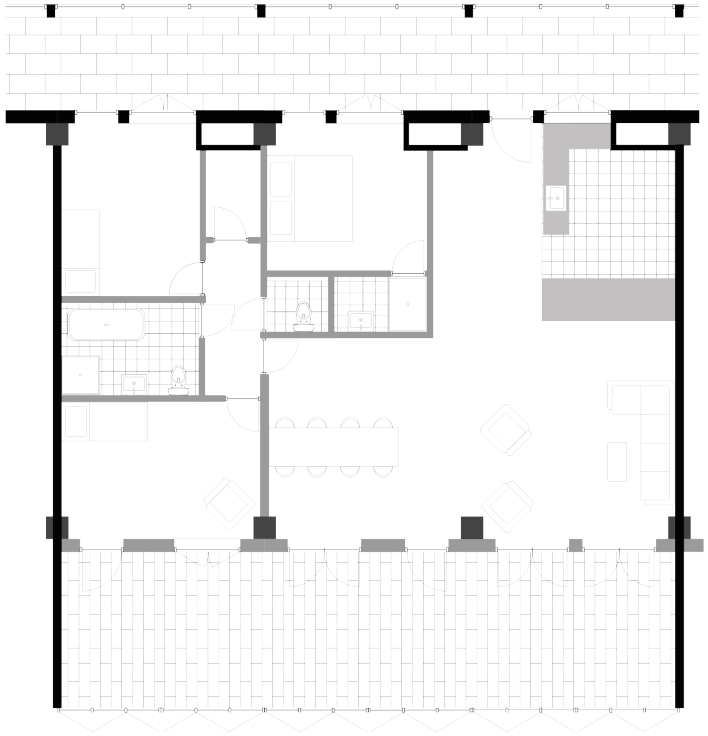
0 2 4 8m

Type C1: 130 m2 BVO

Not adaptable



First Floor

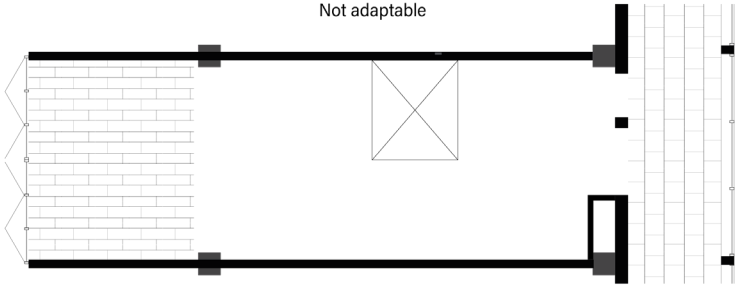


Dwelling floorplans

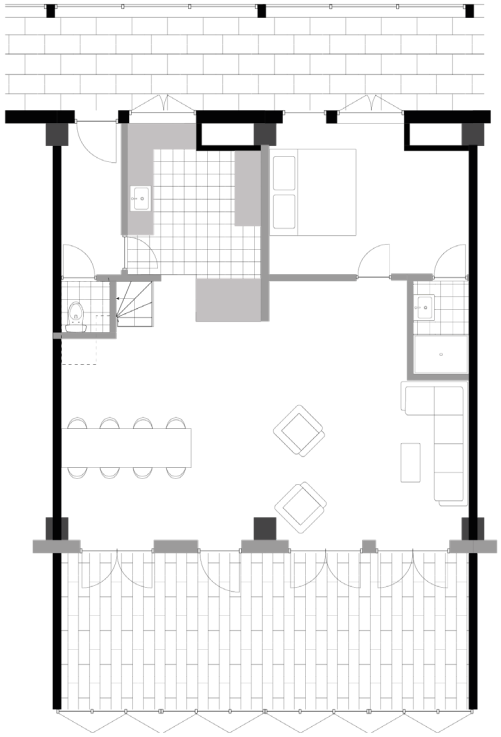
0 2 4 8m

Type C3: 130 m2 BVO

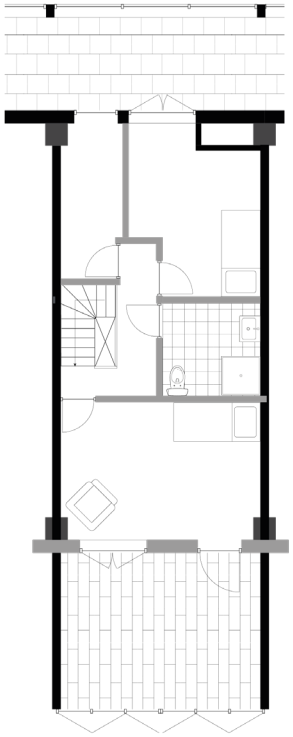
Not adaptable



First Floor



Second Floor

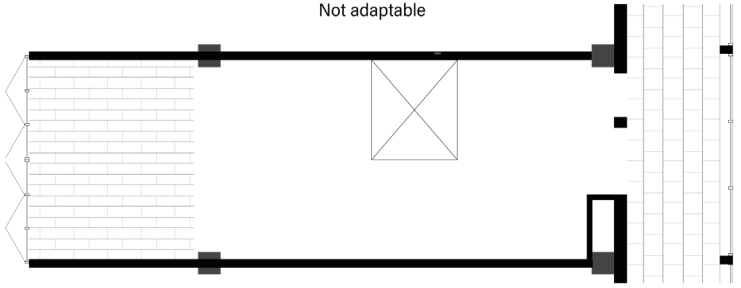


Dwelling floorplans

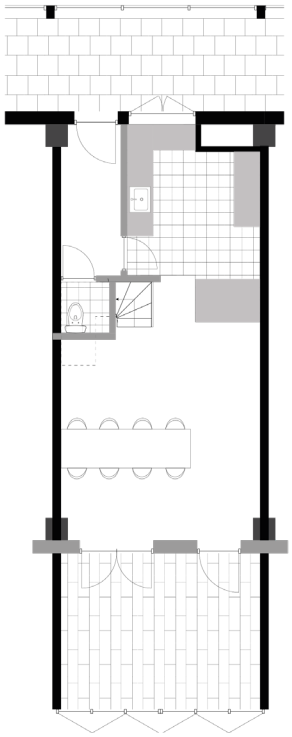
0 2 4 8m

Type C2: 130 m2 BVO

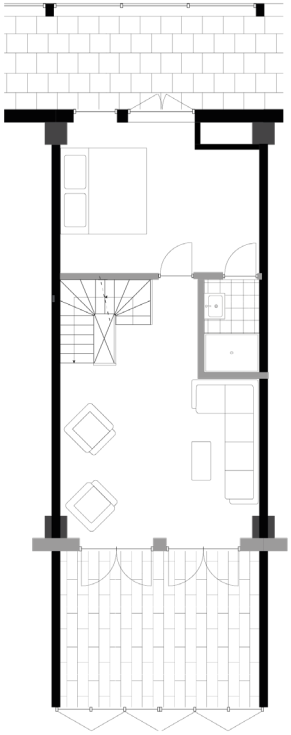
Not adaptable



First Floor



Second Floor

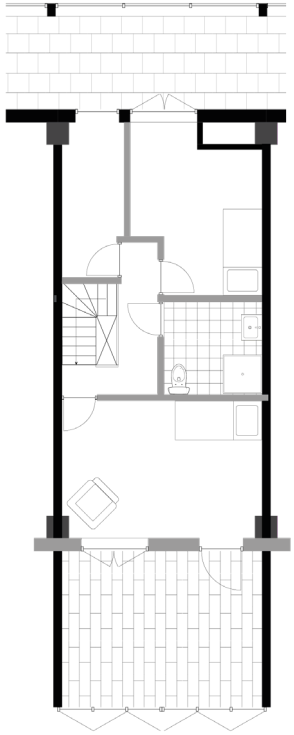


Dwellings

Dwelling floorplans

0 2 4 8m

Third Floor

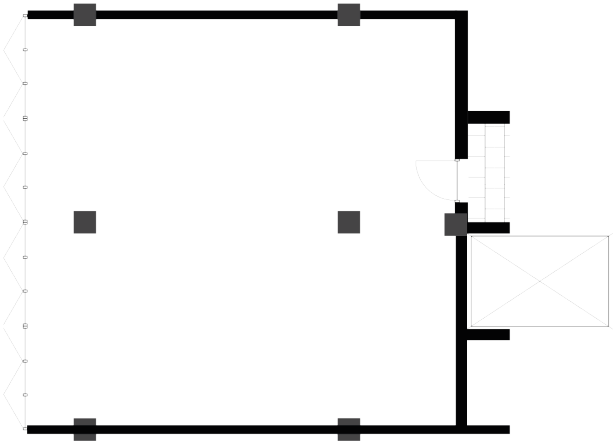


Dwelling floorplans

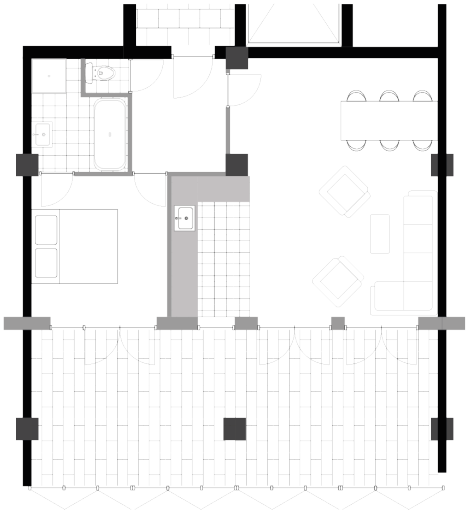
0 2 4 8m

Type D1: 60 m2 BVO

Not adaptable



First Floor

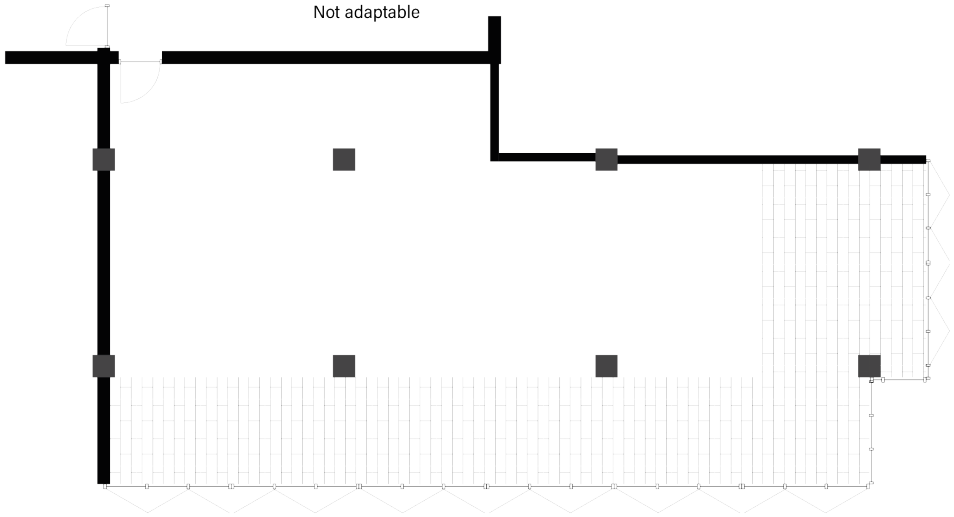


Dwelling floorplans

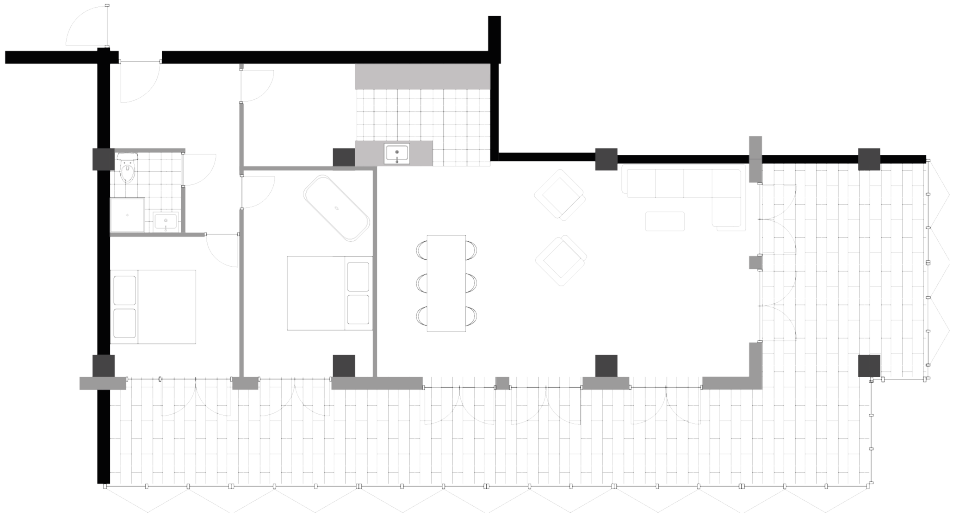
0 2 4 8m

Type E1: 98 m2 BVO

Not adaptable



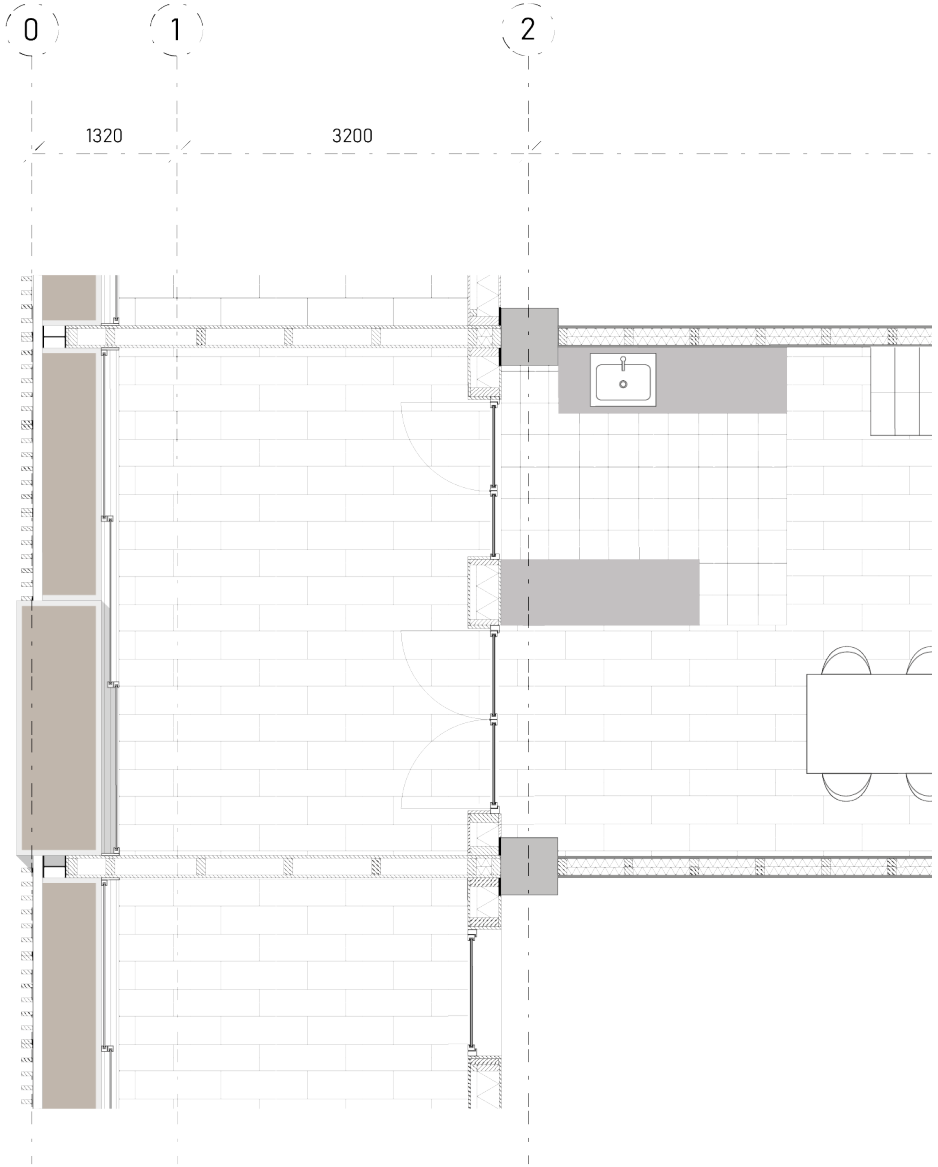
First Floor

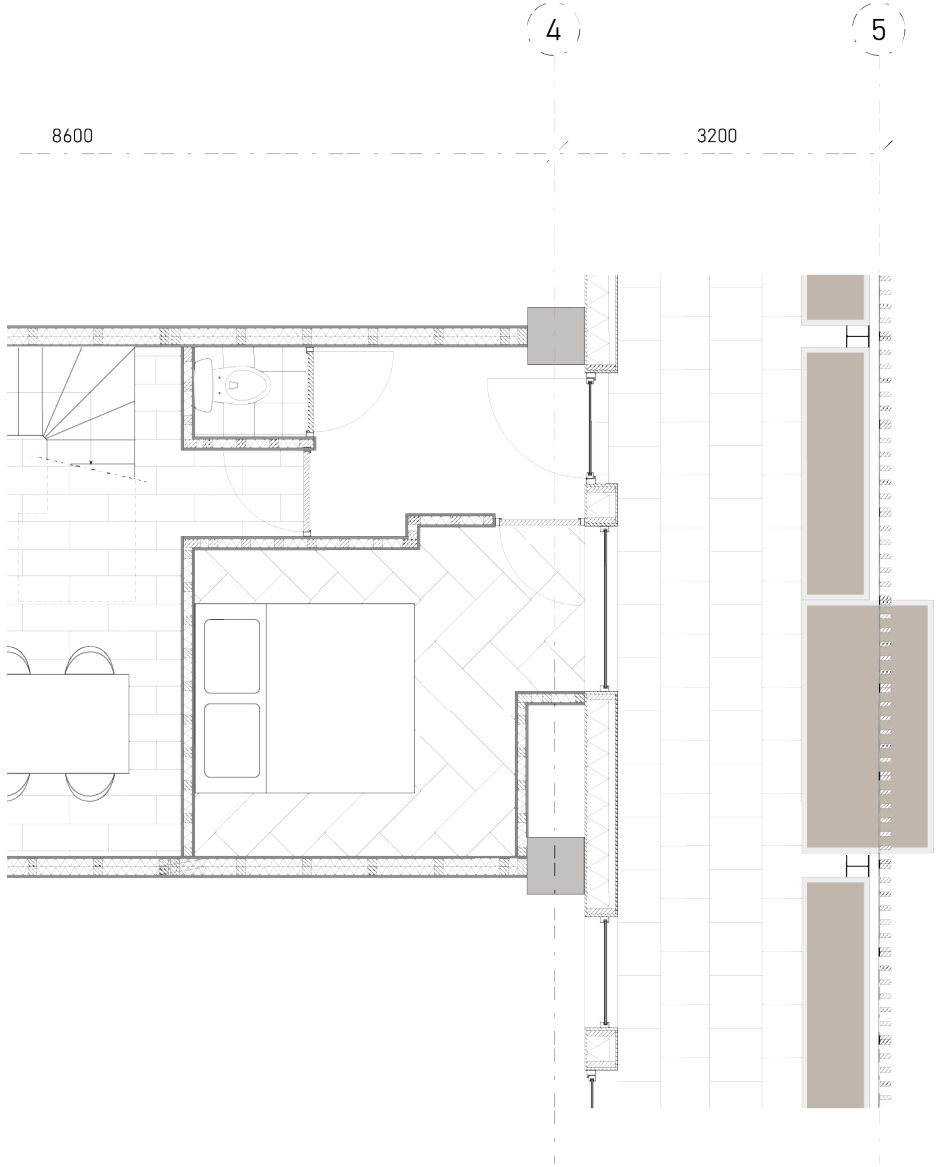


Dwellings

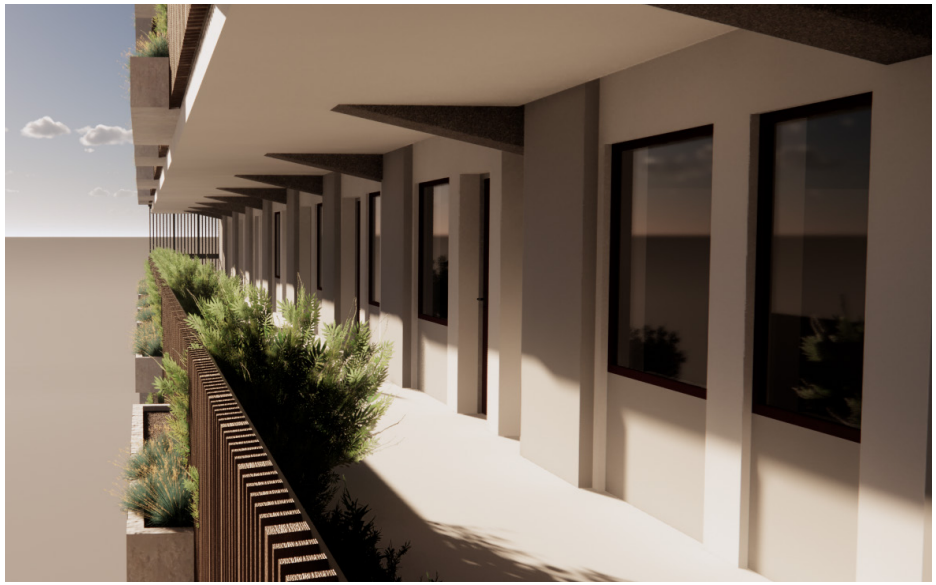
Dwelling floorplan

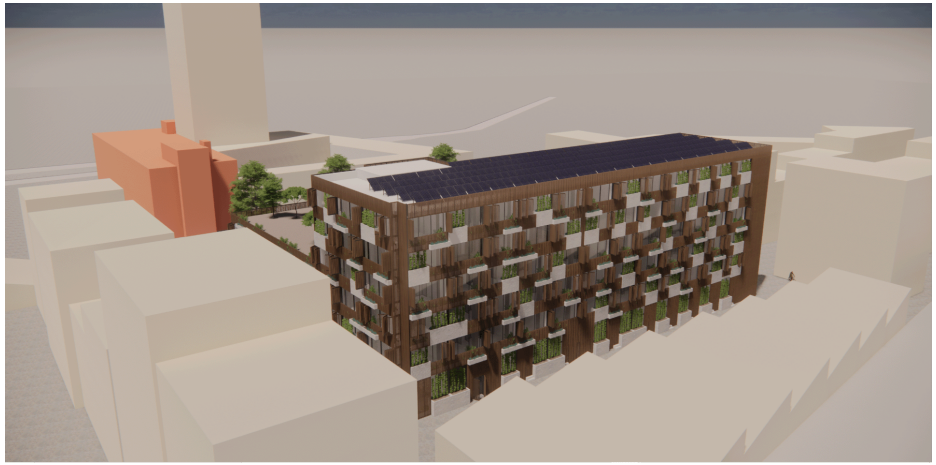
0 1 2 4m





Impressions



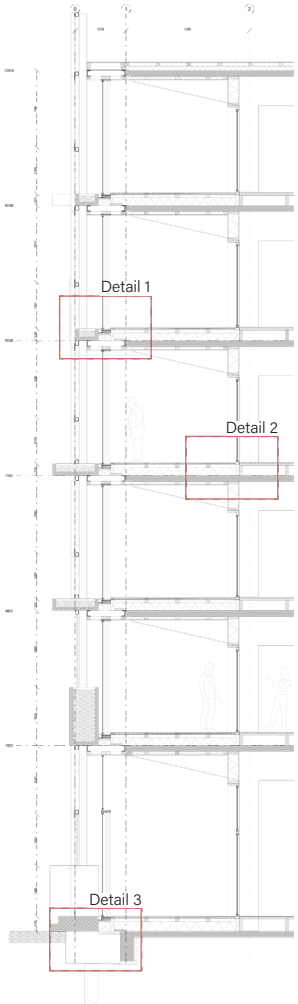


The detailing of the building is all focused on enabling the adaptability of the design. This means that all the connections have to be easy to revert or change in the future.
I did this in the new Harmonica facade by using steel construction with dry connections for the loadbearing structure. Also the floors and walls in the building are all placed in between the existing concrete structure and can be removed as easily.
The planters are all placed loose on the new steel structure. This means that also these are easily replaced or removed.

The buildings construction order begins with the demolition of the existing building up until the concrete structure. Then the new steel structure is placed against that concrete. Then the wooden lamellas are placed against the steel and on the other side on the concrete at the galleries.
After this the planters can be placed, after which the floors and ceilings are put in. Then the glass sliding doors and modular walls are constructed. And lastly the layout of the dwellings and DIY wall are constructed.

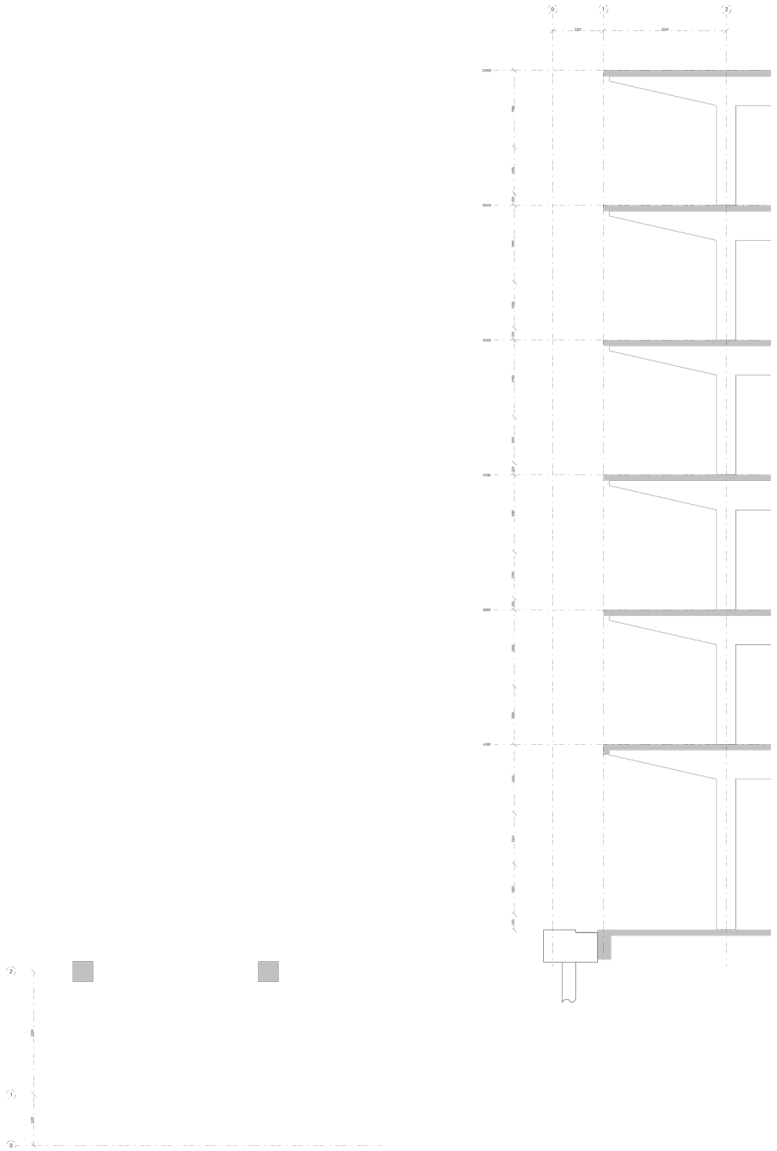
Building fragment

0 2 4 8m



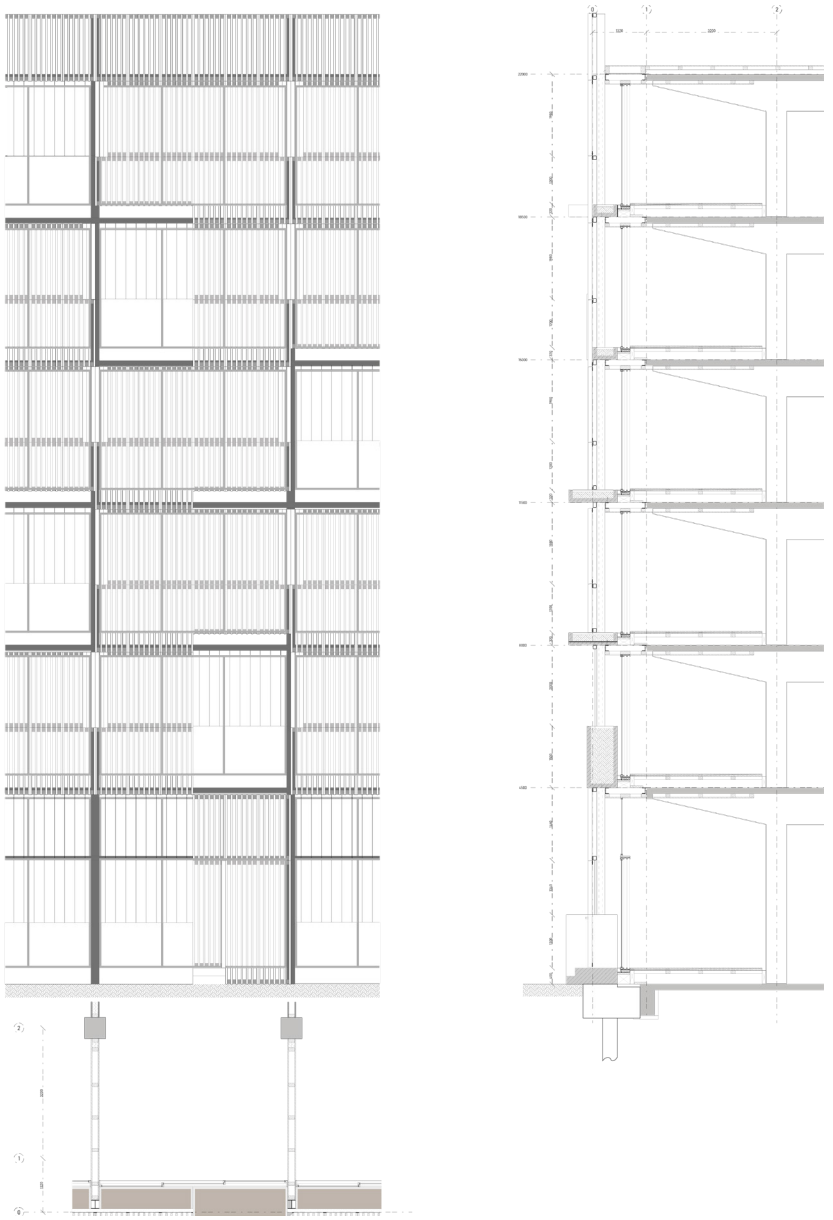
Build order 1

0 2 4 8m



Build order 2

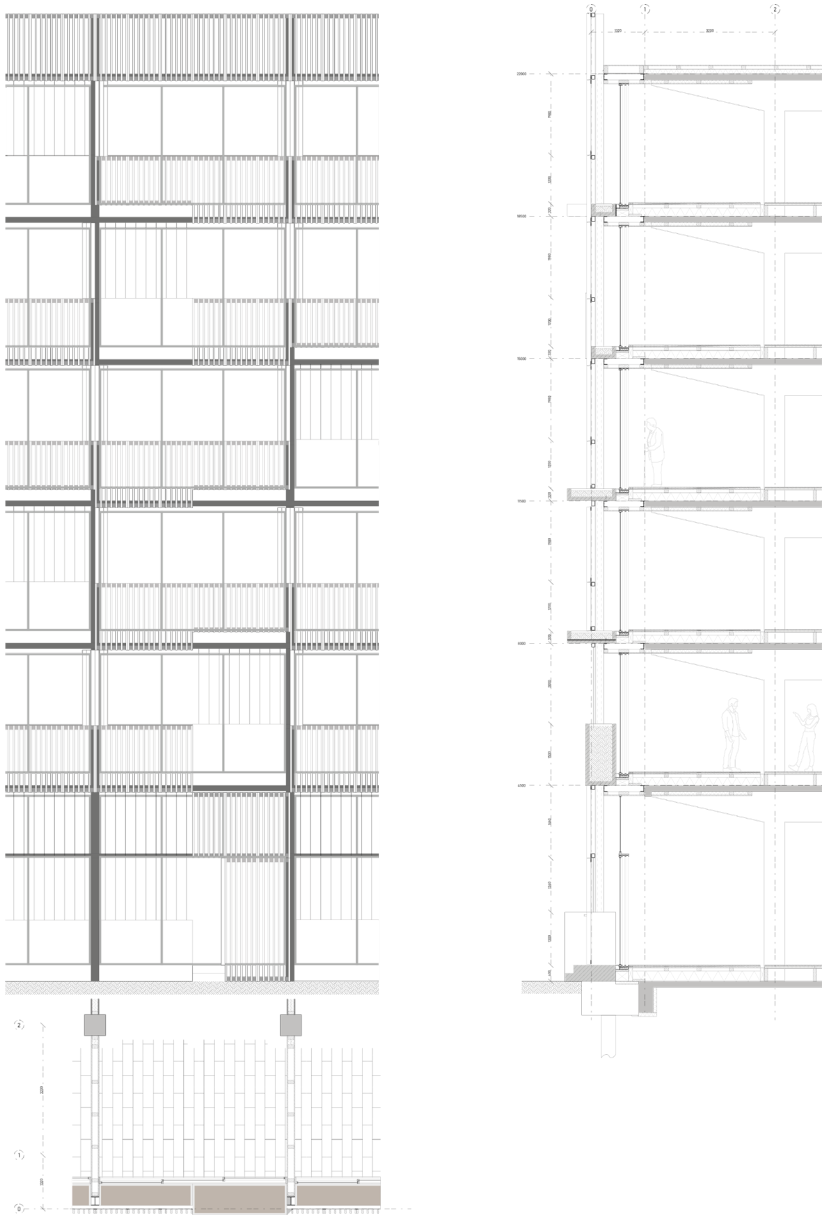
0 2 4 8m



Detailling

Build order 3

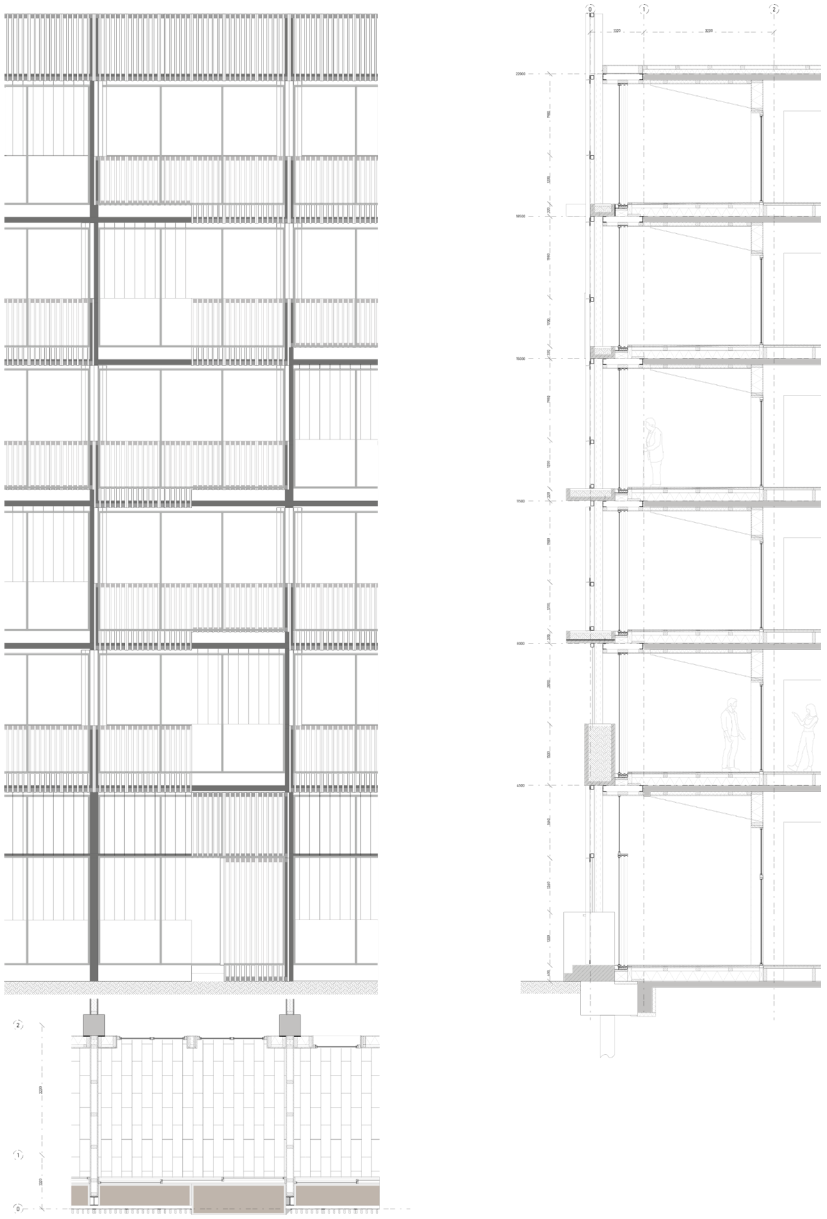
0 2 4 8m



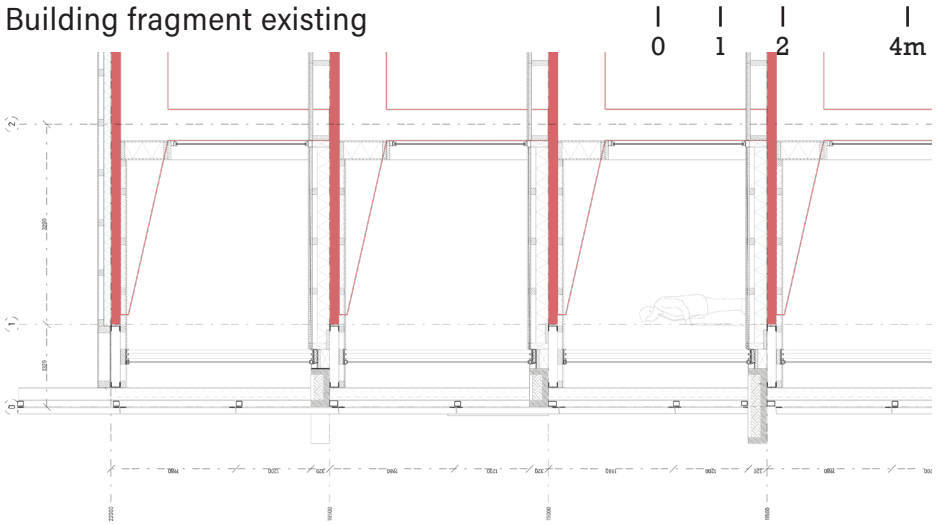
Detailling

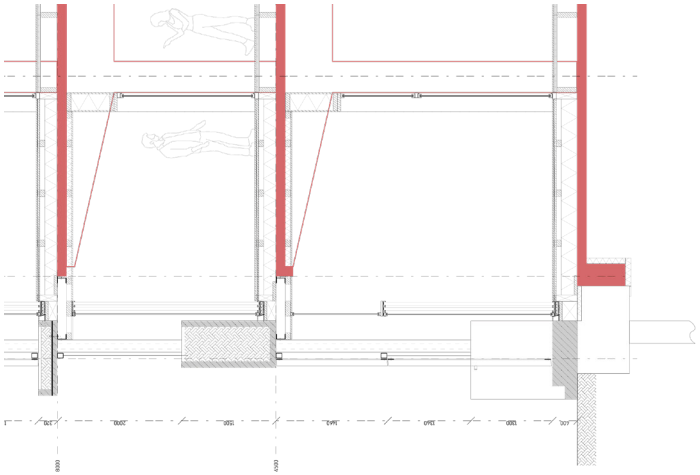
Build order 4

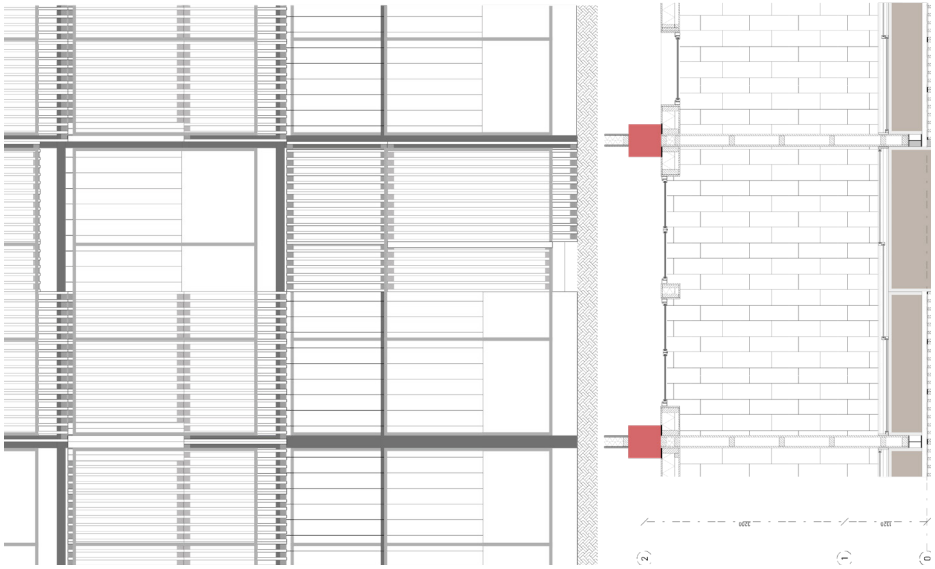
0 2 4 8m



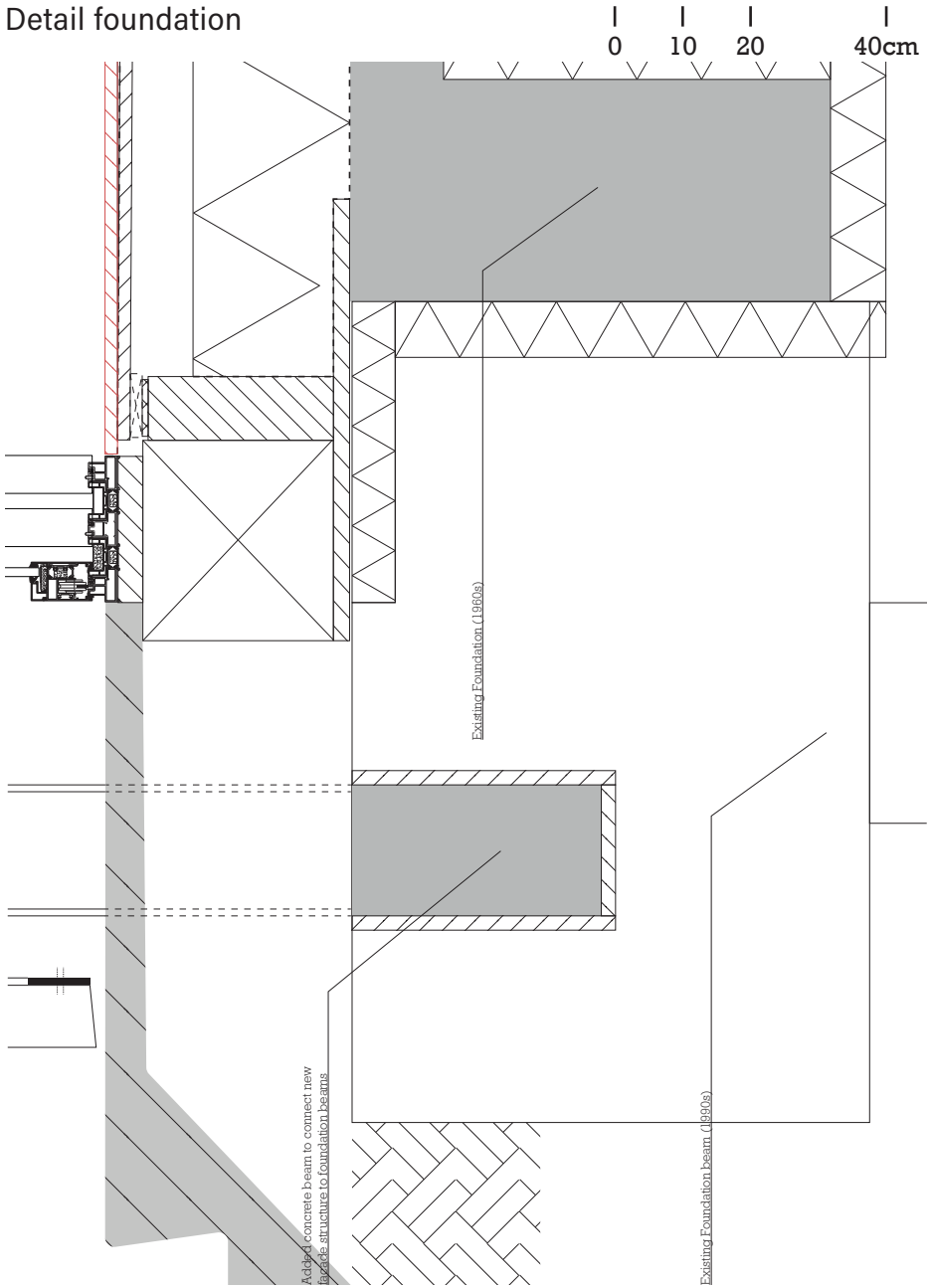
Building fragment existing



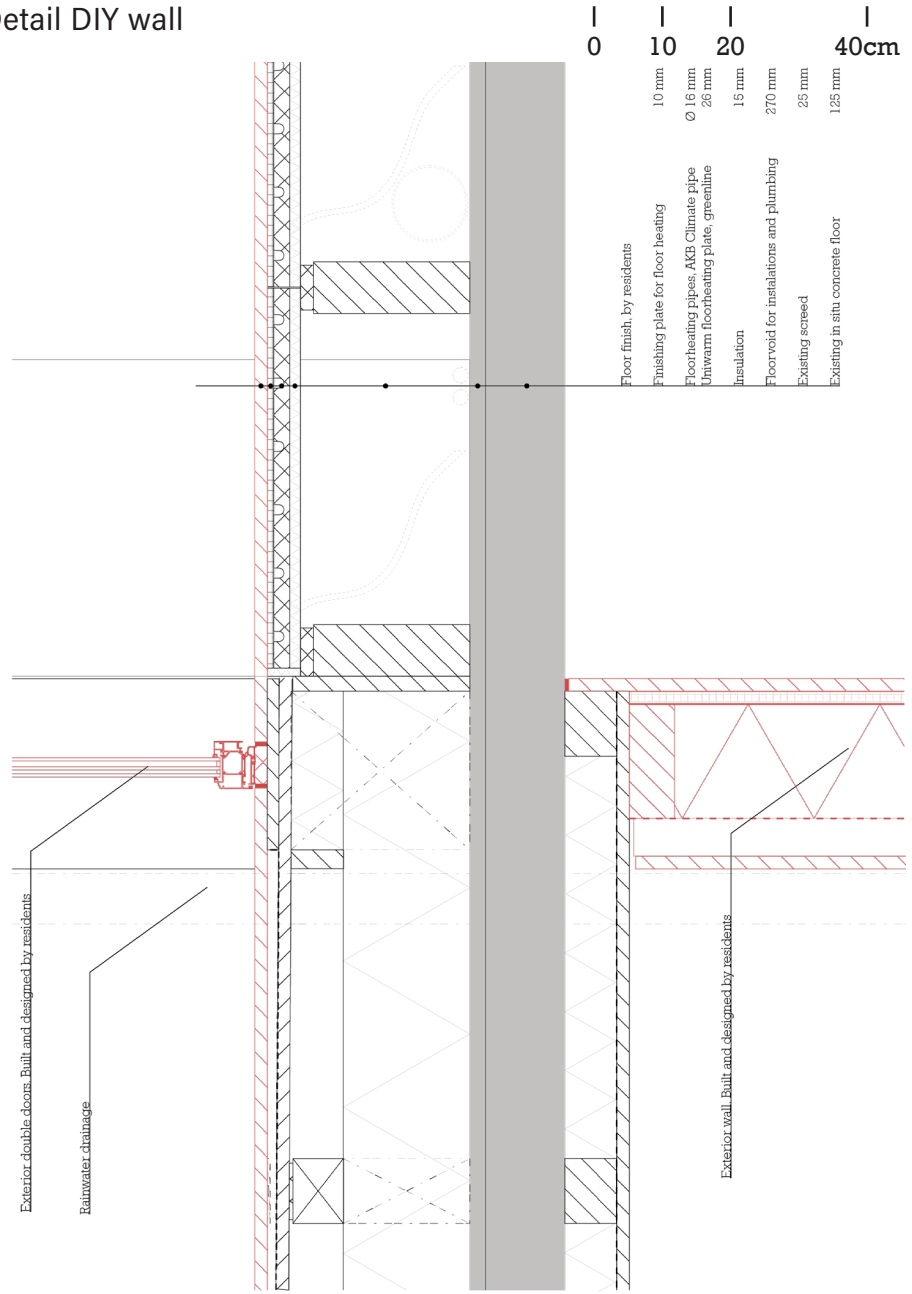




Detail foundation

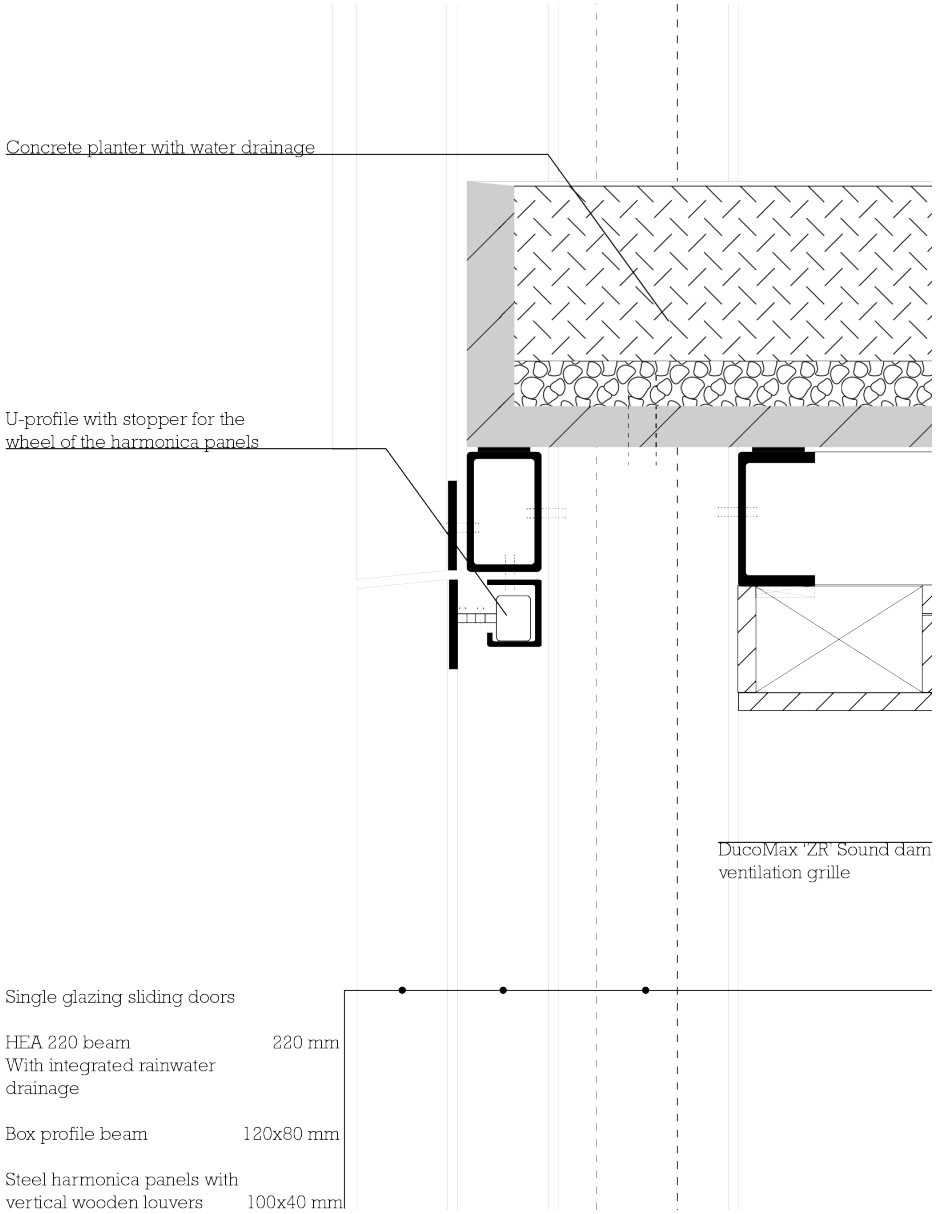


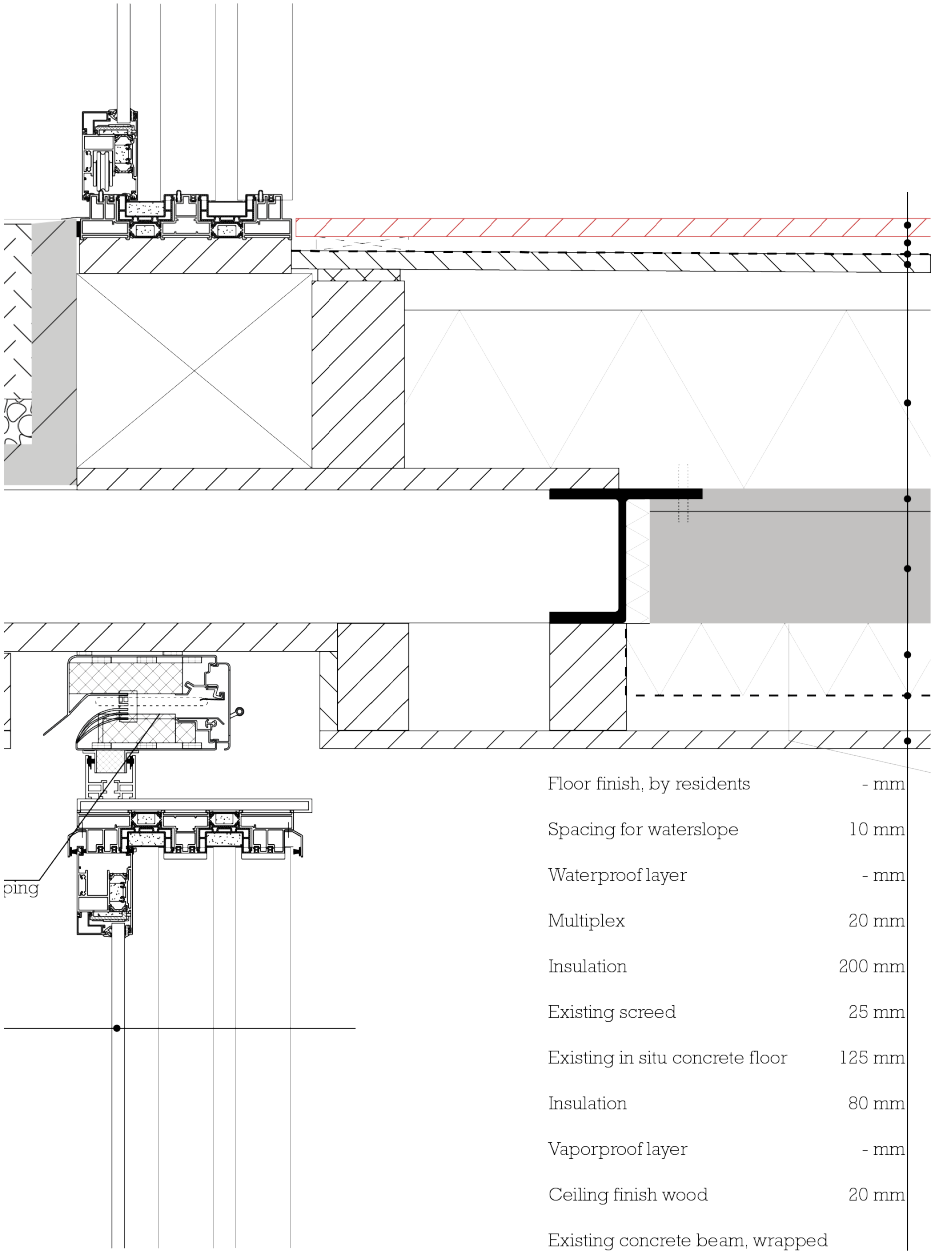
Detail DIY wall



Detail Harmonica wall

0 10 20 40cm

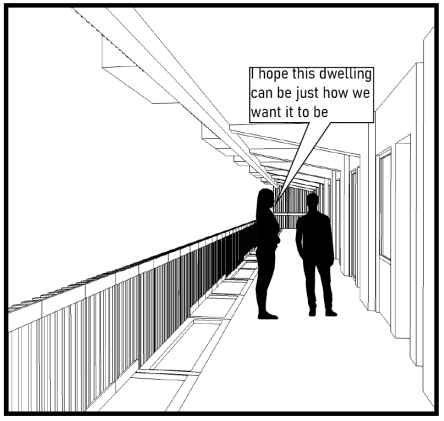


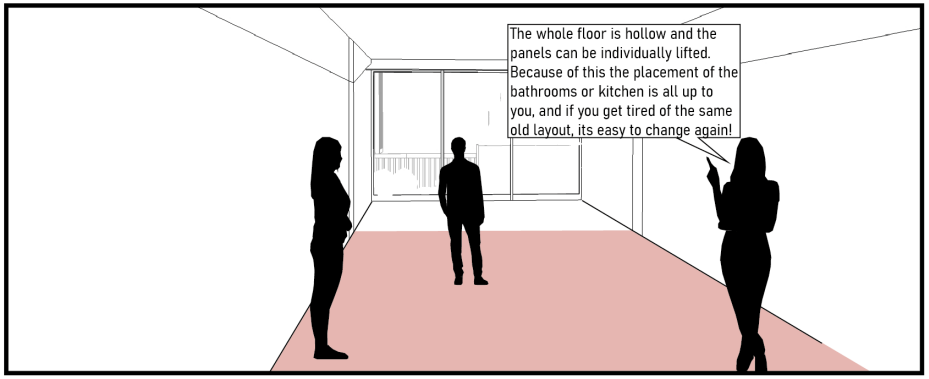


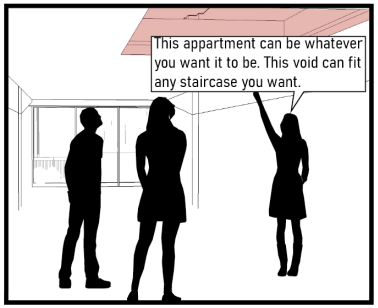
Floor finish, by residents	- mm
Spacing for waterslope	10 mm
Waterproof layer	- mm
Multiplex	20 mm
Insulation	200 mm
Existing screed	25 mm
Existing in situ concrete floor	125 mm
Insulation	80 mm
Vaporproof layer	- mm
Ceiling finish wood	20 mm
Existing concrete beam, wrapped	

Graphic Novel

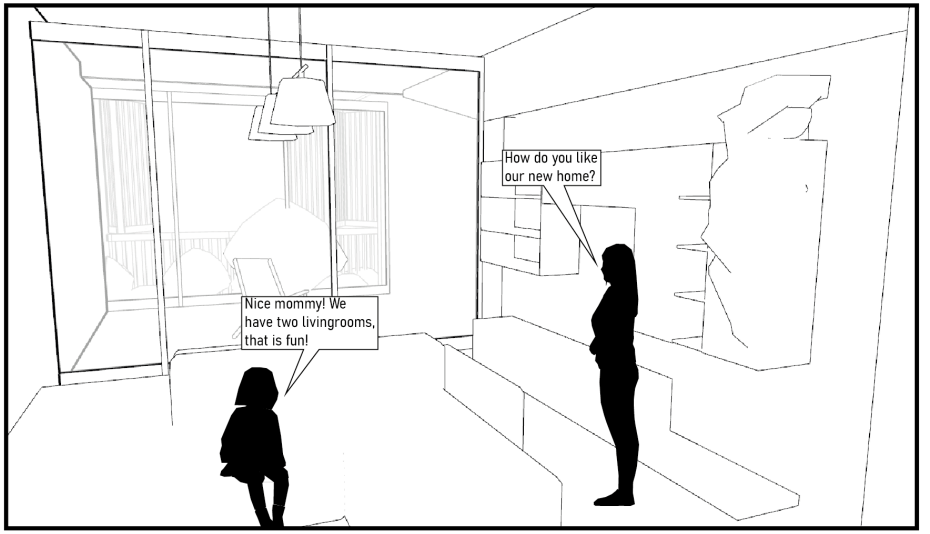

The Admin
We've been looking for a long therm dwelling for so long...
This seems perfect for us!
43 adaptable units
available in spring 2025

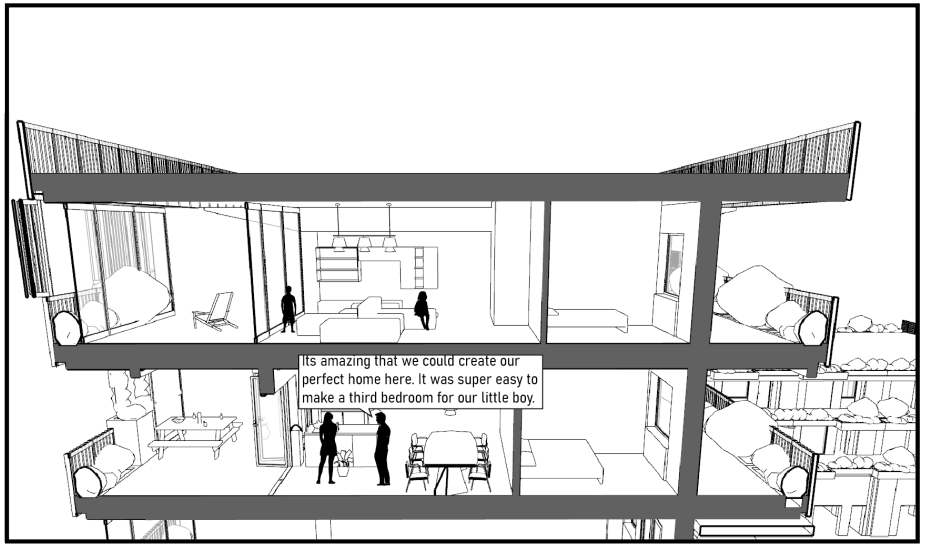

I hope this dwelling can be just how we want it to be

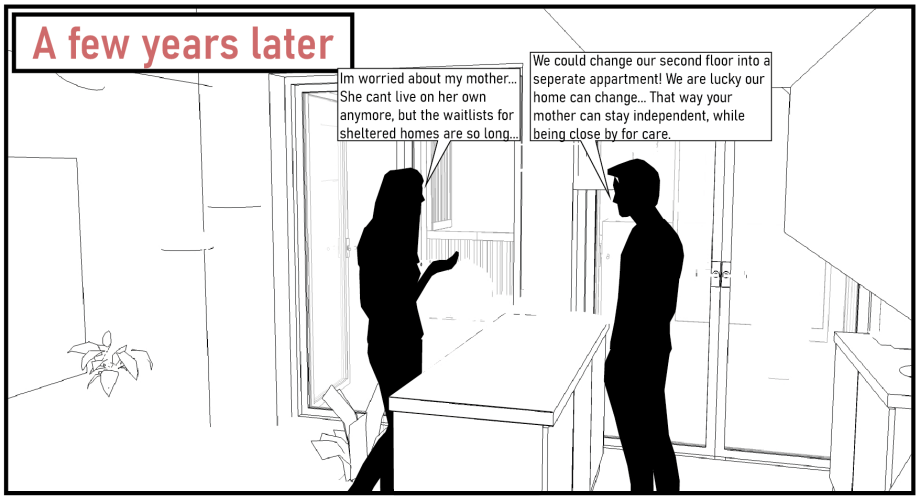

The whole floor is hollow and the panels can be individually lifted. Because of this the placement of the bathrooms or kitchen is all up to you, and if you get tired of the same old layout, its easy to change again!

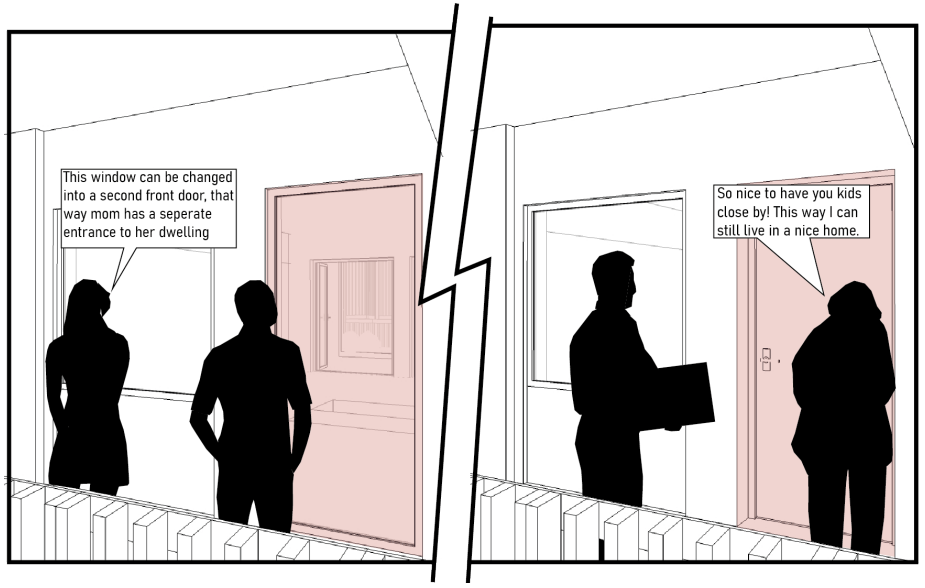

This appartment can be whatever you want it to be. This void can fit any staircase you want.

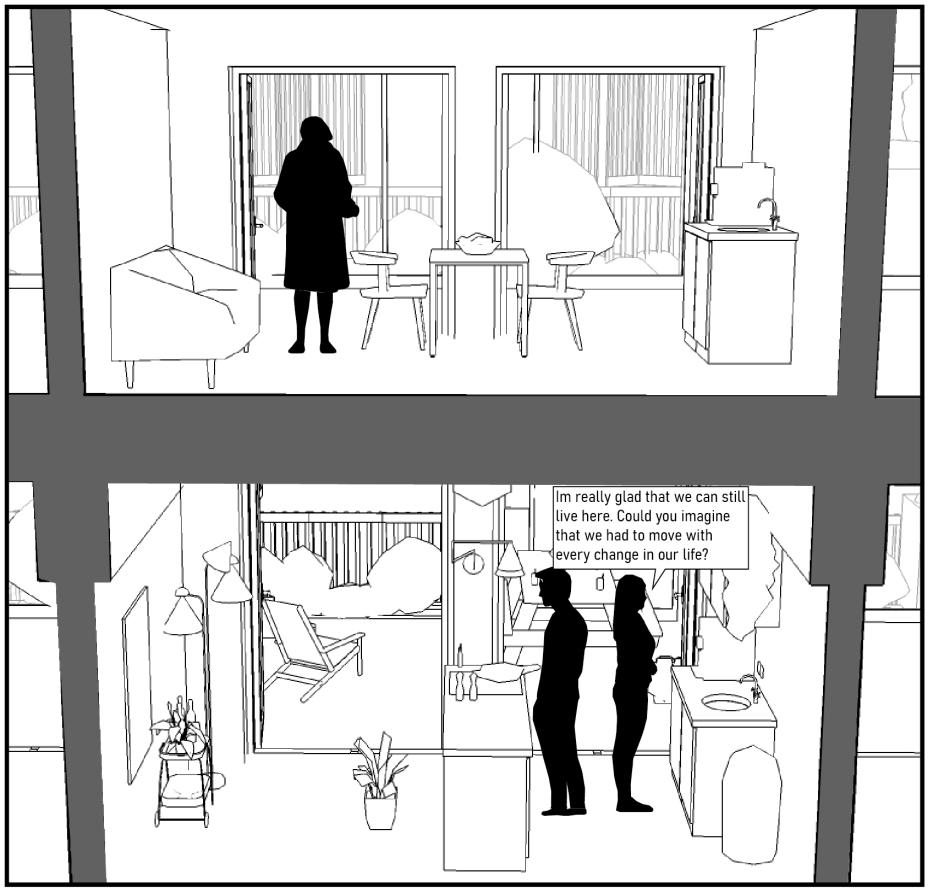

These panels can open like this... Or can be closed completely, creating shade. Next to this the sliding glass doors can be closed to block out the noise from the city.


How do you like our new home?
Nice mommy! We have two livingrooms, that is fun!


Its amazing that we could create our perfect home here. It was super easy to make a third bedroom for our little boy.


A few years later
Im worried about my mother... She cant live on her own anymore, but the waitlists for sheltered homes are so long...
We could change our second floor into a seperate appartment! We are lucky our home can change... That way your mother can stay independent, while being close by for care.


This window can be changed into a second front door, that way mom has a seperate entrance to her dwelling
So nice to have you kids close by! This way I can still live in a nice home.


Im really glad that we can still live here. Could you imagine that we had to move with every change in our life?

Reflection

Situating the project within the TU Delft
The relation between my graduation project and the topic of the studio lies in the focus on researching the societal and environmental issues that have arisen in the housing market of today. With the new insight the research gives me, the design is used as a tool to show new and innovative praxis based solutions. Overall the master track Architecture also tries to teach this sentiment of creating innovative and creative buildings that use the design as a tool to deal with social and spatial issues in the built environment.

Relations between research and design
While doing the research a few things became clear about the adaptability I wanted to implement so badly. Firstly by reading and synthesizing different existing theories related to adaptability I came to the conclusion that it is important in my design to view the building not as a finished product, but view it more as an organism that will change over time after construction. The theory of Steward Brand of Shearing Layers of buildings helps to get this new perspective. I used this division into separate layers in my design to create not only an inclusive building, but also a building that can change easily over time. For example by adding adaptable solutions in the layer of Systems (the piping and plumbing are all refitable)in the shape of a raised floor. Also the separation of a shading layer, soundproofing layer, and thermal layer is an example of the theory bleeding into the final design.
Next to this the specific practical design solutions in my final design are all part of a scale of adaptability, from hard adaptability to soft adaptability. This scale is my interpretation of the theory of Schneider and Till. Where adaptability is divided into hard solutions, which are design solutions that are specifically designed for adaptable use. And soft solutions, that consist of solutions that are not designed, but rather parts that are kept empty or bare for the users to fill in. For the hard solutions think of the sun shading I provide that can be completely opened or closed, thereby gaining two distinct phases. The soft solutions are the layouts of the dwellings that in my design are completely designed by the users.
By separating adaptability in three different kinds I could gain a better view of adaptability in my design and research. In my research I used the three kinds as a structure to analyze three cases. In my design I could use the insights of my case studies to create design solutions that work in all three aspects of adaptability. The raised floor for example is a refitable solution. The use of the existing column structure with zero loadbearing walls in the dwellings gives my design an adaptability of space.

Some design solutions in my final design come straight from the case studies I did. The most obvious is the implementation of a raised computer floor. For this solution I used the case Patch22 as a reference. The added void in my design where users can place their staircase is an homage to the vide in the Diagoonwoningen. This void gives the dwelling a orientation towards a central space that has a more fluid use. I use the idea of letting the residents build the walls themselves from La Mémé. In my design this is implemented in the exterior wall towards the wintergardens.
I feel like the case studies really functions as the glue that binds the relationship between the theory of my research and the design solutions in my final design. The other way around I think that my design gives the research more practical application. The design shows the implementation of the theories and solutions from the research.

Relation between research methods and research insights
The research methods I used in my report exist of an extensive literature review and three case studies. I started with the literature review. With the insights gained in that part I did a praxiological case study on three buildings, La Mémé, Diagoonwoningen, and Patch22. The merit of using the literary method first is that I could very early in the research position myself within the existing discourse on adaptability and user-inclusion. By creating a synthesis of the different existing perspectives I could gain further knowledge and make the literature my own. The disadvantage of starting with this and only after the literature review beginning the case analysis is that I pushed myself into a fixed perspective before looking at the praxiological side of the research. If I did the case studies more in unison with the literature review I think I could combine the two even more effectively. On the other hand the large theoretical foundation I had now did help a lot in doing the analysis. It made sure that my analysis of the cases was more streamlined and could work as a bridge between the theory and the design.
This combination of praxiological and literary research fitted the studio well in my opinion. The focus of the studio on sustainability (social and environmental) and the goal of creating a research based design asked for an approach that could link the two in a well structured way. I believe my structure that combines the two research methods did do that in my case.
The analysis structure I gained from the literature review and further research helped me analyze the cases in a specifically targeted way. The three different kinds of adaptability could be used to find and categorize the different design solutions the cases use. This way I also could find a practical hierarchy of these

theoretical kinds of adaptability.
The theory of shearing layers by Steward Brand was on the other hand very helpful in the design itself. It gave me a different perspective on buildings and how they are used. This way I believe I could create a design that is not only changeable now, but stays that way during its lifetime.

Contemporary societal issues and challenges
During my research and design it became clear to me that the contemporary focus on monetary value in dwelling development is not sustainable. The method of adaptable design gives the users the control over their surroundings. I believe that this shift of control, from the professionals to the residents, can be a solution for the degradation of livability in contemporary housing, as well as make more long term housing solutions that are by longer lifespan more environmentally sustainable.
My method for the case studies can be used as a methodology for further research into adaptability in dwellings. Also the method can be used in practice by developers and architects to gain understanding of new and more sustainable housing that shift the focus from monetary value towards social ecological values.

Ethical issues and dilemmas
The ethical issues I encountered during my research first consisted of the consequences of giving away the designing to 'nonprofessionals'. The idea behind adaptability and user-inclusion is that the dwellings are not completely designed by an architect, but are partly designed by the users themselves. This raises an issue. The architects knowledge on a well-designed dwelling is far greater than of the users. Therefore the users, when they design their dwelling will end up with a worse dwelling than the architect could have made. This way it was important to think of ways to enable this user-inclusion, without losing values in the dwelling (rather gain value even).
The greater control the residents get when my adaptable method is used will lead to better dwellings in the long run. Because who knows the users needs and wants better then the users themselves? I know for a fact it is not the developer that is mainly focused on making a profit.