

Housing the unknown future

Towards adaptability in vacant office transformation

Niels Buring, 4089049

Architectural Engineering Graduation Studio

Abstract

Most of the buildings that have been built throughout the years, especially those designed for a specific function, will be reaching the end of their life sooner than is necessary. Buildings that are still in mint structural condition are being demolished and replaced by designs that carry the same problem: that of a mono-functional building that can only serve the function it is designed for. In order to reach for a solution, this paper focuses on the transformation of vacant offices into buildings that have the ability to adapt to future needs, while housing a wide variety of different functions. The result of literature studies into the topics of adaptable buildings has shown that there are a lot of scales and strategies to deal with inevitable change in the design and re-design of buildings. Also, a study into hybrid and mixed-use buildings have resulted in an overview of important characteristics of buildings that contain multiple functions.

Keywords: office vacancy, existing building stock, transformation, adaptable design, mixed-use development, hybrid buildings

Introduction

Fascination

My fascination is that of the city of tomorrow and in particular the challenges it embodies for us as architects. We are facing one of the major advances in population the world has ever seen and it is influencing the way we have to deal with our existing cities and the way we are using planet in the process. But 'tomorrow' also brings with it a degree of uncertainty. How will we live in a hundred years? What will our cities look like? In order to deal with the unknown, there is almost no other way than to take change as the only constant factor. Within the chair of Real estate and housing, there is a saying that goes like 'Building for the future is like driving a car along a curving street, with only the rear-view mirror as a guide'. For architects and urban planners, what happens in this rear-view mirror can only be used as a guide on how *not* to drive, because especially in architecture, history is barely a recipe for success. This doesn't mean that it is not important for the future: it should be studied very carefully in order to understand what is there now. For me, designing for an unknown future consists of understanding the present and prepare it for a future that will be changing.

Embrace change and use it as the one constant factor in architecture.

Background

Context

In the Netherlands there is an ongoing problem noticeable, and that is that of vacant office buildings. There is an indisputable change in the way we work and do our shopping, which eventually is leading to a structural decline in the need for physical office and commercial space, especially in the stock built between 1960-1980. Those few companies that have the need for a physical office are constructing brand new office spaces far away from the old ones, leaving mostly inner cities with unused buildings and their environments. It is in these buildings that the need arises for transformation. The main problem with these vacant offices is that they are often solely used for offices, which leads to monotony in function but also in building use around the clock. Another problem is that the buildings have an outdated appearance, which makes it quite unattractive to look at, but also for potential new users to rent the building.

Program

Single-use buildings, apart from family houses in the suburbs, are becoming a rare breed, especially in city centres. It is here that there is a search for buildings that can house different functions under a single roof, in order to deal with local land scarcity and increased land value, but also the ambition, with this hybrid program, to activate the building, it's individual users and the surrounding urban fabric (Holl, 2011). The combination of different functions is also an endeavour to stretch the buildings use times to a near 24-hours a day, with all its benefits for the users and the locale it is placed in. In order to get the most out of our built environment, we must seek to find combinations. Combinations that in the end show a clear and distinct benefit over the mere sum of all its individual parts.

Technique

There needs to be a change in the way we design and construct our buildings. For a too long period especially architects have been designing buildings with the intention of a certain image that could stay and live on forever. It is true that for some of the designs this can happen or has happened, but this is such a small part of our built environment. It makes little sense to think of a building, which in a sense is a snapshot of current time and place, to be able to sustain without the need for any alterations. Everything is changing, but not all buildings are, or have the possibility to do so.

Sustainability

Buildings make up for a lot of the energy consumption in use, but also for a great deal of CO₂-emissions during construction. With the need to reduce energy demand by 80 to 95% of what we use now, significant changes has to be made to the way we change our built environment. The roadmap established by the EU GHG, shows that we need to realize a reduction of 53% by 2030 in order to get to a reduction of 88-91% in 2050. To achieve this, it isn't remotely sufficient to apply a zero-energy strategy to new buildings, the existing stock also needs an upgrade. The sustainability issue isn't limited to the excessive energy use of the building sector, it also involves the way we deal with our scarce and limited natural resources. Upgrading or transformation of the existing stock is preferred, because the impact on the environment and resources is significantly less than demolition and rebuilding.

Problem statement

Vacant office buildings are empty for a reason. There are numerous causes of vacancy, but it basically all boils down to a single problem, and that is the building's inability to perform to meet the requirements that are set by the user. When this happens, there are four alternatives to deal with this situation:

- The zero-scenario, leaving it the way it is
- Renovation or refurbishment
- Transformation
- Demolition and eventual rebuild

Because the building doesn't perform sufficiently in the present, leaving the building as-is seems to be the worst alternative, because an empty building is unfavourable for anyone involved. Also, demolition has the greatest impact on the environment, so this isn't the preferred alternative. This leaves renovation and transformation as suitable alternatives to deal with vacancy in offices.

Since we have the energy goals of 2050, renovation or refurbishment is the minimal intervention. Even the buildings built after the energy crisis of 1973, resulting in better insulation and energy efficiency in especially office buildings, still need to be upgraded. They have to be nearly zero-energy buildings in order to achieve the 80 to 95% energy cut in 2050.

But the building's performance isn't only evaluated based on its energy efficiency. The problem with most vacant offices is that they:

- 1- Only host office space, something of which the demand, with the changes in way of working, is significantly decreasing, and

- 2- Have been designed and built only to suit this specific function and are thus unable to adapt to different functions.

This results in the fact that these particular buildings reach the end of their functional lifetime significantly sooner than the building can technically function, often resulting in demolition.

Research goal

Therefore, the main objective of this research paper is to get an idea of how to transform a vacant office into a building that can not only house different functions, but can also adapt to future changes in function or use. Also with the transformation, a thorough renovation will be applied in order to greatly improve the buildings energy efficiency.

Sign posting

First the limitations and the research field of this research will be discussed using the reasons for building vacancy, followed by the overall design question of the graduation studio. From there, the thematic research will be introduced, along with the sub-questions it consists of. After that, the methodology of how to get to the answer will be discussed, followed by the relevance of the complete graduation project and the thematic research. Then the results will be presented in the form of answers to the sub-questions. Starting with the definition of adaptability and its perception within architecture, as they result in the parameters that need to be addressed in order to make a building adapt. Following is the answer to the question of what strategies exist within the concept of adaptability and their applicability within the context of transformation. After that, the important aspects of mixed functions will be discussed, along with their necessities within the building. Every sub-question will be ended with a conclusion. After all the sub-questions have been answered and discussed individually, there will be a main conclusion that includes all the separate conclusions, in order to provide a complete answer to the thematic research question and to feed the discussion, where the limitations, strengths and weaknesses, and recommendations for further investigation will be presented.

Discourse

Research scope

This thematic research will be done into the field of transformation. This particular strategy will be investigated to see how it can influence the buildings ability to change or adapt to future needs. It has to be noticed that building for change is working on different layers and categories within architecture. As Schmidt III, Eguchi, Austin, and Gibb (2010) are stating that there is more to time-based design than technical feasibility. Due to the fact that there will be dealt with *transformation of offices*, a list of reasons for building vacancy will be used in order to define the scope of this research.

The basic problem behind vacancy is a mismatch between what the building can offer and what its current (and potentially future) users demand. If the building can't fulfil requirements set, it

becomes obsolete. Remøy (2010) has established a comprehensive list of types of obsolescence that can occur in a building:

- Aesthetic (or visual) obsolescence, resulting from outdated appearance
- Functional obsolescence, changes in occupiers' requirements due to new ways of working or new technology,
- Legal obsolescence, resulting from the introduction of new standards
- Social obsolescence, resulting from increasing demands by occupiers, or by society in general, for better work environments and improved facilities,
- Tenure obsolescence, where regulatory arrangements become increasingly inappropriate to meet organizational requirements,
- Structural/physical obsolescence, resulting from technical deterioration,
- Financial obsolescence, when costs are not balanced by returns and benefits,
- Environmental obsolescence, when the conditions in a neighbourhood render it increasingly unfit for its present usage patterns,
- Locational obsolescence, where the resources and image of a location are increasingly detrimental to organisational and staff expectations,
- Site obsolescence, where site value becomes greater than the facility asset.

This research paper will be mainly focusing on how to deal with the functional and technical aspects of obsolescence in office buildings. It must be stated that this is seen both absolute and relative: absolute in a way that it deals with the actual change and altering of function(s), but also relative in the sense that it also covers for the aesthetic and social issues the building might have, as they also influence the functionality of the building. This automatically is also covering the tenure obsolescence. Structural obsolescence in this paper isn't being neglected, but is seen as a fixed or given, in combination with environmental and site obsolescence, simply because if one or more exist within the building, it often leads to demolition. Another important aspects of transformation are financial and management. Although significant improvements or changes considering transformation could be made in these fields, for this research the focus will be on the physical ability of the building to house different functions now and in the future.

Furthermore, within the scope of office buildings, there are still a lot of different types that have been built since the office itself was introduced as a typology. For the sake of the theme, and the focus of the graduation studio, the research will be limited to offices built after 1970 and will (therefore) be ruling out any monuments, since they deserve a kind of special attention, that is simply beyond the scope of this graduation.

Scenario

In order to properly define an architectural design assignment, choices have to be made along the way, during the research, on what the brief is going to be for the eventual graduation design assignment. This scenario will be based on the results of both this thematic research paper, as well as the analysis of the case study.

Research question

Overall design question

To provide a better understanding of the thematic research question, the overall design question has to be provided as well. This question will be mainly dealing with the transformation of a vacant office building in general, touching all the main aspects in which the design -supported by this thematic research- will try to give an answer to. The overall design question is as follows:

How can a vacant office be transformed into a building that can adapt to future needs and house a variety of functions, in a way that it revitalizes the building's aesthetics and improves its energy-efficiency?

Thematic research question

The thematic research question will be dealing with different functions being in the same building, and how the building can be made to adapt to future needs:

How can transformation turn a vacant office into a building that can house a variety of functions and is able to adapt to future needs?

Sub-questions

In order to get to an answer, sub-questions need to be answered first:

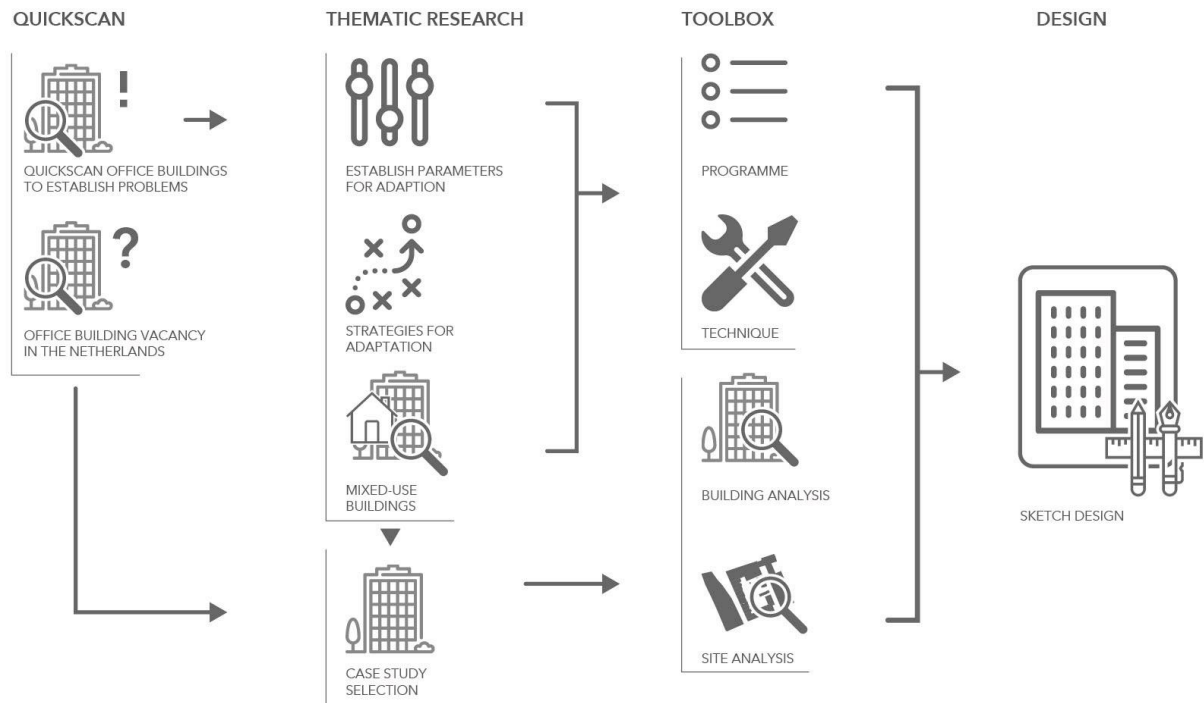
What is adaptability and what are the parameters that need to be addressed to make a building adapt?

What are the strategies in adaptable design and how can these be used in the transformation of office buildings?

How can different functions exist in the same building?

Methodology

Overall methodology



Thematic research methodology

To provide the answer to the thematic research question and to support in answering the overall design question, the sub-questions will first be covered by using a literature study.

In order to answer the question on what parameters need to be addressed to make a building adapt, a literature study has been done to first identify what layers a buildings consist of and what the different lifespans of these layers are. Then the definition of adaptability is given and how it is perceived in the built environment. Next, different concepts related to adaptable and time-based design in relation to the building elements are discussed to determine the main parameters that need to be addressed in adaptable design.

For the second sub-question a literature study has been done into the characteristics of adaptable architecture. Next, from the literature a list of the different strategies is established to identify the different approaches to adaptable architecture and in particular in transformation. After that, the different strategies have been mapped against the building layers to see on which they have influence. Also included is the scale of the change, both physical and in time, in order to create an overview of all the different strategies.

The last sub-question is answered by a literature study into the important aspects of a mixed-use building. A brief introduction of the history of mixed-use buildings will be provided as introduction to the topic. After that, literature on hybrid buildings has been used to define the

most important characteristics of mixed-use buildings. Also, literature, as well as precedent theses have been used to establish the most important necessities of different functions, and how they could be implemented in the same building.

Relevance

Most of the building stock that is now present doesn't meet energy efficiency requirements in order to cut our excessive energy use by 2050. A big part of that building stock, in the Netherlands, is vacant at the moment. This doesn't only affect the owner of the building; its surroundings will also be influenced by the building being empty. Site deterioration and bad image of the context are real threats. An intervention like transformation can be the solution to address both of these problems, therefore eliminating the threat of the buildings being part of the discard cycle.

This research and the resulting design assignment will have a lot of overlap with the Beyond the Current program. Although their focus is more on residential buildings, a lot of starting points resemble that of this research. Both are dealing with the existing stock in order to prevent demolition and have the goal of upgrading the building to make it more energy efficient and also to upgrade its appearance, improving also its surroundings. Where the two projects differ is the scope of the physical building layer the focus lies on. In Beyond the Current, this focus is the façade and the way it provides comfort for the users, in this case the inhabitants. Although the building envelope is of great importance in the following design assignment in order to improve the energy efficiency and the aesthetical representation of the building, the focus lies on the functions within the building.

What is adaptability and what are the parameters that need to be addressed to make a building adapt?

The layers of a building

In order to identify the most important parameters that need to be defined in the process of making a building adapt, it is first necessary to understand what a building actually is and what it consists of.

A building can be seen as a combination of different elements, each with their own lifespan. There are parts of the building that can last as long as the building itself, while other elements will reach the end of their lifespan earlier, so that replacement is necessary. The most comprehensive method of describing these different elements of a building is done by Brand in his book 'How buildings learn' (1995). In this book, he uses the 'shearing layers' of Frank Duffy, who identifies the building's shell, service and scenery (1990) and take this as a starting point for his 'shearing layers of change', which is illustrated by figure 1:

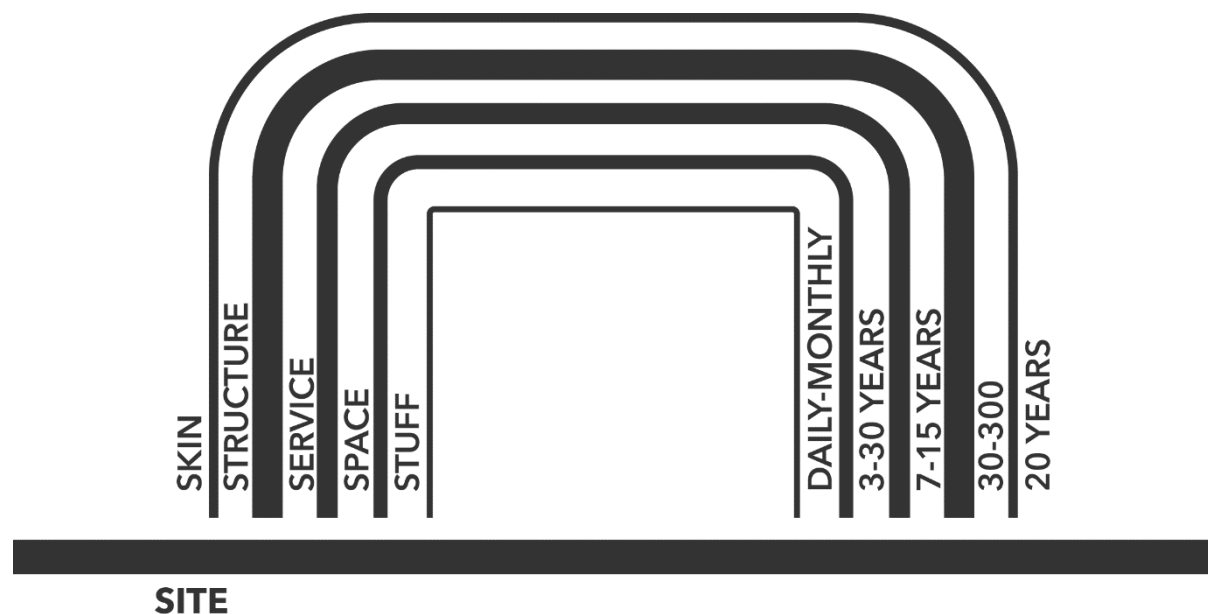


Figure 1: Brand's building layers.

This figure also includes the coarse lifespan of each individual layer:

- **Site,**
The geographical setting, the urban location, and the legally defined lot, whose boundaries and context outlast generations of ephemeral buildings.
The site is eternal.
- **Structure,**
The foundation and load-bearing elements, they are expensive to change, so this doesn't happen very often and therefore the structural life of a building ranges from 30-300 years.

- Skin,
The exterior surface of the building, often related to present day fashion or technology, changes every 20 years.
- Services,
The building services such as wiring, plumbing, escalators and lifts and the heating and cooling systems, usually lasting from 7-15 years.
- Space plan,
The interior layout of the building, depending on the building's function this changes every 3-30 years.
- Stuff,
Moveable furniture of the building, this can change monthly, even daily.

To complete this diagram and make it fit for use in terms of the adaptability of a building, two more layers will be added, in according with the studies performed by the University of Loughborough. These layers are:

- Social,
The people who actually use the building, this also translates to the function of the building, as the people define it.
- Surroundings,
Everything that happens around the building, such as the neighbourhood, infrastructure or natural elements that occur on the site of the building

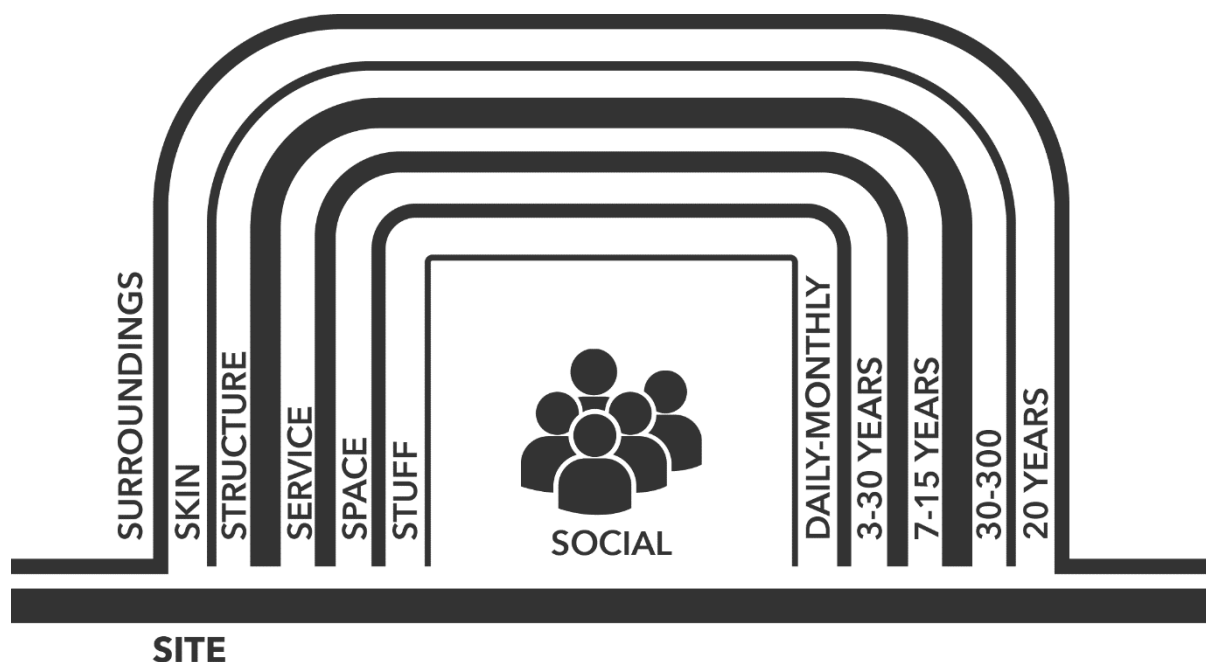


Figure 2: The layer approach as envisioned by Gibb et al. (2016)

Where social are the users and surroundings can be seen in a very literal way, being the situation within the city it is placed and the influence changes around the building have, but also changes in for example regulations.

Difference between *adaptable* and *flexible*

The two terms *adaptable* and *flexible* share some resemblance on first sight. They both imply that there is a situation that has to or will change over time. It is in the time aspect that these terms can be identified as different. *Flexible*, in a way, implies that something can reach a certain state and possesses the ability to return to a previous state, while *adaptable* implies a more linear timeline. To translate this to a building, a building's ability to *adapt* can be based on whether it can house different functions, while its ability to be *flexible* is more based on the internal changes one of these functions can do to the building, like changing internal walls or move entire rooms.

The building itself is *adaptable*; its interior is *flexible*. In this paper, the term *adaptable* will be used to describe the building as a whole, while *flexible* will be used to describe everything that will be happening within the building.

Taking into consideration the time-aspect in buildings

Since change is the only constant factor in the built environment, it is of utmost importance that we take the aspect of time as one of the starting points when it comes to the design of new buildings, but also in when dealing with re-design. Bijsterveld (2005) claim that there are three different ways to deal with time and uncertainty within architecture:

- Make buildings polyvalent
- Make buildings that are part permanent and part changeable
- Make semi-permanent buildings, e.g. demountable or modular buildings.

Polyvalence in buildings

Polyvalence can be linked to flexibility: on the function level it suggests a room, an enclosure that can house a variance of different activities and functions, but also to adaptability: on the building scale it implies the multi-functionality of the building, or the ability to house such functions. This also depends on the function: For Leupen, polyvalence in the public building means that a space is capable of accommodating a variety of activities and changes to happen simultaneously or in sequence without (major) modifications, while in the dwelling, it refers to the interchangeability of different activities in-between different rooms.

This concept is introduced by Hertzberger (2005) who states that when designing a building, we have to look further than the brief that is given, let the brief be the starting point. From here, we have to see if we can add something, add value by study whether each function could complement another, or that a function set by the brief could be used in more than one way. Design to suit more than one single application. It is in this sense that the *interpretation* of the

brief and therefore the space can, in this exact moment, be suiting a particular function, while this can easily be altered with minimal effort.

Buildings that are part permanent and part changeable

The most comprehensive group consists of buildings that are part permanent and part changeable. It is the group that covers all the concept in between polyvalence and semi-permanent buildings. Perhaps the best known example, in a way, is that of the dom-ino principle introduced by Le Corbusier in 1914, proposing a totally open floor plan consisting of concrete floor slabs that are supported by columns, providing absolute freedom for both the façade and the interior lay-out of the house. They are only determined by these vertical supports and fixed circulation in the form of a staircase.

Support and infill

A concept strongly related to that of Le Corbusier, perhaps even further developed, is the Support concept that made its introduction into architecture at the end of the 1950's, by the book *De dragers en de mensen*. This concept describes the ideas N.J. Habraken has on solving the problem of mass housing. He thought that governments should be providing the major structure of a house, the *support*, so that the people themselves could design and built the rest of their homes, the *infill*. It is this concept of *support and infill* that later has been developed into the *open building* concept. Both these ideas are in essence dealing with the changing needs occupiers would have and to be able to deal with the unforeseen changes the future might bring (Bernard Leupen, 2005). This is accomplished by providing a long-lasting framework, where in and around changes could be made, resulting in a building that has a significant longer lifetime. Even though this concept suggests a complete separation of the support and the infill, there will always be a connection since the support can't be a building without the infill and the infill can't possibly exist without the support: they will always, in some way, influence each other in the design.

The carcass concept

This concept of support and infill has developed in the 1960's into the *carcass concept*. It still provides a more permanent *base* in where the users could have their own infill, but in this case the *base* is more than just the support of the building. The carcass is often referred to as a *base building* or the most basic form of a dwelling, a shell surrounding an empty space. This can still be interpreted in different ways: the *carcass* could only consist of a base for a house, that on its own could function, on which extensions could be added. But it could also mean that this *carcass* would be integrating a building's services with the façade, shifting all its necessities outwards, leaving the interior (almost) completely open for every lay-out (Bernard Leupen, 2005).

Frame concept

Leupen elaborates on the above-mentioned concepts by introducing the *frame concept* in his thesis *Kader en generieke ruimte* (2006). In this thesis, he states that a building consists of multiple layers and a combination of different layers can be seen as the frame of the building. With this

combination, other layers could be freed up. The most profound example can be seen in the domino principle, where the use of columns to support the floor can eliminate the use of structural or load-bearing walls and facades, creating freedom in the placement, but also provide easy adjustment. But the frame here is not just the permanent part of the building: it also expresses the building's most important architectural features and cultural values (Bernard Leupen, 2005). This means that by 'fixing' this combination of layers and therefore providing freedom to other layers, the building can preserve its essential character, while other parts will still be able to adapt to different needs and standards.

The facade

The importance of the framework being (more or less) permanent becomes most evident when dealing with the façade, where there is a paradox. Considering the idea of adaptable architecture, one might easily think that this means that the whole building can be easily changed or altered to suit new requirements or standards set by the users. But especially in the façade, this does not apply.

"Freedom - and the ability to change is a form of freedom - will destroy itself without a bounded framework" (B. Leupen, 2006).

As Leupen states, for a building that changes, it is important that certain aspects will remain the same. In order to establish architecture that will live on for many more years, there must be elements that remain the same, give meaning to the building and can be used to identify it. The trap here is that when designing for change, it automatically means that it is designing for changing functions. If we take the "form follows function" approach, so widely used especially for office buildings, one might end up with a building is only fit for a certain function. On the other side of the spectrum we find the neutral building. When considering flexibility as a strategy for adaption, Hertzberger (2005) points out that this leads to architecture of boxes, boxes that can be used differently, all within a neutral, non-expressive frame. The answer on how to deal with the façade lies somewhere in between these two extremes. As Bijsterveld (2005) points out, a building does not necessarily need to reflect what is going on inside to possess value. Especially if what is going on inside is *made* to change. Either way, the façade is something that will act as the one element in the adaptable building that has a more permanent character. It is the façade that will give the building its character, therefore giving it its very important architectural and cultural values that are necessary to make the building last.

Pre-configuration and re-configuration

In their paper on the sustainable aspects of adaptive buildings, Beadle, Gibb, Austin, Fuster, and Madden (2008) discuss the two main elements of adaptable design: pre-configuration, dealing with the initial design choices and re-configuration, approaching the aspects of subsequent changes in use. It is the pre-configuration that in this case can be considered to be the permanent part of the building, while the re-configuration entails the elements that can be changed within or around this perpetual part of the building.

Semi-permanent buildings

The last way of dealing with time in building design is that of the semi-permanent building. It is a kind of adaption that focuses on making the structure flexible in a sense that building elements could be replaced or moved, to be relocated somewhere else. The most profound technique that is emerging quickly in the construction sector is that of IFD, which stands for Industrialized, Flexible and Demountable design and construction of buildings. One of the best examples is modular design. This has a number of advantages over more traditional ways of building. To start, it is possible to design and produce on a different location than the building site, so that the separate elements could be fabricated in a controlled environment. Only the assembly has to be done on site, resulting in a significant decrease in construction time. Also, because there is a focus on flexibility, resulting in easy change during their lifetime. And when they reach their end of life there is always the option to demount, so that individual building elements could be replaced and used in other projects, cutting down both the costs and the environmental impact, because less of our scarce resources need to be used.

Conclusion sub-question 1

A building can be divided into different building layers that all have their respective lifespans. This results in the fact that some will change more often than others, influencing each other in the process. Because most buildings were designed to remain the same, it is difficult to change. Sometimes this can lead to demolishing, or functions will find their way into the building. Strong or weak architecture are both extremes of adaptable future, neither is the right approach. An integrated approach is needed in order to make buildings last. This means that a combination of these two extremes has to be looked for.

Different building layers also imply different types and different scales of change. For instance, a room can already be adjustable to different functions if it provides enough space and moveable furniture, whereas a necessary increment in floor size involves a way larger intervention, perhaps on the scale of the entire building. Figure 3 summarizes the different types and scales within adaption.

Type of change		Scale of change		Result
Cause	Affect	Physical	Time	Tools
Change of task/climate/user preference	Furniture, façade elements,	Component	Hourly to daily	Moveable furniture, adjustable facade
Change of use	Spatial lay-out	Component	Daily to monthly	Multi-use spaces, moveable walls
Change of performance	Building component	Component	1-7 years	Replaceable installations or elements
Change of function	Function	Building	1-15 years	Changeable floor plan, addition/reduction of systems
Change of size	Size	Building	5-30 years	Addition/reduction of mass to the building
Change of location	Location	Building	Weekly to yearly	Physically moving the (entire) building

Figure 3: Overview of the different types of change, the scale and the results.

The concepts on how to deal with time and uncertainty show that in order to make a building last, it needs to have certain elements that can anchor it within time and space. A changing building does not mean that it is floating in space, nor should it be changing that much, so that it has no connections with time. It should contain aspects that can be related to the history, past and present. The most interesting part of the building will be its façade. This is what places it within a certain time and space context, and gives the building its important architectural and cultural values, so that the building can last.

In order to make a building fit to be adaptable, fixing certain building layers, or combining them, could lead to other building layers being liberated, meaning that they can change quite easily, without major interventions. E.g., columns can liberate interior walls by supporting the floors above, eliminating their necessity to be load-bearing, but this can also work the other way. For instance, when fixing the buildings services, one could limit the interior lay-out of the building, to what is possible only to that specific configuration. Moving building services to the façade can contribute in the process of freeing up other building layers, but can lead to new challenges considering aesthetics and daylight. For some services such as ventilation it is the best location though.

What are the strategies in adaptable design and how can these be used in the transformation of office buildings?

Adaptability

In this research paper, the term 'adaptability' or 'adaptable' is widely used. Merriam-Webster (2016) defines the term Adaptable as follows: "*able to change or be changed in order to fit or work better in some situation or for some purpose: able to adapt or be adapted*". It is in this definition where the most important subjects about adaptability are clearly shown. It defines time: a present situation, that may or may not be adequate, and a different future situation. The keywords here are *fit* and *work better*.

The characteristics of changing architecture

In his book, Kronenburg (2007) defines four different characteristics of architecture that can respond to change: adaptation, transformation, movability and interaction. As also stated in the book, these characteristics should be seen as themes within changing architecture, rather than explicit categories, since most of built examples and designs implement a combination of these themes in order to have changing architecture as a result.

Adaptation is the buildings recognition of a future that is not finite and that change is an important aspect. These buildings show that they can respond to changes in function and patterns of use by providing a space where all this can happen, or requires minimal effort to achieve needs set by changing users (Kronenburg, 2007). As a result, the most important feature of a building designed for adaptation is the framework. It is in this type of building that the user plays an important role in the way the building will function in the present as well as in the future. With a framework in which nearly anything can happen, the building can take almost every shape imaginable.

Transformation is the buildings ability to change its shape, volume, form or appearance by physically altering its structure, skin or internal structure, thereby altering the way it is used or perceived. It is architecture that can open, close, expand and contract (Kronenburg, 2007). Although transformable architecture happens mostly on physical level, a change in appearance by an LED-façade can also be considered to be a transformation: a changing character over a day cycle.

Moveable architecture is, not surprisingly, architecture that is made to move from place to place. It is designed to stay at a certain location for a finite period, making not the architecture itself, but its position change overtime. The focus of this type of changing architecture is its mobility. Often integrated is the ability to function in a wide variety of environments with no or little alterations to the structure itself.

Interaction implements the user within architecture, it almost makes the user part of it.

The perception of adaptability

The way we have been designing and constructing our buildings has for a long time had the ambition of being a finished product upon completion. The architect has a vision, which the contractors then put together and with that, the building is complete. Apart from the necessary maintenance, already considered in the design to be as less as possible, the building is made to remain more or less the same; it is based on a snapshot of current time and place and wishes to remain in that moment.

The adaptable building on the other hand, acknowledges that there is not a finite future for the building and recognizes that change is an important aspect that has to be taken into account when designing buildings. This seems like a very rational approach, since it is change that is the only constant factor when it comes to buildings and their lifespan. But there are buildings that have remained more or less the same for ages, while other more recent projects are already facing demolishing.

In their study, Schmidt III et al. (2010) discuss adaptability in the building industry as being something that for most of the people is a concept related to state-of-the-art systems or strategies, that barely work. The most profound example is that of the difference between how we are currently trying to future-proof our buildings, e.g. by flexible floor plans and lowered ceilings etc., as opposed to older, long standing examples of buildings that saw little change, but still exist, such as the medieval centres of European cities, where the houses have barely been modified, but still have stood the test of time. In their opinion the result of accidental adaptability or just simply good design. But neither is the best solution. While these 'strong' buildings may look like they are durable, they often only give the illusion they are, because nothing can and therefore is changed, so that the building itself becomes the bottleneck. The other, 'weak' architecture does demand constant attention and work of both user and architect, but uses time in its advantage to grab the ever available opportunities. In this type of architecture, the rate of success may not always come from the ability of the building itself, but more from the user and/or owners willingness and ability to change (Schmidt III et al., 2010). It is their opinion that for successful future proof design, there need to be a more integrated approach, taking into account all the variables that play a role in architecture: spatial and physical differences between uses, but also social, economic, political, legal, technical and environmental parameters that are of influence.

Figure 3 summarizes their current understanding towards adaptable design:

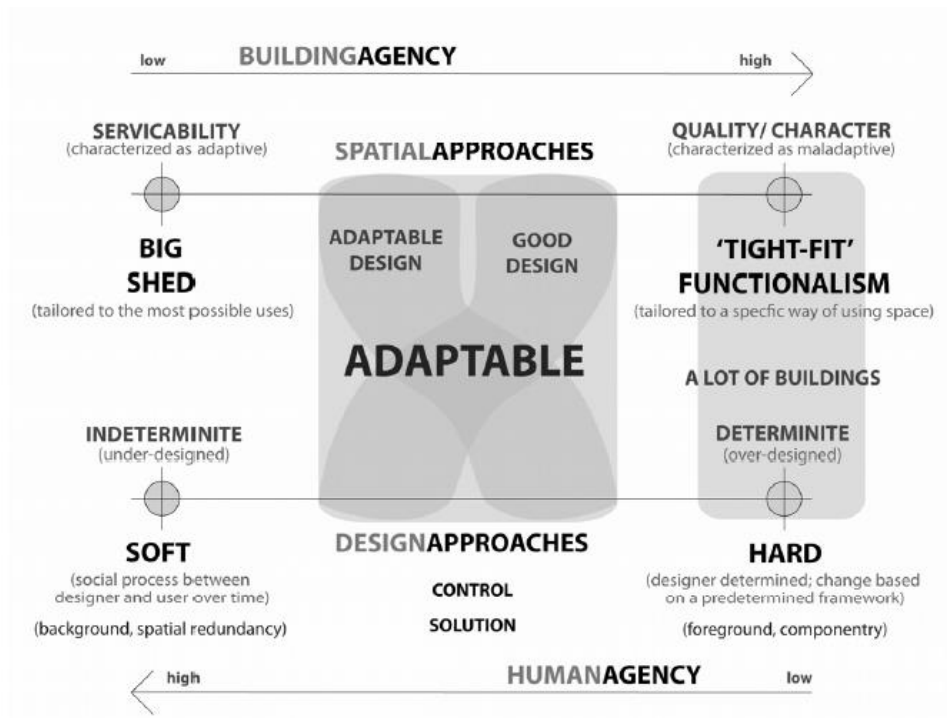


Figure 4: understanding towards adaptable design

It shows the two main approaches when it comes to design: the top one showing the spatial approach and the bottom one the design approaches related to them. The two extremes demonstrated are that of the big shed, in where nearly everything can happen, and the tight-fit building, that is made to suit only a specific function or way of using space. They argue that a building labelled as being adaptive is often using determined architectural tools to achieve the possibility of adaption, while the tight-fit approach often is highly tailored, though the design is often more undetermined. It is on the intersection of these two perceptions where we have to look for a more balanced approach for adaptability.

Strategies

Similar to the method used by Schmidt III et al. (2010), different strategies and their respective definitions from literature are mapped to create an overview and result in main strategies or themes within adaptability. These strategies are as follows:

- Adjustable

This strategy can best be described by the scale of time. It entails alterations that can happen on a daily basis, with great ease. The two main layers where this happens is both the *stuff* and the *skin* layer. The rearrangement of furniture within a certain room or space is one of the affects that fit the *adjustable* strategy. This also includes interaction as described by Kronenburg: *The buildings ability to act and react to user requirements in automatic or intuitive ways* (2007). In addition to changes made within the building, its skin

is also adjustable. The most profound example is that of the CABS, or *climate adaptive building shell*. This means that the façade can adapt to different external factors related to the climate, such as rain and sun, and alter appropriately. Another example is that of LED-integration into the façade, giving it the ability to alter its appearance during the day and night.

- Flexible

Flexibility as a strategy is used to describe the ability of the building's interior to change its lay-out in order to adapt to a certain function. It is within flexibility that Herzberger's *polyvalence* is most applicable. For Leupen, flexibility means *the ability to use a building in different ways without adjustment to the way it is built* (2005). Although this particular definition relates to the building as a whole, for use in this research it will be on the scale of the space. For Hertzberger, the term *polyvalence* has more to do with the interpretation of a specific space or room. He claims that there should be no such thing as translating the brief of the building to a design 1:1, but rather think above and beyond the brief: have rooms that are multifunctional, or can be altered with minimal effort (2005).

- Refitable

This entails the change in performance of the building. Layers where this is most profound are the buildings services and the outer layer: the skin or façade. This strategy can be best described with *upgrading* in order to get to the required level of performance set by the user or external factors such as legislation and climate.

- Convertible

The next scale within the strategies from flexible is to *convert*. Where in flexibility the functions are fixed, conversion entails the physical change of functions within the building. The transformation of vacant offices into new, different functions is, as concept, a conversion strategy.

- Scalable

This strategy simply deals with an existing structure or building and applies horizontal or vertical scaling. In most cases this will be extending the building in order to provide more space, but there is also a scenario thinkable that for instance a dwelling unit will be using less of its available floor space in winter in order to save on energy needed for heating.

- Moveable

The last strategy is very different than the others. Where all the strategies take the site as the only constant factor, this last one turns this around by using a change of the location as the main approach.

Conclusion sub-question 2

In order to make a building adapt, there are multiple strategies that can help to achieve this. The discussed strategies all have a different influence on the buildings layers, the physical scale and the timespan. This means that these strategies will never be used in their own. It is the combination of different strategies that can be applied to a single building, in order to make it adaptable. To get an overview, the strategies will be given a specific type of change and will be linked to Brand's building layers to establish an overview of where the specific strategies apply most to the elements of the building. The aspect of scale will also be considered.

Type of change			Brand's layers						Scale of change	
Strategy	Cause	Affect	Stuff	Space	Service	Skin	Structure	Site	Physical	Time
Adjustable	Change of task/climate	Furniture, façade elements	X			X			Component	Hourly to daily
Flexible	Change of use	Spatial lay-out	X	X					Component	Daily to monthly
Refitable	Change of performance	Building component		X	X	X			Component	1-7 years
Convertible	Change of function	Function		X	X	X			Building	1-15 years
Scalable	Change of size	Size		X	X	X	X		Building	5-30 years
Moveable	Change of location	Location						X	Building	Weekly to yearly

Figure 5: Mapping strategies against Brand's layers and scale

One major conclusion that came forward studying the different strategies is that it is almost the opposite of what the modernists visions on buildings were. The 'form follows function' approach, where the shape and form of the building has to fit the functions as tight as possible, reduces the buildings ability to embrace any type of change to an absolute minimum. Something that is too fixed, offering no 'stretch', will eventually break apart. One might say that, to overcome this, buildings should be offering this manoeuvring space. From a functional point of view, this is a very decent approach, but by overdoing this, buildings will end up as big impersonal, or neutral containers. While building for change, it is important to keep in mind that the building still has to offer significant timeless qualities for it to keep on existing (Kronenburg, 2007). Architecture needs to be responding to change in a balanced way.

Of the previously described strategies in order to create adaptability in architecture, not all are useful or applicable in the transformation of an existing building. The most obvious one is the *movable* strategy. Although as a concept for new architecture, the idea of a changing *site* can be an interesting way of dealing with the fitness of a building within its context, when confronted with the challenge of an existing building, which as a given has that the site is something that is fixed, ruling out this concept for transformation.

How can different functions exist in the same building?

The separation of functions

With the industrial revolution also came a big change in architecture. With the rise of big factories and business centres in the middle of cities, the function of living was moving out of the city. This was mainly because of the market; prices of ground within the centres was simply too expensive for most to afford. But this rapid change of the cities led to an almost unhealthy pace of growth, resulting in cities where diseases were of epidemic proportions (B. A. J. Leupen, 2010). The quality of living within these cities has reached an all-time low, something almost unimaginable in today's world, something that the image by Gustave Doré clearly illustrates.

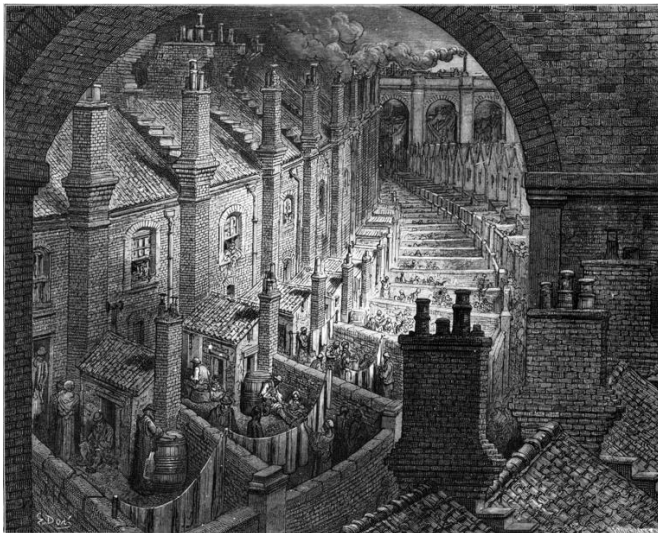


Figure 6: 'Over London by rail' by Gustave Doré

With these horrors in mind and strongly influenced by them, the CIAM promoted their new way of living and working. A vision on the city of the future, in which they completely separate working, living and recreating. With the rise of the automobile, distances have significantly shortened. This resulted in big residential estates where the function was solely living, often located on the outskirts of the cities, separated by extremely large green areas with an inhumane scale.

Maybe because of the failure of this extreme form of separating functions from each other, the focus has been shifting more and more towards an integrated form of architecture. This is not something new, as Fenton (1985) describes the occurrence of mixed use, or *hybrid* buildings throughout history, in the form of the house over the story, or the apartment above the bridge or roman bath. The focus has shifted towards cities with buildings that serve more than a single function.

The hybrid building and the mixed-use development

From the literature, a separation can be made between the *hybrid* and the *mixed-use* building. Simply said, *hybrid* buildings are offering different forms within the same function. An example would be an apartment building that also offers studios and town houses, besides apartments and a *mixed-use* building will be offering multiple functions. Fenton distinguishes two main categories that are readily identifiable. Firstly, there is the thematic program, functions that can be grouped or combined under a main theme, cultivating the dependency between parts and encourage the interaction of elements. The other category is that of the disparate program, which entails the juxtaposition of different functions, placing seemingly different functions next to each other in order to come to a stronger bond within the building (1985). In practice, this separation of *hybrid* and *mixed-use* or *thematic* and *disparate* is almost never there. Apartment buildings, especially within cities, often have a combination of different dwelling types, along with a commercial plinth. For the sake of this research, when mentioning a *hybrid* building, the definition would be a combination of the two separated definitions: A building that offers different functions and different types of the same function under one roof.

Important characteristics of hybrid buildings

The *mix* of programme

The single most important feature a hybrid building contains, lies in the fact that it is a *mixed* building, rather than a collection of functions that happen to be within the same building skin: it suggests interaction between the different functions and their respective users, but also within the context of the building, its surroundings. Holl (2011) underlines this importance and mentions urban porosity as the key intention for large hybrid buildings, with the aim of pedestrian oriented urban places. This porosity entails the occurrence of functions that shift more towards public and have the possibility to be entered, resulting in a porous or permeable building plinth. Another important feature of a hybrid building is the section.

This mix can roughly be categorized with the following main themes (Evans et al., 2007):

1. social mix - income, housing tenure, demography, visitors, lifestyles;
2. economic mix - activity, industry, scales (micro-large), consumption-production
3. physical land-use mix - planning use-class, vertical and horizontal, amenity/open space;
4. temporal mix (of 1. to 3.) - 24-hour economy, shared use of premises/space, e.g. street markets, entertainment, live-work

All of these different themes, and especially the juxtapositioning of them,

Urban hybrid versus the social condenser

In mixed-use buildings roughly two main types exist: the urban hybrid and the social condenser. Both of the types host a variety of functions under the same roof, though there is a big difference. The social condenser, having its moment of fame primarily between the first and the last quarter of the 20th century, was mainly a result of constructivists and the influence they had on Le

Corbusier and his followers. Its functions, although still quite different, often consisted of mainly dwelling and everything related to that. Most of the functions that were not residential, were often functions of private life that have been segregated or converted to 'public' functions (Per et al., 2011). Almost public, because these functions were still intended for only the people who lived in this particular building. One of the main examples is the Unité d'habitation, designed by Le Corbusier himself. It features almost all of the essential services to function as a residential building, even a complete village. This is also the main difference between the urban hybrid and the social condenser. The last-mentioned almost neglects the surrounding city, it can function on its own for residential use. Completely in line with the ideas of the modernists, it is the realisation of the dream to isolate the house from the city. The urban hybrid on the other hand, feeds of the complexity and diversity of the city. It hosts a programme that is as diverse as a city in users, use times and functional programme. Where the social condenser was a result of pure functional thinking, operating within a closed community, the urban hybrid is opening up to the city, embracing its diversity and complexity by seeking connections with it. Where the social condenser was thought out by the State and the ambition to control its inhabitants, the urban hybrid was a purely capitalist invention, taking advantage of the difference in functions and users, and leave enough space for indetermination (Per et al., 2011).

Interaction with the surrounding city

The hybrid building is not a building that stands on its own within the city. The concept of the mixture of functions should also reach beyond the building itself. Because of the scale, the building can implement the urban composition strategies provided by its surroundings, make use of the existing urban structure to dialogue with the other urban landmarks and have a connection with the surrounding public space. The hybrid goes beyond the domain of architecture alone and enters the realm of urban planning (Per et al., 2011).

Public and private spheres

To achieve a truly hybrid building, its mixture of functions will also involve a mix of public and private. This is something that is also giving the hybrid its strength: it feeds on the meeting of the private and public spheres in and around the building; the intimacy of private and the sociability of public life find anchors in the hybrid building. This also has a positive consequence: the building will be more and more used throughout the entire day, extending its timetable close to 24 hours a day (Per et al., 2011).

With this mix of public and private within the same building, it becomes important to understand both of these concepts in the design. It means that a lot of different people will use the building all in a very different way. It is therefore important to properly define what is public and what are the private areas of the building.

Building elements

The building services

The building services are a subject within transformation that require a fair amount of attention. The change of function, along with a mix of functions, creates a great challenge when it comes to these building services, because they all have different requirements. If the building is to house a varied and changing programme, a complex servicing system is required in order to provide the capacity to perform correctly (Kronenburg, 2007). One of the most important aspects of the

building services is that of maintenance and, especially when dealing with adaptability, the ability to make upgrades to the systems and implement new technologies.

The main issue when considering an unknown function is the location of vertical shafts. For a building that has quite varying programme of functions and their respective sizes, it demands quite some attention. The most important feature of these shafts is that they have to be decentralized in order to supply an as broad as possible infill. One of the solutions has been applied to the SOLID buildings, where there is a cluster of shafts located in the centre of the floor plan (Wallagh, van de Riet, & Crooy, 2013). For the sake of flexibility, it adds a structure similar to that of the column, meaning that even though they do not provide an absolute 'free' floor plan, they barely limit the lay-out possibilities of the building. It does, however, in some way limit the maximum size of a particular space. Since there is a repetition of the shafts, it suggests that a certain function uses a single shaft, therefore limiting the maximum size of that particular function.

Another way of dealing with decentralized building services is to move them to the façade (Kok & van Luijn, 2012; Kwant, 2014). Purely judged on logic, the location of vertical shafts is the best option: there is no need to make recesses in the floor, the interior lay-out can be completely free and most of all the functions have the necessity of direct daylight, therefore have a connection with the façade. The main issue with moving building services is that it creates challenges with the horizontal distribution of piping and ducts. Another problem that has to be considered is that in addition to vertical and horizontal distribution along the façade, now also the distribution from the façade inwards has to be considered, as shown in figure 7.

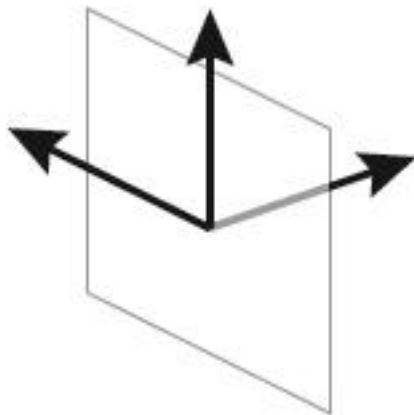


Figure 7: Distribution of building services in three directions

But the building services are not limited to the distribution of energy, water and heat, but also involve the circulation of the building. Access is an important aspect of a multi-use building. There are a great number of users that need to get around in the building, to get to their respective functions within the building. It can range from staircases to the buildings lifts and basically share the same requirements as the building's shafts: they need to be there where the users need it most (although it being on the scale of the building, rather than on the scale of the function or room) and require maintenance and eventually will be upgraded or replaced.

Floor plan

It is in the floor plan that will play the most important role in the adaption of the building. It is the floor plan that defines the different functions in the building, where they are, how big they are and sometimes even how they are used. This is something that, in an adaptable building, should not

be fixed: ambiguity is the key-word here. With rooms that don't have a single function, or can be used in more than a single way, results in a building that can offer freedom of use, without interfering with the way it is constructed. It is here where flexibility takes a big role in the adaptability of the building. In order to achieve the freedom necessary to achieve flexibility within the floor plan, it is necessary to reduce as many obstacles as possible. In this case, this means the elimination of structural walls within the building. In practice, there are two ways of achieving this in the floor plan: by using a column structure that supports the floors only at certain points, or by making the facades load-bearing to completely eliminate all structural elements in the floor plan. With a column structure, there is no complete freedom, because there are still point-like elements in the floor plan. It does however leave the façade open for any type of infill, something that a load bearing façade cannot provide. Furthermore, in terms of spatial design, the floor plan prefers a rectangular shape over any other, simply because it is easy to divide into smaller enclosures (Brand, 1995).

Conclusion sub-question 3

Where the planimetric view is the most important in the adaptability of the building, the section is where a hybrid building will be most profound. The need for interaction between the different levels and layers of the building is what gives the hybrid its strength. This means that the building is so much more than just the sum of its individual parts, in this case the different functions. By cleverly juxtapositioning seemingly unrelated functions can really make the building take advantage of its mixture. This is however not limited to the building itself: the programme stretches further than that, it should be implementing its surroundings as well. The hybrid stretches far beyond the domain of architecture and is sneaking into the domain of urban planning, improving its locale and ensures a stronger bond, anchoring it within its context. What can be concluded, is that not just every function can simply be put anywhere in the building. The functions need to be able to interact with each other, therefore not every type of function is desirable to be put in a mixed-use building. There needs to be a synergy possible: this means that the routing of the building and the placement of the functions are of utmost importance for the hybrid to take full advantage of the mixture of different functions in the building in order to become more than this sum of individual parts.

Because the wide variety of different functions, a mixed-use building will need to provide all the necessities that come with all these different functions. Providing in all these necessities on an individual level, meaning on the level of a single function, would result in an over-complex building without any coherence. Since a mixed-use building will get its actual strength from interaction rather than separation, overlap in the necessities has to be looked for. This can be done on different scales and layers of the building.

Conclusion and discussion

Answering the main question

How can transformation turn a vacant office into a building that can house a variety of functions and is able to adapt to future needs?

From the research it can be concluded that change comes in many sizes, and if the building is going to be able to adapt to this change, the response should also come in variety. All types of change work on a different scale. It could be influencing a physically large section of the building, over a very long period of time, but it could also be a minor relocation, something that could happen nearly every day. In order to achieve adaptability with a variety of different functions, combinations have to be looked for on different scales or levels of the design. Overlapping needs have to be found and integrated into the building. This can also create a stronger bond between these different functions, since they are using the same building with the same features. The most obvious way to do this, is to create a building that can house different functions, no matter what it takes. This so-called loose-fit architecture is flexible enough to change wherever needed, with minimal effort. It is these buildings that thrive on the constant of change, taking full advantage of a world in which nothing is ever fixed. But within architecture, there is always a certain need for some steadiness, in order to have value. Therefore a good framework is necessary in order to provide for a changing building. On the scale of the building, this means that the façade is going to play an important role, especially when it comes to providing the cultural value and placement within the context.

In order to have a successful mixed-use building with a variety of functions, the most important thing is to have this combination be more than just the mere sum of its parts. This means that the combination of functions need to have a certain interaction with each other, a synergy that if positioned in separate buildings would never have been there. It can mean that certain functions that normally won't be related in any way, are now placed alongside each other to create a certain bond. This concept can stretch further than the outline of the building. The synergy of different functions also radiates to the context in where the building lies, creating an even stronger bond with its location, therefore giving it more value. This juxtapositioning of functions in order to create synergy can be more exaggerated by taking into account the routing. Also, when dealing with a combination of function that are both public and private within the same building, these two spheres will eventually have some sort of overlap, which means that special attention is necessary in the realm of the public-private domains and the gradient. This in combination with finding overlapping needs can create a truly powerful hybrid building.

In conclusion, within the transformation of a vacant office into a building that can adapt to future needs, with a variety of different functions, it is important that the building can provide room for movement of what is happening inside. These individual elements, although perfectly capable of existing on their own, will find overlap and need to have interaction with each other to become a true hybrid building. But this has to be done in a balanced way, with a support or framework that

can hold the individual parts, and provide a certain stability that is necessary within the realm of architecture and urban planning.

Appropriateness and limits of the method

A literature study can provide a lot of useful information along with a lot of different views and approaches on the subject that is being investigated. It can provide a clear overview of what is possible. But this is also the limitation of this very method. It is easy to obtain too much data, so that the scope of the research will be too great, meaning that along the way this needs to be changed. Another drawback is that when using a purely theoretic method, a literature study, there are a lot of differences with practice. To counter this, example studies can provide an insight in the practice of adaptability and could have helped to verify the theory. It must be stated that when doing example studies, a lot of the overarching theory will be left out, because every example is one that stands on its own, and the strategies that have been used will always be the most appropriate for that specific case.

Generalizability

The findings presented in this research show more of a set of different approaches in order to achieve a building that can adapt to the unknown future. An actual case-study can provide more input in order to come to a complete strategy, using the findings in this research as a toolbox to create a tailor-made solution to assist in the transformation.

Discussion

There could be quite a discussion on whether building especially for a future we don't know and can't predict, is a wise one. The dream of the architect, to have the building remain as he envisioned is for some the main reason to be involved in any aspect within the field of architecture and the built environment. There is an indescribable feeling that wants the architect to create something that is his and of course that has to live on forever. By designing for change, you take away the fixing of ideas and let change be the factor that dictates what the building will (become).

Further research

This particular thematic research has been focusing on a rather small field of the transformation of vacant buildings. It featured a very particular type of building, the office building, and even within this area, there are still a great number of buildings that have been left out. For instance, monumental buildings are offering multiple extra challenges in comparison to the newer built examples. There is the challenge of intervening with minimal impact on the façade, or a complicated construction.

It also touches upon the more technical and functional aspects of transformation, but there is still way more that comes into play in the transformation of buildings. There is a number of rules that have to be considered and also the financial aspects are amongst the most important in order to achieve a successful transformation. Also, the process of actually acquainting the building, dealing with developers, the owners also involves a lot of process management, something that can even be a graduation project on its own. This also involves the present users of a particular building,

there could also be a scenario in which only half of the building is vacant, leading to a different approach to the transformation.

The research's focus, although quite broad in its framing, could still be much more focused. For instance, the research done by Willem Kok and Peter van Luijn into a modular façade system to transform offices into dwellings, is already way more focused on a single problem within transformation (Kok & van Luijn, 2012). The same goes for the research done by Benjamin Kwant on integrating buildings services into the façade, thereby focusing on one very specific problem, namely the difficulty of making recesses in floors, and the problem of load-bearing facades (Kwant, 2014). These researches show that it is somehow possible to focus on a very specific aspect of office transformation, something that could have been done in this research as well. But then, even though this thematic research is quite technical, it also touches on less pragmatic aspects such as the public-private sphere. This does make it harder to focus on a single aspect, and that is why the decision was made to broaden the scope a little.

Unanswered questions

After completing this thematic research, there are still questions that remain unanswered. This is first of all due to the scope of the research, because there is a limited to what can be investigated in the time being, but also because of the research. When answering certain predetermined questions, it also raises new, unforeseen questions that are strongly related to the theme. For instance, the influence of the surroundings on the building, or that of the people that use the building, or interact with it on a daily basis.

Reflection

For a subject as broad as adaptable transformation, it is easy to find a lot of information, all providing very interesting approaches on the subject. At the start of such an investigation, the goal is always to eventually end up with an overview of all the different views on the subject, objectively presented. In practice, when finding a good source, it will steer you in a particular direction. By the article itself, with all of its approaches and arguments why that is the way to proceed, and also by the literature they are using and referring to. This also happened in this research. From early on, it became evident that presenting (and maybe comparing) all of the different approaches within this subject is not only too much work, it simply cannot be done, since it is impossible to list every approach or view. This led to the fact that certain authors and their respective ideas are dominant in this research.

Also, the scope of the research wasn't completely fixed in the beginning of the investigation. This led to an overload of interesting information, meaning a broad research rather than an in-depth one.

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Brand's layers with the addition the approach as discussed by Gibb et al. (2016).

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Three dimensional distribution of building services, own work.