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Master thesis

METHODS TO READ ADAPTIVE REUSE STRATEGIES AND CAPACITIES IN INDUSTRIAL BUILDINGS

Supervisor: Prof. Matteo Robiglio
Co-supervisor: PhD candidate Elena Guidetti

Candidate: Elina Amiri

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Abstract

Industrial buildings are evidence of the industrial revolution and its effects on the transition of urban areas to new manufacturing spaces. Nowadays industrial heritages are acting like landmarks in the urban fabric. Unfortunately in the last decays, due to growing urban areas, environmental effects, population increase, ecological and economic issues, the use of industrial buildings inside the cities reduces and these buildings were relocated to city borders or become abandoned inside urban areas. Each existing building and specially industrial buildings have a high potential to reuse and change. The best way to reactivate these vacant buildings is to find a new function that fits the existing structure. Adaptive reuse is a good answer to the demand for reactivation of these valuable heritages. The aim of this research is to highlight briefly the methods used for remodelling and to evaluate the adaptive capacity of buildings that reveals the capacity of the existing building for future changes in function. Also, it is important to apply the general building type adaptive capacity evaluation on case studies and to figure out if the existing weighting system introduced for specific building types in FLEX 4.0 evaluation method is acceptable for all types of functions in buildings or it is necessary to introduce a separate weighing system for different future changes in the function of existing buildings.

Key words: Industrial buildings, adaptive reuse, remodelling, FLEX method, flexibility.

Introduction 1

1.1. Introduction
1.2. References

1.1. Introduction

Industrial buildings were born by the industrial revolution in the period of 1760 to 1820-1840. The revolution caused the transition to new manufacturing processes and different industrial building types such as factories, warehouses, foundry… in Europe and the United States. During that period urban image and structure changed by constructing factories and industrial buildings.
Unfortunately in last decays, due to growing urban areas, environmental effects, population increase, ecological and economic issues, the use of industrial buildings inside the cities reduces and these buildings were relocated to city borders, or some buildings stopped to be productive or the original production function is interrupted and the building becomes unused.
This series of changes are the basis of the slow and unstoppable abandonment of a large number of industrial buildings on a worldwide scale. These buildings are not able to adapt themselves with a new condition or they no longer meet present requirements and the result is buildings that had been transformed from a symbol of technology and innovation to decay nowadays. For this reason, today we can see abandoned industrial buildings inside cities which are empty and not used for years. In some cases, the absences of activity in these structures have effects on urban Space face too and they become forgotten areas in the neighborhoods which cause urban gaps in the city.
Many industrial buildings have cultural values and they can preserve as a physical landmark to get in touch with the past experiences of society. Each industrial building can be unique with its own structure and memory.
Industrial buildings can be a limit or an advantage in urban areas. They usually overlooked and unwelcomed due to their inadequate surroundings, polluted landscape and ordinary architecture[1], while some of them have high potential to be an adaptive building, they were built to have large scales for maximum efficiency, sizeable openings with natural daylight which is ideal for human activities. [2]
We can consider industrial buildings as historical heritage, their structure can reflect the way of thinking of those who have created them and the level of civilization that made them.[3] The important aspect of the conversion or reuse of industrial buildings is to help to preserve the identity and memory of the building. What we need is to avoid the vacancy of buildings. This aim is possible by designing and constructing adaptable buildings that can adapt to changes in user demands. Industrial buildings, sites, structures with their unique features have effects on the neighbourhood which they are located in and they have the potential to be a link between past and present. It is important to make places sustainable over time.
Adaptive reuse as an act of finding a new use for an existing building could be a good solution to answer the question that how we can preserve our existing buildings and reuse them as an active urban space.[4] Adaptability as a design characteristic can assist in reply to changing operational parameters over time.[5]

The aim of this research is to introduce briefly some methods of adaptive reuse strategies used in remodelling process, describe the development of FLEX method[6] which is used for this research.[7]

The thesis structure consists of 7 chapters. Each chapter will explain different aspects related to adaptive reuse and remodelling topic.

The introduction chapter will be followed by second chapter. The second chapter explains industrial heritage, their classifications, the definition of industrial buildings, and their values and adaptability capacity.

The third chapter is an introduction about adaptive reuse, its definition, theoretical approaches, reuse process and its advantages.

Chapter four will start with the definition of remodelling, explaining its value from different aspects, highlight the strategies, tactics and interventions used for remodelling process.

Chapter five is talking about adaptive capacity in buildings. It explains the adaptive capacity method, different versions of the FLEX method, analysing the development process and its details.

Chapter 6 is related to case studies. There will be a brief introduction to the case studies. In this chapter, four industrial buildings are chosen from Europe. All case studies have different characteristics and functions. Each case study will be explained in detail about its remodelling process, strategies, tactics and intervention used for reuse. The analysis will be continue with evaluating the adaptive capacity of the building with FLEX 4.0 and by the suggested FLEX version with different weighting system which could be suitable for different types of building functions in future.

Chapter 7 is related to the conclusion and the results of evaluating the FLEX method and the suggested version with a different weighting system. The conclusion part will be shown if the case studies are enough adaptable for future changes in function or not and if it is necessary to have different weighting systems for different functions in the reuse process of buildings in future.

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2

Industrial heritage

2.1. Industrial heritage definition
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2.12. References

"Industrial sites are important milestones in the history of humanity, marking humanity's dual power of destruction and creation that engenders both nuisances and progress. They embody the hope of a better life, and the ever-greater power over matter."[1]

Unesco.org

2.1. Industrial heritage definition

The term heritage is usually used for unique natural features, areas and buildings with historical or architectural value.
"Industrial heritage consists of the remains of industrial culture which are of historical, technological, social, architectural or scientific value. These remains consist of buildings and machinery, workshops, Mills and factories, mines and sites for processing and refining, warehouses and stores, places where energy is generated, transmitted and used, transport and all its infrastructure, as well as places used for social activities related to industry such as housing, religious worship or education."[2]
Industrial heritage represent history, architecture and technology in different time and area, which needs to keep in good condition for next generations.[3]
They are an important part of our environment and landscape which provide links between past industrial age to the contemporary world and have a potential to play effective roles in the urban environment. Accepting these areas as an evidence of past age and consider them as specific areas with need of protection is the reason which makes the industrial buildings an important factor for the city transformation.[4]
World heritage is divide to three groups; Natural, Cultural and Mixed heritage. Industrial heritage is consider inside the Cultural heritage group.

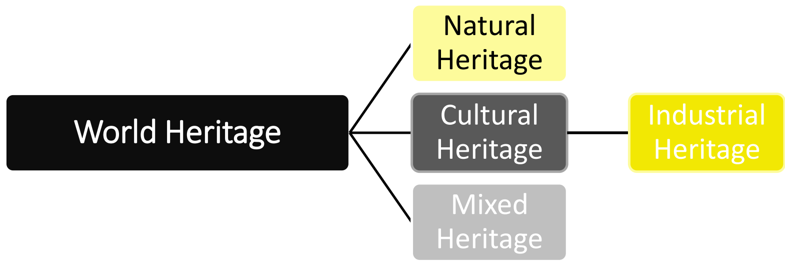

Figure 01

Figure 01
World heritage division to different groups. Natural, Cultural and Mixed heritage.

2.2. Industrial heritage on the world heritage list

According to the world heritage list between inscribed sites there are 28 sites that are considered as Industrial heritage. The pie chart below shows the Industrial Heritage is about 4% of world heritage.

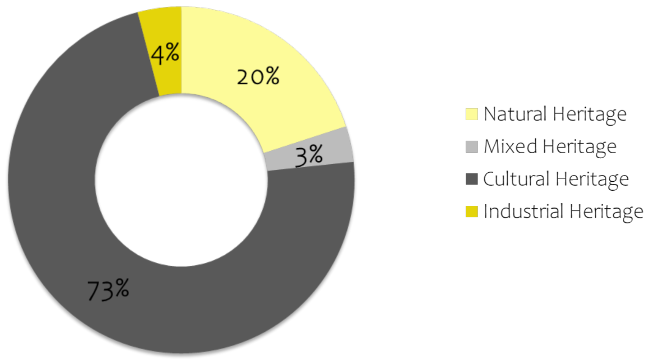

Figure 02

Figure 02
Percentage of different heritage types in world, UNESCO World Heritage Centre, 2001.

2.3. Industrial heritage site classification by region

The combination of Industrial heritage is completely different in each region. The 28 inscribed industrial heritage sites are classified by region. 22 Industrial heritage sites are found in the Europe / North America region, 4 in the Latin America/Caribbean region, 2 in the Asia/Pacific region. In Africa and the Arab States, there are no Industrial sites on the list.[1]

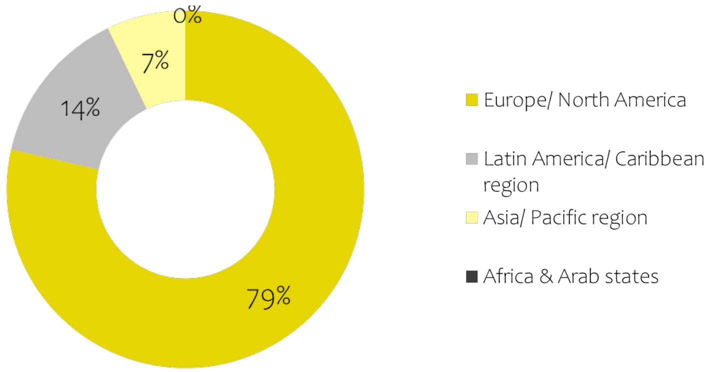

Figure 03

Figure 03
Percentage of Industrial heritage sites classification by region, UNESCO World Heritage Centre, 2001.

2.4. Categories, sub-themes, proposed classification system (HAER)

The Industrial structures classification system by Historic American Engineering Record (HAER) shows 10 sub-categories:

1. Extractive industries (e.g. Ore- or Gold-mining)
2. Bulk products industries (e.g. Primary Metal Industries)
3. Manufacturing industries (e.g. Machine Manufacture)
4. Utilities (e.g. Water Supply, Electricity)
5. Power sources and prime movers (e.g. Water wheels, Steam turbines)
6. Transportation (e.g. Railroads, Cannels, Harbour)
7. Communication (e.g. Radio, Telephone)
8. Bridges, Trestles, Aqueducts
9. Building technology (Roof systems, Fenestration)
10. Specialized structures/objects (e.g. Dams, Tunnels, Hydraulic works) [1]

2.5.New inscribed properties for Industrial Heritage list

There are number of new properties which inscribed to the world industrial heritage list each year. The chart below shows the number of new industrial properties and the conutry from 2005 to 2019.

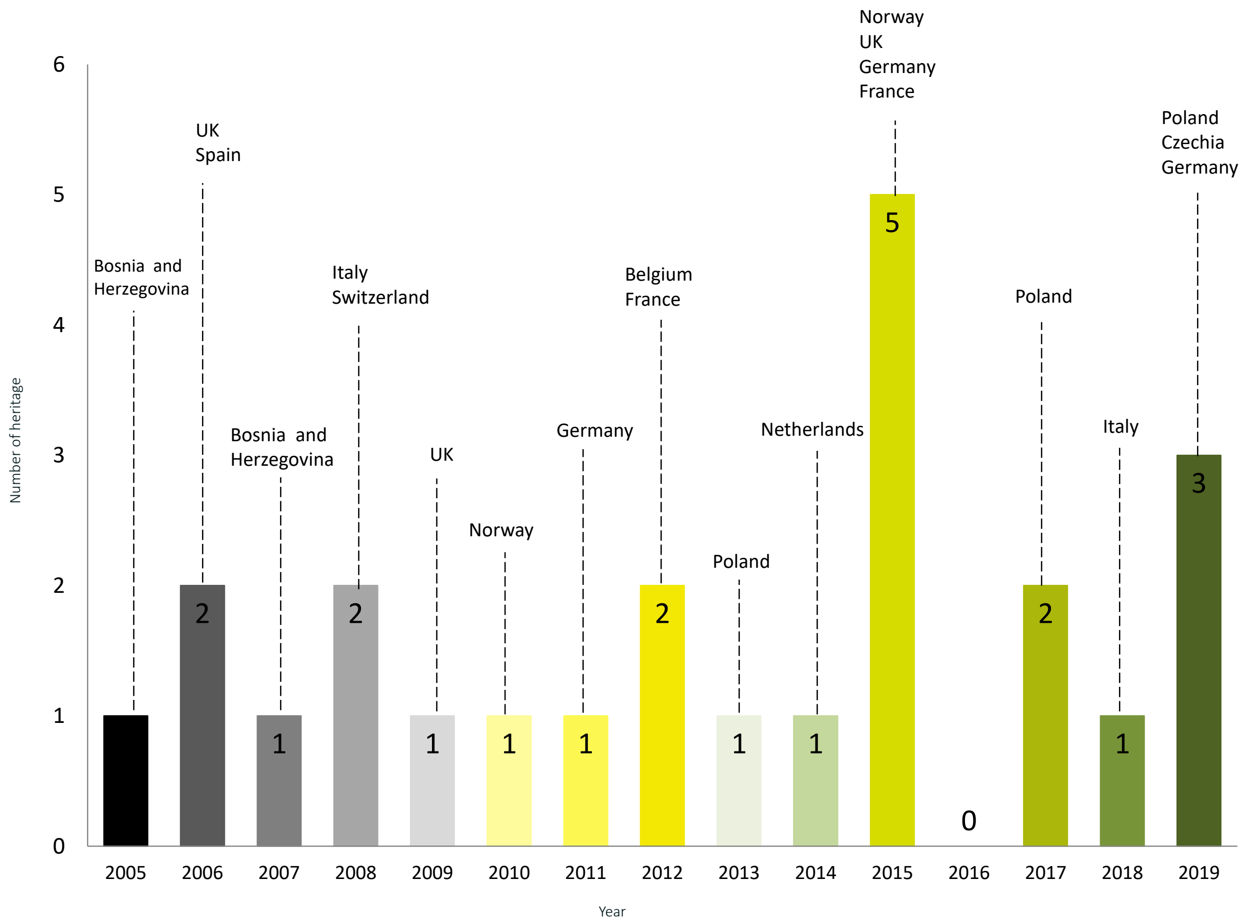

Figure 04

Figure 04
New inscribed properties for Industrial Heritage list from 2005 to 2019 in Europe, UNESCO World Heritage Centre.

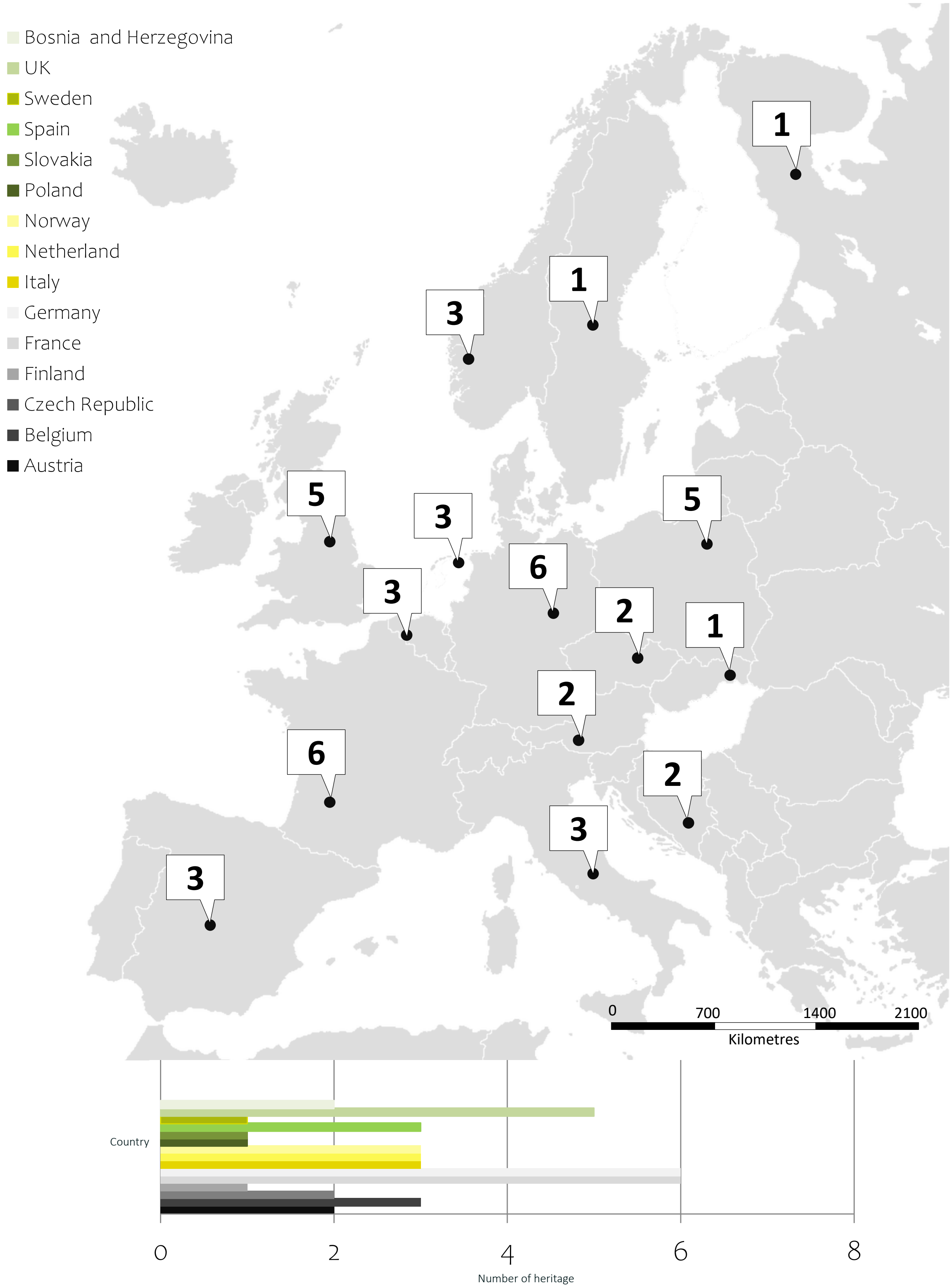

Figure 05

Figure 05
Map of Industrial Heritage sites in Europe, UNESCO World Heritage Centre, 2019.

According to the data Europe has the largest variety of industrial sites. Beside well known industrial sites and new inscribed properties in world heritage list, there are other industrial sites in urban and sub-urban areas. These sites may not have the title of the nomination Industrial heritage or not consider as a significant amount of industrial heritage in the descriptions of the site by the State Party, but they have the potential and value to invest.

2.6. Industrial buildings

The industrial revolution affected large-scale urbanization and significantly changes the urban landscape. Many industrial large buildings and sites constructed after this revolution and the number of these buildings was high during industrial era. Industrial revolution in cities and industry develop both together. In general these kinds of cities, designed to accommodate the industry and its related activities. Industrial building is a building designed and constructed to house industrial operations, activities and provides the necessary conditions for workers and the operation of industrial utilities.
Weak areas, underdeveloped areas, urban voids are different phrases which use to indicate industrial buildings. The international phrase for old industrial sites is "brownfields". According to CLARINET working group, established by the European Commission, the phrase brownfields refer to sites that:

• Have been affected by the former uses of the site and the lands surrounding it
• Are abandoned or insufficient use
• Have real or remark pollution problems
• Located mainly in developed urban areas
• Need intervention to have beneficial use [5]

Image 01

Image 01
Abandoned Mineral Oils factory, "OMA", Rivalta, Italy,
© Olegs Belousovs,2007.

2.7. Reasons behind industrial buildings abandoned

The industrial zones were slowly incorporated into the growing cities and industrial production being gently moved out of the new city limits or they abandoned inside the city.[6]

There are different factors for disposal and being abandoned for industrial buildings such as radical changes in economic condition, pollution, environmental issues, technological factors, urban areas growth and decentralization or re-location of these buildings.

The most important reason in abandoning is that the original production of the building is stopped, they no longer meet present requirements[7] and the building becomes unused.

Economic crises can rapidly affect the market needs and industrial productions which causes dramatic changes in industry sector from large scale production system to small scale distributed ones.[8]

New technologies also affect the production system; change the need to inexperienced labour to educated and professional workforce.[8]

Also the facility and the old production machines were not adapted with this technology change. High speed of technological developments which have taken place in the 1960s and 1980s causes the suspension of industrial buildings in Europe.[9]

Environmental factors are related to the impact of special production activities on the site causes a change from polluting production to a unpolluted and sustainable production system.[8] The urban factors also play an important role in this abandoned process, industrial buildings usually transform into suburban areas because of the increase in population and changing or growing of urban areas.

When industrial buildings don't have any industrial activities, the structure may not be used officially even for the short or long term. The future life of the abandoned building will be distinctive by a decision takes by the owner.[9]

In the general view, the industrial decline is the result of rapid changes from the industrial revolution until today. The series of changes in modern world causes an unstopped abandonment flow of industrial buildings on a worldwide scale. Old industrial buildings and sites are not able to adapt themselves with new condition and the result is abandonment.

Image 02

Image 02

Abandoned Cigarette factory, Turin, Italy. © Olegs Belousovs,2007.

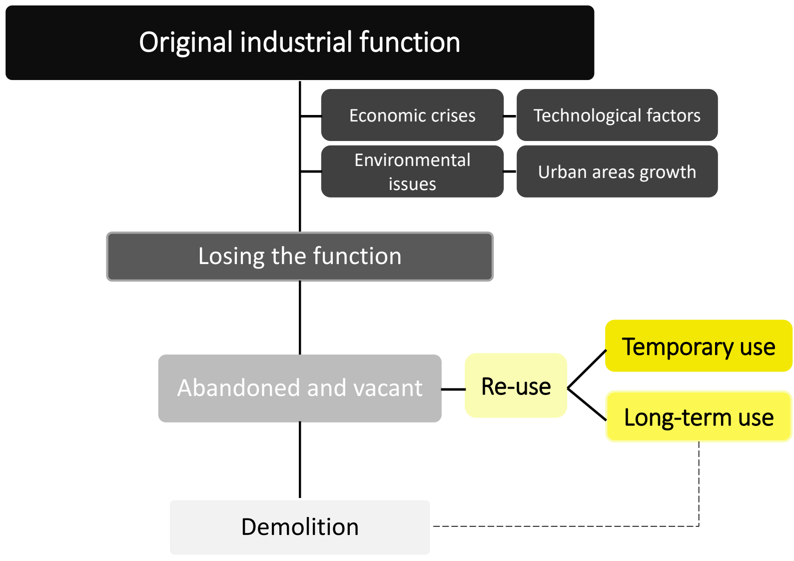

Figure 06

Figure 06
Industrial building life cycle process.

The absence of activity within these structures creates some urban gaps.[10] There are also other disadvantages of abandoned industrial buildings:

1. Vacant buildings
2. Unsecure structures
3. Non official functions may increase in the building
4. Pollution for environment
5. Negative effects from visual point of view in neighbourhood
6. Decrease the attraction in the existing district
7. Loss in property value

Image 03

Image 03
Abandoned industrial building, Hartford Mill, Oldham, UK, © Diego Sideburns.

2.8. Relation between industry and city evolution

The industrial zones were slowly incorporated into the growing cities and industrial production being moved out of the new city limits or they abandoned inside the city.[6]
From historical point of view, it is possible to identify four key periods in the evolution of city and industry relationships: [8]

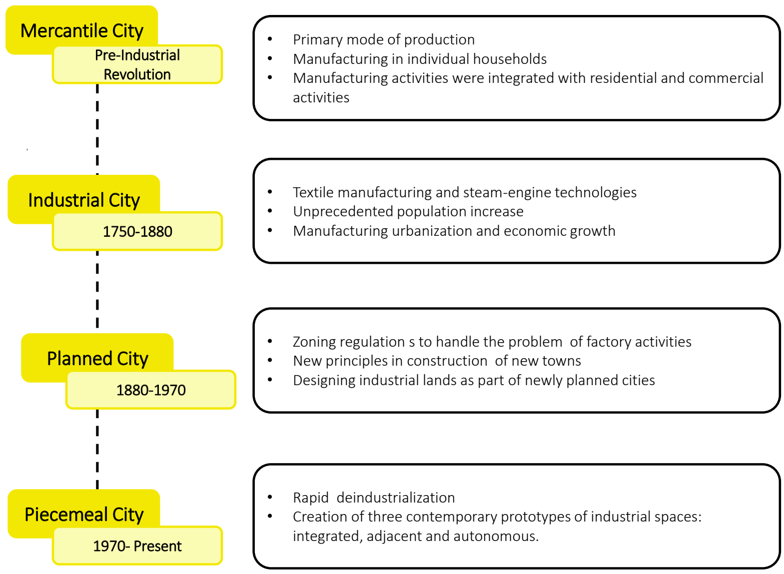

Figure 07

Figure 07
Key periods in the evolution of city and industry relationship, Kim, M., Ben-Josep, E., “Manufacturing and the city”, Paper presented at the annual meeting for the American Collegiate Schools of planning, Dublin, Ireland, July, 2013.

There are also three prototype of industrial spaces in urban fabric: integrated, adjacent, autonomous.

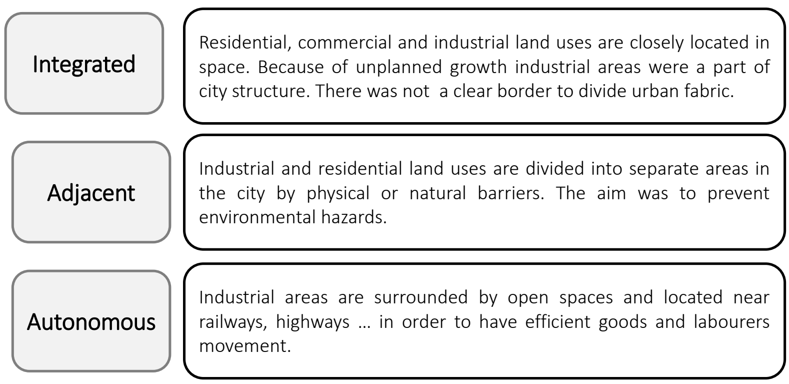

Figure 08

Figure 08
Prototypes for industrial space in urban areas, Hatuka, T., Eran, B., J., Industrial Urbanism: Typologies, Concepts and Prospects, Tel Aviv, 2017.

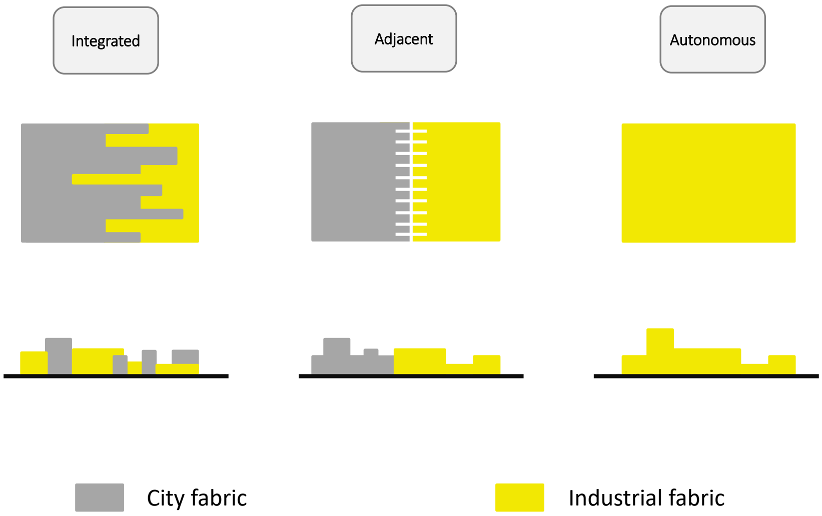

Figure 09

Figure 09
Prototypes for industrial space in urban areas, Hatuka, T., Eran, B., J., Industrial Urbanism: Typologies, Concepts and Prospects, Tel Aviv, 2017.

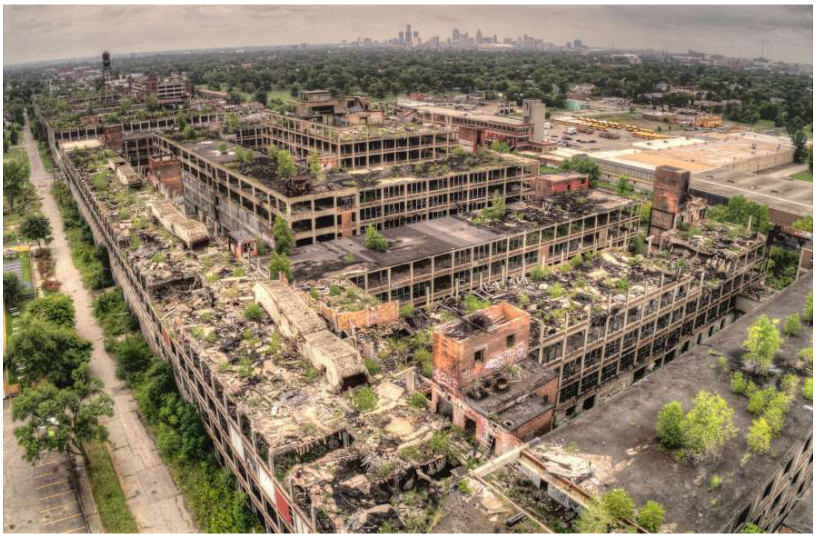

Image 04

Image 04
Relics of the West's industrial heyday, a multitude of crumbling mills, factories and power plants, © Jacob Boomsma.

2.9. Industrial buildings characteristics

Industrial buildings were constructed for production and can give information in different aspects such as economic, technological and architectural achievements of their construction time. They could have fixed use or their use for production had been changes several times in their life cycle. Their character could be adapted by continues changes in their function, structures, and elements for new uses. From an architectural point of view:
The types of industrial building structures are suitable to support heavy loads and activities. They usually have load-bearing brick walls or metal frame structures with a volume in proportion with their functions, high and large spaces with good natural lighting and technical rooms that accommodate equipment.[1]

2.10. Industrial buildings value

Many industrial buildings and sites are vacant and unused in the urban and suburban areas. They made a gap in their neighborhood and lost connection with other urban spaces. Industrial buildings can be considered as a potential or a problem in urban spaces. They can be easily changed to a weak or negative point in their neighborhood and face decay until totally destroyed in time. From other points of view, they can be totally different by being reused and find new functions and life.

The old industrial buildings have various values such as architectural, historical and economic values. Each industrial building has a memory, identity and a part of cultural heritage.

They can make a connection between past and present and with preserving and correct decisions it can be used for the next generations too. It is important to keep the memory and identity of the place while trying to meet the new requirements.

The historical buildings play an important role in establishing some patterns of urban revitalization, representing some distinctive elements that add character and value to an area and help preserving its identity.[6]

2.11. Industrial buildings adaptability

Marcus Jauer in his essay “The City. Becoming and Decaying” writes: “The future of the world lies in the city. It is where the fate of humanity will be decided. What happens to the city also happens to us.”[10] so it is very important to make sure our city and urban areas will work and be alive.

Industrial buildings are highly adaptable and they offer good adaptability features. They construct to host industrial functions, activities, machinery with big dimension, so they have large spaces which can be adapted easily with new functions such as cultural centres, museum, art galleries, education centre, library, public centre, exhibitions … and all other functions which require spaces with large scale. These types of buildings are naturally designed to maximize the efficiency of space. They usually have access to large amount of natural daylight which is important for any other new function in the future too. Natural ventilation and shading are also two factors that are not forgotten in design of industrial buildings.

In 1975, Serban Cantacuzino wrote in his book “New Uses for Old Buildings”, that “because the structure of a building tends to withstand longer than its function, the buildings were always adapted to new uses, which allowed generation after generation to find the sense of continuity and stability in the environment”[3]

According to potential of industrial buildings for adaptation there are different solutions to create new function for existing vacant buildings in urban and sub-urban areas which will be mentioned in next chapters.

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Website

https://olegs.be/photos/genre/abandoned-places/

Image 05: Zollverein Coal Mine Industrial Complex, © Christian Meermann.

3

Adaptive reuse

3.1. Introduction to adaptive reuse
3.2. A theoretical approach towards adaptive reuse
3.3. Adaptive reuse definition
3.4. Analysing the re-use of the industrial buildings
3.5. Conditions of the change in function
3.6. Conditions promoting and hindering the re-use
3.7. Reuse process
3.8. Advantage of adaptive reuse
3.9. References

"More often than we like to admit, we are not engaged in changing the world to some determined end. We are adapting responding to outside forces beyond our control, seeking to survive, to preserve something, to maintain some desired level of performance."[1]

Lynch, k.

3.1. Introduction to adaptive reuse

Adaptive reuse has existed since distant past, from the reuse of caves up to today`s built environment with the idea to extend structures that are not able to accommodate their purpose of use any longer.[2]

Following the transformation of cities reveals that each city can be consider as a living organism because of its ability to constant movement and transformation in time.[3] Existing buildings need to evolve and transform to fit with needs not only in terms of technical but also in terms of functional. [4]

Among human built structures in cities industrial buildings are physical legacy of industry era. Technological development and the changes in the economic structures which happened in the 1970's and 1980's caused the close-down of factories in many countries in Europe.[5]

When production is not present in industrial building, "the loft is what is left." [6]

Image 06

Image 06
Abandoned "CEAT" electric cables factory, Turin, Italy,
© Olegs Belousovs, 2007.

The result of deindustrialization was a large opportunity of empty and abandoned industrial buildings and sites in cities. Until the late 1990`s industrial infrastructures are consider as barriers and obstacles which should be removed. But nowadays it seems that industrial buildings are built to reuse[3] and the point of view toward these industrial legacy changes from demolition to reuse.
The urban areas that mostly became subjects to adaptive reuse in the process of development of the city in the 20th century include high number of industrial buildings and sites. Our response to re-shaping our environment is very important. It is not just about reusing these abandoned buildings by turning them into any structure with new function but it is more about reactivate them in a meaningful way.[7]

Image 07
Abandoned "ELBI" electrical components manufacturing factory, Collegno, Italy, © Olegs Belousovs, 2008.

Image 07

If buildings are not preserved correctly, they can turn into ruins. The demolition of buildings which are no longer in use and not preserved on time is considered as ecological waste and it damage the building`s identity of that space.[8]
"Given the fact that in most parts of the world our built environment is still largely determined by already existing buildings and constructions rather than new developments, one of the greatest tasks faced by today's architects is the creative handling and inspiring transformation of such architectural remains."[9] When a building lost its function adaptive reuse becomes a sustainable option for reclamation of it. The adaptation of existing buildings to ensure their continued use is a central aspect of architectural design in existing built contexts. Change of use is the simplest way to certify the continued development of a building.[8]

3.2. A theoretical approach towards adaptive reuse

A theoretical approach towards adaptive reuse was established in the 19th century[10] by Eugène Emmanuel Viollet-le-Duc. According to him adaptive reuse is a way to preserve historic monuments. He argued that "the best way to preserve a building is to find a use for it, and then to satisfy so well the needs dictated by that use that there will never be any further need to make any further changes in the building" [11] His ideas have been strongly objected by John Ruskin and William Morris. They argued that it is "impossible, as impossible as to raise the dead, to restore anything that has ever been great or beautiful in architecture" and instead of restoration they favoured regular care and maintenance to ensure the preservation of historic buildings.[12] In the early 20th century, the conflict between these opposing theories on adaptive reuse also has been discussed by Alois Riegl.[13]

From the 1970s, adaptive reuse has been a key subject for many conferences on architecture. In 1972 the Architectural Review published an issue about New Uses for Old Buildings that published three years later in a book with the same title.[14]

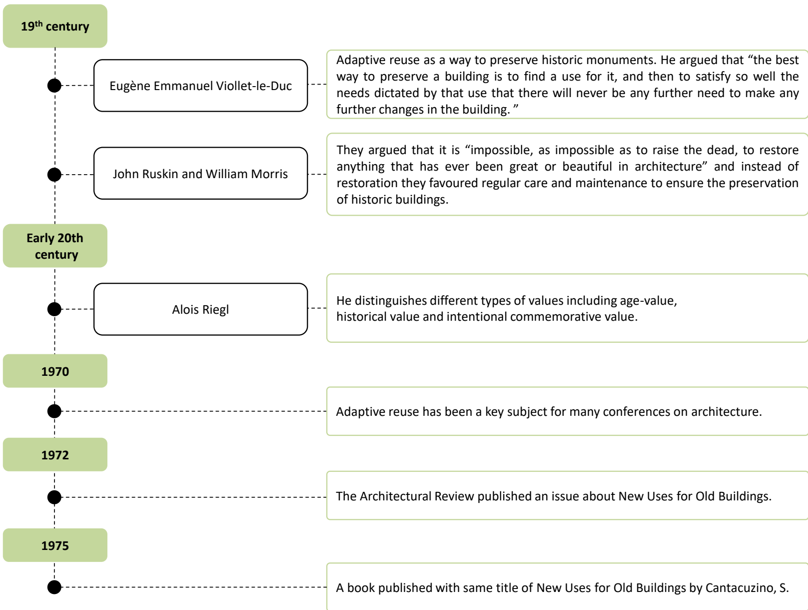

Figure 10

Figure 10
A theoretical approach towards adaptive reuse in time, according to collected data from documnets.[10-14]

There are different theories to classify the approach toward adaptive reuse and it has been studies in different fields according to international literature. Three main approaches can be distinguished: Typological, Technical and Architectural strategies.[15] Typological approach can be presented according to building type before adaptation.[16-17]

Technical approach is according to several writers the reuse process is a technical matter.[18] Strategic approach focuses on the process and methods used for adapting structures.[19]
The architectural strategies is one of the main focus points of this research and will be explain in detail in next chapter.

3.3. Adaptive reuse definition

Adaptive reuse refers to the process of reusing existing sites, buildings or infrastructures which lost their function and abandoned in time and to adapt them with new functions by minimum transformation.[6]
There are many definitions for adaptive reuse; the current meaning is "the process of reusing an old site or building for a purpose other than which it was built or designed for." [20] The term reuse could be expressed more complete. Reuse can be done in old and recently buildings, sites and infrastructure too.
Other term for 'adaptive reuse' can be called 'remodelling', 'retrofitting', 'conversion', 'adaptation', 'reworking', 'rehabilitation' or 'refurbishment'. It includes that 'the function is the most obvious change, but other alterations may be made to the building itself such as the circulation route, the orientation, the relationships between spaces; additions may be built and other areas may be demolished'[19]

Image 08
Docks Malrauxby Heintz-Kehr architects, apartment and office, Strasbourg, France, © Courtesy of Heintz-Kehr architects, www.archdaily.com.

Image 08

Image 09
Anish Kapoor Studio I by Caseyfierro Architects, workshop, office, London, UK, © Jim Stephenson, www.archdaily.com.

Image 09

According to Robiglio M. adaptive reuse definition could be: "the process of reusing an existing site, buildings, or infrastructure that has lost the function it was designed for, by adapting it to new requirements and uses with minimal yet transformative means."[6]
In architecture, the transformation of a building could be expressed as a change of its content or function of building without the change of building form. By understanding conversion as a path that connects the previous function of the building with the new one with the idea not to transform completely but to try to keep the overlap between new and old.[3]
Usually restoration can only be used for a few buildings while the reuse of the buildings is more effective method of preservation and can be extended the life cycle of buildings.[5]

3.4. Analysing the re-use of the industrial buildings

In general industrial building has a kind of structure which makes adaptation process more possible. The structure type in these buildings creates two types of buildings in cities: multi-story frames and big sheds.[21]
The frames were used for factories and warehouses and sheds were used for covering and surrounding heavy production. Key features in industrial buildings are their oversize structure, redundancy of space and distribution opportunity.[6]

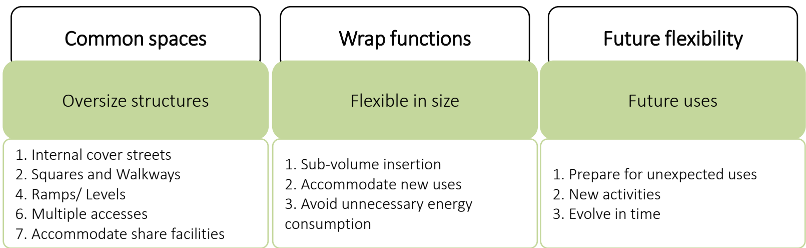

Figure 11

Figure 11
Key features in industrial buildings, Robiglio, M., RE-USA: 20 American stories of adaptive reuse, A toolkit for post-industrial cities, Jovis Verlag GmbH, 2017.

Image 10

Image 10
C-Space by BuckleyGrayYeoman, London, UK., © Hufton+ Crow, www.archdaily.com.

3.5. Conditions of the change in function

Change in building function could be for temporary utilisation. Buildings need to be protected and saved. In case of both state ownership and private ownership, economic conditions and reuse concept should be considered in order to find a suitable building. Old buildings have different type of values such as architectural, historic, economic... which have to be saved during reuse process.[5]

A German study categories building after reuse process by their new functions:
a) industry, industrial yards
b) Services, commerce and gastronomy
c) Flat
d) Social infrastructure
e) Mixed usage
f) Temporary/pre-utilisation[22]

Image 11

Image 11
Ermenegildo Zegna HQ / Antonio Citterio Patricia Viel + Beretta Associati, Milan, Italy, © Leo Torri, www.archdaily.com.

3.6. Conditions promoting and hindering the re-use

The following factors facilitated the changes in building function:
- Beneficent location of building
- Being in a good structural condition
- Have financial and professional assistance from government
- Minimum transformation for new concept

And factors bellow can prevent the process of change in building function:
- Improper location
- Poor accessibility to site or building
- Unclear condition of ownership
- Dependent infrastructure system
- Soil condition[5]

3.7. Reuse process

When the reuse process starts, architect or the designer have to start from specific conditions of building or site and try to adapt the design idea or concept with limits in order to make connection between the concept and the existing building. Abandoned industrial buildings and sites have memories, polluted and usually without any economic value. The aim of reuse is to find the limits and potentials and propose the best design in order to make connection between new function, users and existing space. [6]

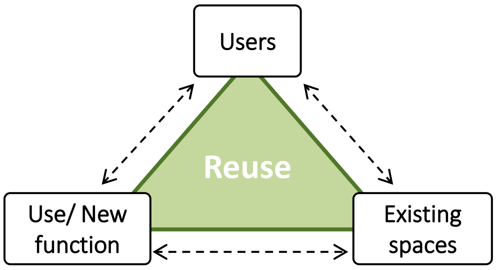

Figure 12

Figure 12
Best design condition in reuse,
Robiglio, M., RE-USA: 20 American stories of adaptive reuse, A toolkit for post-industrial cities, Jovis Verlag GmbH, 2017.

Reuse process can be explained in different steps:
1. Explore possibilities
2. Assess potential
3. Envision the future
4. Involve partners
5. Colonize the place
6. Design to reuse
7. Place making and funding
8. Run and evolve [6]

Walter C. Kidney an architectural historian specializing in industrial structures described the process of conversion and reuse of industrial buildings in following steps:
1. Identify the current plans and prospects of the building
2. Identify the owner
3. Determine the condition of building and utilities
4. Survey the neighbourhood
5. Control the accessibility to the building or site
6. Identify the possible reuse ways
7. Check the rules and laws
8. Involve public organizations
9. Determine the demands for the proposed reuse idea
10. Engage the public
11. Identify financial resources
12. Prepare feasibility study [23]

3.8. Advantage of adaptive reuse

Adaptive reuse has many advantages in different aspects and fields and the main ones are:
1. Increase economic value of the building or the site.
2. Social advantages.
3. Solution for energy conservation.
4. Revitalization of neighbourhood.
5. Connect urban voids with city.
6. Increase the life cycle of the building.

Image 12

Image 12
Aarhus Gymnasium by Cubo Arkitekter, Aarhus, Denmark,
© Martin Schubert, www.archdaily.com.

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Website

www.archdaily.com

Image 13: Ermenegildo Zegna HQ by Antonio Citterio Patricia Viel + Beretta Associati, Milan, Italy, © Leo Torri.

Methods for remodelling

4

4.1. Introduction to remodelling
4.2. Clarification of the different methods of building conservation
4.3. The value of remodelling
4.3.1. Structure
4.3.2. History and function
4.3.3. Context and environment
4.3.4. Proposed function
4.4. Strategies for remodelling
4.4.1. Intervention
4.4.2. Insertion
4.4.3. Installation
4.5. Tactics for remodelling
4.6. Intervention types in remodelling
4.7. References

"An old building is not an obstacle but instead a foundation for a continued action.Designing with them is an exhilarating enterprise; adding to them, grafting, inserting, knitting new pieces into the existing building fabric is endlessly stimulating".[1]

Plevoets, B. & Van Cleempoel, K.

4.1. Introduction to remodelling

Buildings can live or last longer than civilization, they transform and change during time. Buildings have the ability to maintain the memory of the former function and value. They can keep the identity of the previous function in their structure. In remodelling a building the inherent quality is combined with future use. They have the capacity to be a multi-layered complex. The number of buildings being remodelled is increased and the act is accepted based on the understanding of negative points of detrition of the city.[2]
Until the last decade of the 20th century, people prefer to live in the suburbs. This condition changed during the time and people more interested in the city centre. For this reason, abandoned and vacant industrial buildings started to convert and reuse according to the demands of users.[2]
According to Raskin J. "The buildings of the past are not ours, they belong to those who built them, and partly to all the generations of mankind who are to follow us"[3]. Remodelling could be an answer for sustainable use of existing buildings. Sustainable use and reuse is a subject with two distinct but linked components. A building can be adapted or remodelled using sustainable methods of construction.[2]
The design concept is formed by the existing building. The design task is depending upon which values are chosen to view as more or less important. Without a clear concept, a design will end up as a mixture of different concepts and approaches.[4]
Remodelling can be done both inside and outside of the existing building. In this chapter remodelling in interior[2] and exterior[6] parts of the building will be explained.

“what does it want to be?”

Louis Kahn[5]

4.2. Clarification of the different methods of building conservation

There are different types of approaches for attitude toward existing buildings:

1. Preservation
2. Restoration
3. Renovation
4. Remodelling [2]

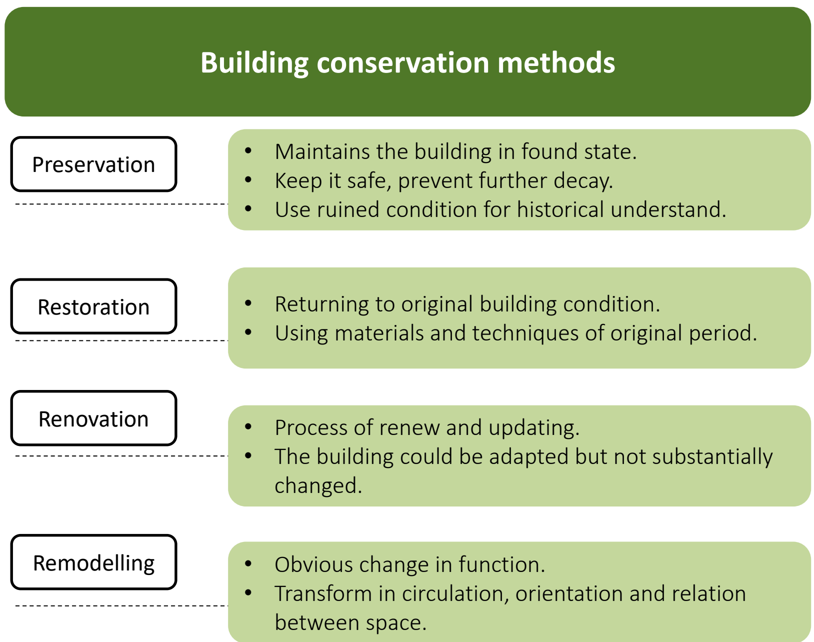


Figure 13

Figure 13
Methods of building conservation, Brooker, G. & Stone, S., Re-readings. Interior architecture and the design principles of remodelling existing buildings, RIBA Enterprises: London, 2004.

In remodelling process building may transfer under addition or demolition. The process could be called adaptive reuse specially in the USA, or reworking adaptation, interior architecture or even interior design. [2]

4.3. The value of remodelling

Reshaping of the city and meanwhile find a way to re-address the value of the existing building or site is difficult. The relation between new and existing is dependent on the approach of the designer. It is important to keep the relation between the original building and the reuse idea, also it is essential to have deep information and study about the quality of existing condition in order to have a successful remodelling. [2]

Buildings could be analysis in 4 different sections:

1. From and structure
2. Historic and functional
3. Context and environment
4. Proposed function [2]

1 Form and structure

It is easiest way to collect information about building that how it stands up, is there any rhythm or relation between spaces in building.

2 Historic and functional

It is necessary to aware of the previous function of the building and the history of it because it may effect the reuse concept and idea.

3 Context and environment

The existing building has relation with the site and its neighbourhood which should be consider in the reuse process.

4 Proposed function

The important phase in reuse is to know the requirements and demands of the new function to be able to make connection between new and old.

Figure 14

Figure 14
Building analysis in 4 section,
Brooker, G. & Stone, S., Re-readings. Interior architecture and the design principles of remodelling existing buildings, RIBA Enterprises: London, 2004.

4.3.1. Structure

There are two types of structures for old buildings in a traditional way, load-bearing and framed structures. Each structure creates a different type of space and atmosphere. Load-bearing structures made of thick heavy masonry walls with a limited span which caused to have close and small spaces in building, while the frame structure is used in big scale constructions. In these structures walls and floors could be independent without any limitation. [2]

4.3.2. History and function

Buildings transform over time, they can evolve, surplus or decrease in size and scale. Also, the function changes by needs and the previous function usually have a strong effect on the new one. [2]

4.3.3. Context and environment

The analysis of context and environment of the existing building could help to undesratnd the relationships between the site and the neighbourhood. Climate is the other factor which can effect the remodelling concept and adaptation [2]

4.3.4. Proposed function

The proposed function as an idea has a significant effect on the remodelling. Users expected from remodelled buildings to meet their requirements and to feel the past in relation with the present. To have a successful merge between these two, it is important to know the expectations from building. [2]

4.4. Strategies for remodelling

In the phase of interior remodelling, building architectural strategies employed as controlling tools. Strategies are made from combination of different factors such as the site condition, the building structure, the construction year, building demands and requirements. [2]
When a building is reused the most important point that should not forget is the original building and the relation between new and old. [2]
The method that this relation is established by is the key factor in the strategic analysis of a building. There are three types of strategies for building reuse in the relation of host building (existing building) and new elements. [2]

4.4.1. Intervention

Intervention is a transformation process in building remodelling; the new and existing parts are completely dependent on each other. The existing building provides motivation, elements imposed directly to the existing building and the form of the new building is under the effect of the original one.
The existing structure shows the direction of the reuse, the position of the sections, their relation, size, and scale. Usually in intervention the qualities of building explored, the story is read, reshaped and changed. [2]

4.4.2. Insertion

The second strategy for remodelling is insertion. This remodelling process creates a kind of relation between new and old which each part could keep their own character in a strong and independent way. Insertion could be the introduction of a new part inside the building, between or beside the existing structure. The inserted part can independent or single element on a large scale, also the materials could be different. There is a physical property in insertion according to existing buildings because it is built to fit the building. The scale and the dimensions of the main structure usually affect the design of insertion. It is important that the host building has a strong structure in order to accepts the new parts. In the insertion the two components must have equal voice but in different languages.[2]

4.4.3. Installation

In remodelling by installation, elements are independently from the existing building. They could simply align with each other and a group of elements can be placed in the context of the existing structure. The character of new elements is a design by the style of architects or the artists. Elements in the installation part usually have a limited size or life span but they can increase the impact of building too. Installation is a way to figure out and complete the hidden potential or lost part of the existing building.[2]

Image 14

Image 14
Elbphilharmonie Hamburg, Hamburg, Germany, intervention strategy,
©Iwan Baan.

Image 15

Shad 19, Reggio Emilia ,Italy, insertion strategy, ©Laurian Ghintoiu.

Image 16

The Reina Sofía Museum, Madrid, Spain, © José Barea, www.totem-madrid.com.

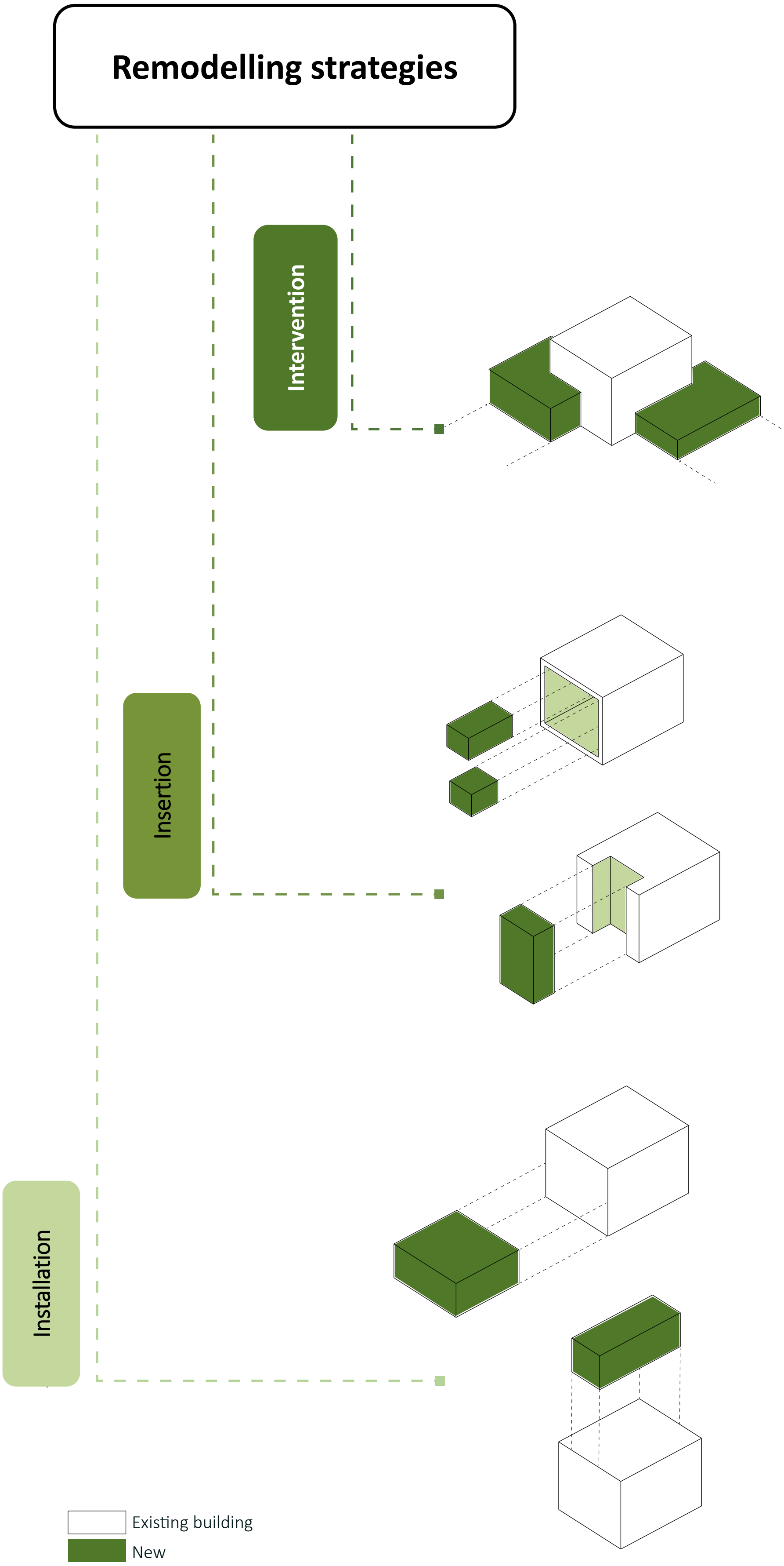


Figure 15

Figure 15

Remodelling strategies,

Fisher, D., Adaptive Reuse Architecture Documentation and Analysis, Technion - Israel Institute of Technology, 2016.

4.5. Tactics for remodelling

Tactics show the qualities of the building that how it sounds and feels like. It is the way of managing elements and to support the remodelling strategy. They are the expression of how we use the building and give different characters to spaces. Considering tactics as a detail could help to read the building and understand the way of changes. Tactics divided into 6 sections and each concentrates on a different aspect of use elements in remodelling and their relation with the building.[2]

1 Light

Light can control space and form and it is a necessary element to understand them. Lights can effect the experience of space.

- Natural/ artificial
- Spot light
- Guide to suggest direction
- Effect the quality of movement
- Necessary for space visualisation
- Highlight a single object
- Effect the size of space

2 Surface

Surface has the most contact with human and building. Materials can show character of building and each material has different texture quality. Way of using material can create different atmosphere and mood.

- Different material means different character
- Brick, traditional
- Steel and iron, strong
- Wood, warm
- Concrete, modernism
- Glass, transparency
- Material properties determine the use

3 Opening

Opening are crucial points in buildings with obvious uses for lights and movements but they also have other functions in the building.

- Be a single physical or visual movement
- Extension for journey in place
- Be a frame for picture-like view
- Give movement to space
- Circulation guide
- Act as a sign
- Transition between spaces
- Boarder between public and private space
- Use for ventilation
- Admit light and view in day and night

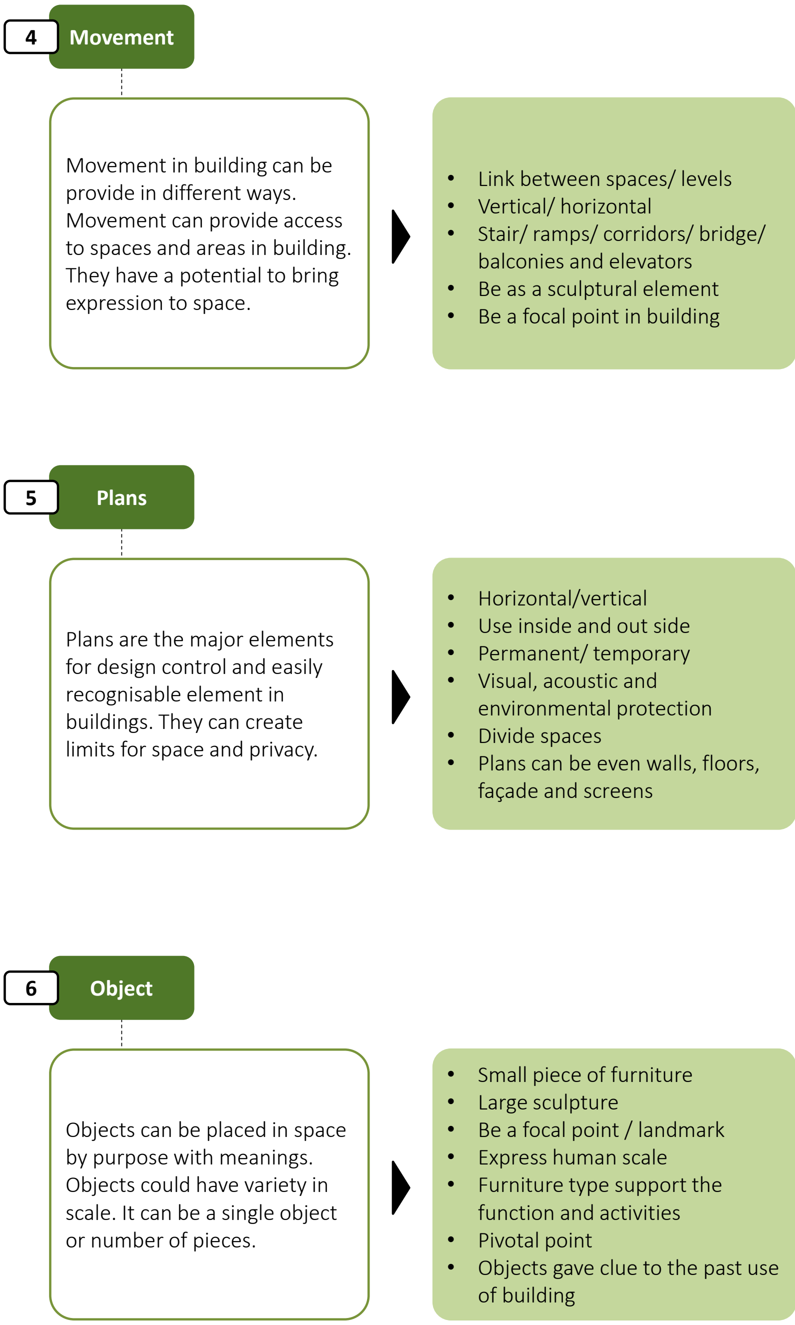


Figure 16

Figure 16
Remodelling tactics,
Brooker, G. & Stone, S., Re-readings. Interior architecture and the design principles of remodelling existing buildings, RIBA Enterprises: London, 2004.

4.6. Intervention types in remodelling

Our build environments are made of buildings and spaces between them. In remodelling of buildings, there is a relation between the volumes of existing buildings and the intervention. According to White,[6] it is possible to explain how remodelling and exterior elevates of buildings alter by simple diagrams.
The intervention categories are divided in:
Wall, Gate, New growth potential, Divider/ buffer, Boundary, Bridge, Zipper, Backdrop, Knuckle, Filter, Composition/ pattern completion,

Consolidator, New face, Feature building, Pattern shift, Infill, Transition, Skyline pattern, Porch, Protector, Dialog participation, Plaza/ underground, Violator of regulating lines, Marriage/ alignment, Dis-alignment, Corner, Point of reference, Space maker/ marker, Landmark, Oasis, New precedent, New interior, Invisible structure/ underground, Axis, Edge reinforce, Umbrella, Hator Roof, parasite. Some methods are used often than others that are mentioned belowed, also there are some examples of building interventions with images.

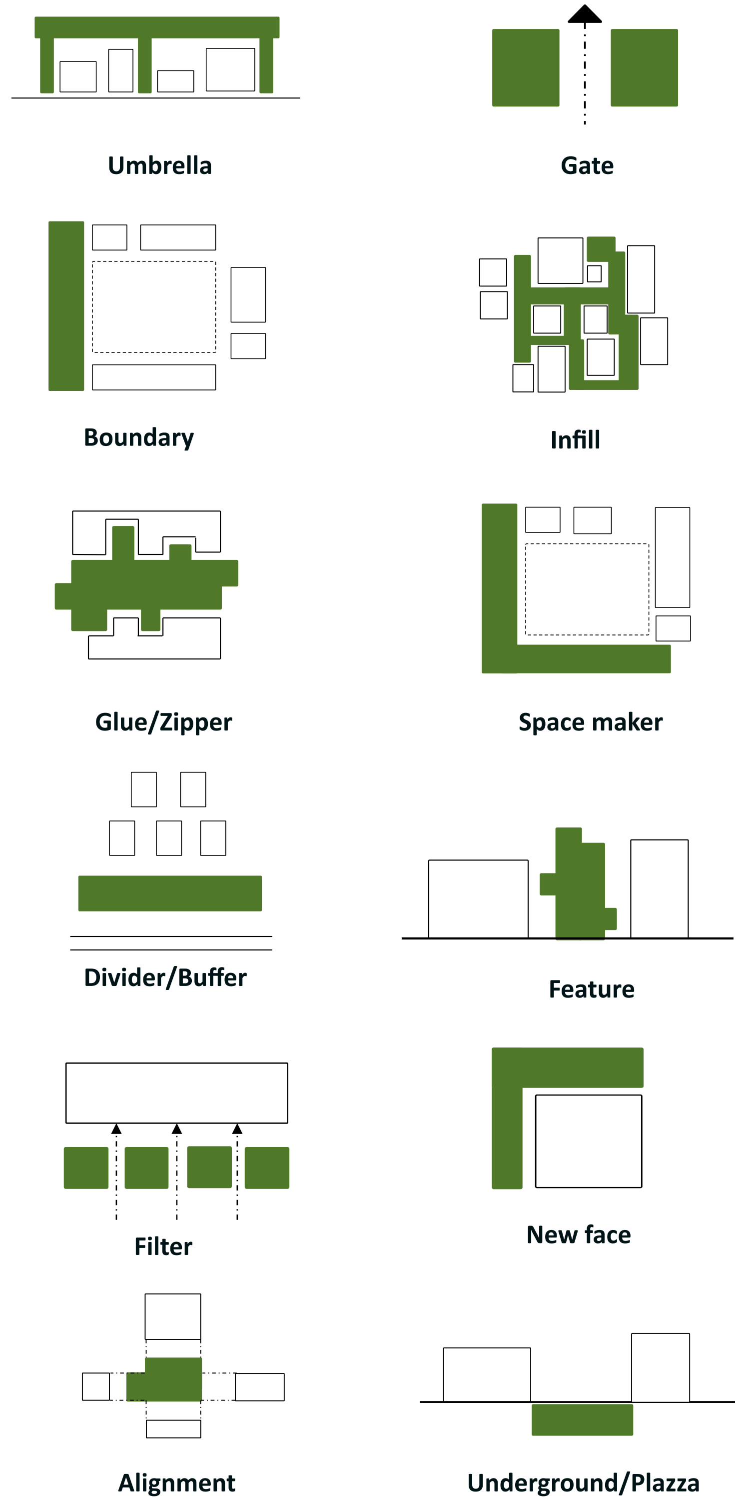
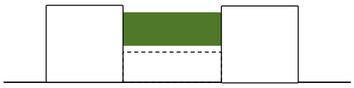


Figure 17

Existing building
New

Figure 17
Remodelling interventions, White, T., E., Path. Portal. Place, Appreciating public space in urban environments, Architectural Media Ltd., 1999.

Image 17
Caixaforum Madrid, north facade,
©Wojtek Gurak, www.inexhibit.com.



Roof/ Hat

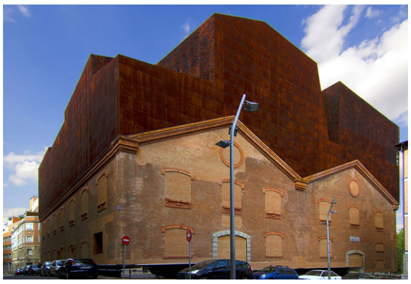
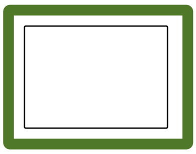


Image 17

Image 18
Gemini residence, Copenhagen, Denmark, www. inhabitat.com.



Skin

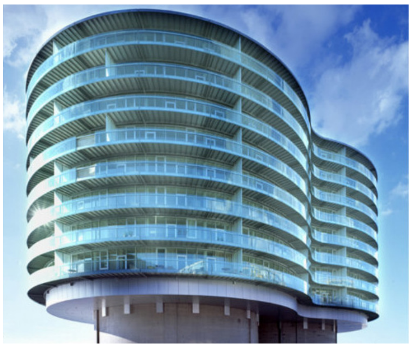


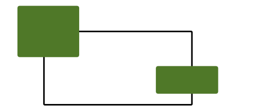
Image 18

Image 19
Dream factory, Rotterdam, The Netherlands, ©Willem de Kam ,www. archdaily.com

New interior

Image 19

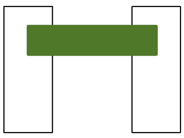
Image 20
Dok centrum, The Netherlands © Arjen Schmitz.



Parasite

Image 20

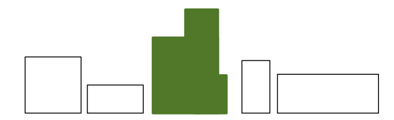
Image 21
Lumière Cinema Maastricht, Masstricht, The Netherlands,
© Marcel van der Burg, www.archdaily.com.



Bridge

Image 21

Image 22
Aldeburgh Music, London, UK,
© Philip Vile,www.archdaily.com.



Wall

Image 22

4.7. References

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2. Brooker, G. & Stone, S., **Re-readings. Interior architecture and the design principles of remodelling existing buildings**, RIBA Enterprises: London, 2004.
3. Ruskin, J., **The Seven Lamps of Architecture**, Smith, Elder: Londen, 1849.
4. Cramer, J., Breitling, S., **"Architecture in existing fabric"** Basel, Birkhauser, 2007.
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Website

https://www.inexhibit.com/it/mymuseum/caixaforum-madrid-centro-arte-herzog-de-meuron/
https://www.totem-madrid.com/en/museo-reina-sofia/
https://inhabitat.com/mvrdv-converts-twin-silos-into-the-gemini-residences-located-on-copenhagens-waterfront/gemini-residences-mvrdv-6/
https://www.archdaily.com/801721/the-dream-factory-studio-roosegaarde
https://www.archdaily.com/266672/mediatheek-delft-dok-architecten
https://www.archdaily.com/881397/lumiere-cinema-maastricht-jhk-architecten-plus-verlaan-and-bouwstra-architecten
https://www.archdaily.com/43371/aldeburgh-music-haworth-tompkins

Image 23: Ermenegildo Zegna HQ, Milan, Italy, © Leo Torri.

5

Adaptive capacity

5.1. Definition of adaptive capacity
5.2. Adaptive capacity method (AC)
5.3. Flexibility and decision-making level
5.4. The FLEX method
5.4.1. The primary version of FLEX method: FLEX 1.0
5.4.2. FLEX 2.0
5.4.3. FLEX 2.0 Light
5.4.4. FLEX 3.0
5.4.5. FLEX 4.0
5.5. References

"A sustainable building is not one that must last forever, but one that can easily adapt to change" [1]

Moffatt, S., Russell, P.

5.1.Definition of adaptive capacity

The adaptive capacity of a building includes all properties and qualities that help the building to keeps its functionality during the life cycle, under change of conditions and needs. Interest in sustainability, environmental, economic issues and a high number of vacant industrial buildings direction us toward flexible buildings than before.[2]

These concepts often have strongly overlapping meanings such as flexible, extendible, multifunctional, reusable.[3]

Schuetze defines this concept as easily adaptable to different functions or changing requirements, constructed with components and products, which allow re-use and recycle with a minimum of effort and loss of quality.[4] Wilkinson states that there is a direct connection between adaptive building and sustainability.[5]

Buildings could have long term utility value that enables them to accommodate different types of users and functions during their life cycle. The adaptive capacity of a building represents this value and the capacity of building for future modifications. It makes certain that the future use of the building will occur. [2]

5.2. Adaptive capacity method (AC)

The adaptive capacity method (AC) helps the owner or user of the building to assess the capacity of the new or existing buildings. This method can be used to make three different decisions: purchasing an existing building, constructing a new building, or renovating and transforming an existing building. [2]

The owner, users, and society are three groups that involve the need to change a building. The AC method focuses on the flexibility of a building during the use phase and the aim is to find the demands and transform them into three levels of location, building and units.[2]

Figure 18
Perspectives of the demand for change in buildings, Geraedts, R., Remøy, H., Hermans, M,. Groep, B., van Rijn, E., ADAPTIVE CAPACITY OF BUILDINGS, A determination method to promote flexible and sustainable construction, International Union of Architects World Congress UIA 2014, Durban SA, August 2014.

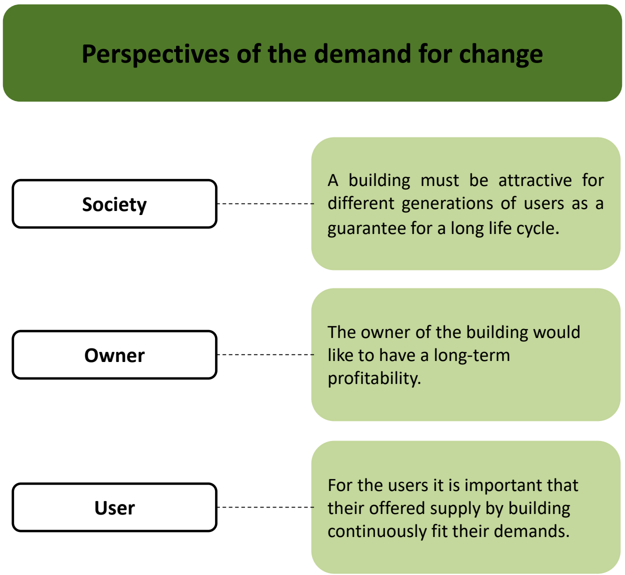


Figure 18

In general demand in building, the phase can be divided into two groups; Use dynamics and Transformation dynamics. [2]

Figure 19
Use dynamics and Transformation dynamics, Geraedts, R., Remøy, H., Hermans, M,. Groep, B., van Rijn, E., ADAPTIVE CAPACITY OF BUILDINGS, A determination method to promote flexible and sustainable construction, International Union of Architects World Congress UIA 2014, Durban SA, August 2014.

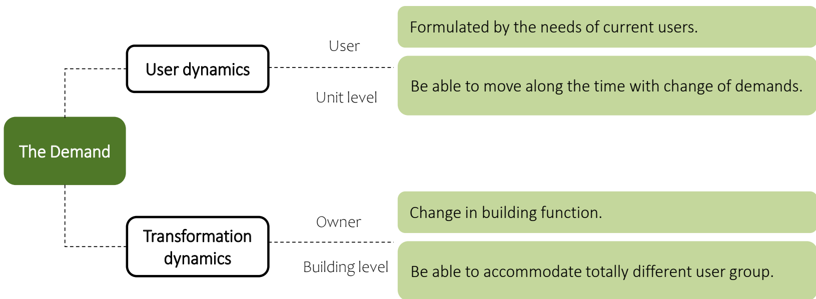


Figure 19

5.3. Flexibility and decision-making level

The expected amount of flexibility always has an impact on the building or at least part of it. It is important to know at what rate a certain modification takes place and how influence extends in the building. Habraken considered a subdivision, from large (city, location) to small (built-in systems, furniture) for decision-making level.[18]

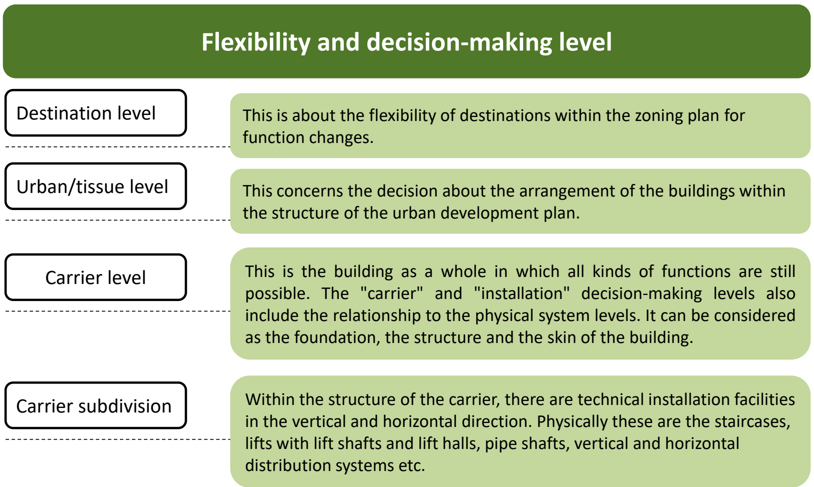


Figure 20

Figure 20
Flexibility and decision-making level, Habraken, 1961.

Also Schneider explains different flexibility levels as following: [16]

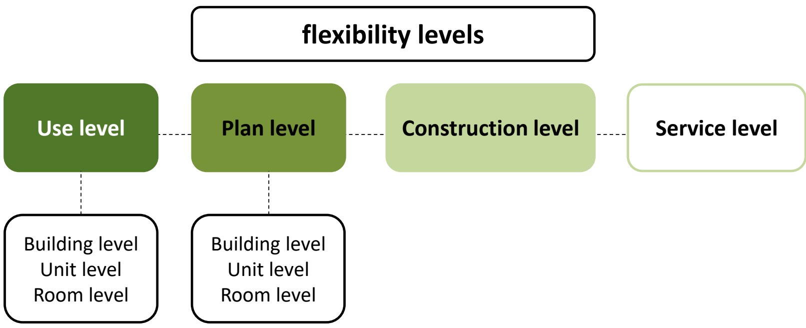


Figure 21

Figure 21
Flexibility levels, Schneider, 2007.

The next table esplains the flexbility aspects from different points of view by different people [7-17]. All mentioned factors are combined and used as an flexibility indicators in the FLEX method later.

Flexibility aspects in the building

. Demountable/reusable components . Service location . Vertical building service . Flexible site	Beadle, 2008
. Façade . Daylight . Adding balconies . Operable windows . Acoustic and thermal insulation . Possibility to enlarge building horizontal and vertical . Structure, columns grid . Access routs . Free ceiling height> 2.6 m . Floor load capacity> 3.5 KN/m^2 . Possibility to add service ducts	Remoy, 2009
. Placement of stairs and lifts (number and place) . Facade grids	Geraedts, 2007 Remøy, 2010 Wilkinson, 2009
. Possibility of reusing the facade . Self-supporting facade . Possibility of reusing stairs and lifts . Possibility of installing balconies or other outdoor spaces . Possibility of maintaining the facade . Possibility of maintaining and using existing windows . Free floor height	Geraedts, 2007 Remøy, 2010

. Building access . Unit size / subdivision . Entry of daylight into the building . Independence of the unit	REN 1992
. Degree of presence of hazardous substances . Sound insulation floors . Sound insulation partition walls . Heat insulation façades and / or roof . Daylight entry on floor surface	Geraedts, 2007 Remøy, 2010
. Expandability horizontal . Surroundings of building . Horizontal and vertical additions . Expandability vertically . Adaptability environment . Adapt to (new) urban development plan . Accessibility . Parking . Noise load . Enlarging building (hor. & Vert.)	Geraedts, 2007 Remøy, 2010 DGNB 2012 Beadle 2008
. Modularity . Partition ability . Extendibility . Multi-functionality	Geraedts, 2008 Geraedts, 2009

. Spatial flexibility . Use flexibility . Rejection flexibility . Technical flexibility . Central and decentralized . Detachable . Dismountable . Expandable . Multifunctional	Geraedts 1998

Table 01

Table 01
Flexibility aspects, Berg 1981, Houtsma 1982, Geraedts 1989, REN 1992, Geraedts 1998, Geraedts 2001, Geraedts 2007, Schneider 2007, Beadle 2008, Geraedts 2009, Wilkinson 2009, DGBC 2012.[7-17]

The AC method uses rearrange, extension and rejection as an answer or supply to both owner and user demands. The 7 Transformation dynamics indicators from the perspective of the owner of a building ,joined together in rearrange flexibility, extension flexibility and rejection flexibility. [2]

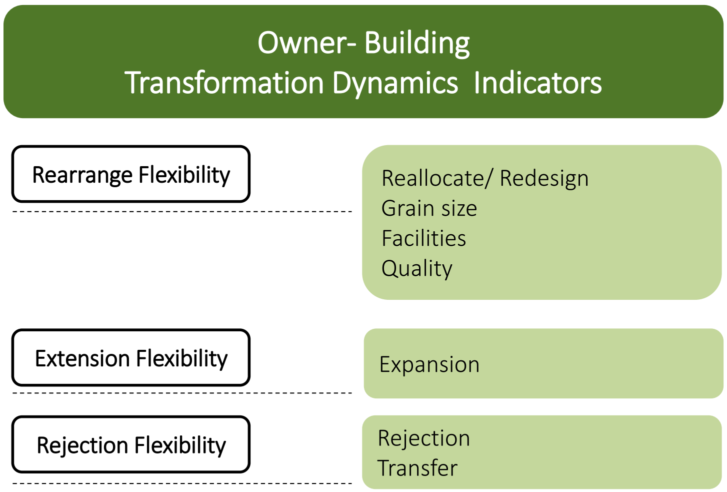
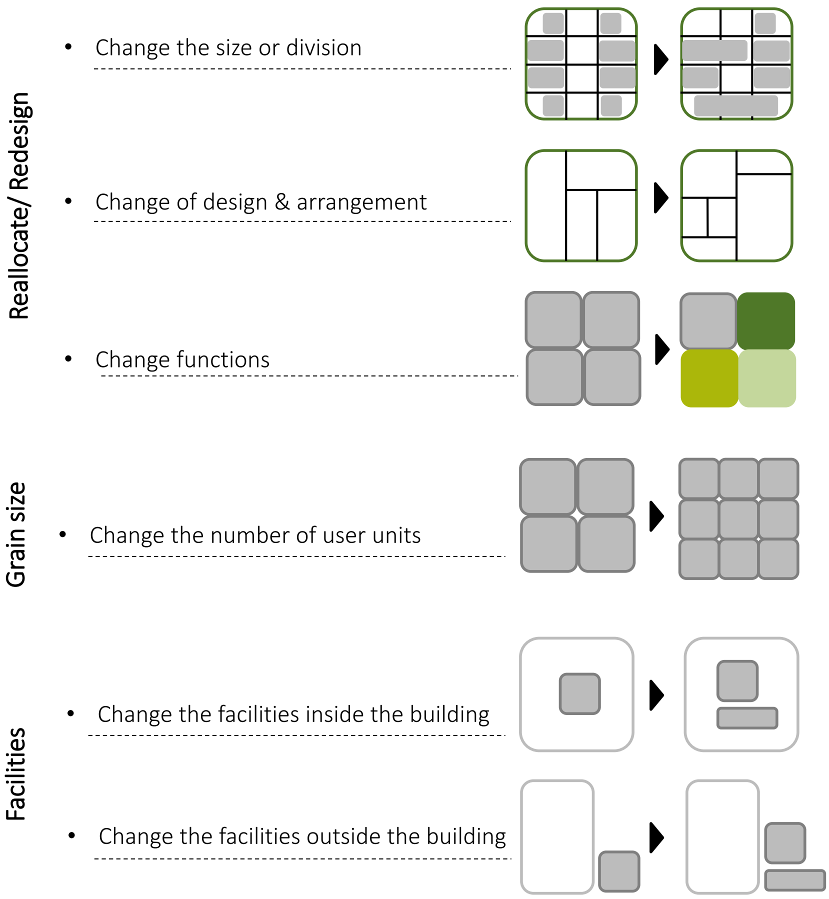


Figure 22

Figure 22
The 7 Transformation dynamics indicators from the perspective of the owner of a building. Geraedts, R., Remøy, H., Hermans, M,. Groep, B., van Rijn, E., ADAPTIVE CAPACITY OF BUILDINGS, A determination method to promote flexible and sustainable construction, International Union of Architects World Congress UIA 2014, Durban SA, August 2014.



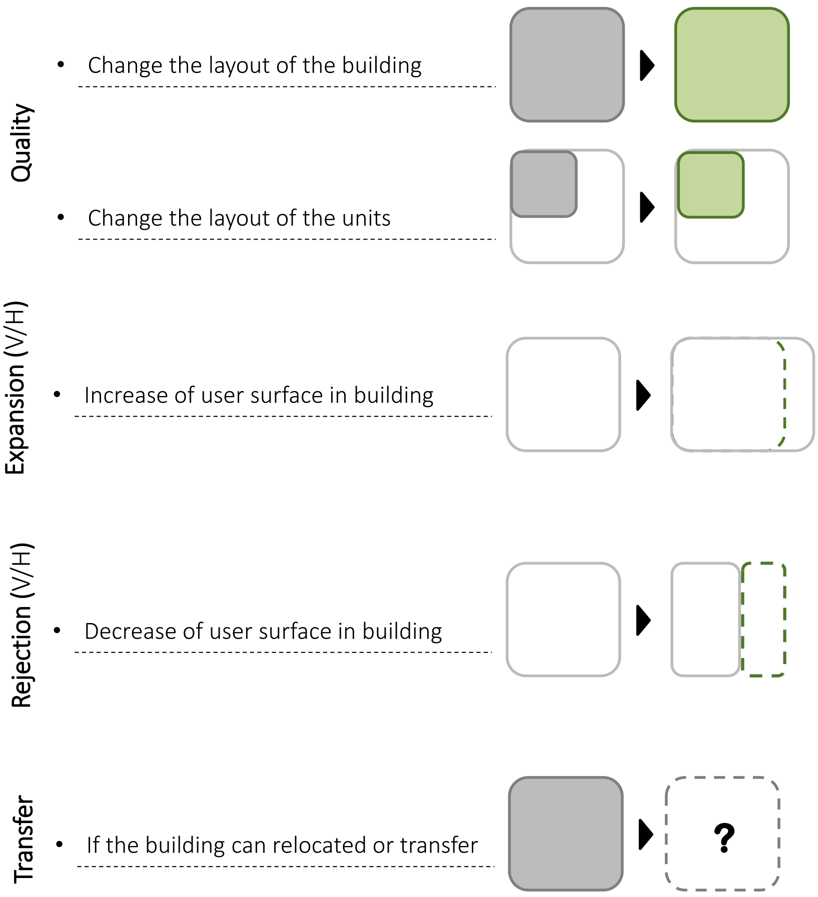


Figure 23

Figure 23
The 7 Transformation dynamics indicators in detail from the perspective of the owner of a building. Geraedts, R., Remøy, H., Hermans, M,. Groep, B., van Rijn, E., ADAPTIVE CAPACITY OF BUILDINGS, A determination method to promote flexible and sustainable construction, International Union of Architects World Congress UIA 2014, Durban SA, August 2014.

Also the 7 Use dynamics indicators from the perspective of the user of a building, joined together in rearrange flexibility, extension flexibility and rejection flexibility. [2]

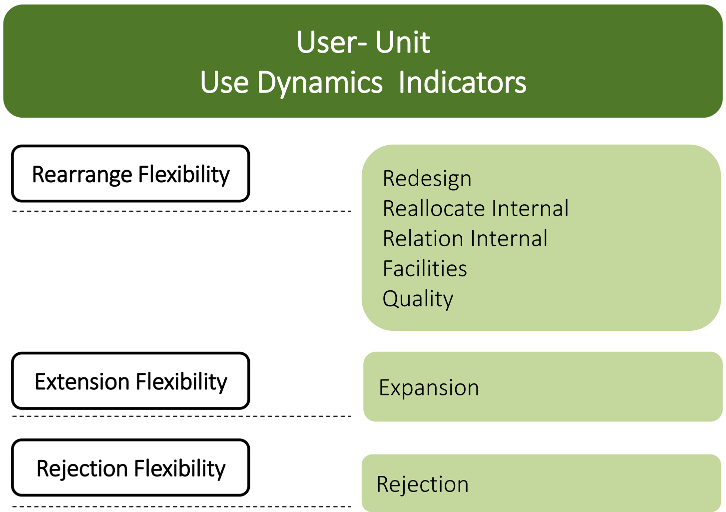


Figure 24

Figure 24
The 7 Use dynamics indicators from the perspective of the user of a building. Geraedts, R., Remøy, H., Hermans, M,. Groep, B., van Rijn, E., ADAPTIVE CAPACITY OF BUILDINGS, A determination method to promote flexible and sustainable construction, International Union of Architects World Congress UIA 2014, Durban SA, August 2014.

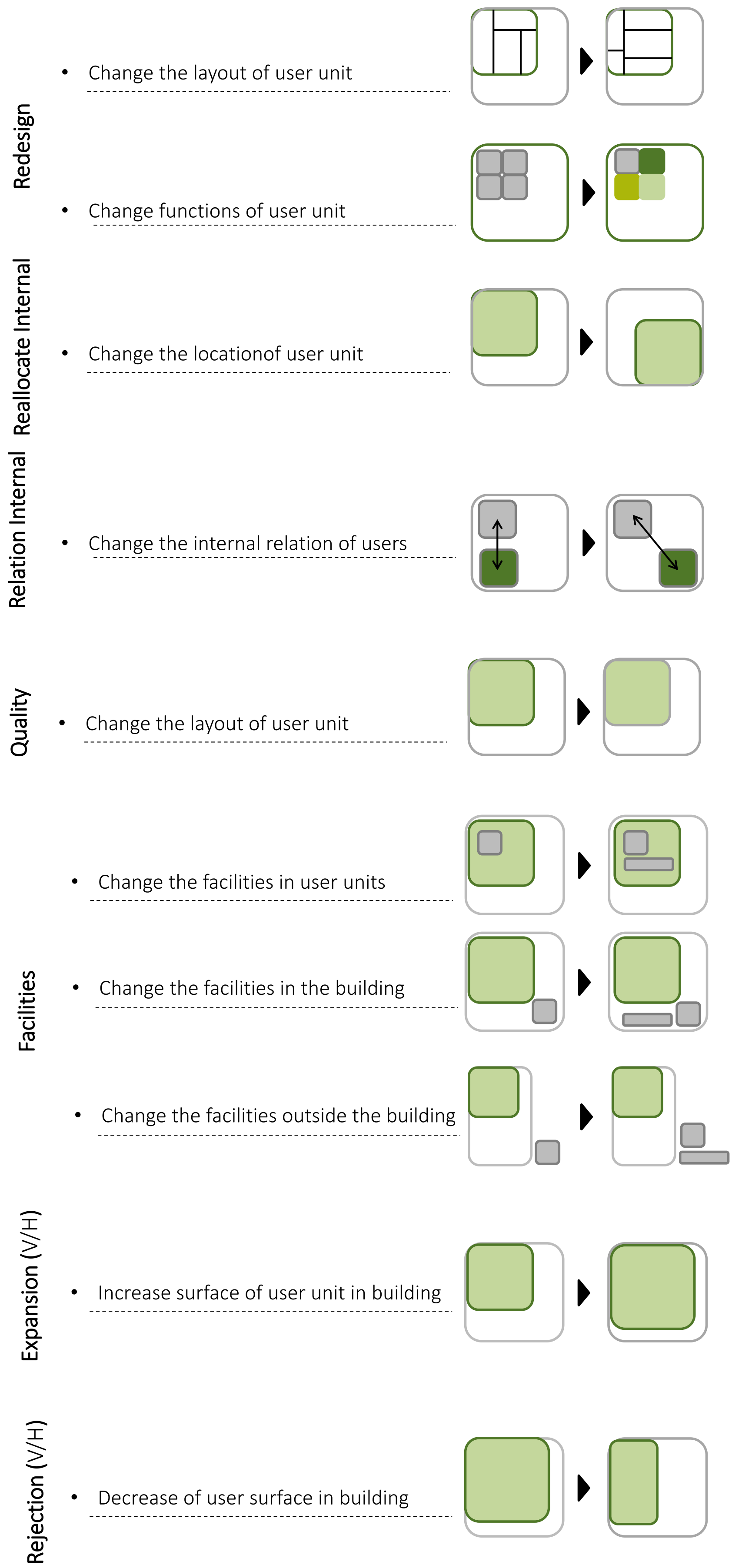


Figure 25

Figure 25
The 7 Use dynamics indicators in detail from the perspective of the user of a building. Geraedts, R., Remøy, H., Hermans, M,. Groep, B., van Rijn, E., ADAPTIVE CAPACITY OF BUILDINGS, A determination method to promote flexible and sustainable construction, International Union of Architects World Congress UIA 2014, Durban SA, August 2014.

Also a subdivision of a building in different layers or levels proposed by Habraken in 1961: the support level and the infill level.[18]

Figure 26
Subdivision of building layers, Habraken, N., De dragers en demensen, het einde van de massawoningbouw, Eindhoven, Stichting Architecten research, 1961.

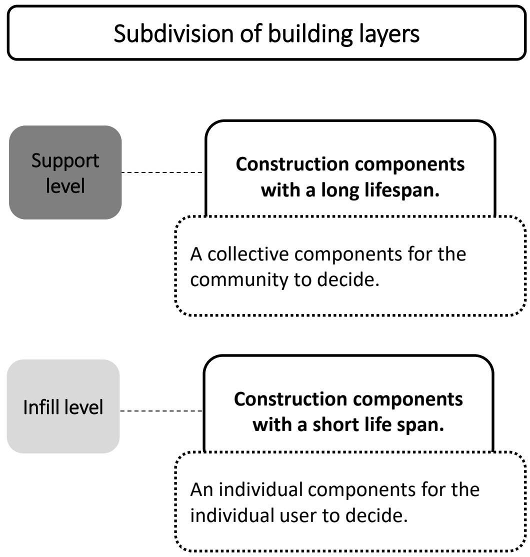


Figure 26

Building functional levels are defined by Brand[19] and Duffy[20] in six functional levels within a building to identify functions. Each level has different changing life cycles in a building.

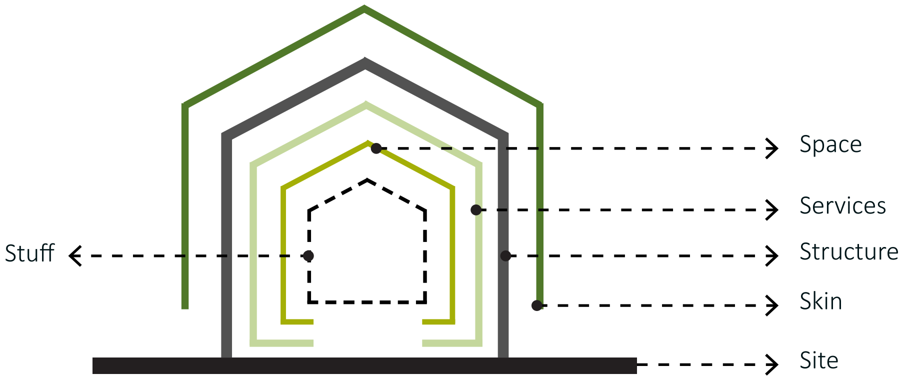


Figure 27

Figure 27
Building functional layers, Brand, S., How buildings learn; what happens after they're built, New York, Viking, 1995.

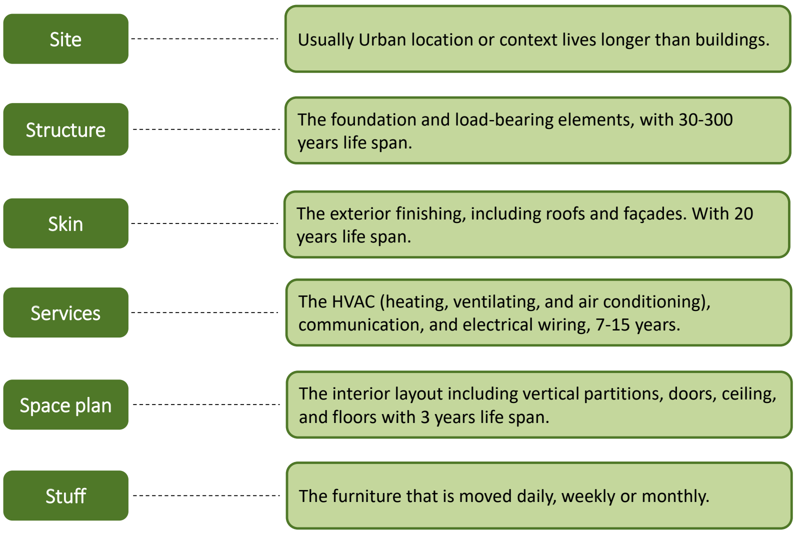


Figure 28

Figure 28
Building functional layers by Brand and Duffy, Brand, S., How buildings learn; what happens after they're built, New York, Viking, 1995.
Duffy, F., Design for change, The Architecture of DEGW. Basel, Birkhauser, 1988.

5.4. The FLEX method

In 2014 a paper was presented at the International Union of Architects World Congress UIA2014 in Durban SA, titled Adaptive Capacity of Buildings.[2]
It was a report on a literature survey and the development of a method in order to determine the adaptive capacity of Buildings.[6]

5.4.1. The primary version of FLEX method: FLEX 1.0

The method combined existing knowledge on flexibility and sustainability by Berg 1981, Houtsma 1982, Geraedts 1989, REN 1992, Geraedts 1998, Geraedts 2001, Geraedts 2007, Schneider 2007), Beadle 2008, Geraedts 2009, Wilkinson 2009, DGBC 2013).[7-17]

The primary version of this method had 147 indicators with assessment values. The problem of this version was the high number of evaluation indicators; therefore the recommendation was to have a limited number of flexibility performance indicators (FPI) in order to have easy use.[6]
The method is divided between to different indicator groups, 36 (owner) and 29 (user) indicators for assessing spatial/functional characteristics, 49 (owner) and 33 (user) indicators for assessing construction/technical characteristics of buildings.[2]

Figure 29
Primary version flex method,
Geraedts, R., Remøy, H., Hermans, M,. Groep, B., van Rijn, E., ADAPTIVE CAPACITY OF BUILDINGS, A determination method to promote flexible and sustainable construction, International Union of Architects World Congress UIA 2014, Durban SA, August 2014.

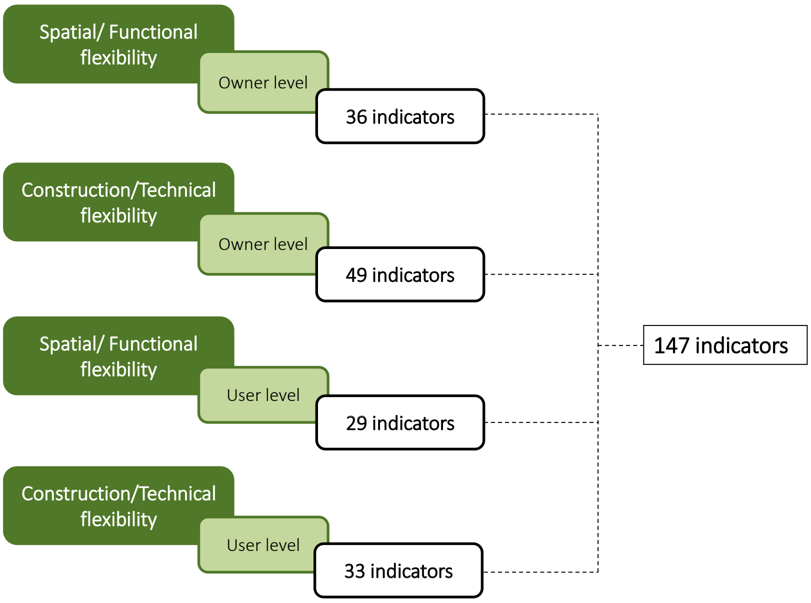


Figure 29

There were four possible values in the primary method: 1=Bad, 2=Business As Usual (BAU), 3=Better, 4=Good [2]

Figure 30
the 4 possible assessment values of the spatial/functional flexibility characteristics and the constructional/technical flexibility characteristics,
Geraedts, R., Remøy, H., Hermans, M,. Groep, B., van Rijn, E., ADAPTIVE CAPACITY OF BUILDINGS, A determination method to promote flexible and sustainable construction, International Union of Architects World Congress UIA 2014, Durban SA, August 2014.

Figure 30

5.4.2. FLEX 2.0

FLEX 2.0 is the result of primary FLEX method renew according to the Brand building layers definition. In general, the number of flexibility indicators is reduced from 147 to 83 indicators. The structure of the evaluation method is made of 83 indicators, a weighting system and the assessment level of the special indicators. Weighting system varies from 1(not important) to 3 (very important) and the assessment system has four possible values from 1 up to 4.[6] The evaluation table is explain in detail in next page. It is divided to layers, sub-layers, flexibility indicators, weighting and assessment values.

Layer	Sub-Layer	Flexibility indicators	Weighting (1 2 3 4)	Value
Site		1. Multifunctional site		
		2. Surplus of site space		
		3. Expandable site		
		4. Rejectable site		
Structure	Measurement	5. Surplus of building space		
		6. Available floor space		
		7. Size of building floors		
		8. Number of floors		
		9. Ground surface of the building		
		10. Vertical exchangeability of building floors		
		11. Surplus free floor height		
		12. Measurement system		
		13. Measurement system façade		
		14. Horizontal canvas measurement		
		15. Horizontal zone division		
		16. Shape of floor plan		
	Access	17. Access to the building		
		18. Presence of stairs or elevators		
		19. Vertical extension		
		20.Extension or reuse of stairs and elevators		
	Construction	21. Surplus load bearing capacity of the floors		
		22. Load bearing floors		
		23. Self supporting façade		
		24. Shape of columns		
		25. Positioning columns		
		26. Presence of fontanel construction		
		27. Positioning of facilities zones		
		28. Fire resistance		
		29. Extendible building/ unit horizontal		
		30. Extendible building/ unit vertical		
		31. Rejectable part of building horizontal		
		32. Rejectable part of building vertical		
		33. Vertical extension, construction/ foundation		
		34. Horizontal extension, construction/ foundation		
		35. Interruption of load bearing structure		
		36. Detailed connection between foundation and facilities		
		37. Construction technique for main load bearing		
		38. Insulation between floors and units		
Skin	Entrance	39. Visibility of main entrance of building		
		40. Social safety of main entrance of building		
	Facade	41. Possibility of balconies at façade		
		42. Dismountable façade		
		43. Reuse façade windows		
		44. Facade windows to be opened		
		45.Placement bottom side of façade windows		
		46. Location and shape of daylight facilities		
		47. Daylight facilities		
		48. Insulation of façade		
		49. Detailed connection between façade & wall components		
	Roof	50. Outdoor space on the roof		
		51.Own identity of roof/ façade of building		
Facilities	Measurement	52. Measure and control techniques		
		53. Customisability and controllability of facilities		
		54. Control of sun space		
		55. Adaptability of elevators		
	Dimensions	56. Surplus of facilities shafts and ducts		
		57. Surplus of capacity of facilities		
		58. Overdesign capacity public facilities		
		59. Number of connecting points facilities		
		60. Modularity of facilities		
		61. General- purpose of facility components		
		62. Independence of user units		
	Distribution	63. Distribution of facilities (heating, electricity)		
		64. Location source of facilities		
		65. Disconnection of facilities components		
		66. Reachability of facilities components		
		67. Independence user unit		
Space	Functional	68. Multifunctional building		
		69. Multifunctional units		
		70. Disconnection between support and infill		
		71. Exchangeability of construction components		
		72. Size of units		
	Access	73. Horizontal routing, corridors, access		
		74. Access of units		
		75. Personal access of user units		
		76. Relocation of building/units access		
	Technical	77. Disconnect ability/ portability/ movability of units		
		78. Disconnect ability/ portability/ movability of interior walls		
		79. Disconnect ability of connection between interior walls		
		80. Possibility od suspended ceilings		
		81. Possibility of raised floors		
		82. Individual infill/ finishing		
		83. Barrier- free access of building/ units		
		Total Adaptively Score		
		Adaptively class		

Table 02

Table 02

Overview of the 83 flexibility performance indicators of FLEX 2.0 , Geraedts, R., Matthijs, P. The CE Meter; An instrument to assess the circular economy capacity of buildings, Conference: CIB International Conference Going North for sustainability; London South Bank University, UK, November 2015.

5.4.3. FLEX 2.0 Light

The light version was presented in 2015 at the CIB Conference. The aim of this version was to find a limited number and the most important indicators. The result was a table with a reduced number of indicators from 83 to 17 indicators. This version is an easy and fast way to evaluate the adaptive capacity of the buildings. In this method weighting system, is between 1 to 3 and each indicator assessed from 1 to 4. The maximum adaptability of the building is 204 and the minimum amount is 17. According to the classification table, it would be possible to understand the adaptively class of building too.[6]

Layer	Sub-Layer	Flexibility indicators	Weighting (1 / 2 / 3)	Value
Site		1.Surplus of site space	1	
Structure	Measurement	2. Surplus of building space	2	
		3. Surplus free floor height	3	
	Access	4. Access to the building/ Location of stairs or elevators	2	
	Construction	5. Surplus load bearing capacity of the floors	3	
		6. Extendible building/ unit horizontal	3	
		7. Extendible building/ unit vertical	1	
Skin	Facade	8. Dismountable façade	3	
Facilities	Measurement	9. Customisability and controllability of facilities	2	
	Dimensions	10. Surplus of facilities shafts and ducts	2	
		11. Surplus of capacity of facilities	3	
		12. Disconnection of facilities components	2	
Space	Functional	13. Distinction between support and infill	3	
	Access	14. Horizontal routing, corridors, access	1	
	Technical	15. Removable, reloadable units in building	3	
		16. Removable, reloadable units walls in building	3	
		17. Disconnecting/ detailed connection interior walls, Horizontal/ Vertical.	3	
		Total Adaptively Score		
		Adaptively class		

Table 03

Table 03
Overview of the 17 flexibility performance indicators of FLEX 2.0 Light, Geraedts, R., Matthijs, P. The CE Meter; An instrument to assess the circular economy capacity of buildings, Conference: CIB International Conference Going North for sustainability; London South Bank University, UK, November 2015.

By comparing the final flexibility score from previous table in the classification table below it would be easy to understand the flexibility and adaptability of of our building.

Class Table Adaptively Score	Score Range
Class 1: Not adaptive	17-54
Class 2: Hardly adaptive	55-92
Class 3: Limited adaptive	93-130
Class 4: Good adaptive	131-168
Class 5: Excellent adaptive	169-204

Table 04

Table 04
FLEX 2.0 Light, flexibility class table , Geraedts, R., Matthijs, P. The CE Meter; An instrument to assess the circular economy capacity of buildings, Conference: CIB International Conference Going North for sustainability; London South Bank University, UK, November 2015.

5.4.4. FLEX 3.0

Meanwhile, the Light version was developed experts use version 2.0 in order to develop the next version of the method. The results renewed the framework for the next version of the FLEX method.[21]
The third version is the result of two separate research projects for evaluation in the development of school[22] and office buildings.[23] It has been presented at the CIB World Building Congress in Tampere, May 2016.[21]
The experts in the educational sector choose 21 indicators as the most important flexibility performance indicators and ranked them by their importance.[21] The table below describes the chosen indicators for School buildings.

Layer	Flexibility indicators	Weighting (1 2 3 4)	Value
Structure	1.Positioning obstacles/ columns	4	
	2 Extendible building/ unit horizontal	4	
	3. Extendible building/ unit vertical	4	
	4. Rejectable part of building horizontal	4	
	5. Access to the building/ location of stairs or elevators	4	
	6. Surplus of building space/ floor space	3	
	7. Surplus of free floor height	3	
	8. Measurement system; modular coordination	3	
Facilities	9. Surplus of facilities	4	
	10. Modularity of facilities	3	
	110 Customisability / controllability of facilities	3	
	12. . Disconnection of facilities components	1	
Skin	13. Daylight of facilities	2	
	14. Location and shape of daylight facilities	2	
	15. Facade windows to be opened	1	
Space	16. Distinction between support and infill	3	
	17. Removable, reloadable interior walls in building	2	
	18. Disconnecting/ detailed connection interior walls, Horizontal/ Vertical.	2	
	19. Multifunctional building	1	
	20. Horizontal routing, corridors, access	1	
Site	21. Expandable site/ location	1	
		Total Adaptively Score	
		Adaptively class	

Table 05

Table 05
FLEX 3.0, example of the assessment of a school building, Geraedts, R., Matthijs, P. The CE Meter; An instrument to assess the circular economy capacity of buildings, Conference: CIB International Conference Going North for sustainability; London South Bank University, UK, November 2015.

Class Table Adaptively Score for Educational Real Estate	Score Range
Class 1: Not adaptive	55-92
Class 2: Hardly adaptive	93-132
Class 3: Limited adaptive	133-172
Class 4: Good adaptive	173-220

Table 06

Table 06
FLEX 3.0 Light, flexibility class table, Geraedts, R., Matthijs, P. The CE Meter; An instrument to assess the circular economy capacity of buildings, Conference: CIB International Conference Going North for sustainability; London South Bank University, UK, November 2015.

In contrast to instrument for educational real estate as described in the previous table, the instrument for office buildings uses Transformation dynamics and User dynamics instead of using a weighting factor between the different flexibility indicators.[23]

Layer	Flexibility indicators	Trans	Use
Site	1.Multifunctional location	X	X
	2.Expandable Location	X	
Structure	3. Building entrance, location of elevators, stairs, cores	X	X
	4. Positioning pipes and shafts	X	X
	5. Storey height	X	X
	6. Insulation between stories and units	X	X
	7. Bearing capacity of floors	X	
	8. Column layout	X	X
	9. Positioning obstacles supporting structure	X	X
	10. Availability of stairs and elevation	X	X
	11. Expanding/ reusing stairs and elevators	X	X
	12. Division support- infill		X
	13. Fire resistance supporting structure	X	
	14. Oversized building space/ surface	X	
	15. Available floor area	X	X
	16. Size of storey		X
	17. Horizontal grid size	X	
Skin	18. Daylight entry	X	X
	19. Open able windows	X	X
	20. Insulation façade	X	
	21. Dismountable facade	X	X
Services	22.Overdimensioning capacity installation	X	X
	23. Measurement and control technology		X
	24. Over dimensioning pipes and shafts		X
	25. Location of supplying installation		X
	26. Independence user units		X
	27. Adjustable and controllable installation		X
	28. Distribution/ modularity installations	X	X
	29. Distribution heating and cooling installations		X
	30. Dismountable facility components	X	X
Space	31. Accessible facility components	X	X
	32. Horizontal routing, corridors, units	X	X
	33. Detailing joints inner walls- horizontal/ vertical		X
	34. Possibility suspended ceiling		X
	35. Possibility elevated floor		X

Table 07

Table 07
FLEX 3.0, example of the assessment of a office building, Geraedts, R., Matthijs, P. The CE Meter; An instrument to assess the circular economy capacity of buildings, Conference: CIB International Conference Going North for sustainability; London South Bank University, UK, November 2015.

In general FLEX 3.0 is created by the combination of the three developed versions of the FLEX method and the result is made of 44 indicators in different building layers.

Layer	Sub-Layer	Flexibility indicators	Light	School	Office	T	U
Site		1.Surplus of site space	X			X	
		2. Expandable site/location		X	X	X	
		3. Multifunctional site/ location			X	X	
Structure	Measurement	4. Surplus of building space	X	X	X	X	X
		5. Available floor space of building			X	X	X
		6. Size of building floors			X	X	X
		7. Surplus free floor height	X	X	X	X	X
		8. Measurement system; modular coordination		X		X	X
		9. Horizontal zone division			X	X	X
	Access	10. Access to the building/ Location of stairs or elevators	X	X	X	X	X
		11. Presence of stairs and elevators			X	X	X
		12. Extension/ reuse of stairs and elevators			X	X	X
	Construction	13. Surplus load bearing capacity of the floors	X		X	X	
		14. Shape of columns			X	X	X
		15. Positioning obstacle/ columns in load bearing structure		X	X	X	X
		16. Positioning of facilities zones and shafts			X	X	X
		17. Fire resistance of main load bearing construction			X	X	
		18. Extendible building/ unit horizontal	X	X		X	
		19. Extendible building/ unit vertical	X	X		X	
		20. Rejectable part of building/ unit		X		X	
		21. Insulation between stories and units			X	X	X
Skin	Facade	22. Dismountable façade	X		X	X	
		23. Façade windows to be opened		X	X	X	X
		24. Daylight facilities		X	X	X	X
		25. Location and shape of daylight facilities		X		X	X
		26. Insulation of facade			X	X	
Facilities	Measurement	27. Measure and control techniques			X	X	X
		28. Customisability and controllability of facilities	X	X	X	X	X
	Dimensions	29. Surplus of facilities shafts and ducts	X	X	X	X	X
		30. Surplus of capacity of facilities	X		X	X	X
		31. Modularity of facilities		X	X	X	X
	Distribution	32. Distribution of facilities			X	X	X
		33. Location source of facilities			X	X	X
		34. Disconnection of facilities components	X	X		X	X
		35. Accessibility of facility components			X	X	X
		36. Independence of user units			X	X	X
Space	Functional	37. Multifunctional building		X		X	
		38. Distinction between support and infill	X	X	X	X	X
	Access	39. Access to building: horizontal routing, corridors, gallery	X	X	X	X	X
	Technical	40. Dis connectible, removable, re locatable units in building	X	X		X	
		41. Dis connectible, removable, re locatable interior walls	X	X		X	X
		42. Dis connecting/ detailed connection interior walls	X		X	X	X
		43. Possibility of suspended ceilings			X	X	X
		44. Possibility of raised floors			X	X	X

Table 08

Table 08
FLEX 3.0, the integral combination of the three developed instruments, Geraedts, R., Prins, M., FLEX 3.0; an instrument to formulate the demand for and assessing the supply of the adaptive capacity of buildings, CIB World Building Congress WBC2016. N. Achour. Tampere, Tampere University of Technology, Department of Civil Engineering, 2016.

The results show seven general applicable flexibility performance indicators (most right column) which can be used for each type of real estate. The other 37 more specific indicators can be used for the assessment of specific real estate like schools or office buildings.

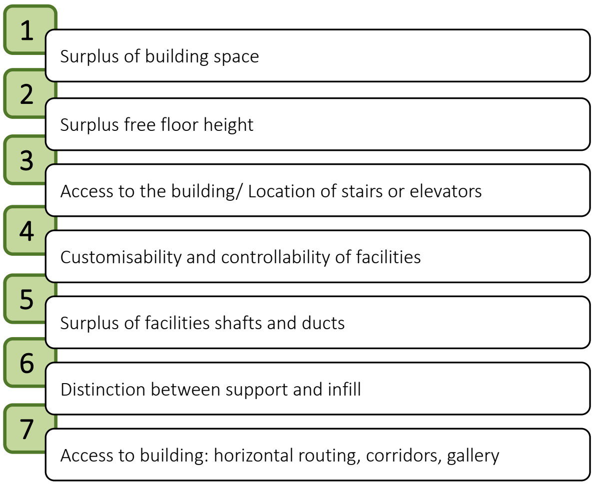


Figure 31

Figure 31
The seven general applicable flexibility performance indicators, Geraedts, R., Matthijs, P. The CE Meter; An instrument to assess the circular economy capacity of buildings, Conference: CIB International Conference Going North for sustainability; London South Bank University, UK, November 2015.

5.4.5. FLEX 4.0

The framework of last version is similar to FLEX 3.0 based on three different instruments:
1. FLEX 2.0 Light with 17 indicators.[21]
2. An assessment for school building.[22]
3. An assessment for office building.[23]

FLEX 4.0 is divided to two parts; first part called generally applicable indicators which is related to indicators can be used to all type of buildings. First category has 12 flexibility performance indicators: the so-called support category.[24]
Second part of evaluation table called specifically applicable indicators; this category has 32 flexibility indicators which are based on the practices on the school and office buildings: the so-called infill category. [24]
Each evaluation table is discribed with layers, sub-layers in detail, and the Adaptivety class tables are followed in next pages.

Layer	Sub-Layer	Flexibility indicators	Value	Weighting	Score
Site		**1. Expandable site/ Location** Dose the site have a surplus of space and is the building located at the centre?		1	
Structure	Measurement	**2. Surplus of building space/ floor** Does the building or the user units have a surplus of the needed usable floor space?		4	
		3. Surplus of free floor height How much is the net free floor area?		4	
	Access	**4. Access to building** To what extend a centralized building access has been implemented?		2	
	Construction	**5. Positioning obstacles/ columns** Is adaptation of building obstacle by load bearing obstacles or columns?		3	
Skin	Facade	**6. Facade windows to be opened** Can windows in the façade be opened per planning grid size?		1	
		7. Daylight facilities What is the daylight factor for the spaces in the building?		2	
Facilities	Measure	**8. Customisability/ controllability** Is it possible to customize the facilities: temperature, ventilation, electricity, ICT?		3	
	Dimensions	**9. Surplus of facilities shafts and ducts** Do the facilities shafts and ducts have a surplus of space (heating, cooling, electricity, ICT)		4	
		10. Modularity of facilities Are the facilities assembled by modular components according to the façade planning grid?		2	
Space	Construction	**11. Distinction between support – infill*** To which degree deals the building with the division between support and infill?		4	
		12. Horizontal access to building In what way is the horizontal access of the units in the building accomplished?		3	

Table 09

	Assessment value
1	1. No, the site has no surplus at all (Bad) 2. 10-30% surplus (Normal) 3. 30-50% surplus (Better) 4. The site has a surplus space more than 50% (Best)
2	1. Not oversized (Bad) 2. 10-30% oversized (Normal) 3. 30-50% oversized (Better) 4. > 50% oversized (Best)
3	1. <2.60 m (Bad) 2. 2.6-3.00 m (Normal) 3. 3.00- 3.40 m (Better) 4. > 3.40 m (Best)
4	1. Decentralized/ separated building entrance/ core (Bad) 2. Decentralized/ combined building entrance/ core (Normal) 3. Building divided in different wings, each with entrance (Better) 4. One centralized building entrance and different wings with separate entrance (Best)
5	1. Adaptation completely obstructed by difficult to replace load bearing obstacle(Bad) 2. <50% of the building adaptation is by load bearing obstacle (Normal) 3. <10% of the building adaptation is by load bearing obstacle (Better) 4. No building space is obstructed by difficult to replace load bearing obstacles (Best)
6	1. No or <10% of the windows can be opened (Bad) 2. 10-30%(Normal) 3. 30-80% (Better) 4. 80-100% (Best)
7	1. Daylight factor* <1/20 (Bad) 2. Daylight factor 1/20-1/10 (Normal) 3. Daylight factor 1/10-1/5 (Better) 4. Daylight factor >1/50 (Best)
8	1. Bad/ not customizable; mono-functional or fixed centralized use (Bad) 2. Limited customizable; after drastic interventions (Normal) 3. Partly customizable; after simple interventions (Better) 4. Good and easy customizable without any interventions (Best)
9	1.Shafts and ducts have no surplus at all (Bad) 2. 10-30% surplus (Normal) 3. 30-50% surplus (Better) 4. Surplus of space of more than 50% (Best)
10	1. No facilities in the building is divided in modular components (Bad) 2. 1 of the 4 facilities is divided in modular components according to the grid (Normal) 3. 2-3 of the 4 facilities are divided according to the façade planning grid (Better) 4. all of the 4 facilities are divided according to the façade planning grid (Best)
11	1. <10% of the building is divided in a support and infill part (Bad) 2. 10-30% of the building is divided in a support and infill part Normal) 3. 30-50% of the building is divided in a support and infill part (Better) 4. >50% of the building is divided in a support and infill part (Best)
12	1. Horizontal access is only by a single internal corridor (Bad) 2. Horizontal access is only by a double internal corridor (Normal) 3. Horizontal access directly by a central core in the building with a surrounding corridor (Better) 4. Horizontal access directly by a central core in the building or an external gallery (Best)
	Total Adaptively Score
	Adaptively class

Daylight factor*(DF): Is the ratio of the light level inside a structure to the light level outside the structure.
Distinction between support – infill*: The more construction components belong to the infill, the easier a building can be rearranged/ transformed to other functions, the better a building can meet to changing demands.

Table 09

Table 09
The FLEX 4.0, Generally applicable indicators table, Geraedts, R., FLEX 4.0, a practical instrument to assess the adaptive capacity of buildings, SBE16 Tallinn and Helsinki Conference; Build Green and Renovate, Tallinn and Helsinki, 2016.

Layer	Sub-Layer	Flexibility indicators	Value	Weighting	Score
Site		**1. Surplus of site space** Dose the site has a surplus of space and is the building located at the centre?		4	
		2. Multifunctional site/ location Is the location capable to support more functions, like offices, living, care and shops?		3	
Structure	Measurement	**3.Available floor space of building** Dose the building or user units have a surplus of space needed usable floor space?		4	
		4. Size of floor buildings What is the size of the usable floor surface?		3	
		5. Measurement system Have positioning/ measurement modular rules for construction components been used?		3	
		6. Horizontal zone division / layout Has use been made of a horizontal zoning system, including in the building?		1	
		7. Presence of stairs/ elevators Are sufficient stairs and elevators present in the building.		2	
		8. Extension/ reuse of Is there a possibility to add new stairs/ elevators to the building and reusing the existing ones?		1	
	Construction	**9. Surplus of load bearing capacity** How large is the load bearing capacity of the floors in the building?		2	
		10. Shape of columns How are the columns in the building shape?		1	
		11. Positioning of facilities zones Are facilities zones and vertical shafts located at central building level and/ or local unit level?		3	

	Assessment value
1	1. The site has no surplus of apace at all (Bad) 2. 10-30% surplus (Normal) 3. 30-50% surplus (Better) 4. The site has a surplus space of more than 50%
2	1. Just one function is suited (Bad) 2. two functions (Normal) 3. Three functions (Better) 4. > Three functions (Best)
3	1. No the building or user units have no surplus of floor space (Bad) 2. 10-30% surplus (Normal) 3. 30-50% surplus (Better) 4. The building has a surplus of floor space of >50% (Best)
4	1. The usable floor space < 400 m^2 (Bad) 2. 400- 600 m^2 (Normal) 3. 600- 1000 m^2 (Better) 4. The usable floor space is > 1000 m^2 (Best)
5	1. Rules for modular coordination are not implemented (Bad) 2. < 50% implemented (Normal) 3. > 50% implemented (Better) 4. Rules for modular coordination are > 90% implemented (Best)
6	1. No zoning system without intermediate margins (Bad) 2. Yes, with 10-30% intermediate margins (Normal) 3. Yes, with 30-50% intermediate margins (Better) 4. Yes, with met > 50% intermediate margins (Best)
7	1. Only one decentred located stairs/ elevator core is available in the building (Bad) 2. There is one central located stairs/ elevator core is available in the building (Normal) 3. The building divided into different wings each with a central stairs/ elevator core (Better) 4. The building has one central and several decentred stairs/ elevator cores per wing (Best)
8	1. No stairs/ elevators can be added without drastic expensive measures (Bad) 2. A new stairs/ elevators core can be accidently added and existing reused (Normal) 3. New stairs/ elevators can be limited added and existing ones reused (Better) 4. New stairs/ elevators can be easily added without drastic expensive measures (Best)
9	1. < 3 kN/m^2 (Bad) 2. 3-3.5 kN/m^2 (Normal) 3. 3.5-4 kN/m^2 (Better) 4. >4 kN/m^2 and several areas > 8 kN/m^2
10	1. The columns are shaped round and/ or have vertical different sizes (Bad) 2. The columns are shaped octagonal (Normal) 3. The columns are shaped rectangular (Better) 4. The columns are shaped square (Best)
11	1. All facility zones and vertical shafts are only located at central level(Bad) 2. Facility zones/ shafts are located at central level and occasionally at local level (Normal) 3. Facility zones/ shafts are located at central level and limited at local level (Better) 4. Facility zones/ shafts are located at central level and at local level as well (Best)

		12.Fire resistance main bearing How many minutes is the fire resistance of the main load bearing construction?	3
		13. Extendible building/ units horizontal Is it possible to expand the building horizontal for new extension to the building/ user units?	2
		14. Extendible building/ units vertical Is it possible to expand the building vertical for new floors or a new basement?	4
		15. Rejectable part of building/ unit? Is it possible to reject part of the building for selling/ renting to third parties?	2
		16. Insulation between stories/ units How is the thermal and acoustic insulation between the different storeys in the building?	2
Skin	Facade	**17. Dismountable facade** To what extend can façade components be dismantled in case of transformation?	1
		18. Location/ shape daylight In what way are the façade/ daylight openings positioned and shaped?	2
		19. Insulation of façade How is the thermal and acoustic insulation quality of the façade?	1
Facilities	Measure	**20. Measure & control techniques** Is it possible to control/ measure facilities on building level as well as user unit level?	4
	Dimensions	**21.Surplus capacity of building** Dose the facilities have a capacity to surplus?	4

12

1. The fire resistance of the load bearing construction is 30 minutes (Bad)
2. The fire resistance of the load bearing construction is 60 minutes (Normal)
3. The fire resistance of the load bearing construction is 90 minutes (Better)
4. The fire resistance of the load bearing construction is 120 minutes (Best)

13

1. Horizontal extension of building/ units is not possible at all. (Bad)
2. Horizontal extension of building/ units is very limited possible. (Normal)
3. Horizontal extension of building/ units is limited possible at some parts. (Better)
4. Horizontal extension of building/ units is easily possible at all. (Best)

14

1. Vertical extension of building/ units is not possible at all. (Bad)
2. Vertical extension is limited possible, only for few units in the building. (Normal)
3. Vertical extension (added floor or basement) is possible after total arrangement. (Better)
4. Vertical extension (new floors/ basement & individual user unit) is easily possible. (Best)

15

1. It is not possible to reject part of building/ units. (Bad)
2. It is possible to reject 10-30% of the building/ units. (Normal)
3. It is possible to reject 30-50% of the building/ units. (Better)
4. It is possible to reject > 50% of the building/ units. (Best)

16

1. Insulation does not meet the current demands for building. (Bad)
2. Insulation meets the current demands for building. (Normal)
3. Insulation also meets the current demands for other building functions. (Better)
4. Insulation meets 10% above the current demands of building and other functions. (Best)

17

1. Façade components cannot or hardly be dismantled without demolition. (Bad)
2. A small part of the façade components can be dismantled, <20< 50% (Normal)
3. A large part of the façade components can be dismantled, >50< 90%. (Better)
4. All façade components are easily dismountable, < 90% (Best)

18

1. There are large closed surface in the façade. (Bad)
2. There are small horizontal open surface in the façade. (Normal)
3. Large open surfaces in the façade, but with different height size. (Better)
4. Large continuous horizontal, open surface; connections according to planning grid. (Best)

19

1. Insulation does not meet the current demands for building. (Bad)
2. Insulation meets the current demands for building. (Normal)
3. Insulation also meets the current demands for other building functions. (Better)
4. Insulation meets 10% above the current demands of building and other functions. (Best)

20

1. Control/ measurement takes place only at central building level. (Bad)
2. On central level and occasionally on unit level. (Normal)
3. On central level and limited on unit level. (Better)
4. As well central on building level as well completely on unit level. (Best)

21

1. The capacities of facilities have no surplus at all. (Bad)
2. The capacities of facilities have a surplus of 10-30%. (Normal)
3. The capacities of facilities have a surplus of 30-50%. (Better)
4. The capacities of facilities have a surplus of >50%. . (Best)

Space				
Distribution	**22. Distribution facilities** Does the building have a specific distribution facility for hot/ cold water, heating, cooling and gas?		4	
	23. Location sources facilities What is the location of the central facility sources?		3	
	24. Disconnection of facility Can the components of the facilities be easily disconnected?		3	
	25. Accessibility of facility To what extend are facility components good accessible?		3	
	26.Independence of user units In what way are the user units independent related to services as toilet facilities?		1	
Construction	**27. Multifunctional building/ units** Is the building capable to support different functions?		2	
Technical	**28. Disconnectable, removable** To what extend are the user units in a building removable, re-locatable?		1	
	29. Disconnectable, removable To what extend are inner walls in a building easily replaceable?		4	
	30. Disconnectable connection detail Which detailed construction is applied between the interior walls and support structure and façade?		4	
	31. Possibility of suspended ceilings Is it possible to apply suspended ceilings and to adapt these to the different user demand?		2	
	32. Possibility of raised floors Is it possible to apply suspended raised floors and to adapt these to the different user demand?		2	

Total Adaptively Score	
Adaptively class	

Table 10

22	1. There is a specific distribution for all the different sources. (Bad) 2. There is a specific distribution for some of the different sources (Normal) 3. There is a specific distribution for 2 of the different sources (Better) 4. There is no specific distribution for one of the different sources (Best)
23	1. The facilities sources are located at only one central location in the building. (Bad) 2. The facilities sources are located at several locations in the building. (Normal) 3. The facilities sources are located at only one central location and decentred location as well. (Better) 4. The facilities sources are located at outside the building at city level. (Best)
24	1. Facility can`t be disconnected or demounted; wet connections (Bad) 2. Hardly be disconnected, demounted (Normal) 3. Partly be disconnected, demounted (Better) 4. Facility can be disconnected very easily (Best)
25	1. Hardly or not accessible, components are in support level. (Bad) 2. Limited accessible and partly in infill level. (Normal) 3. Good accessible, a lot of components in infill level. (Better) 4. Very good accessible. (Best)
26	1. No service available at user unit level. (Bad) 2. 1-2 services available (Normal) 3. 3-4 services available. (Better) 4. >4 services available. (Best)
27	1. The building supports only one function. (Bad) 2. The building supports 2 functions. (Normal) 3. The building supports 3 functions. (Better) 4. The building supports >3 functions. (Best)
28	1. The user units are not removable. (Bad) 2. The user units are re-locatable with drastic expensive measures. (Normal) 3. The user units are easily re-locatable. Constructed by demountable components. (Better) 4. Easily re-locatable. Constructed by 2D/3D modules. (Best)
29	1. Inner walls are not replaceable without drastic/ expensive interventions.(Bad) 2. Inner walls are not replaceable, but good destructible.(Normal) 3. Inner walls are replaceable by dismantling and rebuilding at another location.(Better) 4. Inner walls are easily replaceable without radical/expensive interventions.(Best)
30	1. The detailing connection consists of penetrating connections. (Bad) 2. The detailing connection consists of wet connections, mortar, and glue. (Normal) 3. The detailing connection consists of specific bound connection elements. (Better) 4. The detailing connection consists of project unbound dismountable connections. (Best)
31	1. Suspended ceilings results in free floor height of < 2.60m (Bad) 2. Suspended ceilings results in free floor height of 2.60- 2.70m (Normal) 3. Suspended ceilings results in free floor height of 2.70- 2.80m (Better) 4. Suspended ceilings results in free floor height of > 2.80m (Best)
32	1. Raised floor results in free floor height of < 2.60m (Bad) 2. Raised floor results in free floor height of 2.60- 2.70m (Normal) 3. Raised floor results in free floor height of 2.70- 2.80m (Better) 4. Raised floor results in free floor height of > 2.80m (Best)

Table 10

Table 10

The FLEX 4.0, Specifically applicable indicators table, Geraedts, R., FLEX 4.0, a practical instrument to assess the adaptive capacity of buildings, SBE16 Tallinn and Helsinki Conference; Build Green and Renovate, Tallinn and Helsinki, 2016.

A default weighting system is defined for this method which could be change by users. But changing the weighting system directly affects the maximum and minimum final adaptability score and the related flexibility class too.[24]

Class Table	Score Range
Class 1: Not flexible at all	12-48
Class 2: Hardly flexible	49-85
Class 3: Limited flexible	86-122
Class 4: Good flexible	123-159
Class 5: Excellent flexible	160-192

Table 11

Class Table	Score Range
Class 1: Not flexible at all	32-128
Class 2: Hardly flexible	129-225
Class 3: Limited flexible	226-322
Class 4: Good flexible	323-419
Class 5: Excellent flexible	420-512

Table 12

Table 11-12
The FLEX 4.0, Generally and Specifically applicable indicators class table, Geraedts, R., FLEX 4.0, a practical instrument to assess the adaptive capacity of buildings, SBE16 Tallinn and Helsinki Conference; Build Green and Renovate, Tallinn and Helsinki, 2016.

The Flex adaptive capacity method is the first important step in the development of an instrument to formulate adaptive demands and to assess adaptive supplies of buildings. All versions are in general considered building levels, layers, and they become more practical and easy to use by time. For evaluating small buildings previous versions of the method such as FLEX 2.0 Light could be useful but in case of detail evaluation the latest version in more useful. The last version, FLEX 4.0 gives the opportunity for users to evaluate the building according to the building type by the general evaluation or the specific case evaluation table. It lets the user evaluate the building at a general level with less detail and specific cases in detail.
To be able to actually use the adaptive capacity of a building or to change the use of building indicators it is maybe necessary to make changes in weighting values. The next step for a better evaluation method for different building types is to evaluate the method and answer research questions. The research questions will be needed to answer such as: Does the assessment method and weighting system need to be specified for different building types and functions? Is it possible to use the specific assessment aspects for different building types too?
The evaluation table for different building types with different weighting systems will be suggested in the next chapter and will be applied to the case study to answer these questions.

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Image 24: Gouda Cheese Warehouse Loft Apartments, The Netherlands, Kaaspakhuis, ©Ossip van Duivenbode, ©Jeroen Musch.

6 Case studies

6.1. Introduction to case study analysis
6.1.1. Case studies location
6.2. Tate Modern
6.2.6. References
6.3. Baltic art centre
6.3.6. References
6.4. Shad 19
6.4.6. References
6.5. De Lakfabriek
6.5.6. References

6.1. Introduction to case studies analysis

Chapter 6 is related to the analysis of industrial buildings that already experienced the adaptive reuse process. Case studies are chosen from different countries in Europe, Tate Modern and Baltic art centre from the UK, Shad 19 from Italy and De Lakfabriek from The Netherlands.
The chosen case studies have critics such as: be an industrial building as the original function, have steel or concrete structure or Brick wall structure and at least two-story buildings. They have variety in shapes of building, volumes and current function in order to be evaluated as different samples.
The analysis of each case study starts with general information about the building, brief history, and dates related to construction and remodelling. The relations between different building levels are illustrated in simple diagrams. The analysis is continued with reviewing the strategies, tactics and intervention methods used for remodelling of each building. The next part is to evaluate the adaptive capacity of buildings with the FLEX 4.0 method. A general evaluation table for all types of buildings is used to understand the flexibility class of each case study and a suggested evaluation table with different weighting systems for different functions for the future is applied to understand how much the building is suitable and flexible for future changes. The aim is to figure out if the weighting system should be changed according to the future use of existing buildings or the existing weighting system could be used. Some weighting amounts for flexibility indicators change according to examples of building and studies. All modifications are explained briefly in the following table and figures.

Flexibility indicators	Default weighting	User weighting A	B	C	D
1. Surplus of site space is more important in functions A, C and D than buildings with function B. Other functions may need more space such as extra parking areas or spaces for outdoor events and facilities.	4	4	3	4	4
2. The multi-functional site functions A, C and D could need additional functions and services to their sites, while function B is usually designed with specific layouts.	3	3	1	3	3
7. The presence of stairs and elevators is usually dependent on the area and the number of users in the building. Buildings in big space usually have more stairs and elevators. Usually, the importance of existing enough stairs and elevators is higher in function A than other ones. (Figure 32)	2	4	3	3	3
8. Extension/ reuse of stairs and elevators: is important in function A, due to the big scale of this kind of buildings, to reduce the walking distance inside the building. in some cases staircase in function A acts as an sculpture in the space.	1	3	2	1	1
9. Surplus of load-bearing capacity is important for all types of buildings but it should be higher with buildings with function A, due to the high number of users or visitors. (Figure 33)	2	4	1	2	3
11. The positioning of facilities zones is important for all building functions. The facility zone could be located at the central level in public functions such as functions A, C and D, but for function B it is important to also have facilities in unit levels too.	3	3	4	3	3
12. Fire resistance of buildings is related to construction materials. From the security point of view, it is very important to have a high fire resistance rate for all functions in both public and private buildings.	3	4	4	4	4
13. Extendible horizontally in buildings with function A is more important than others because of the artworks, scale of objects the arrangement of space in these buildings needs more horizontally extension. (Figure 33)	2	3	2	2	2
15. Reject able part of the building usually function A is designed for rent or sell. Functions A and C could have the possibility to rent or sell some units, while in function D is the opposite.	2	3	4	3	2

A Gallery/ Museum
B Residential
C Office
D School

16. Insulation between stories is very important in all buildings from the thermal, acoustic and energy point of view and users comfort.	2	4 4 4 4
17. A dismountable façade is useful in functions with a high chance of changes. Functions A and B have more possibility of change in their facades during their life cycle such as changes in opening size and windows.	1	3 2 1 1
18. The location/ shape of daylight Lighting is an effective factor in building functions. The importance of daylight shape and their position in the building is different in each function.	2	4 4 4 4
19. Insulation of the façade is important for all types of buildings as explained in number 16.	1	4 4 4 4
20. Measure and control techniques are more important buildings with functions B, C, and D due to the division of space to more small units than big spaces in the building with function A.	4	3 4 4 4
26. Independence of user units Buildings with function A need more facility service than other functions according to their floor area and scale.	1	4 1 1 1
27. Multi-functional units are more important for function A than others. Functions of spaces in these buildings can easily change according to the type of exhibitions or artworks.	2	4 2 2 2
28. Dis connectable units usually the design of space in functions C and D are more regular. The possibility of adjusting and combine the spaces or units in functions A and B is higher than others.	1	3 3 1 1
31. The possibility of suspended ceilings is not very important in buildings with B, C, and D functions, but in function, A due to the possibility of having a high floor height is more than others.	2	4 2 2 2
32. The possibility of raised floors is usually more important in spaces with more flexible design rules and high floor height like buildings with function A.	2	3 2 2 2

Table 13

Table 13
Flexibility indicators modification table.

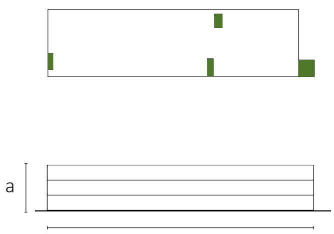
Figure 32 shows the presence of stairs and elevators in the building, and extendibility of building horizontaly . Drawings show the relation between the length and height of floors in the building.
a: sum of floor height, b: building length

A

Gallery/ Museum

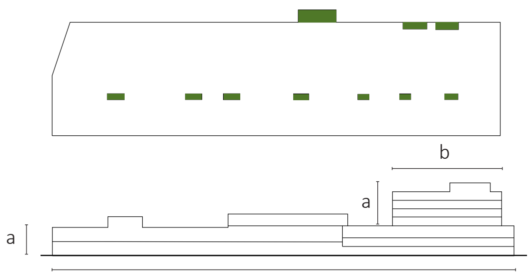
Presence of stairs/ elevators

Extendible horizontally



La Sucriere, Cultural centre,
Lyon, France

a<b

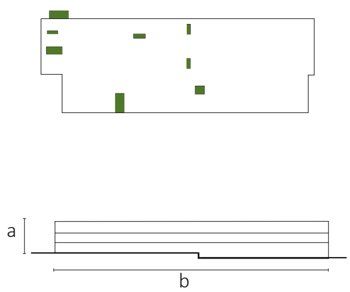


Silesian Museum,
Katowice ,Poland.

a<b

Presence of stairs/ elevators

Extendible horizontally



Stella Matutina Museum,
France.
a<b

Lindower 22 ateliers and galleries,
Berlin, Germany.
a<b

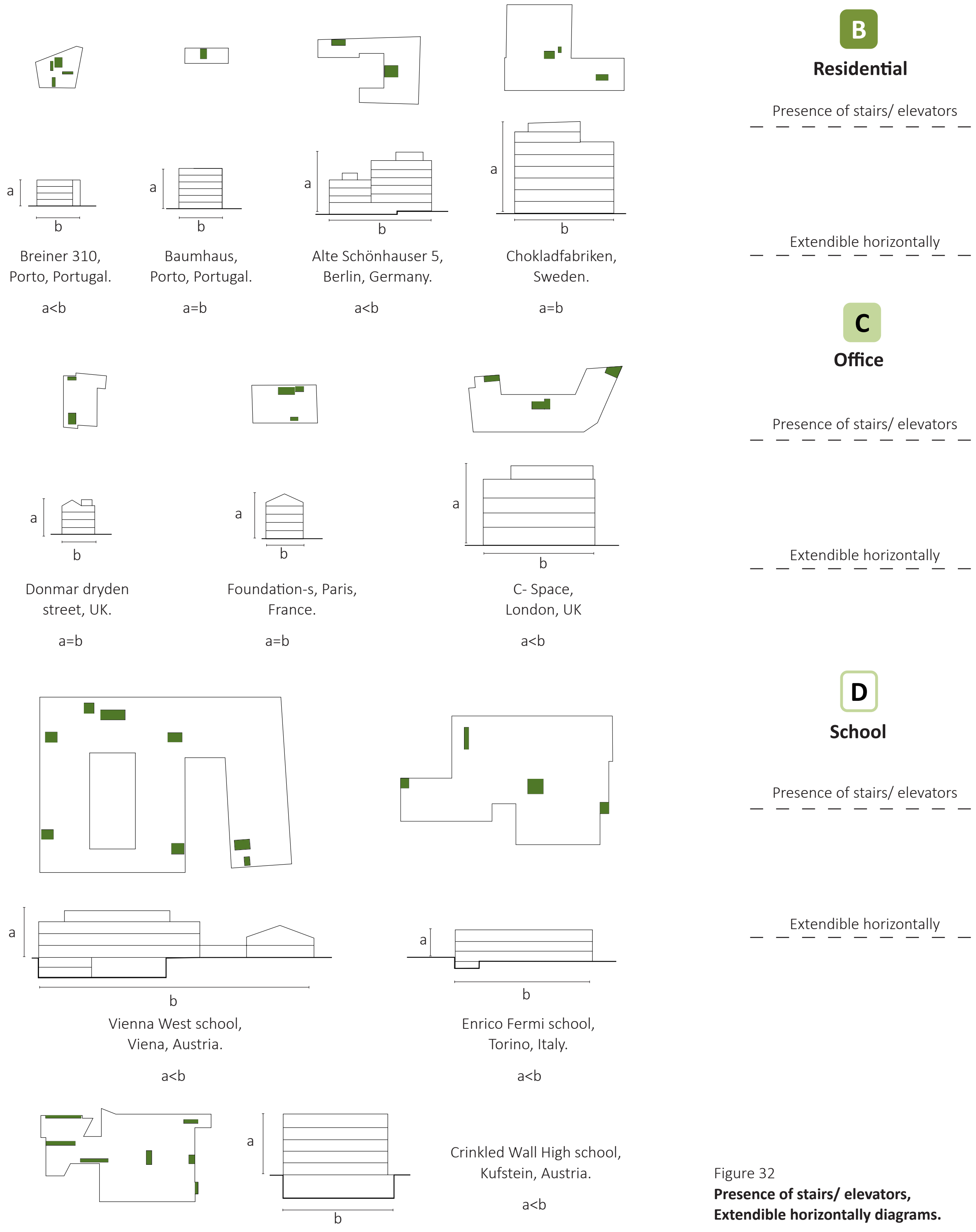


Figure 32

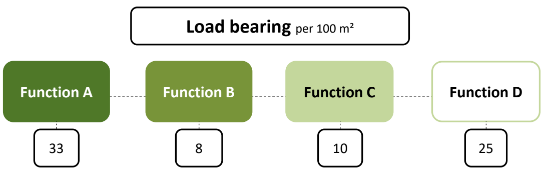


Figure 33

Figure 32
Presence of stairs/ elevators, Extendible horizontally diagrams.

Figure 33
Load bearing in different building function, General building requirements, Bibliogov, 2013.

6.1.1. Case studies location

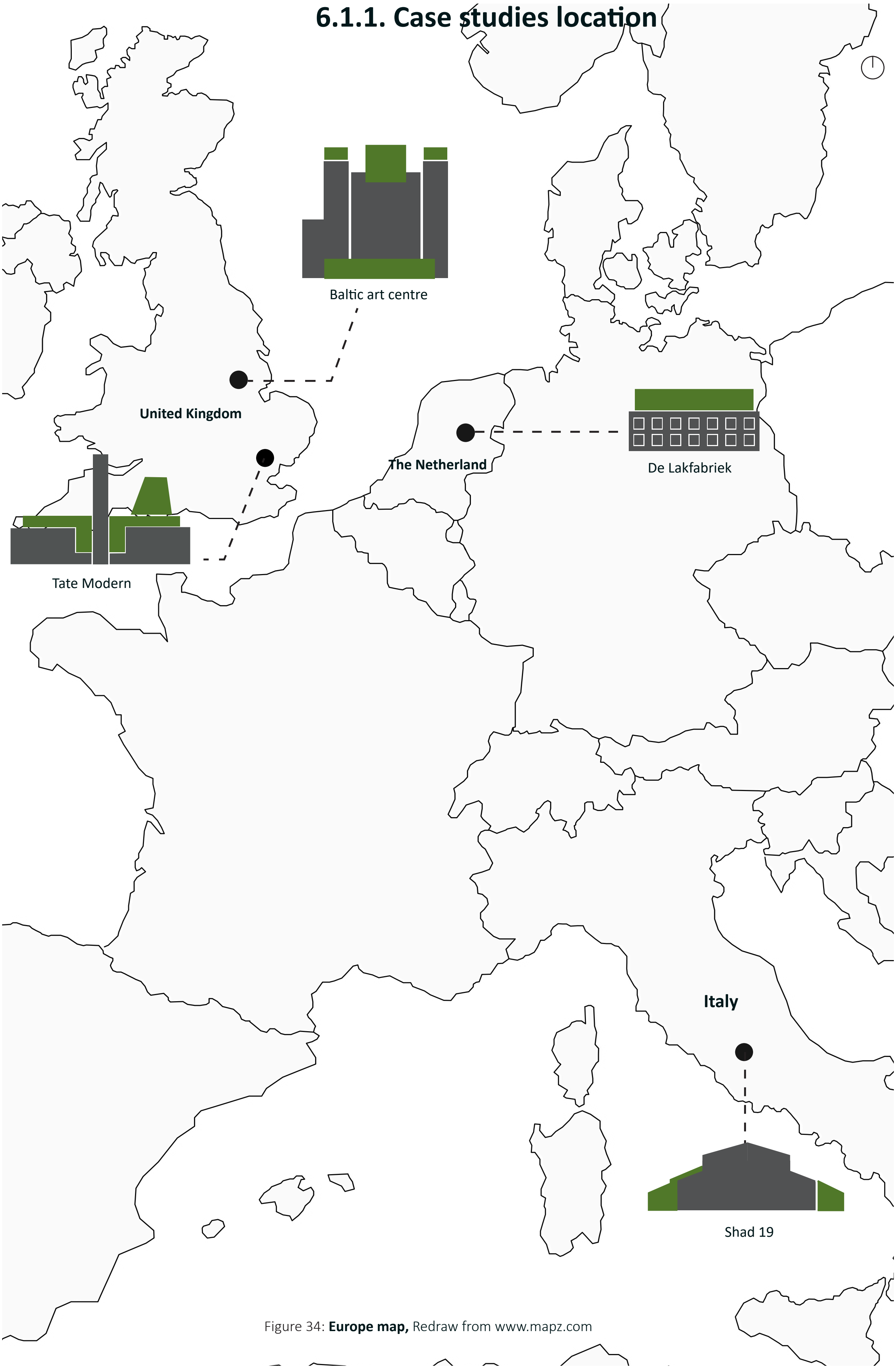


Figure 34: **Europe map,** Redraw from www.mapz.com

6.2. TATE MODERN

LONDON, UNITED KINGDOM

Image 25: **Tate Modern building,** © Lorenzo Zandri.

6.2.1. Tate Modern, London, United Kingdom

Architects	Sir Giles Gilbert Scott Herzog & de Meuron
Location	Bankside, London, Greater London SE1, UK
Current function	Art Museum
Previous function	Power station
adaptation phase	1994-2000, 2005-2016
Project area	34.000 m2
Client	Tate Gallery Projects Ltd
Construction cost	Switch house £45 M, Boiler house £134.5 M

Bankside Power Station was an electricity generating station located on the south bank of the Thames River in London. Bankside has been called the last great 'brick cathedral' power station.[1] The original building was designed by Giles Gilbert Scott in 1947 and generated electricity from 1891 to 1981. The station become unused from 1981 until the Tate Gallery bought the Bankside in 1993.
In 1995 Tate presented their preference and desire to create a 'new urban model' for the museum of modern art in an international architecture completion.[2]

Swiss architects, Herzog & de Meuron won the competition with the idea to make the turbine hall a vast public space, together with multi-level galleries in the boiler house which would be extended upwards by the addition of a two-story glass 'light beam' structure running the length of the building. [3] "Our strategy was to accept the physical power of Bankside's massive, mountain-like brick building and to even enhance it rather than breaking it up or trying to diminish it. [4]
We discovered step-by-step where we should hold back and where we should push, more aggressive. That had nothing to do with more or less respect for the existing building but only what will be the final result. We treated the Scott building like part of our own structure, not something which is worse or different." [5]

Since 2000 the building has been used for the Tate Modern art museum and gallery.
The building has two adaptation phase:
1. Adaptation of the former Bankside Power Station (now known as The Boiler House and Turbine Hall, Light beam addition)
2. Transformation and extension (The Switch House and Tanks).

Image 26:
Perspective view of Tate Modern and the Millennium Bridge, © Iwan Baan.

Image 27:
A view of Boiler and Switch house, © Frank Kaltenbach.

Image 28:
Exterior view of Tate Modern, © Simone Graziano Panetto.

Image 29:
Interior view of Tate Modern,Turbin Hall, © Frank Kaltenbach.

Image 30:
Interior view of Tate Modern, Switch house, © Frank Kaltenbach.

Building`s tower, with a height of 99m, was designed not to compete with the dome of St. Paul's over the river, at 112m. The completed steel framed building was 155m long, 73m wide and wrapped in 4.2 million bricks.

The two-story green glass box that sits on top Tate Modern, referred to as the Light Beam, runs the entire length of the Boiler House but stops short of the eastern end.

The Switch House extension is a ten-floor pyramidal form and the perforated brickwork cladding structure. 336,000 bricks used for the Switch House façade.

Urban effect of this building is the transformation of the South Bank in the seventeen years since Tate Modern's first opening.

In the nineties, it was an undesirable place, the poor neighbor to the northern side of the Thames with St. Paul's looking down at the derelict Bankside Power Station.

Creating a museum and public space on this site, with the landscaped grounds and transport links such as the Millennium bridge has been pivotal in this urban regeneration.[6]

Image 31: **Exterior view of Tate Modern, west facad, Turbin Hall enterance**, © Frank Kaltenbach.

6.2.2. Site plan analysis and design diagrams

Drawing 01
1. St. Paul`s Cathedral
2. Tate Modern
3. Millennium Bridge
4. Shakespeare’s Globe
5. Sampson House
6. Riverside

Landmarks
Neighbor buildings
Bridge
Roads/ Access
Railway

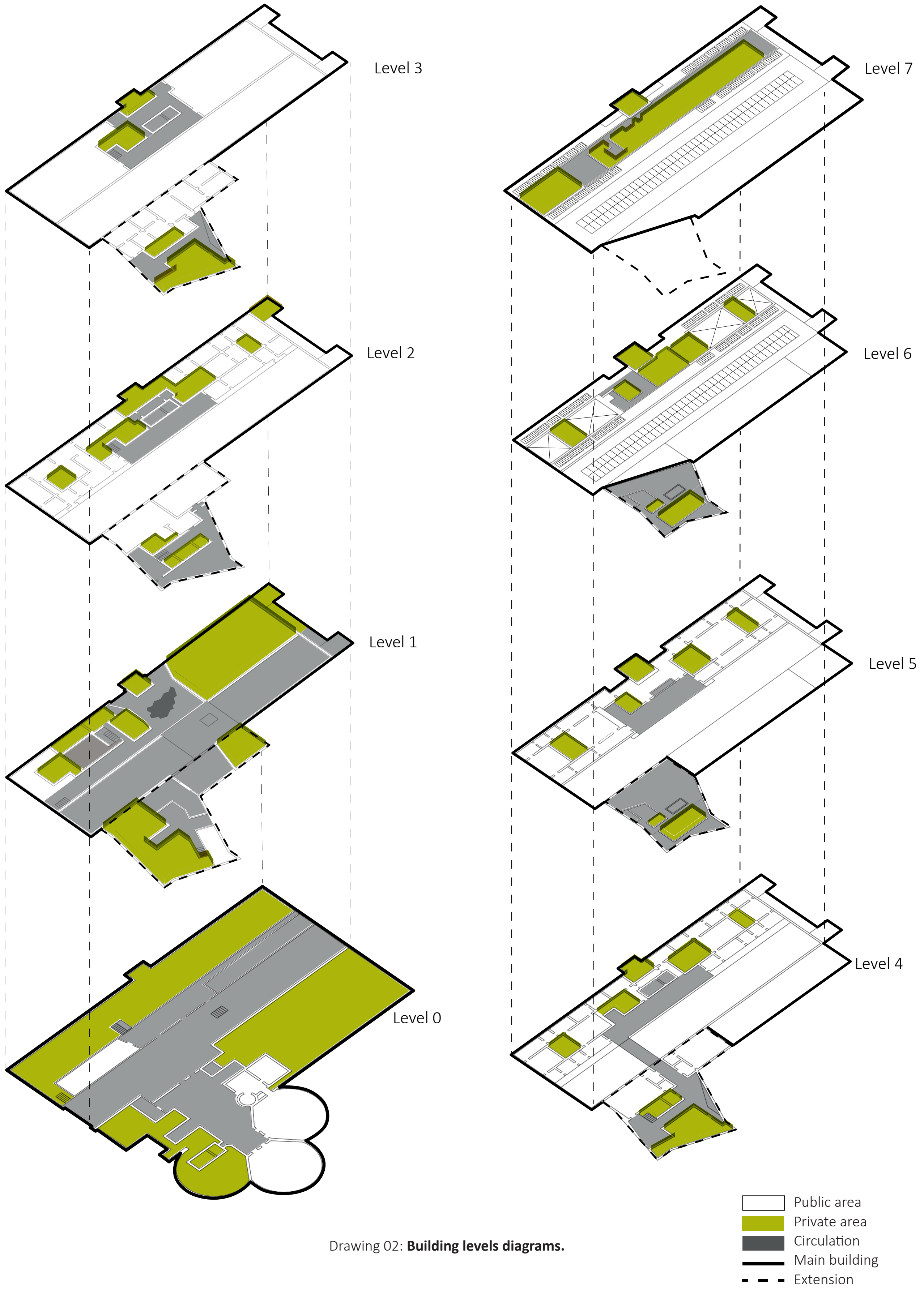
Drawing 01: **Site plan, Relation between Tate Modern building and St. Pual`s Cathedral**, © Herzog & de Meuron.

Image 32: **Perspective view of Tate Modern, the Millennium Bridge and St Paul`s Cathedral**, © Frank Kaltenbach.

Image 33: **Perspective view of Tate Modern and the Millennium Bridge,** © Iwan Baan.

Image 34: **Perspective view of Tate Modern and Switched house,** © Frank Kaltenbach.

Image 35: **Perspective view of Tate Modern and Switched House**, © Frank Kaltenbach.



Drawing 02: **Building levels diagrams.**

6.2.3. Analyze remodelling tactics and strategies

Strategy

Installation

Herzog & de Meuron`s idea was to add a light beam hovering above the station structure to let the day light in to the rooms at the top floor of gallery. The light beam is highlight the building also at night. The beam is a strong feature in the structure. According to Herzog once the light beam is lit it will be very, very powerful in combination with the tower. The light beam balances the tower, shines during night and shows the livness of the building.

Insertion

The second phase of intervention and remodeling in Tate modern was inserting the Switched House to the building. A new thenth floor structure which is going to accommodate new galleries and other functions.

Image 36: **Remodeling strategy and tactics, Instalation and Insertion,** © Frank Kaltenbach.

Original Building

Remodeling
First phase

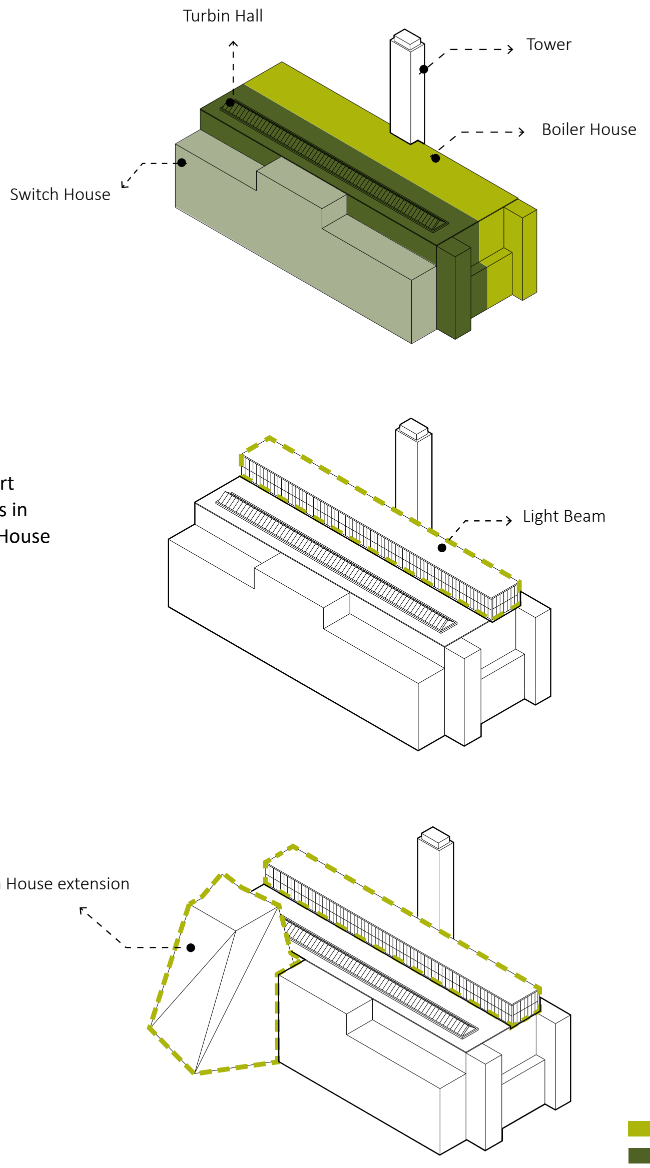
1994-2000
- Clean up the interior part
- Remove the equipments in Turbin House and Boiler House
- Add Light beam on roof

Installation

Remodeling
Second phase

2005-2016
- Switch House extension

Insertion



Boiler House
Turbin House
Switch House
Existing structure
New structure

Figure 35: **Remodeling strategies, Installation and Insertion**, Brooker and Stone, 2004.

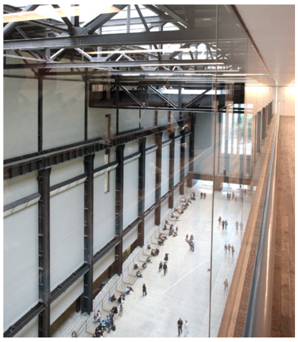


Image 37

Image 38

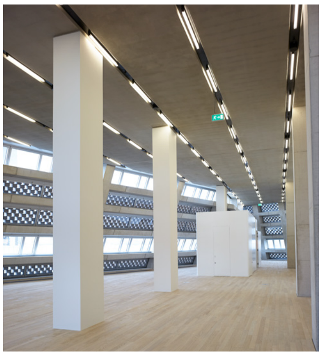


Image 39

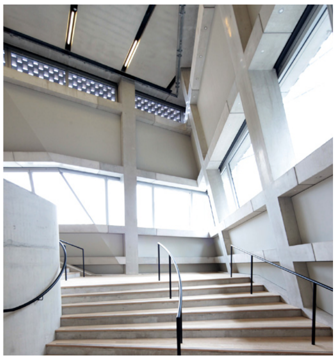


Image 40

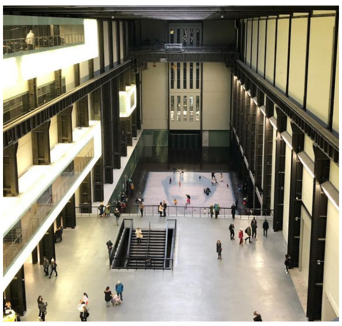


Image 41

Image 37-38-40-41: **Remodeling tactics**, © Frank Kaltenbach.
Image 39: **Remodeling tactics**, © Julian Anderson.

Tactics

Movement

There are vraity of movement types in Tate Modern, such as bridges in first and forth floor. Stairs and elevators exist in different parts of building for visitors (public) and staff (private) use. Corridors and consourses connect galery and exihibition areas. Stairs take on varying forms as you proceed up the Switch House, helical, wide and taperedand narrow and straight switchbacks. The ramp which is connected the outside and inside by passing through the north entance is an interesting example of movement in this structure.

Opening

Tate Modern has different entrances to building in each directions. There are three balconies which acts as a frame and let the visitors to have a view to Turbin Hall. The north entrance is interesting because it a kind of transition from one space to other one, from out side to a industrial structure. There are big vertical windows in main structure and horizontal ones in Extention part in Switched House. The bay window is an opening wich makes a visual connection between galeries and Turbin Hall. Also there is a view terrace in thenth floor of Swich House which offers a 360 degree view to visitors.

Surface

Herzog & de Meuron`s design maintanes the brick structure in facade and the intervention idea was to have different materials wooden floor, metal grille, metal structure, brick and concrete, glass.

Light

Lightening in Tate Modern is alternates between daylight, artificial illumination and mixure of both. The artificial illumination supply by glass panels in the ceiling. Natural light is acessible by cathedral windos placed by Scott in the brick facade. Durin day Turbin Hall use the daylight by a skylight in the roof also clerstory windows in the light beam helps in natural lightening.

Plane

The plateform in ground floor acts not only as a bridge but as a connection between North Entrace and Switched House. It is a horizontal plane wich suggested direction to visitors. There is another bridge in level 4 with the same function. The Bay window is a vertical surface that divides the Turbin Hall and the galleries in different level.

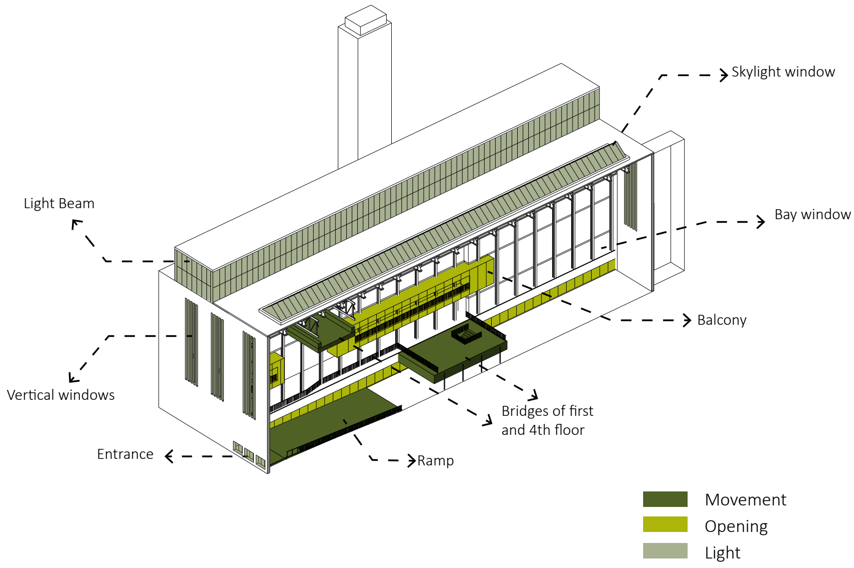


Figure 36

Figure 36
Remodeling Tactics, Movement, Opening and Light, Brooker G, Rereadings SS (2004) Interior Architecture and the design principles of remodeling existing buildings. RIBA Enterprises Ltd London.

Interventions

Hat

The light beam is a strong Hat intervention type. It located on the roof on Tate Modern as glass box. The material which used in this part is significialy different with industrial brick structure. The differenc in material selection highlight the old and new structure an their border.

New Interior

Herzog & de Meuron completely change the inside building, they removed the old boilers, turbins and machines and replace it with new interior elements such as rapm, platform, bridge and balconies.

Image 42

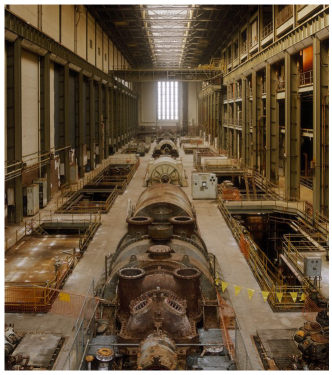


Image 43

Image 44

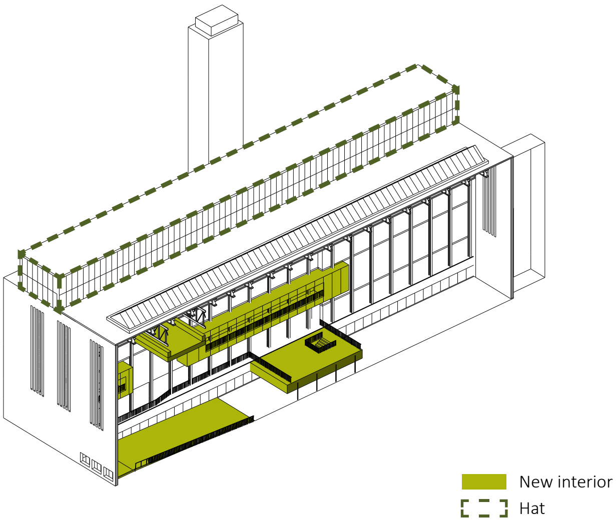


Figure 37

Image 42, 44: **Hat & new interior,** © Darrell Godliman.
Image 43: **Interior view to Turbin Hall before transform**, © Marcus Leith.

Figure 37: **Path, Portal, Place Appreciating Public Space in Urban enviornments**, White (1999).

6.2.4. FLEX 4.0 Evaluation tabel-Default weighting

FLEX 4.0: GENERALLY APPLICABLE INDICATORS					
Layer	**Sub-layer**	**Flexibility Performance**	**Assessment value**	**Weighting**	**Score**
1.Site		**1. Expandable site/ Location** Does the site have a surplus of space and is the building located at the centre?	**1**	**1**	**1**
2.Structure	Measurement	**2. Surplus of building space/ floor** Does the building or the user units have a surplus of the needed usable floor space?	**3**	**4**	**12**
		3. Surplus of free floor height How much is the net free floor area?	**4**	**4**	**16**
	Access	**4. Access to building** To what extend centralized building access has been implemented?	**4**	**2**	**8**
	construction	**5. Positioning obstacles/ columns** Is adaptation of building obstacle by load-bearing obstacles or columns?	**4**	**3**	**12**
3. Skin	Facade	**6. Facade windows to be opened** Can windows in the façade be opened per planning grid size?	**3**	**1**	**3**
		7. Daylight facilities What is the daylight factor for the spaces in the building?	**4**	**2**	**8**
4.Facilities	Measure & control	**8. Customisability/ controllability** Is it possible to customize the facilities: temperature, ventilation, electricity, ICT?	**3**	**3**	**9**
	Dimensions	**9. Surplus of facilities shafts and ducts** Do the facilities shafts and ducts have a surplus of space (heating, cooling, electricity, ICT)	**2**	**4**	**8**
		10. Modularity of facilities Are the facilities assembled by modular components according to the façade planning grid?	**1**	**2**	**2**
5.Space	Functional	**11. Distinction between support – infill*** To which degree deals the building with the division between support and infill?	**4**	**4**	**16**
	Access	**12. Horizontal access to the building** In what way is the horizontal access of the units in the building accomplished?	**4**	**3**	**12**
				Total flexibility score	**107**
				Flexibility class	**3**

Daylight factor (DF): Is the ratio of the light level inside a structure to the light level outside the structure.
Distinction between support – infill*: The more construction components belong to the infill, the easier a building can be rearranged/ transformed to other functions, the better a building can meet to changing demands.

Table 14: **FLEX 4.0 Evaluation table according to default weighting.**

Class table Flexibility scores	Score range
Class 1: Not flexible at all	12-48
Class 2: Hardly flexible	49-85
Class 3: Limited flexible	86-122
Class 4: Very flexible	123-159
Class 5: Excellent flexible	160-192

Table 15: **FLEX 4.0 class table flexibility scores, Rob Geraedts, 2016.**

6.2.5. FLEX 4.0 Evaluation tabel-User weighting

	FLEX 4.0: SPECIFICALLY APPLICABLE INDICATORS			Gallery/ Museum			Residential			Office			School		
	Layer	Sub-layer	Flexibility Performance	Weighting	Assessment value	Score	Weighting	Assessment value	Score	Weighting	Assessment value	Score	Weighting	Assessment value	Score
TATE MODERN	1.Site		1. Surplus of site space	4	1	4	3	1	3	4	1	4	4	1	4
			2. Multifunctional site/ location	3	4	12	1	4	4	3	4	12	3	4	12
	2.Structure	Measurement	3.Available floor space of building	4	2	8	4	2	8	4	2	8	4	2	8
			4. Size of floor buildings	3	4	12	3	4	12	3	4	12	3	4	12
			5. Measurement system	3	3	9	3	3	9	3	3	9	3	3	9
			6. Horizontal zone division / layout	1	4	4	1	4	4	1	4	4	1	4	4
			7. Presence of stairs/ elevators	4	4	16	3	4	12	3	4	12	3	4	12
			8. Extension/ reuse of	3	4	12	2	4	8	1	4	4	1	4	4
		Construction	9. Surplus of load bearing capacity	4	4	16	1	4	4	2	4	8	3	4	12
			10. Shape of columns	1	4	4	1	4	4	1	4	4	1	4	4
			11. Positioning of facilities zones	3	4	12	4	4	16	3	4	12	3	4	12
			12.Fire resistance main bearing	4	3	12	4	3	12	4	3	12	4	3	12
			13. Extendible building/ units horizontal	3	3	9	2	3	6	2	3	6	2	3	6
			14. Extendible building/ units vertical	4	3	12	4	3	12	4	3	12	4	3	12
			15. Rejectable part of building/ unit?	3	1	3	4	1	4	3	1	3	2	1	2
			16. Insulation between stories/ units	4	3	12	4	3	12	4	3	12	4	3	12
	3. Skin	Facade	17. Dismountable facade	3	4	12	2	4	8	1	4	4	1	4	4
			18. Location/ shape daylight	4	3	12	4	3	12	4	3	12	4	3	12
			19. Insulation of façade	4	2	8	4	2	8	4	2	8	4	2	8
	4.Facilities	Measure & control	20. Measure & control techniques	3	4	12	4	4	16	4	4	16	4	4	16
		Dimensions	21.Surplus capacity of building	4	2	8	4	2	8	4	2	8	4	2	8
		Distribution	22. Distribution facilities	4	2	8	4	2	8	4	3	12	4	2	8
			23. Location sources facilities	3	4	12	3	4	12	3	3	9	3	4	12
			24. Disconnection of facility	3	3	9	3	3	9	3	3	9	3	3	9
			25. Accessibility of facility	3	2	6	3	2	6	3	2	6	3	2	6
			26.Independence of user units	4	4	12	1	4	4	1	4	4	1	4	4
	5.Space	Functional	27. Multifunctional building/ units	4	4	16	2	4	8	2	4	8	2	4	8
		Technical	28. Disconnectable, removable	3	3	9	3	3	9	1	3	3	1	3	3
			29. Disconnectable, removable	4	4	16	4	4	16	4	4	16	4	4	16
			30. Disconnectable connection detail	4	3	12	4	3	12	4	3	12	4	3	12
			31. Possibility of suspended ceilings	4	4	16	2	4	8	2	4	8	2	4	8
			32. Possibility of raised floors	3	4	12	2	4	8	2	4	8	2	4	8
			Total flexibility score	326			281			277			280		
			Flexibility class	4			3			3			3		

Table 16: **FLEX 4.0 Evaluation table according to User weighting.**

Class table Flexibility scores	Score range
Class 1: Not flexible at all	32- 128
Class 2: Hardly flexible	129- 225
Class 3: Limited flexible	226- 322
Class 4: Very flexible	323- 419
Class 5: Excellent flexible	420- 512

Table17: **FLEX 4.0 class table flexibility scores, Rob Geraedts, 2016.**

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Image 45: Interior view of Turbin Hall before transform, © Marcus Leith.

6.3. Baltic Art Factory

Gateshead, Tyne and Wear, UK

Image 46: BALTIC former Flour Mill entrance, © https://baltic.art.com

6.3.1. Baltic Art Factory, Gateshead, Tyne and Wear, UK

Architects	Rank Hovis[4] Ellis Williams Architects, London
Location	Gateshead, Tyne and Wear, UK
Current function	Contemporary Art Centre
Previous function	Flour Mill
adaptation phase	1999-2002
Project area	13.000 m^2
Client	Gateshead Council
Construction cost	45.7 million £

The Baltic Flour Mills is located on the south side of the Riverside of Tyne River. This building has wonderful views of the Tyne Bridge, river and city. Ellis Williams Baltic Centre of Contemporary Arts has the potential to maximize the views over the Tyne while continuing the area's regeneration. [3]
Foundation work begins for Baltic Flour Mill in Gateshead in 1940 but the project interrupted during the Second World War. In 1948 construction works continued. Baltic looks like a very old industrial structure.
The project site was occupied by Gateshead Ironworks which was well known for its high-level bridge works until 1988-90. In 1950 the Mill consists of five buildings and it had flour and animal feed production. After 30 years in 1982 the Mill closed, the silo building was the only part of the Mill which remains and the rest demolition.[1]

Image 47: **Baltic Art Centre,** © www.newcastlephotos.blogspot.com, 2008.

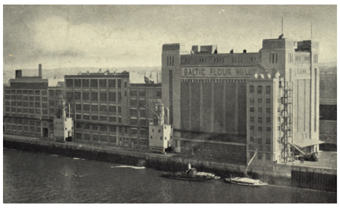


Image 48
The Baltic Flour Mill taken in 1950 showing the Mill surrounding buildings and boats on the Tyne, ©J. Rank.[5]

Image 49
Baltic Art Centre, © www.newcastlephotos.blogspot.com, 2012.

Image 50
Baltic Art Centre, ©John Riddy.

Dominic Williams was the architect who wins the Gateshead Council /RIBA competition in 1994 for the transformation of the former Baltic Flour Mill into an International art center. According to Dominic Williams, It is important to keep as much of the existing character of the fabric as possible while presenting the new use or function of the structure at same time. "The main aim is to follow contemporary art to happen in whatever it takes. Often art installations take on or prevent, the nature of the place they occupy. The original function of the building was to collect, contain and distribute flour through the unseen workings of the silos. In many ways these activities will be unchanged, with the building now refocused to a new use. Works will come, be created, and travel on from the place. The functionless secret though still housed between its sheer walls. Components such as gallery floors, café, and library, will be inserted between those two walls to create a new living body within the building."[2]
Building transformation starts in 1999 by removing 148 silos from inside the building. Finally, in 2002 the Baltic art factory opens to the public which called "B.OPEN".

Image 51

Image 51
Gateshead Millennium Bridge connection with Baltic Art Centre, © David Simpson.

In explanation of the building design concept, Sube Nordgen the director of Baltic mentioned that "Our objective is the development and conversion of the Baltic Flour Mills is to provide a national and international center of contemporary visual arts with large, temporary exhibition spaces."[1]
The Baltic Flour Mill design concept was to remove the silos inside of the existing structure, open the east and west walls and keep the monolithic brick walls in both north and south. They keep a part of the brick façade and support the other parts in place by scaffolding steel cage. Both east and west facades are with glazing and there is a wing door on the east façade of the building. This sliding door has almost the full height of the building which used to control light levels in the art spaces and acts as a screen when closed. There are four towers in each corner of building which were empty before, while in new design these towers are used for public as staircase and elevators.[1]

The project formed from two parts, the two-story Riverside building with the main entrance to Baltic and the main building. The main building consists of 6 floors with Art spaces for different kinds of artworks at each level and three mezzanines between them.
There is a restaurant on the top floor of the riverside building which is connected to the viewing box. The energy center is in a separate building located outside of building which runs 24 hours, it called combined heat and power and use to produce electricity for Baltic.

According to Sune Nordgren, people call Baltic the Tate Modern of the North, while Tate Modern is more like a museum with permanent collection and Baltic is an art factory, place to produce the art of our time and exhibit it. “The art factory idea is not only based on the fact that Baltic is an old building”, they need creative people to come and use the facilities and technologies inside even the building looks like an old industrial structure from outside.[1]

Image 52
Baltic former flour mill on site of Hawks’ Iron Works, © David Simpson.

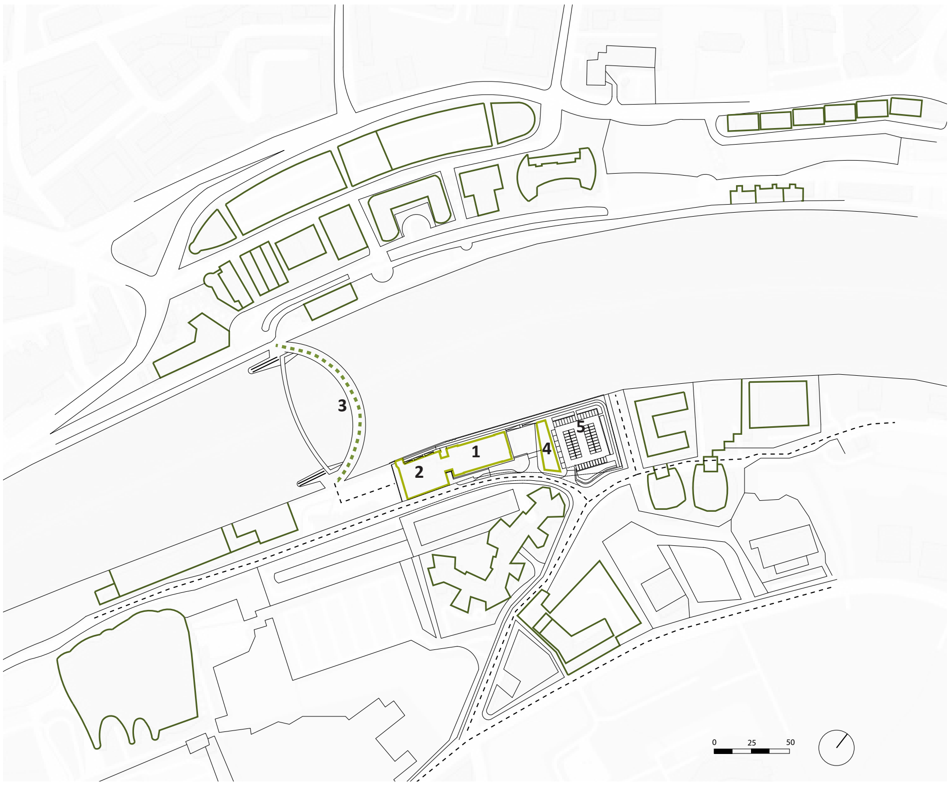
Image 53
Baltic Art Centre with riverside building extension, © www.newcastlephotos.blogspot.com, 2010.

Image 54: **Baltic art centre,** © www.newcastlephotos.blogspot.com, 2010.

6.3.2. Site plan analysis and design diagrams

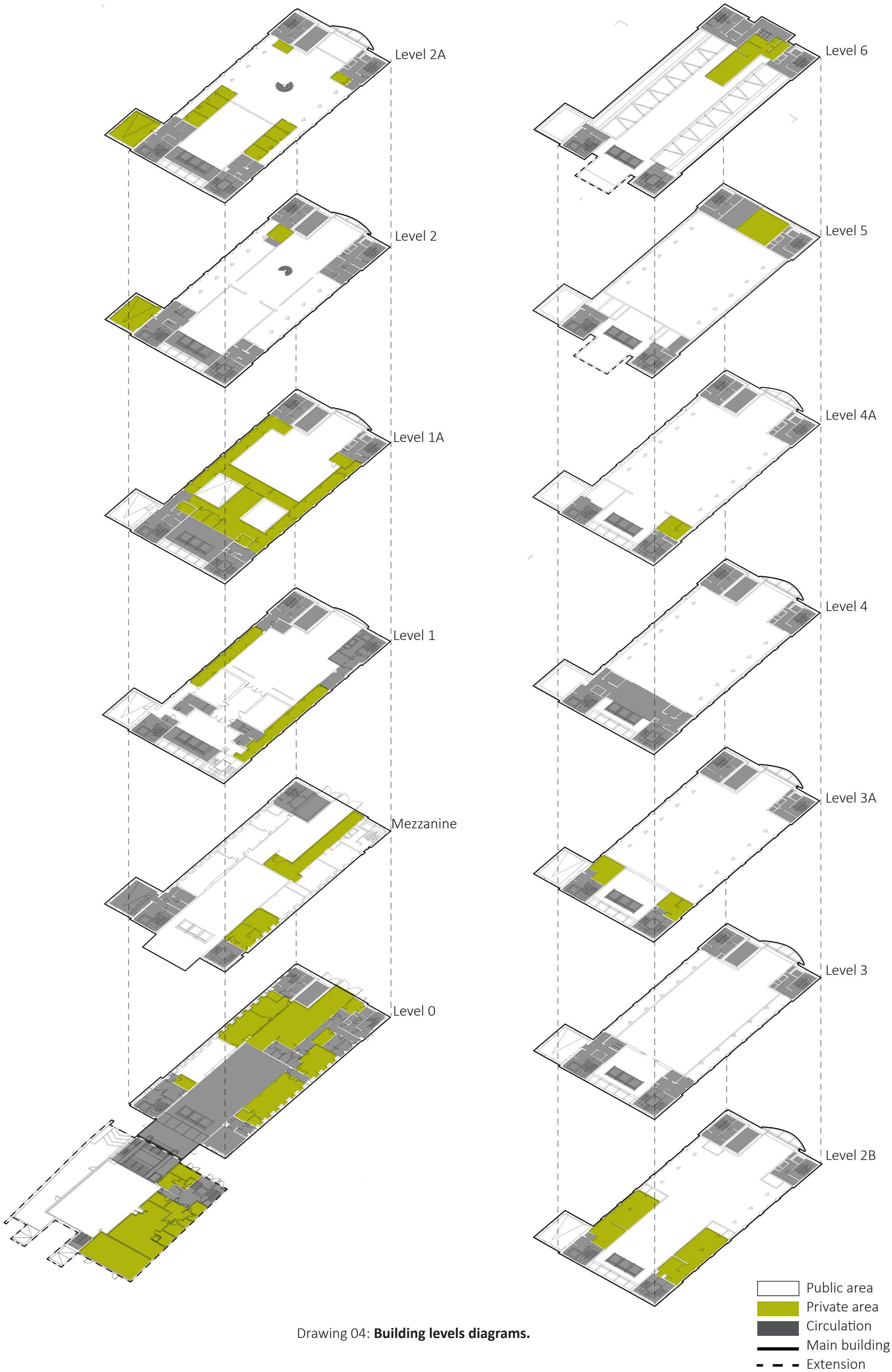
Drawing 03
1. Baltic Art Centre
2. Riverside building
3. Tyne River Bridge
4. Energy centre
5. Parking

Baltic Art Centre
Neighbor buildings
Tyne River Bridge
Roads/ Access
Ferry landing



Drawing 03: **Site plan of Baltic Art Centre,** Redraw from Ellis Williams Architects documents.

Image 55: **Baltic viewed from the Gateshead Millennium Bridge,** © David Simpson, www.englandsnortheast.co.uk



Drawing 04: **Building levels diagrams.**

6.3.3. Analyze Remodelling tactics and strategies

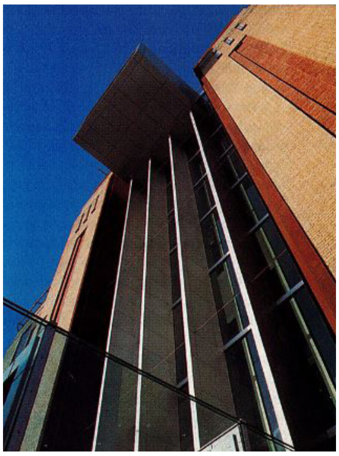


Image 56: **Remodeling strategies**, © Etienne Clement.

Strategy

Installation

The viewing box is a basic glass box on the highest point of building. The area is about 135 m^2 in two levels with a height of 7m from west façade of the building. This area has the capacity to accommodate 70 people. It is a place where people can observe and be observed too. This idea also helps to have more natural daylight inside the building. The viewing box can be considered as a key element in the building. This box is connected with rooftop restaurant between four towers of building.The box continues on the west side to ladies' toilet on level 6.[1]

Insertion

The design concept was to remove the both east and west façade and to insert a complete glazing surface in both sides to have a better view and to use more natural light for building.

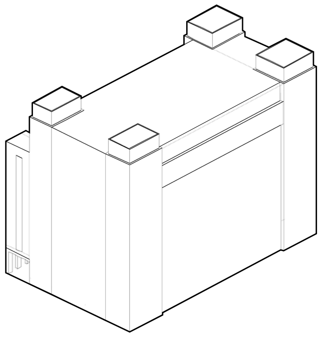
Construction

First phase

1940
- Construction works started.
- The project interrupted during the Second World War.

Second phase

1948
- Consreuction works continued after Second World War.



Remodeling

1999- 2002
- Viewing box extension
- Insert glass walls in east and west facade

Installation & Insertion

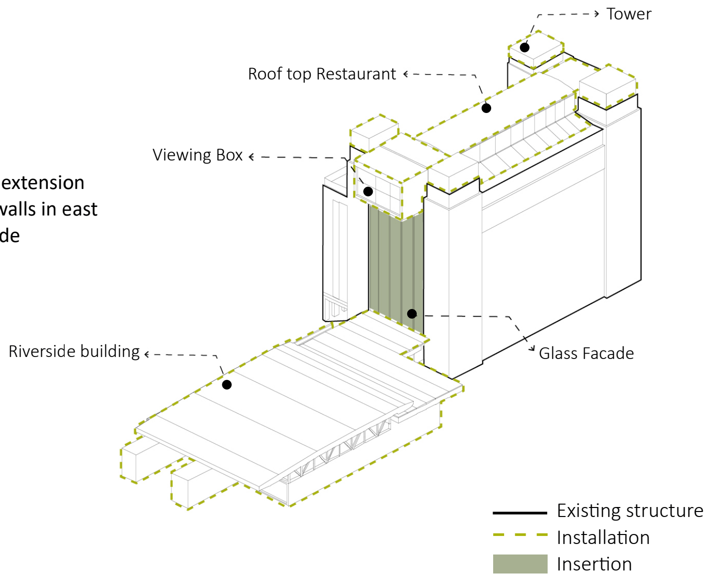


Figure 38

Figure 38
Remodeling strategies, installation and insertion, Brooker and Stone, 2004.

Movement

Movement is important in Baltic building, people can move horizontally in the building through open Art spaces or by elevators and stairs in the towers on each corner of the building. The main public staircase is located in the south-west corner with internal glazing which provides views to each floor. Using elevators in open space on one side of the building helps visitors to feel the vertical potential of the building. Orientation space is the main connection part between vertical and horizontal movement in the building.

Opening

Baltic Building has 2 entrances; the first one is to enter the Riverside building and the second one is the entrance to the main building which is connected with stairs to the Riverside building. Baltic has a low entrance which guides people to reach the main building. The frame in the Viewing Box acts as a perfect opening to the building. The glazing façade on the west and east also has a special function in the building; they give a huge view to out and inside of the building. Also, there is an opening in the ladies' toilet on the sixth floor which gives a different experience of private space to the users. There is a roof Terrace on the 4th floor of the building to give an open view of the city and river to visitors. There 2 balconies in the Art spaces which lets the visitors experience the space from different levels.

Surface

Special material used in the Baltic Art centre helps visitors to connect the past and new functions of the building. Cor-Ten steel used to complete the missing parts of the brick façade, to finish the towers in each corner and the Riverside building. This material has been used before for bridges and ships in this area. Aluminum panels are the next material used in the Viewing box on the rooftop and Riverside building. In the ground floor café they used about 30 mm slate in the back wall as a natural material. Glass used as a replacement for the east and west façade of the building, roof of the level 4 Artspace, viewing Box and walls of the Rooftop restaurant. Swedish pine is used for flooring of all Art spaces in the building.

Light

The access to the daylight provides by the west and east glaze façade. Art spaces at each level have the possibility to use natural light which controlled by the wing door on the east façade. There are skylight windows on the roof of the 4th floor Artspace to have natural daylight. Artificial lights are located in the ceilings of the second and third floors. All artificial lights are able to control by using hand-held computers.

Image 57

Image 58

Image 59

Image 60

Image 57: **Baltic remodelling tactics,** © Antony waller.
Image 58-59-60: **Baltic remodelling tactics,** © John Riddy.

Image 61

Image 62

Image 61-62
Baltic remodelling tactics,
© John Riddy.

Tactics

Plane

On the first level, there is a Cube called black box, this area is consists of four walls as a plane with the facilities for projection on the walls, roof, and ceiling.

Object

The wing door on the east façade acts as an object with a specific function. This element can be used as a shading during the day to control the daylight in Art spaces and it can be used as a surface for projection when it is closed.

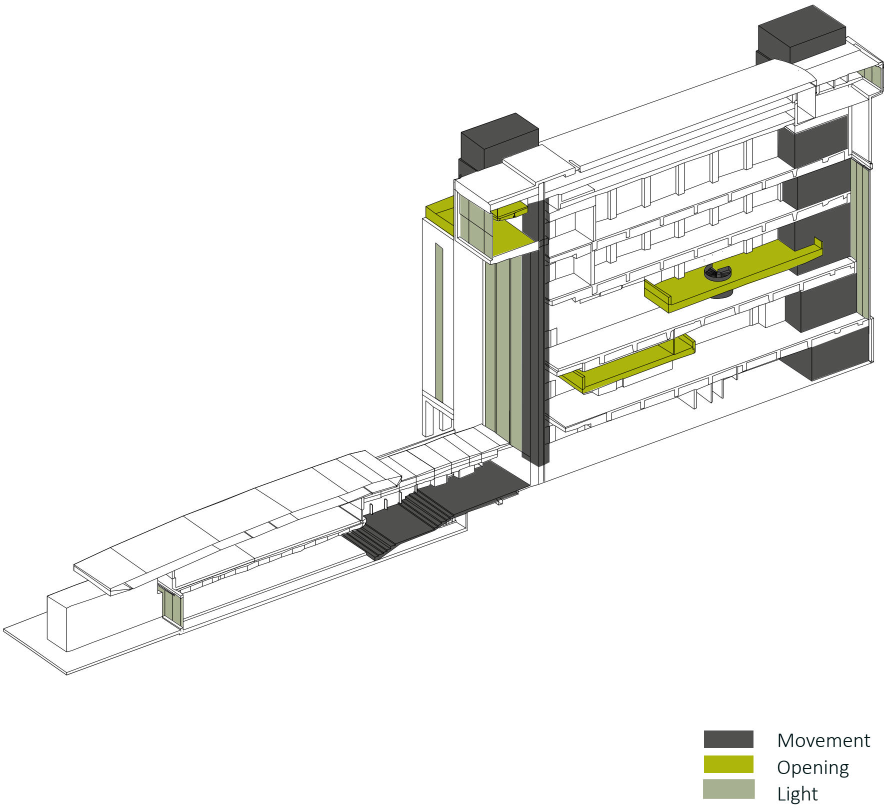


Figure 39

Figure 39
Remodeling Tactics, movement, opening and light, Brooker G, Rereadings SS (2004) Interior Architecture and the design principles of remodeling existing buildings. RIBA Enterprises Ltd London.

Hat

Viewing box is a glass space on the roof top which accommodates restaurant, services and viewing terracein in both east and west side. the box supported with four tower in corners and it has a compelete view to city and river.

New Interior

The main idea was to change the inside building, they removed the old silos and replace it with new interior elements such as Art spaces, Cave, and balconies.

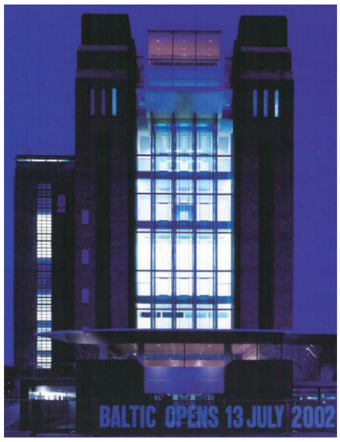


Image 63

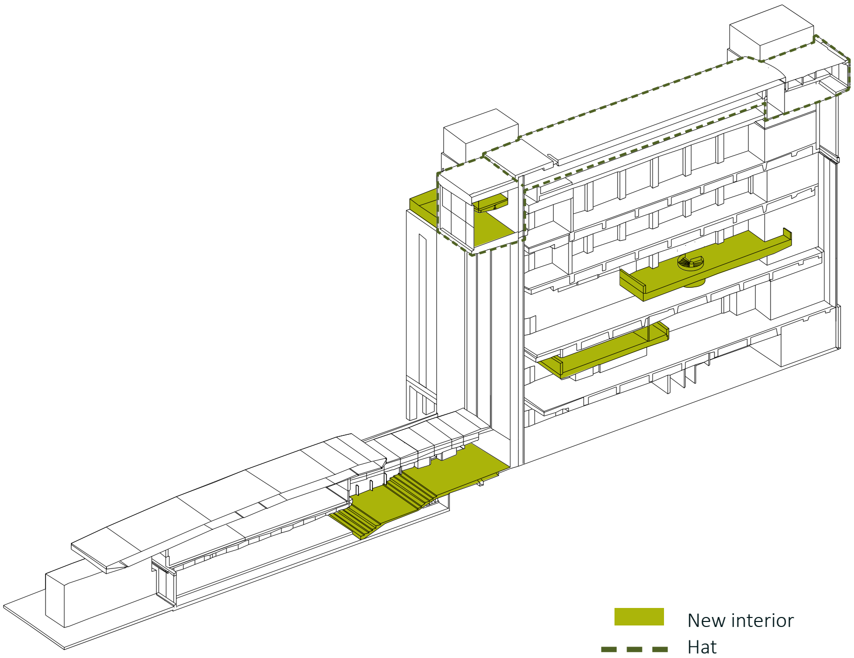


Figure 40

Figure 40
Path, Portal, Place Appreciating Public Space in Urban enviornments, White T. White (1999).

Image 64

Image 63-64
Baltic remodelling tactics,
© John Riddy.

6.3.4. FLEX 4.0 Evaluation tabel-Default weighting

FLEX 4.0: GENERALLY APPLICABLE INDICATORS					
Layer	**Sub-layer**	**Flexibility Performance**	**Assessment value**	**Weighting**	**Score**
1.Site		**1. Expandable site/ Location** Does the site have a surplus of space and is the building located at the centre?	**1**	**1**	**1**
2.Structure	Measurement	**2. Surplus of building space/ floor** Does the building or the user units have a surplus of the needed usable floor space?	**3**	**4**	**12**
		3. Surplus of free floor height How much is the net free floor area?	**4**	**4**	**16**
	Access	**4. Access to building** To what extend centralized building access has been implemented?	**3**	**2**	**6**
	construction	**5. Positioning obstacles/ columns** Is adaptation of building obstacle by load-bearing obstacles or columns?	**3**	**3**	**9**
3. Skin	Facade	**6. Facade windows to be opened** Can windows in the façade be opened per planning grid size?	**1**	**1**	**1**
		7. Daylight facilities What is the daylight factor for the spaces in the building?	**4**	**2**	**8**
4.Facilities	Measure & control	**8. Customisability/ controllability** Is it possible to customize the facilities: temperature, ventilation, electricity, ICT?	**2**	**3**	**6**
	Dimensions	**9. Surplus of facilities shafts and ducts** Do the facilities shafts and ducts have a surplus of space (heating, cooling, electricity, ICT)	**2**	**4**	**8**
		10. Modularity of facilities Are the facilities assembled by modular components according to the façade planning grid?	**2**	**2**	**4**
5.Space	Functional	**11. Distinction between support – infill*** To which degree deals the building with the division between support and infill?	**2**	**4**	**8**
	Access	**12. Horizontal access to the building** In what way is the horizontal access of the units in the building accomplished?	**4**	**3**	**12**
				Total flexibility score	**91**
				Flexibility class	**3**

Daylight factor (DF): Is the ratio of the light level inside a structure to the light level outside the structure.
Distinction between support – infill*: The more construction components belong to the infill, the easier a building can be rearranged/ transformed to other functions, the better a building can meet to changing demands.

Table 18: **FLEX 4.0 Evaluation table according to default weighting.**

Class table Flexibility scores	**Score range**
Class 1: Not flexible at all	12- 48
Class 2: Hardly flexible	49- 85
Class 3: Limited flexible	86- 122
Class 4: Very flexible	123- 159
Class 5: Excellent flexible	160- 192

Table 19: **FLEX 4.0 class table flexibility scores, Rob Geraedts, 2016.**

6.3.5. FLEX 4.0 Evaluation tabel-User weighting

	FLEX 4.0: SPECIFICALLY APPLICABLE INDICATORS			Gallery/ Museum			Residential			Office			School		
	Layer	Sub-layer	Flexibility Performance	Weighting	Assessment value	Score	Weighting	Assessment value	Score	Weighting	Assessment value	Score	Weighting	Assessment value	Score
BALTIC ART CENTRE	1.Site		1. Surplus of site space	4	1	4	3	1	3	4	1	4	4	1	4
			2. Multifunctional site/ location	3	1	3	1	1	1	3	1	3	3	1	12
	2.Structure	Measurement	3.Available floor space of building	4	3	12	4	2	8	4	2	8	4	2	8
			4. Size of floor buildings	3	4	12	3	4	12	3	4	12	3	4	12
			5. Measurement system	3	2	6	3	2	6	3	2	6	3	2	9
			6. Horizontal zone division / layout	1	3	3	1	3	3	1	3	3	1	3	4
			7. Presence of stairs/ elevators	4	4	16	3	4	12	3	4	12	3	4	12
			8. Extension/ reuse of	3	4	12	2	3	6	1	3	3	1	3	4
		Construction	9. Surplus of load bearing capacity	4	4	16	1	4	4	2	4	8	3	4	12
			10. Shape of columns	1	4	4	1	4	4	1	4	4	1	4	4
			11. Positioning of facilities zones	3	4	12	4	4	16	3	4	12	3	4	12
			12.Fire resistance main bearing	4	4	16	4	4	16	4	4	16	4	4	16
			13. Extendible building/ units horizontal	3	3	9	2	3	6	2	3	6	2	3	6
			14. Extendible building/ units vertical	4	2	8	4	2	8	4	2	8	4	2	12
			15. Rejectable part of building/ unit?	3	1	3	4	1	4	3	1	3	2	1	2
			16. Insulation between stories/ units	4	4	16	4	4	16	4	4	16	4	4	16
	3. Skin	Facade	17. Dismountable facade	3	3	9	2	2	4	1	2	2	1	2	4
			18. Location/ shape daylight	4	3	12	4	3	12	4	3	12	4	3	12
			19. Insulation of façade	4	2	8	4	2	8	4	2	8	4	2	8
	4.Facilities	Measure & control	20. Measure & control techniques	3	4	12	4	4	16	4	4	16	4	4	16
		Dimensions	21.Surplus capacity of building	4	2	8	4	2	8	4	2	8	4	2	8
		Distribution	22. Distribution facilities	4	2	8	4	2	8	4	2	8	4	2	8
			23. Location sources facilities	3	4	12	3	4	12	3	4	12	3	4	12
			24. Disconnection of facility	3	3	9	3	3	9	3	3	9	3	3	9
			25. Accessibility of facility	3	3	9	3	3	9	3	3	9	3	3	6
			26.Independence of user units	4	4	16	1	4	4	1	4	4	1	4	4
	5.Space	Functional	27. Multifunctional building/ units	4	4	16	2	4	8	2	4	8	2	4	8
		Technical	28. Disconnectable, removable	3	2	6	3	2	6	1	2	2	1	2	3
			29. Disconnectable, removable	4	4	16	4	4	16	4	4	16	4	4	16
			30. Disconnectable connection detail	4	4	16	4	4	16	4	4	16	4	4	12
			31. Possibility of suspended ceilings	4	4	16	2	4	8	2	4	8	2	4	8
			32. Possibility of raised floors	3	4	12	2	4	8	2	4	8	2	4	8
			Total flexibility score	317			267			270			273		
			Flexibility class	3			3			3			3		

Table 20: **FLEX 4.0 Evaluation table according to default weighting.**

Class table Flexibility scores	Score range
Class 1: Not flexible at all	32- 128
Class 2: Hardly flexible	129- 225
Class 3: Limited flexible	226- 322
Class 4: Very flexible	323- 419
Class 5: Excellent flexible	420- 512

Table 21: **FLEX 4.0 class table flexibility scores, Rob Geraedts, 2016.**

6.3.6. References

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Website

https://newcastlephotos.blogspot.com/2005/12/the-baltic-arts-museum.
https://www.flickr.com/photos/newcastlelibraries/4075866463/

Image 65: Baltic art centre, © dyls.

6.4. Shad 19;

Reggio Emilia, Italy

Image 66: Shad 19; Technopole for industrial research entrance, © Kai- Uwe Schulte- Bunert.

6.4.1. Shad 19, Reggio Emilia, Italy

Architects	Andrea Oliva Architect's office
Location	Reggio Emilia, Italy
Current function	Industrial research Lab
Previous function	Plant
adaptation phase	2010-2013
Project area	3700 m^2
Client	Municipality of Reggio Emilia, Strategic planning Area
Construction cost	5.5 million €

The Reggio Emilia Tecnopole is one of the ten Technopolis of the Emilia-Romagna High Technology Network (HTN - High Technology Network) [1] which is located in the shad 19 in the historic area of Reggiane mechanical workshops, Italy. The idea was to regenerate this urban area to Innovation Park. The shad 19 is the first building which remodelled for this project as a headquarters and it accommodates 4 industrial research laboratories. [2]
Shad 19 area was an old factory that transformed and reuse for industrial investigation. The site has an industrial history and it was important to consider it. The project is near to the Ferrovie dello stato central railway station. This industrial area switched from different kinds of functions such as rolling stock to weapons, war materials, and aircrafts. Finally, during the economic crisis, the plant closed in early 2000. [3]

Image 67: **Shad 19, Entrance,** ©Laurian Ghintoiu.

Image 68
Shad 19, exterior view, © Laurian Ghintoiu.

Image 69
Shad 19, remodelling process, © Laurian Ghintoiu.

Image 70
Shad 19, exterior view, © Laurian Ghintoiu.

In 2010 the Municipal Administration organized a competition to find a solution to redevelop and reused the abandoned space. The goal was to recover an important part of the city`s industrial history.
Andrea Olvia's architecture office won the competition and they supposed to finish the project in three years. According to the design concept, there were few controlled demolitions and it was important to consider the energy-saving, seismic improvements of the structure in order to make it coexist with new reuse solutions. "Industrial archaeology is transformed into a container that ideologically continues the old production process connected to the former Reggio workshops within the new ones." [4]

The important point was to keep the memory of the machines and labour which embedded in the building. The remodelling idea was to recover the ruined structure by divide the interior space to specific modules which can are completely independent of structural, thermal and material point of view. According to the proposed idea, the building would be able to adapt to contemporary requirements by providing a space for public and research and to keep the history of the place at the same time. [3]

Image 71: **had 19; Technopole for industrial research entrance,** © Kai- Uwe Schulte- Bunert.

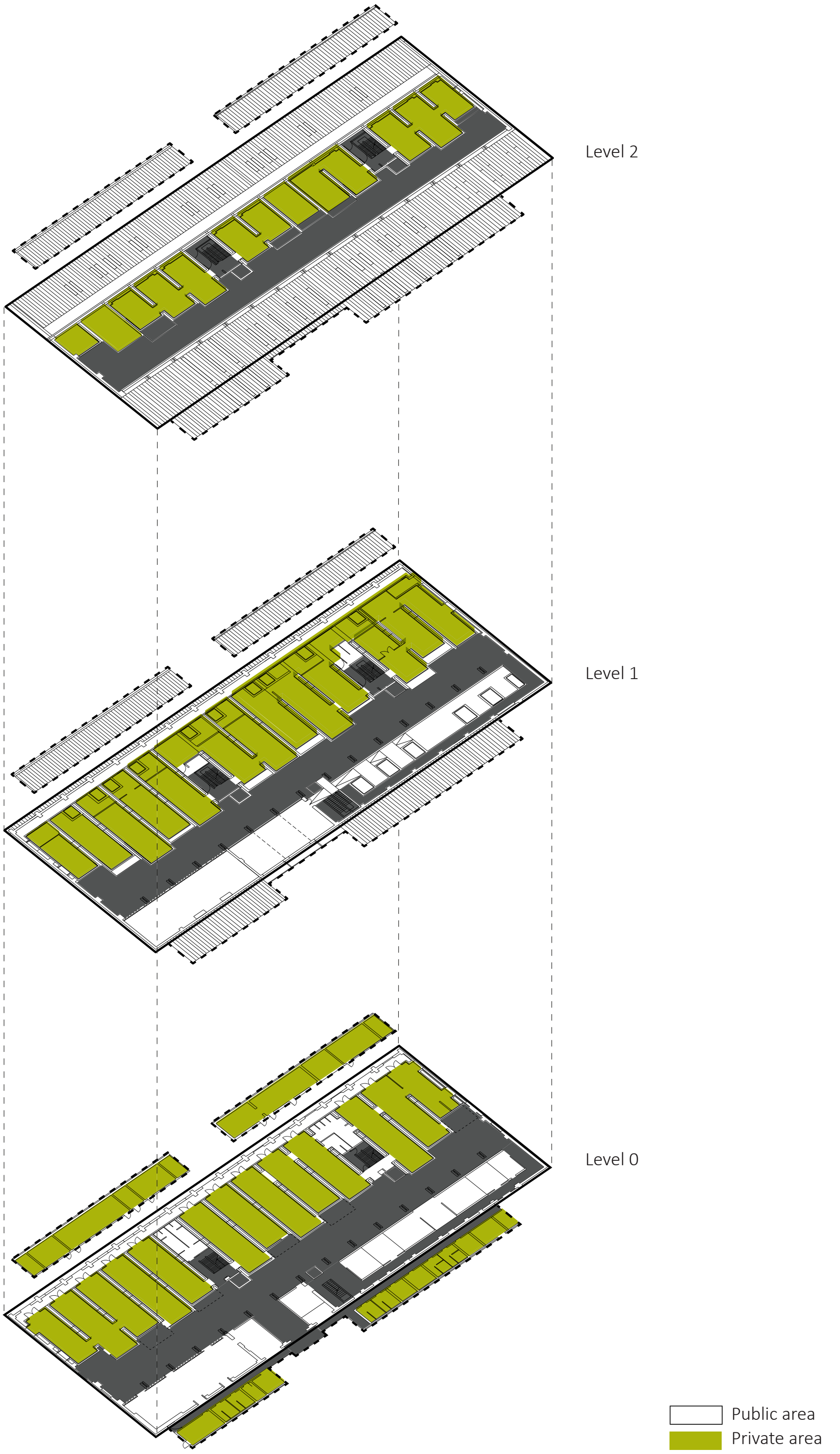
6.4.2. Site plan analysis and design diagrams

Drawing 05
1.Shad 19, Technopole
2. Neighborhood buildings
3. Railway

Shad 19, Technopole
Neighbor buildings
Roads/ Access
Railway

Drawing 05: **Site plan of Shad 19,** Redraw from https://cittaarchitettura.it/competitions/a-prize-16-17/

Image 72: **Shad 19; Technopole reuse phase,** © Kai-Uwe Schulte-Bunert.



Drawing 06: **Building levels diagrams.**

6.4.3. Analyze Remodelling tactics and strategies

Strategy

Installation

Remodelling idea was to keep the structure and memory of place. for this reason without a big demolition in facade from outside, the structure is completed by adding continuous façades of foyers ,meeting rooms and the serving volumes in concrete. These attached volumes are connected to the main building without being confused with the original structures. [7]

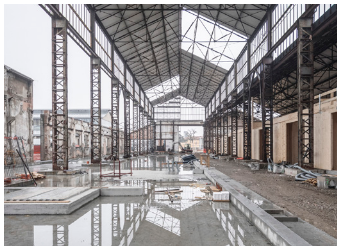


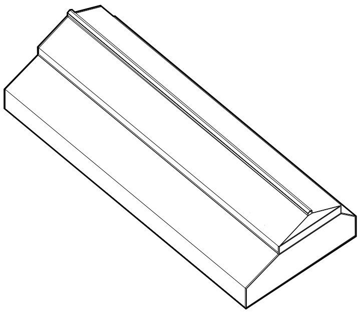
Image 73

Insertion

Wooden boxes are inserted inside building to accommodate offices and labroatories.

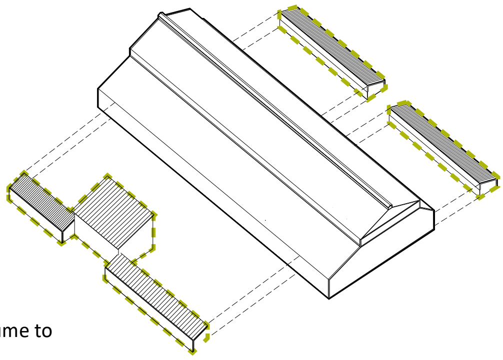
Construction

1901 - The "Officine Righi" chose the Santa Croce suburban area for their industrial settlement.[5]

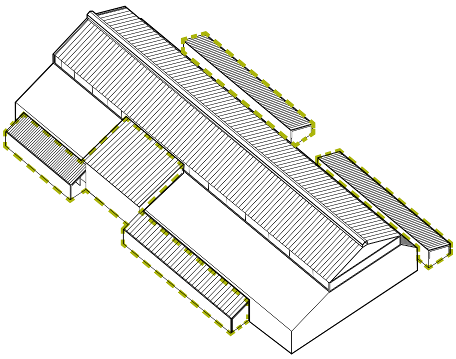


1949- 1951 - Economic crisis determined the end of the "Reggiane" glorious life.

Remodeling



2010- 2013 - Attach a new volume to building.



Installation

Image 74

Image 73- 74
Remodeling strategies, main structure and extended volumes, ©Laurian Ghintoiu.

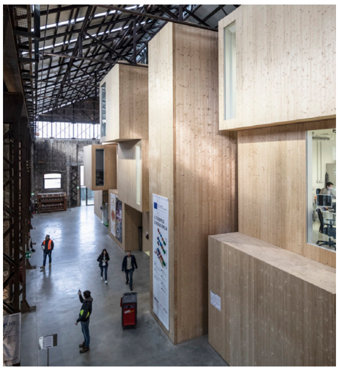


Image 75

Image 76

Image 77

Image 78

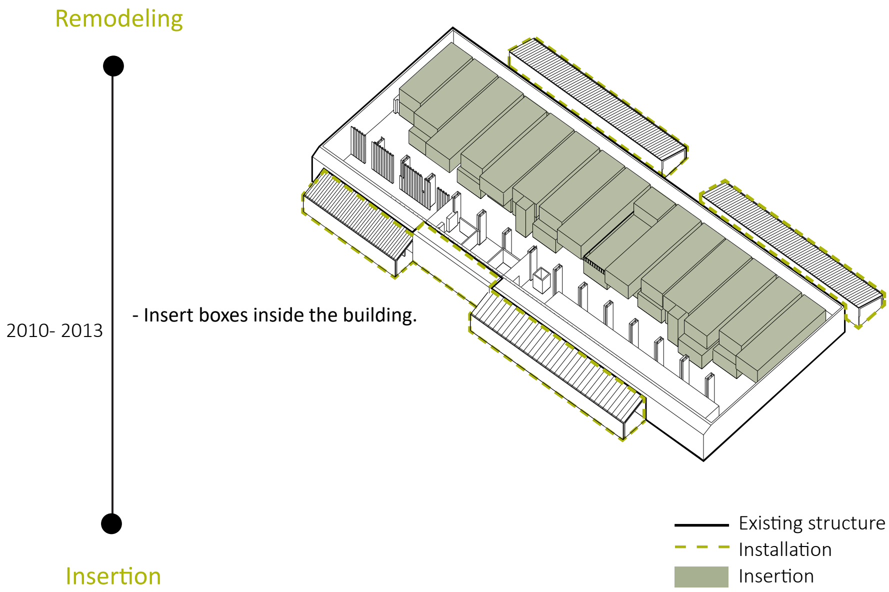


Figure 41

Tactics

Movement

Movement in Shad 19 building is defined by staircases, elevators as vertical and corridors as horizontal connector. The middle Corridor as a new off-center axis respects the main entrance[7] and connected two side of inetrior space.

Opening

The building has 3 entrances; the main entrance is located on the west facade and two others are placed in north and south facades. Inserted boxes have opening to the corridors and the movement between these boxes create terraces and overhangs.

Surface

Different kind of matrials used for remodelling Shad 19. In order to keep the industrial sense of space the main metallic skeleton has re-emerged and the exterior skin of building made of brick. Roof and new extended containers are made from insulated metal. Inside the building is occupied by wooden, energy self-sufficient box-shaped modules. The serving volumes out side the building are in sandblasted concrete. Also conservation of murals on the north and south facade as an evidence was an idea to keep the memory of place.

Light

Natural light can easily enter the building by a window row located as a loop all around the building. Extended volumes to the building are lighted by skylight windows in the roof. there are openings for all modules inside the building to have access to day light. Artificial light is also used to illuminte the interior space.

Image 75-75-77: **Remodelling tactics,** ©Laurian Ghintoiu.

Image 78: **Remodelling tactics,** © Kai- Uwe Schulte- Bunert.

Figure 41: **Remodeling strategies, installation and insertion,** Brooker and Stone, 2004.

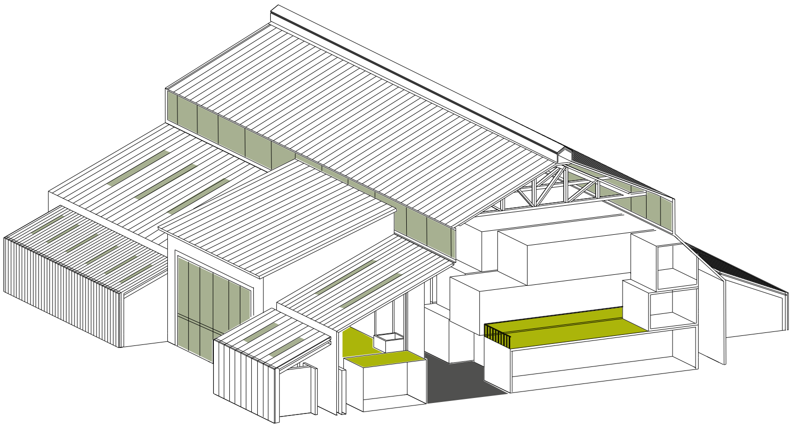


Figure 42

Figure 42:
Remodeling tactics, movement, Opening and light, Brooker G, Rereadings SS (2004) Interior Architecture and the design principles of remodeling existing buildings. RIBA Enterprises Ltd London.

Interventions

New Interior

The main idea was to change the inside building, they removed the old silos and replace it with new interior elements such as Art spaces, Cave, and balconies.

Image 79

Image 80

Image 79: **Inserting Boxes inside the building,** © Kai- Uwe Schulte- Bunert.

Image 80: **New interior for Shad 19,** ©Laurian Ghintoiu.

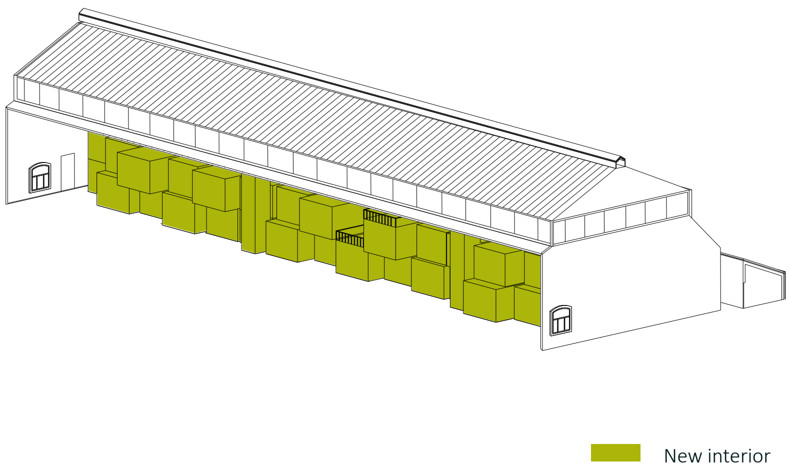


Figure 43

Figure 43: **Path, Portal, Place Appreciating Public Space in Urban enviornments**, White T. White (1999).

6.4.4. FLEX 4.0 Evaluation tabel-Default weighting

FLEX 4.0: GENERALLY APPLICABLE INDICATORS					
Layer	**Sub-layer**	**Flexibility Performance**	**Assessment value**	**Weighting**	**Score**
1.Site		**1. Expandable site/ Location** Does the site have a surplus of space and is the building located at the centre?	2	1	2
2.Structure	Measurement	**2. Surplus of building space/ floor** Does the building or the user units have a surplus of the needed usable floor space?	3	4	12
		3. Surplus of free floor height How much is the net free floor area?	4	4	16
	Access	**4. Access to building** To what extend centralized building access has been implemented?	4	2	8
	construction	**5. Positioning obstacles/ columns** Is adaptation of building obstacle by load-bearing obstacles or columns?	4	3	12
3. Skin	Facade	**6. Facade windows to be opened** Can windows in the façade be opened per planning grid size?	2	1	2
		7. Daylight facilities What is the daylight factor for the spaces in the building?	4	2	8
4.Facilities	Measure & control	**8. Customisability/ controllability** Is it possible to customize the facilities: temperature, ventilation, electricity, ICT?	3	3	9
	Dimensions	**9. Surplus of facilities shafts and ducts** Do the facilities shafts and ducts have a surplus of space (heating, cooling, electricity, ICT)	2	4	8
		10. Modularity of facilities Are the facilities assembled by modular components according to the façade planning grid?	1	2	2
5.Space	Functional	**11. Distinction between support – infill*** To which degree deals the building with the division between support and infill?	4	4	16
	Access	**12. Horizontal access to the building** In what way is the horizontal access of the units in the building accomplished?	2	3	6
				Total flexibility score	**101**
				Flexibility class	**3**
Daylight factor (DF): Is the ratio of the light level inside a structure to the light level outside the structure. **Distinction between support – infill***: The more construction components belong to the infill, the easier a building can be rearranged/ transformed to other functions, the better a building can meet to changing demands.					

Table 22: **FLEX 4.0 Evaluation table according to default weighting.**

Class table Flexibility scores	Score range
Class 1: Not flexible at all	12- 48
Class 2: Hardly flexible	49- 85
Class 3: Limited flexible	86- 122
Class 4: Very flexible	123- 159
Class 5: Excellent flexible	160- 192

Table 23: **FLEX 4.0 class table flexibility scores, Rob Geraedts, 2016.**

6.4.5. FLEX 4.0 Evaluation tabel-User weighting

	FLEX 4.0: SPECIFICALLY APPLICABLE INDICATORS			Gallery/ Museum			Residential			Office			School		
	Layer	Sub-layer	Flexibility Performance	Weighting	Assessment value	Score	Weighting	Assessment value	Score	Weighting	Assessment value	Score	Weighting	Assessment value	Score
SHAD 19	1.Site		1. Surplus of site space	4	2	8	3	2	6	4	2	8	4	2	8
			2. Multifunctional site/ location	3	4	12	1	4	4	3	4	12	3	4	12
	2.Structure	Measurement	3.Available floor space of building	4	3	12	4	3	12	4	3	12	4	3	12
			4. Size of floor buildings	3	4	12	3	4	12	3	4	12	3	4	12
			5. Measurement system	3	2	6	3	2	6	3	2	6	3	2	6
			6. Horizontal zone division / layout	1	3	3	1	3	3	1	3	3	1	3	3
			7. Presence of stairs/ elevators	4	4	16	3	4	12	3	4	12	3	4	12
			8. Extension/ reuse of	3	3	9	2	3	6	1	3	3	1	3	3
		Construction	9. Surplus of load bearing capacity	4	2	8	1	2	2	2	2	4	3	2	6
			10. Shape of columns	1	3	3	1	3	3	1	3	3	1	3	3
			11. Positioning of facilities zones	3	2	6	4	2	8	3	2	6	3	2	6
			12.Fire resistance main bearing	4	2	8	4	2	8	4	2	8	4	2	8
			13. Extendible building/ units horizontal	3	3	9	2	3	6	2	3	6	2	3	6
			14. Extendible building/ units vertical	4	4	16	4	2	8	4	2	8	4	2	8
			15. Rejectable part of building/ unit?	3	1	3	4	1	4	3	1	3	2	1	2
			16. Insulation between stories/ units	4	2	8	4	2	8	4	2	8	4	2	8
	3. Skin	Facade	17. Dismountable facade	3	4	12	2	4	8	1	4	4	1	4	4
			18. Location/ shape daylight	4	2	8	4	2	8	4	2	8	4	2	8
			19. Insulation of façade	4	2	8	4	2	8	4	2	8	4	2	8
	4.Facilities	Measure & control	20. Measure & control techniques	3	4	12	4	4	16	4	4	16	4	4	16
		Dimensions	21.Surplus capacity of building	4	3	12	4	3	12	4	3	12	4	3	12
		Distribution	22. Distribution facilities	4	2	8	4	2	8	4	2	8	4	2	8
			23. Location sources facilities	3	2	6	3	2	6	3	2	6	3	2	6
			24. Disconnection of facility	3	4	12	3	4	12	3	4	12	3	4	12
			25. Accessibility of facility	3	2	6	3	2	6	3	2	6	3	2	6
			26.Independence of user units	4	4	16	1	4	4	1	4	4	1	4	4
	5.Space	Functional	27. Multifunctional building/ units	4	4	16	2	4	8	2	4	8	2	4	8
		Technical	28. Disconnectable, removable	3	3	9	3	3	9	1	3	3	1	3	3
			29. Disconnectable, removable	4	4	16	4	4	16	4	4	16	4	4	16
			30. Disconnectable connection detail	4	4	16	4	4	16	4	4	16	4	4	16
			31. Possibility of suspended ceilings	4	4	16	2	4	8	2	4	8	2	4	8
			32. Possibility of raised floors	3	4	12	2	4	8	2	4	8	2	4	8
			Total flexibility score	324			262			257			260		
			Flexibility class	4			3			3			3		

Table 24: **FLEX 4.0 Evaluation table according to default weighting.**

Class table Flexibility scores	Score range
Class 1: Not flexible at all	32- 128
Class 2: Hardly flexible	129- 225
Class 3: Limited flexible	226- 322
Class 4: Very flexible	323- 419
Class 5: Excellent flexible	420- 512

Table 25: **FLEX 4.0 class table flexibility scores, Rob Geraedts, 2016.**

6.4.6. References

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Image 81: Shad 19, building entrance, © Kai- Uwe Schulte- Bunert.

6.5. De Lakfabriek

Oisterwijk, The Netherlands

Image 82: De Lakfabriek, building entrance, © Tim van de Velde.

6.5.1. De Lakfabriek, Oisterwijk, The Netherlands

Architects	A. Benoit Wenink Holtkamp Architecten
Location	The Netherlands
Current function	Residential building
Previous function	Leather factory complex
adaptation phase	2018
Project area	1200 m^2
Client	Buoy, Nico de Bont

De Lakfabriek building designed by A. Benoit in 1925. It has characterized by brick structure and the result is a rigid brickwork façade. The building is part of the former leather factory complex KVL, which was one of the largest leather producers in Europe. It served to paint the leather sheets, subsequently. The factory closed in 2001.[1]
In 2010 the factory complex started to be developed and the area becomes a live space again. De Lakfabriek is the first building in the site which reused as a residential block. It was important to preserve the industrial character of, building and to keep the value. For this reason, the raw concrete structure is exposed and left visible inside the building. "We only removed loose paint parts and stucco, the rest of the walls and ceilings we left as untouched"[2]

Image 84
De Lakfabriek, exterior view before reuse, © Tim van de Velde.

Image 85
De Lakfabriek, interior view before reuse, © Tim van de Velde.

Image 83: **De Lakfabriek,** © Tim van de Velde.

In reuse process, an extra building layer added to existing building. The addition glass part to the building distinguishes by its modern character and structure. In this level the extended volume moves backward and accommodates the roof on the top floor.[1] "One of the biggest challenges for us was to shape the roof extension in such a way that it would form a new chapter in the history of the building, but it also needed to engage into a modest and respectful relationship with the existing building." [3]

The extended part in of black timber-clad with diagonal pattern.[2]

At the moment building accommodates 25 living units in three different classifications: studios, apartments and ground-based units.[1] and they prefer to stay in a place that is close to the original character of the building. Wenink added "We deliberately chose a different material than the existing building, in order to make a clear distinction between the two parts. "[2]

Image 86: **De Lakfabriek, exterior view after reuse**, © Tim van de Velde.

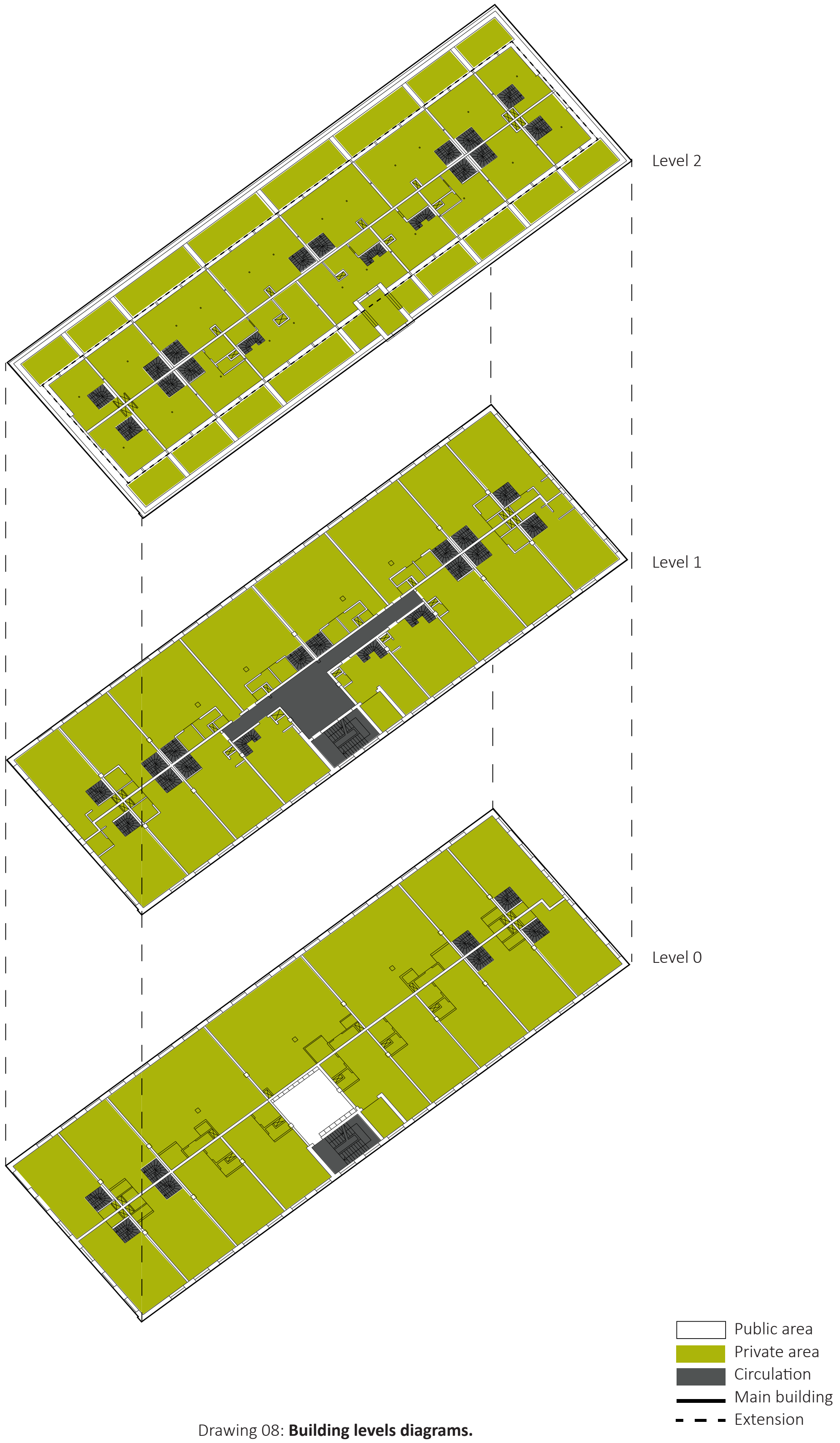
6.5.2. Site plan analysis and design diagrams

Drawing 07
1.De Lakfabriek
2. Neighborhood buildings
3. Main road

De Lakfabriek
Neighbor buildings
Roads/ Access
Main road

Drawing 07: **De Lakfabriek,** Redraw from www.archdaily.com

Image 87: **De Lakfabriek,** © Tim van de Velde.



Drawing 08: **Building levels diagrams.**

6.5.3. Analyze Remodelling tactics and strategies

Strategy

Installation

For remodelling the building, the structure in the roof top has been removed and a new volume installed as a replace. the addition part is made by Timber and glass to express the difference between new and existing part in building.

Image 88

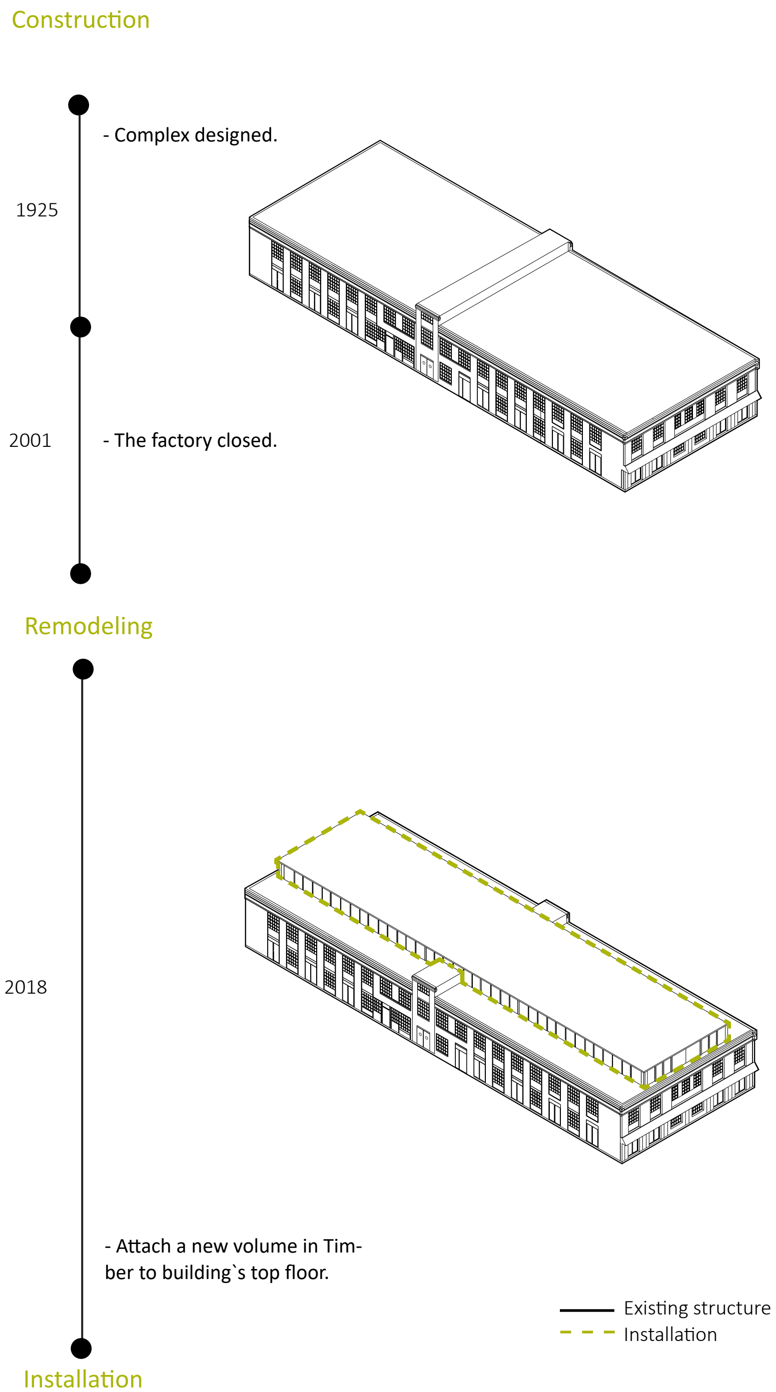


Figure 44

Image 89

Image 88-89: **Remodeling strategies, main structure and extended volumes**, www.weninkholtkamp.nl

Figure 44: **Remodeling strategies, installation,** Brooker and Stone, 2004.

Tactics

Image 90

Image 91

Image 92

Image 90-91-92: **Remodelling tactics,**
© Tim van de Velde.

Movement

Movement in the building is just by stairs. there is not any elavators in the building. Stairs connected different building levels. The main stair is used for public and the other stairs are located inside the units.

Opening

The main entarance to building is located on the north facade. Ground based units have access to street level too. The installed volume on the top floor creates a terrace all around second level which gives a view to neighborhood for the users.

Surface

Matrials used for remodelling in the project are selected carefully in order to keep the industrial character od the building. The brick facade is maintained during the reuse process and the concrete sturucture is exposed inside. The steel material in window farmes are replaced with aluminum frames.

Light

Natural light access to building by the existing windows and openings in the building. Additional openings are located in the installed volume on the top floor. All the units have access to natural light during the day and artificial lights too.

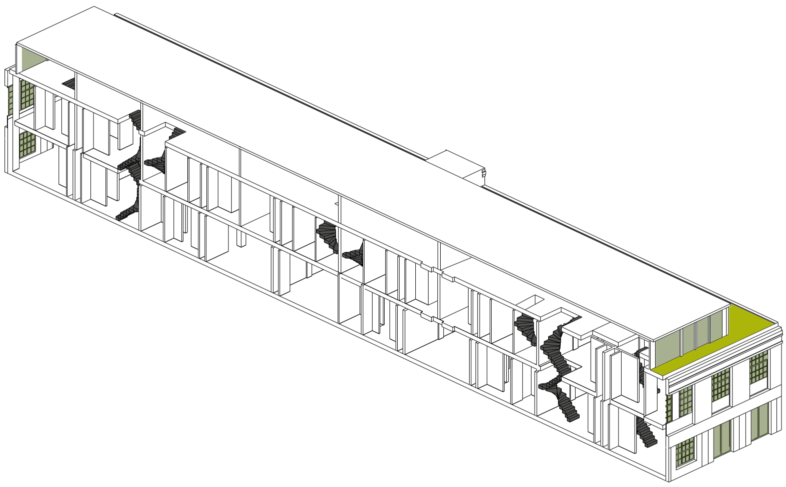


Figure 45

Figure 45
Remodeling tactics, Brooker G, Re-readings SS (2004) Interior Architecture and the design principles of remodeling existing buildings. RIBA Enterprises Ltd London.

New Interior

The main idea was to minimize the changes in the building, because the clients prefer to stay in place with industrial character. For this reason there was a change in position of interior walls of building for unit division.

Image 93

Image 93: **Remodelling tactics,**
© Tim van de Velde.

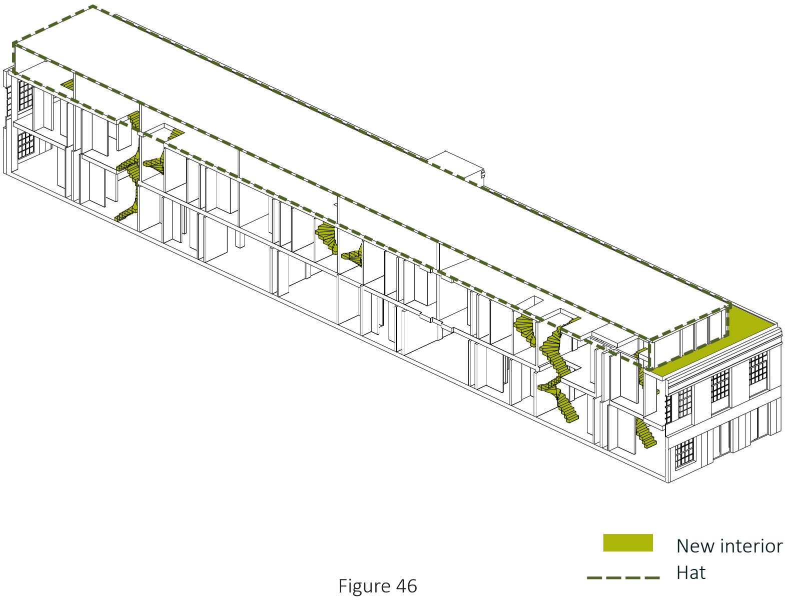


Figure 46

Figure 46
Path, Portal, Place Appreciating Public Space in Urban enviornments, White T. White (1999).

Image 94: **Remodelling tactics, hat.**

Image 94: **Remodelling tactics,**
© Tim van de Velde.

6.5.4. FLEX 4.0 Evaluation tabel-Default weighting

FLEX 4.0: GENERALLY APPLICABLE INDICATORS					
Layer	**Sub-layer**	**Flexibility Performance**	**Assessment value**	**Weighting**	**Score**
1.Site		**1. Expandable site/ Location** Does the site have a surplus of space and is the building located at the centre?	**1**	**1**	**1**
2.Structure	Measurement	**2. Surplus of building space/ floor** Does the building or the user units have a surplus of the needed usable floor space?	**2**	**4**	**8**
		3. Surplus of free floor height How much is the net free floor area?	**3**	**4**	**12**
	Access	**4. Access to building** To what extend centralized building access has been implemented?	**4**	**2**	**8**
	construction	**5. Positioning obstacles/ columns** Is adaptation of building obstacle by load-bearing obstacles or columns?	**4**	**3**	**12**
3. Skin	Facade	**6. Facade windows to be opened** Can windows in the façade be opened per planning grid size?	**2**	**1**	**2**
		7. Daylight facilities What is the daylight factor for the spaces in the building?	**4**	**2**	**8**
4.Facilities	Measure & control	**8. Customisability/ controllability** Is it possible to customize the facilities: temperature, ventilation, electricity, ICT?	**2**	**3**	**6**
	Dimensions	**9. Surplus of facilities shafts and ducts** Do the facilities shafts and ducts have a surplus of space (heating, cooling, electricity, ICT)	**1**	**4**	**4**
		10. Modularity of facilities Are the facilities assembled by modular components according to the façade planning grid?	**1**	**2**	**2**
5.Space	Functional	**11. Distinction between support – infill*** To which degree deals the building with the division between support and infill?	**2**	**4**	**8**
	Access	**12. Horizontal access to the building** In what way is the horizontal access of the units in the building accomplished?	**1**	**3**	**3**
		Total flexibility score		**74**	
		Flexibility class		**2**	

Table 26: **FLEX 4.0 Evaluation table according to default weighting.**

Class table Flexibility scores	**Score range**
Class 1: Not flexible at all	12- 48
Class 2: Hardly flexible	49- 85
Class 3: Limited flexible	86- 122
Class 4: Very flexible	123- 159
Class 5: Excellent flexible	160- 192

Table 27: **FLEX 4.0 class table flexibility scores, Rob Geraedts, 2016.**

6.5.5. FLEX 4.0 Evaluation tabel-User weighting

	FLEX 4.0: SPECIFICALLY APPLICABLE INDICATORS			Gallery/ Museum			Residential			Office			School		
	Layer	Sub-layer	Flexibility Performance	Weighting	Assessment value	Score	Weighting	Assessment value	Score	Weighting	Assessment value	Score	Weighting	Assessment value	Score
De Lakfabriek	1.Site		1. Surplus of site space	4	1	4	3	1	3	4	1	4	4	1	4
			2. Multifunctional site/ location	3	1	3	1	1	1	3	1	3	3	1	12
	2.Structure	Measurement	3.Available floor space of building	4	2	8	4	2	8	4	2	8	4	2	8
			4. Size of floor buildings	3	4	12	3	4	12	3	4	12	3	4	12
			5. Measurement system	3	2	6	3	2	6	3	2	6	3	2	9
			6. Horizontal zone division / layout	1	3	3	1	3	3	1	3	3	1	3	4
			7. Presence of stairs/ elevators	4	4	16	3	4	12	3	4	12	3	4	12
			8. Extension/ reuse of	3	3	9	2	3	6	1	3	3	1	3	4
		Construction	9. Surplus of load bearing capacity	4	4	16	1	4	4	2	4	8	3	4	12
			10. Shape of columns	1	4	4	1	4	4	1	4	4	1	4	4
			11. Positioning of facilities zones	3	4	12	4	4	16	3	4	12	3	4	12
			12.Fire resistance main bearing	4	4	16	4	4	16	4	4	16	4	4	16
			13. Extendible building/ units horizontal	3	3	9	2	3	6	2	3	6	2	3	6
			14. Extendible building/ units vertical	4	2	8	4	2	8	4	2	8	4	2	12
			15. Rejectable part of building/ unit?	3	1	3	4	1	4	3	1	3	2	1	2
			16. Insulation between stories/ units	4	4	16	4	4	16	4	4	16	4	4	16
	3. Skin	Facade	17. Dismountable facade	3	2	6	2	2	4	1	2	2	1	2	4
			18. Location/ shape daylight	4	3	12	4	3	12	4	3	12	4	3	12
			19. Insulation of façade	4	2	8	4	2	8	4	2	8	4	2	8
	4.Facilities	Measure & control	20. Measure & control techniques	3	4	12	4	4	16	4	4	16	4	4	16
		Dimensions	21.Surplus capacity of building	4	2	8	4	2	8	4	2	8	4	2	8
		Distribution	22. Distribution facilities	4	2	8	4	2	8	4	2	8	4	2	8
			23. Location sources facilities	3	4	12	3	4	12	3	4	12	3	4	12
			24. Disconnection of facility	3	3	9	3	3	9	3	3	9	3	3	9
			25. Accessibility of facility	3	3	9	3	3	9	3	3	9	3	3	6
			26.Independence of user units	4	4	16	1	4	4	1	4	4	1	4	4
	5.Space	Functional	27. Multifunctional building/ units	4	4	16	2	4	8	2	4	8	2	4	8
		Technical	28. Disconnectable, removable	3	2	6	3	2	6	1	2	2	1	2	3
			29. Disconnectable, removable	4	4	16	4	4	16	4	4	16	4	4	16
			30. Disconnectable connection detail	4	4	16	4	4	16	4	4	16	4	4	12
			31. Possibility of suspended ceilings	4	4	16	2	4	8	2	4	8	2	4	8
			32. Possibility of raised floors	3	4	12	2	4	8	2	4	8	2	4	8
			Total flexibility score	326			277			259			262		
			Flexibility class	4			3			3			3		

Table 28: **FLEX 4.0 Evaluation table according to default weighting.**

Class table Flexibility scores	Score range
Class 1: Not flexible at all	32- 128
Class 2: Hardly flexible	129- 225
Class 3: Limited flexible	226- 322
Class 4: Very flexible	323- 419
Class 5: Excellent flexible	420- 512

Table 29: **FLEX 4.0 class table flexibility scores, Rob Geraedts, 2016.**

6.5.6. References

Websites

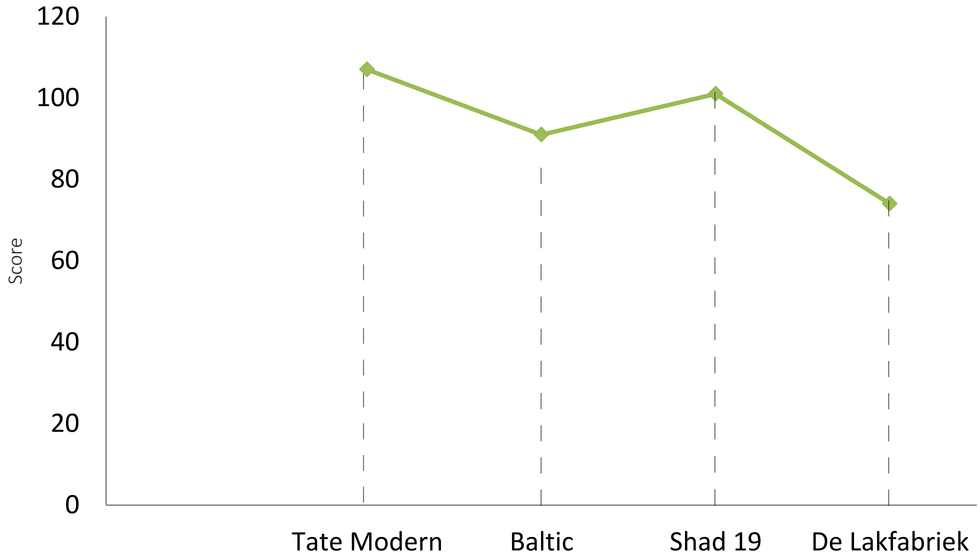
1. https://www.archdaily.com/904708/de-lakfabriek-wenink-holtkamp architecten?ad_source=search&ad_medium=-search_result_projects
2. https://www.dezeen.com/2019/07/01/de-lakfabriek-wenink-holtkamp-architecten-factory/
3. https://weninkholtkamp.nl/werken/herbestemming-lakfabriek-kvl-oisterwijk/
4. https://weninkholtkamp.nl/kozijnen-dakopbouw-lakfabriek-geplaatst/

Image 95: De Lakfabriek, the expose of concrete structure, © Tim van de Velde.

7

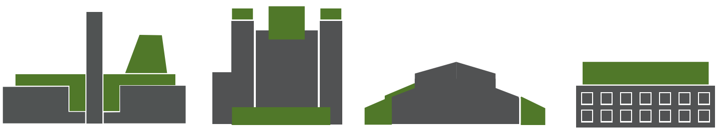
7.1. General flexibility capacity charts
7.2. Specific flexibility capacity charts
7.3. Conclusion

7.1. General flexibility capacity charts



Class table Flexibility scores	Score range
Class 1: Not flexible at all	12- 48
Class 2: Hardly flexible	49- 85
Class 3: Limited flexible	86- 122
Class 4: Very flexible	123- 159
Class 5: Excellent flexible	160- 192

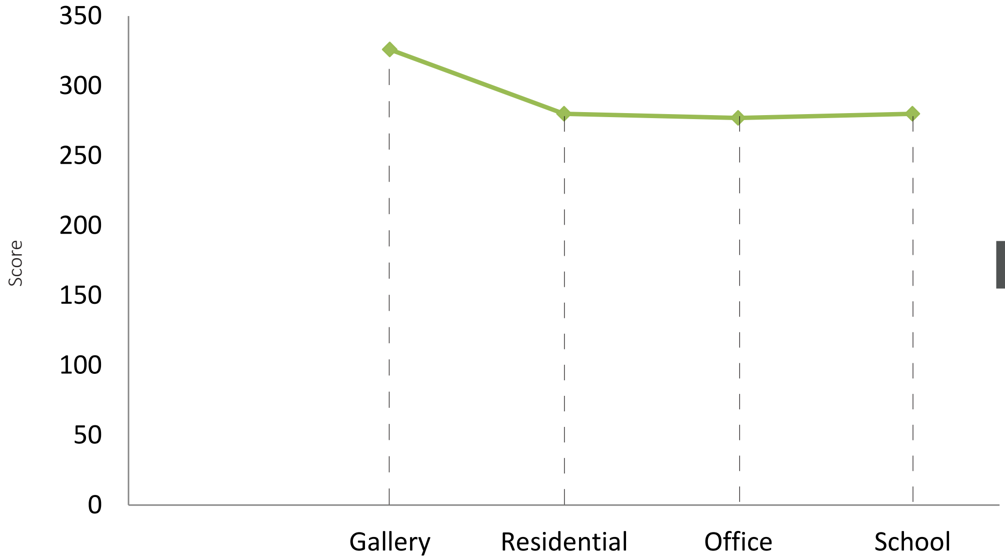
Table 30: **Legend table.**

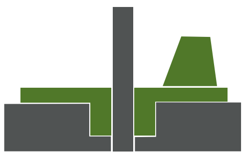


Score	107	91	101	74
Class table	3	3	3	2

Chart 01: **General flexibility capacity charts.**

7.2. Spesific flexibility capacity charts



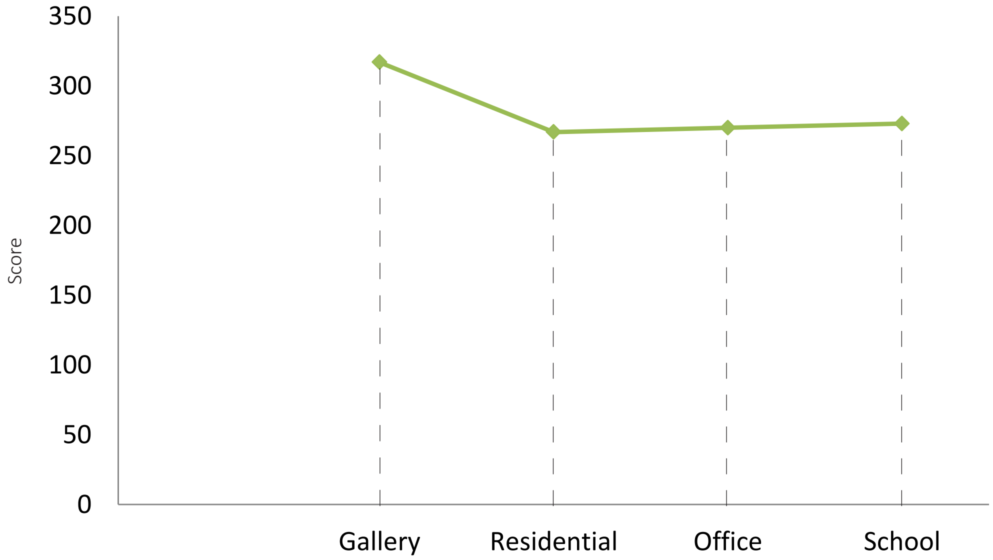


Tate Modern

Score	326	280	277	280
Class table	4	3	3	3

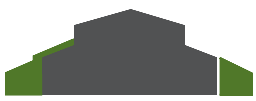
Chart 02: **Spesific flexibility capacity charts, Tate Modern.**

Baltic art centre

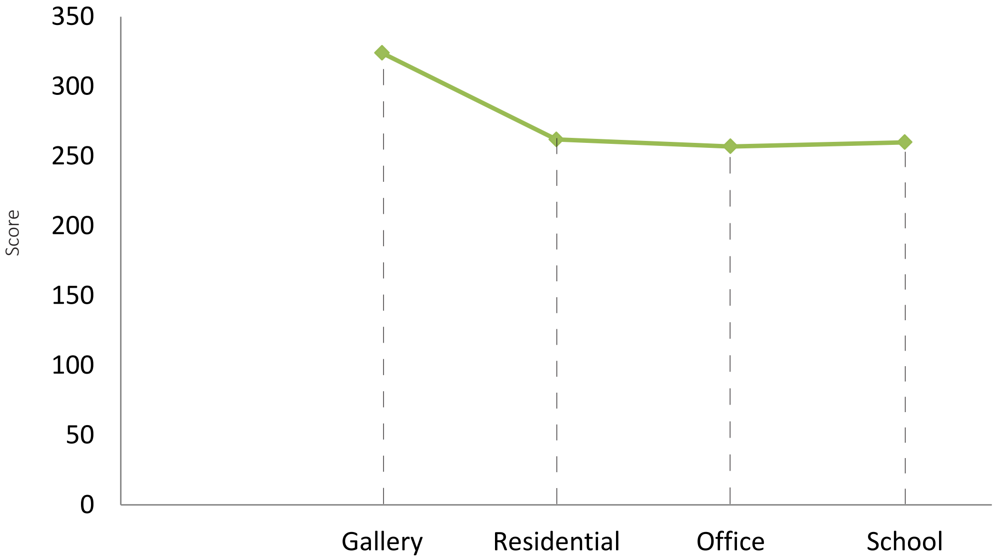


Score	317	267	270	273
Class table	3	3	3	3

Chart 03: **Spesific flexibility capacity charts, Baltic art centre.**

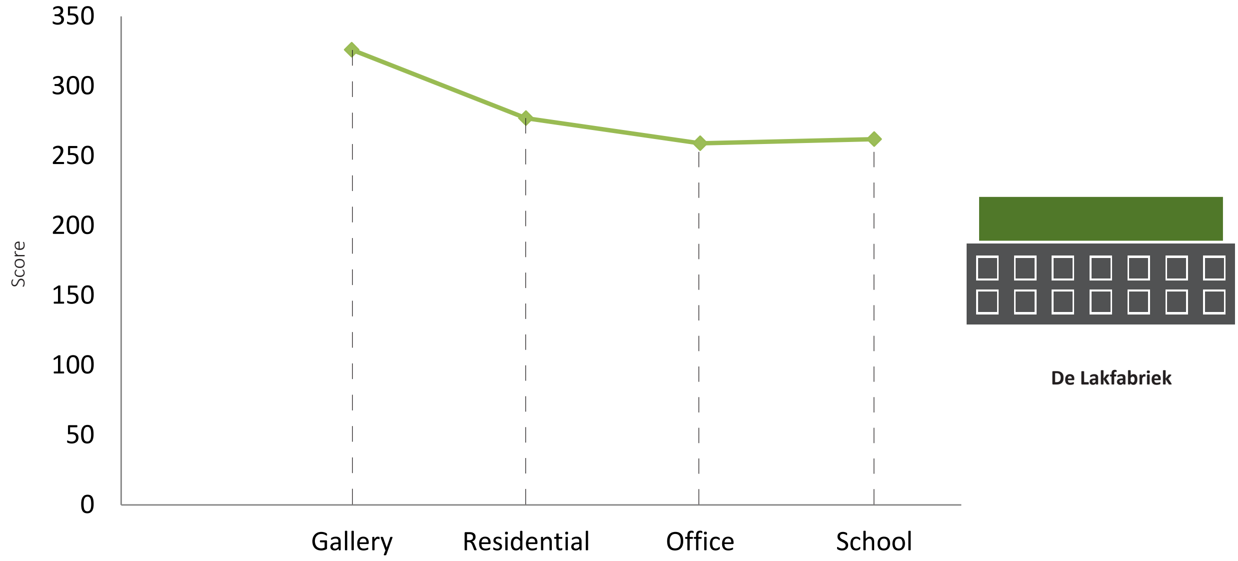


Shad 19



Score	324	262	257	260
Class table	4	3	3	3

Chart 04: **Spesific flexibility capacity charts, Shad 19.**



Score	326	277	259	262
Class table	4	3	3	3

Chart 05: **Spesific flexibility capacity charts, De Lakfabriek.**

Class table Flexibility scores	Score range
Class 1: Not flexible at all	32- 128
Class 2: Hardly flexible	129- 225
Class 3: Limited flexible	226- 322
Class 4: Very flexible	323- 419
Class 5: Excellent flexible	420- 512

Table 31: **Legend table.**

7.3. Conclusion

According to studies, there are varieties of functions in building reuse. Art gallery, exhibition, museum, residential, office, educational and school buildings are the most usual function in building reuse than others. Two types of flexibility charts are illustrated, general and specific charts and four different functions are considered to evaluate the flexibility for each case study.
Figure 47 shows the four different functions that used for evaluation.

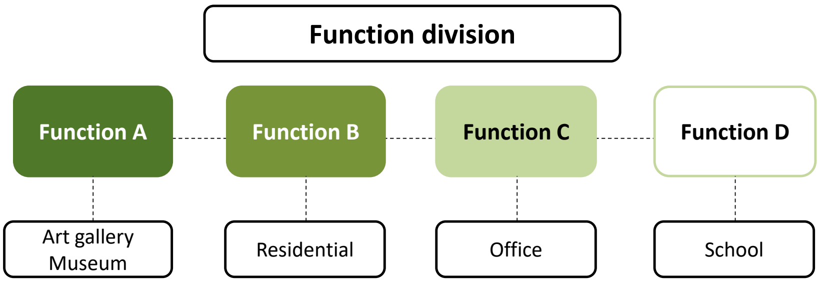


Figure 47
Functional division for buildings.

Figure 47

The general flexibility chart reveals the amount of flexibility between case studies and their capacity for future changes and reuse without considering the function. This chart is the result of evaluation table thet already suggested by experts and explained in chapter 5.
The results of the first chart show that although three case studies, Tate Modern, Baltic art centre and Shad 19 are limited flexible, they are generally more flexible than the De Lakfabriek building with hardly flexible class.

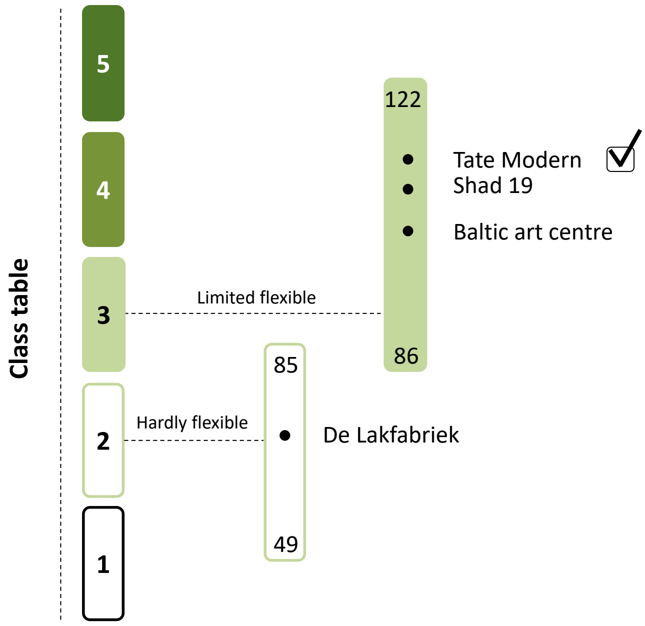


Figure 48
Level of flexibility according to general class table.

Figure 48

The Tate Modern as the general evaluation table shows, meanwhile is limited flexible, is more flexible than other buildings in the case study group for future change in function. Also, each case study is evaluated by the special evaluation table with a new user weighting system which is explained at the beginning of chapter 6.

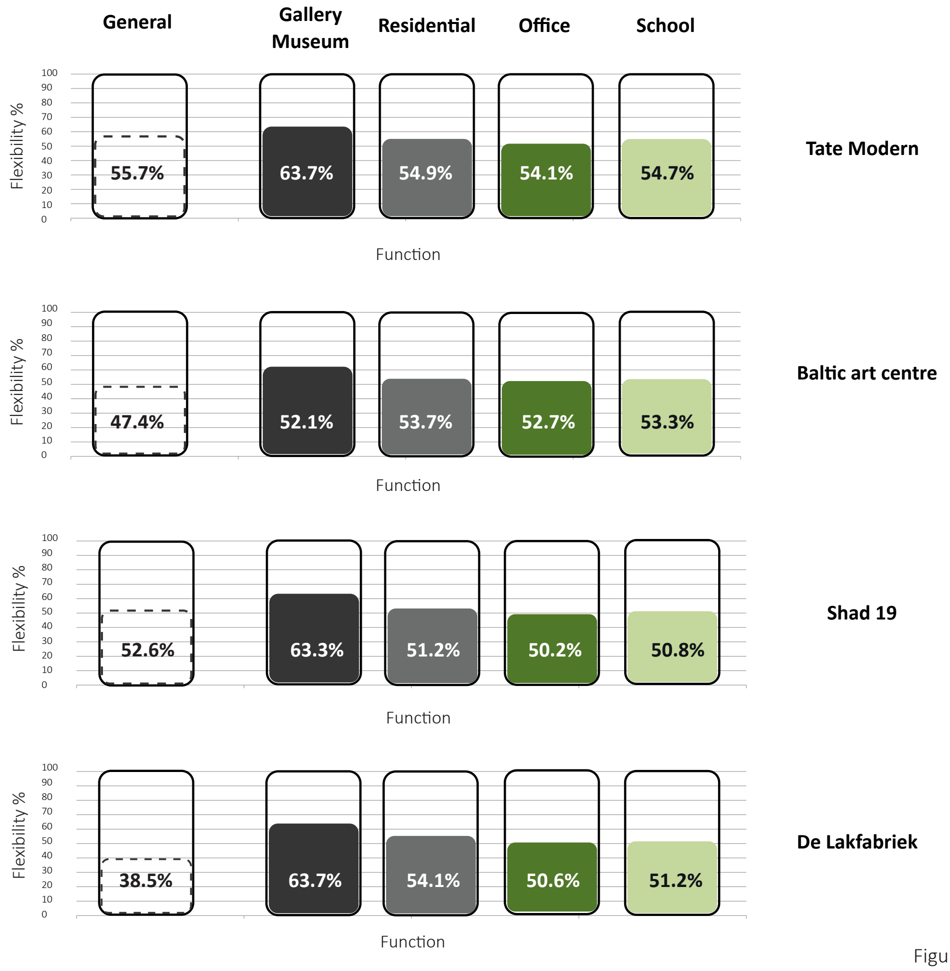


Figure 49

Figure 49
Level of flexibility to functions.

To discuss the results of evaluation, it is acceptable that buildings could be limited or hardly flexible, because they designed for specific functions in the past and in the adaptive reuse process, the reuse process starts from a semi-ready building with a background. For this reason, buildings could be considered limited flexible for functions that need more regular spaces and standards. Between the chosen functions, the art gallery has more flexibility in the design and organization of spaces, while the other functions have more regular standards respectively.
According to the results of general felxibility chart it could be suggested that the industrial buildings with almost same typology as case studies may reach to the same results if their flexibility is evaluated.
The flexibility trend in specific charts indicates slight changes in building flexibility for some functions except art gallery, which means that the case studies need almost same effort to transform and reach to these functions.
Figure 49 illustrates that it is possible for a case study to has a low amount of flexibility according to general evaluation table, while when the evaluation switched from general type of building to specific type, these flexibility amount could be changed. In addition, the type of building function is one of the important factors that effects the flexibility level of the buildings. The considered type of future function for buildings is one of the factors that defines the flexibility capacity of it.

The FLEX method has a point-based system. The existing indicators for specific building types are already cover all building layers and sub-layers in detail and there is not a necessity to add more indicators to the evaluation table.

The new weighting system for special building types is the result of changes by the user. The suggested weightings for this research is an experiment and the modifications are based on studies on builsings in order to highlight better the importance and value of each flexibility indicator.

The flexibility result for future functions of each case study is almost matched with the results of the general table. The difference between the results of the general and special table is not great and case studies are limited flexible for future changes. Also the change in the weighting system for office and school functions did not change the flexibility class results that much.

In conclusion, as a suggestion it would better to have a separate weighing system beside the general evaluation table for each building type to have more precise evaluation. As the FLEX method is introduced recently, the weighting system for different functions needs to be evaluated in practice with building owners, users, professional and experts on more number of case studies in order to be definitive.

Also, the assessment values may need modification like the weighing system according to building type. As the research is an experiment to evaluate the FLEX method, working on both weighting and assessment values in more detail is recommended for future.