Strategies in the Renovation of Industrial Heritage Buildings

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ABSTRACT

Due to the fact that many industrial buildings had remained the situation of vacancy since the late 1970s, reusing has become a term to be used as a sustainable method of preserving the cultural identity of these industrial buildings in order to prolong their life-spans. In this research, case study is conducted to analyze the spatial order between the existing construction and its new intervention; three prototypes, which are building-within-a-building, building-beyond-a-building, and building-on-a-building, are summarized. The current strategies towards renovation of the industrial heritages from four relative aspects (facade, structure, material, and thermal insulation) are concluded as well. This paper aims to provide potential strategies of reusing and renovating the discard industrial building in the sense of preserving its valuable architectural elements as well as of involving the contemporary ambience into the building. These tactics allow us , as architects, to firstly approach them from the macro view with a clear understanding of the merit and demerit of each prototype, and to find out the primary issues which play fundamental roles in the whole story of our interventions into the history and the future of a building.

KEYWORDS

Industrial Heritage Buildings; Spatial Order; Prototype, Renovation Strategy

I. INTRODUCTION

Renovation of existing buildings is becoming more and more important as space and resources are often limited, especially in urban areas. It not only honors the past, it also means looking into the future. Renovation can help us to create more space, reduce energy consumption and preserve our culture heritages while bringing the building up to the latest technical standards. This research focuses on industrial heritage buildings which make up a significant part of the architectural stock.

Buildings from the industrial era are not adequate for the spatial and functional requirements in the contemporary society with the arrival of digital era. They embrace and share the historical, social, cultural and economic value of a city in a certain moment. In the early 19th century, these industrial buildings located on the suburban area of a city. Interestingly, when the city expands in the 20th and 21st century, these obsolete buildings are enclosed in the city center, and thus they deserve a second life to continue witnessing the urban history and growth, providing alternative images of a city.

In this paper, several industrial renovation projects in Europe are analyzed and summarized into three prototypes in the sense of the spatial order between the existing construction and its new intervention, and provide a design starting point for the renovation of industrial heritage from a macro perspective. It also highlights the design approaches from many perspectives, such as the building facade, structure, material and thermal insulation, so that the renovated building will better respond to the needs of modern society. The purpose of this essay is to provide the information about the potential reconstruction strategies in the renovation process and compare the advantages and disadvantages between three prototypes.

II. METHODOLOGY

This paper presents a study of 11 industrial heritage renovation projects in Europe, which are used as study cases to provide more practical techniques, in order to find out the potential strategies. Case study is the fundamental method in this paper, while descriptive research helps to categorize those cases.

More specifically, three different prototypes, namely “building-within-a-building”, “building -beyond-a-building”, and “building-on-a-building”, are summarized and described from the perspective of spatial order. Furthermore, the paper analyzes specific reconstruction strategies from four aspects of facades, structures, materials and insulation in those projects. Finally, it concludes the advantages and disadvantages of different prototypes and make recommendations for future industrial heritage renovation projects.

III. PROTOTYPES IN RENOVATION PROJECTS

In the design process of renovating an industrial heritage building, the degree of preserving against renewing the existing construction is the most essential contradiction of its spatial and functional requirements. Eleven projects are chosen as the study cases out of their intriguing

spatial interactions between the newly created spaces and the original buildings, upon which they are catagorized into three types: building-within-a-building, building-beyond-a-building, and building-on-a-building. The industrial heritage building features itself with a large, continuous and homogeneous space in the sense of Form Follows Function. With this intrinsic character, the building embraces multiple ways of redesigning and accommodating new components into the old part in order to meet the new requirements of the society. In the end, the architectural intervention into an industrial heritage building determines not merely the dialogue between the history and future of the building, but also the architect's position towards the living environment and the urban scenarios.

3.1. Building within a building

The notion of *building-within-a-building* was first proposed by GMP (Gerkan, Marg & Partners, an international architectural company based in Hamburg, Germany) in the project Alsdorf Culture and Education Center (Appendix I). It indicates that the new component is fully isolated from the original building's structure and facade, and it appears inside the original building in a self-contained state (Fig.1), where these two parts have less impacts on each other.

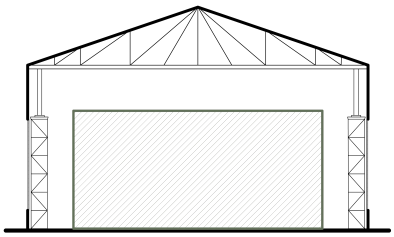

Figure 1. Building-within-a-building

Due to the added construction is wholly independent from the original structure and facade, the existing building's heritage value and integrity are well preserved. The original building's structure of Alsdorf Culture and Education Center and The Forge Offices and Exhibition Space (Appendix II) is totally restored without any change, and the newly constructed portions are all disconnected from it. They all have their own load bearing system. As for the original building facade, which emphasizes the historical significance and industrial characteristics, was restored and renovated, for instance, broken glass of original windows are replaced in Alsdorf Culture and Education Center renovation. The old industrial traces on the interior facade are beautifully conserved, and the original facade is effectively safeguarded from damage.

Because industrial buildings rarely require building thermal insulation design during the first stage of construction, so in reconstruction process, thermal insulation design needs to be considered. In this type, because of the detachment of the new building from the original building, an in-between space is created to serve as a climate buffer, requiring no heating and cooling anymore while the newly constructed building has their own climate control.

As for the choice of materials for the new building, the architects of The Forge chose birch plywood and galvanized steel which they believe that will reflect the industrial nature of the main building. The birch's brilliant colors contrast sharply with the aging industrial heritage. While in the GMP's design, the three cubes on the inside are wrapped with highly polished

composite aluminum panels in a white gold color, in contrast to the historic brickwork. So in this prototype, In order to achieve the goal of emphasizing the qualities of the old buildings, designers typically pick more contrasting materials to emphasize the distinction between the new and old buildings.

3.2. Building beyond a building

Referring to the description that GMP defines the notion of the new construction being enclosed by the existing envelop, *building-beyond-a-building* is used in this essay to define the condition that architectural elements of the heritage building are split up into different fragments in the renovation process, where only some of these elements are remained and melt into the new design of the project (Fig. 2).

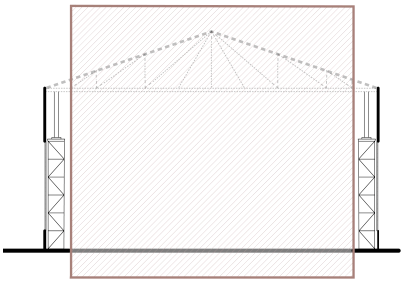

Figure 2. Building-beyond-a-building

Under this prototype, the original facade, as the most recognizable element of an industrial heritage, will become the focus of protection. For instance, in project Valby Machinery Halls (Appendix III), the original industrial building's middle section was converted into an apartment function suitable for living. Its old facade of the central portion of the original building was demolished, and a new setback facade was redesigned and constructed to meet the requirements of the residential function in terms of sunlight. The cadence and the long , rhythmic flow characteristics of the original facade have been continued because of the use of the steel structure erected on the new front. At the same time, this lately created steel structure is being utilized to add balconies, with the goal of having a balcony or ground-floor terrace for each unit. Similarly, in project Smederij NDSM (Appendix IV), A portion of the total heritage was lifted 30 meters and converted into a hotel. This hotel became the visual point of the NDSM port by constructing a tall and slender tower. From the perspective of urban vision, the entire building necessitates a design with raised features to provide for a deeper visual connection between the city and the wharf. The top of the new-built hotel has been intended as a public space with a panoramic view of Amsterdam’s skyline. This public space is also recognizable from outside, where its scale, form, and partition on the elevation bring back the memory of its previous façade. These two projects all involve the strategy of echoing the rhythm of the original building facade.

However, in case CaixaForum Madrid (Appendix V), the strategy of restoring the whole facade was used during the renovation process. The original industrial heritage old power station's designated brick wall is a reminder of Madrid's early industrial history. Herzog & de Meuron also felt that this was the only portion of the original building that can be used. They detached and demolished the basement as well as the no longer needed building components, for instance,

structure that will obstruct the expansion of the building space. Removal of the plinth solved many of the site's issues, and gave a fresh look to the project while the original building facade appears to float on the street, resulting in a roofed plaza that also serves as the building's entrance.

In terms of material selection for the new construction, I will concentrate on the usage of facade materials due to the need to safeguard the original facade. In example Valby Machinery Halls, the newly developed facade's structure has decided to manifest itself in the same way as the original building structure, all lattice columns and steel profiles are made in the characteristic red color which is repeated throughout the building. In project NDSM Hotel renovation, the primary facade is a glass curtain wall that fits the hotel design criteria, while the public area on top is painted rust red to accentuate the contrast with the hotel's activities and to correspond the brown-red brick facade of the original industrial building. On the basis of heightening the contrast with the original brick wall, the designer chose cast iron plates that mirrored features of industrial architecture in Project CaixaForum. In conclusion, the material selection strategy is mainly based on two essential principles: echoing the previous function and material and highlighting contrast.

Due to the greater damage to the original building, most of the thermal insulation content has been redesigned, so under this type, it will not be discussed any more.

3.3. Building on a building

In a similar way of definition, *Building-on-a-building* is used to describe that the new construction has a tectonic connection with at least one part of the original building, the elements of the original building will be reused, redesigned or restored during the renovation process, and the proportion, scale of the building will be remained (Fig. 3).

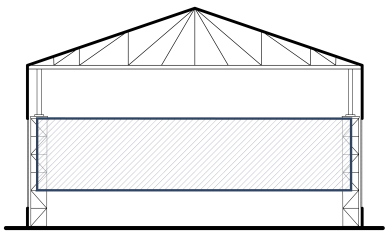

Figure 3. Building-on-a-building

Compare to the other two prototypes, this one was more extensively used. Due to the relationship between the new and old buildings is closer under this type, different particular reconstruction strategies and design techniques are included in the facade, structure, materials and thermal insulation design. In this chapter, this paper will analyze strategies in the above mentioned four aspects separately.

Facade

There are two main facade renovation strategies involved in this prototype. The first strategy is to restore and renovate. In project Social Housing Complex (Appendix VI), all constructions were conducted within the facade, restoring the historic building facade and replacing the glass in the original windows. Similarly, the entrance was reintroduced during the renovation of Art

Zaanstad (Appendix VII), but all other facade components were restored, including the remnants of the previous building's usage, which can be seen on the inner facade.

Another strategy is Redesign. It is difficult to fully adjust to the new functions following the transformation since the facades of industrial buildings have a regular pattern of opening windows. In order to meet the daylight standards of new constructions, it is frequently essential to redesign the facades.

The strategy is applied to Werkspoor Factory (Appendix VIII), since the original building does not belong to any level of monumental building, and the remodeling of the interior space produces new demands for the openness of the building facade, all of the windows on the facade are modified to let more sunshine into the various spaces inside the building. Multiple building entrances have been added to the facade as a result of the large building length and various functional requirements, making the architecture easier to access and thereby expanding the possibility of activating it.

However, in schemes Gjuteriet (Appendix IX), the redesign of the facade is based on the remaining elements of the original building facade. A new building facade was created in conjunction with the existing space requirements and structural system. To be more specific, a rich collage of demolished building components may be seen on the ruins of the west facade, which was previously an inner wall. The original apertures, which had previously been bricked up, have been reintroduced, revealing the brick wall on the interior. A large-area glass curtain wall was designed for the east facade. The original building's wide windows are kept on the facade, and the new curtain wall's module division is aligned with the interior's major load-bearing structure.

Completely different from the above two cases, Transformation House (Appendix X), which was a small-scale building, the architect chose to enlarge the building because the tiny internal plan cannot provide enough space to adequately accommodate the extra function. The original facade was exploded. The large protruding masonry surfaces have been sawn on three sides.Three bay windows have been mounted against the building at the location of the newly created openings.

In general, the renovation design strategy for the facade under this sort of renovation prototype is based on two separate starting points. One option is to preserve the recognizable features of the facade, even if the original building facade is severely damaged, the redesign process will also attempt to retain parts of the original building's facade characteristics and elements. While the goal of another strategy is to enable the new facade to fit the needs of the new functions, with the “ Form following function” principle.

Structure

There are mainly three different strategies in the structure aspects. One strategy is to reuse the original building structure.The original building at Project Gjuteriet relies on a steel framework to handle the load as well as the continuous traverses on either side. The original building has a huge open space due to the clear logic of the load-bearing system. One of the renovation's main goals is to create new functional spaces while preserving the original heritage space qualities.

Two of the four new timber structure systems are detachable from the walls and maintain a distance from the previous structure, preserving the original spatial quality. The remaining overhead crane runways are used to hang the other two new interventions. This method eliminates the need for structural columns, allowing for a large and free open space on the ground floor. Timber was chosen as the major material of the new structural system in the example of structural reuse to achieve the goal since wood is a light-weight material that is 5 times lighter than a steel structure and may lessen the load placed on the existing structure.

Another strategy is to restore the original building structure. As one of the most important components of industrial heritage buildings, the structure has been well restored in some projects.The antique industrial columns on which the old layers of paint are still visible are preserved in the project LocHal Library (Appendix XI), the library capitalizes the existing structure, thereby greatly minimizing the amount of new structural elements and portions of them are given a new lease on life as spaces for reading and studying by fitting them with wooden tables and lights. The enormous steel framework of the main building was restored and renovated in Project NDSM, preserving the building's industrial character. The columns and trusses were just sandblasted and not treated further, giving them a stark contrast to the clean and white pieces installed during the renovation process.

The third strategy is to add new structural systems to meet the requirements for new functions. The designer created a modular building system of wooden pieces that may be simply re-positioned in the case of the Werkspoor factory reconstruction. The new structure's flexibility allows the reorganization to adapt to changing demands in the future. While in Project Valby Machinery Halls, both ends of the original building achieved the goal of adding more interior space by constructing a new steel structure system, and the new structure also corresponded to the original design intent and echoed the building's original industrial expression.

When these instances are compared, it is clear that structural design is an essential component in the industrial transformation under this prototype in order to fully utilize the enormous internal space of industrial buildings. It can be restored as an important piece of industrial architectural heritage, or because its original conditions of massive bearing capacity can be reused, also making it possible to create a new structural system within the immense space. Under this prototype, the structure's design has a variety of options, and it will influence the new building's spatial quality to some extent. The space requirement of the new function also affects the choice of structural strategy.

Materials

Different strategies have been presented in the selection of materials for the renovation process. It primarily entails reusing, recycling, and introducing new materials. In Hembrug Site, the Superuse Studios transformed the old factory into a flexible exhibition space. They have realized an interior which is circular by reusing the materials from elsewhere in Netherlands. They collected oak floorboards, glass panels, carpet tiles, etc. In project Gjuteriet, recycled bricks retrieved from recently demolished buildings in Kockum were used in the reconstruction facade. The vast majority of the remaining projects have chosen to incorporate new materials in

order to enhance the expression of the new construction. In addition to the lightweight wood mentioned above for reusing the old structure, in project Valby Machinery Halls, the new construction is made of durable, almost maintenance-free materials, which means that operating and maintenance costs, as well as material consumption for restoration, will be greatly reduced over the building's lifetime. In the project LocHal Library, a warm atmosphere was created interior because of the newly introduced oak which has an exciting combination with the original industrial historical elements. While in Project Transformation House, some completely different modern elements, such as galvanized steel plates, were selected to emphasize the new extension.

Insulation

Because this prototype of renovation takes place inside the original building, thermal insulation is a critical component of the renovation process. First strategy is to build a climate buffer zone. The case study mainly involves the following methods. First example is the Valby Machinery Halls, where the new constructions are isolated from the inside by a climate screen of glass, with the traces of the prior function apparent behind the glass. Another example is Social Housing Complex, the newly constructed residential units are separated from the exterior and roof by a new wood facade. The in-between space is used to circular air and the housing units don't require air conditioning for the most of the year.

Introduce new climate system is another strategy which was used in the project LocHal Library. A type of adaptable technology was applied to make the majority of the building serve as one enormous space. The openness of the building is preserved thanks to an intelligent climate zone system, which was designed to heat the people rather than the entire area. Based on flexible, user-led heating system, seating on the bleacher stands will be heated and cooled, while all the smaller offices have their own temperature control. The efficient use of a selective heating system reduces the high expenses associated with heating such an area.

Another strategy to solve the need for insulation from an architectural perspective is the detailed design of the facade. In project Gjuteriet, the brick wall on the long sides have previously functioned as inner walls, but since the extensions have been demolished, they become outer walls now. Thermal insulation is placed on the inside and sandwiched in by another layer of recycled brick, left the original wall exposed to the interior.

In short, under this prototype, there are more possibilities for the choice of design strategy between different parts, and different functions, space requirements and other factors will affect the choice of strategy.

IV. CONCLUSION

All of the renovation prototypes and specific strategies involved are summarized in Appendix XII based on case study analysis and comparison. Distinct renovation strategy prototypes have different benefits and drawbacks, and they are appropriate for various project types.

Building-within-a-building, since new constructions are separated from the original buildings, they can be totally removed under certain circumstance, and it preserves the existing

architectural heritage to the greatest extent. And due to this prototype's transition is reversible, it's better suited to projects with a greater original building protection value, for example, the National Monument's industrial architectural heritage.

Because it is more destructive to historical buildings and irreversible, building-beyond-a-building is not suitable for the renovation and reconstruction of monument buildings. It is, nevertheless, ideal for more demanding programs, such as the transformation of residential units, due to its higher flexibility. In terms of space, thermal insulation, and illumination, industrial buildings have massively different construction needs than residential buildings, making it difficult to meet the requirements of the residential function. In this cases, Some components of the industrial building are fragmentedly preserved in this scenario, while the remaining sections are modified to more easily and efficiently answer the space and function needs.

Compared with the other two prototypes, the industrial architectural heritage has been fully utilized in Building-on-a-building strategy. It makes the best use of the original building on the basis of protection, giving the original building a second life. This kind of renovation strategy is more suitable for adaptive projects, because it has a larger choice of reconstruction strategies for each part, which can meet the different needs of different functions, and is a relatively more widely used renovation prototype.

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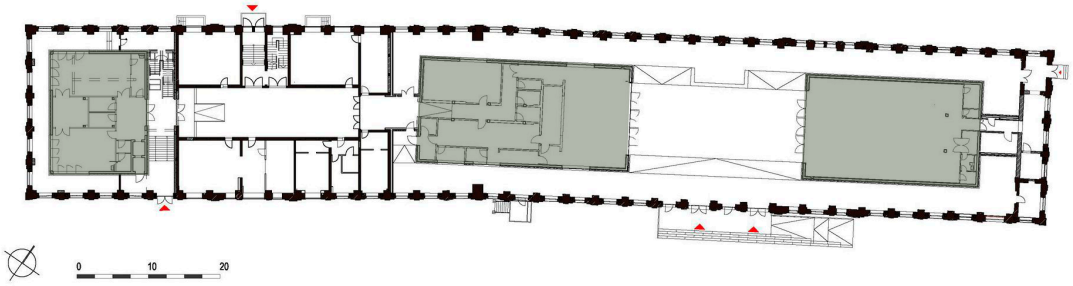
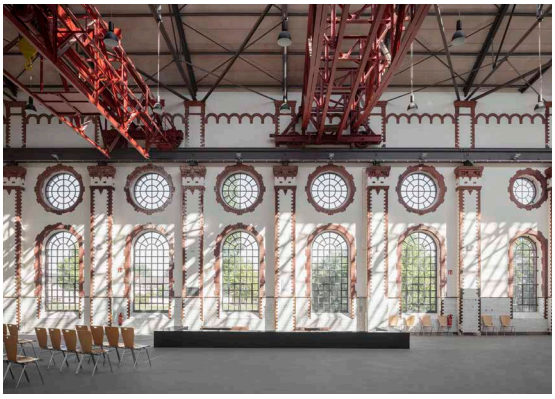
Appendix I

Building-within-a-building

Alsdorf Culture and Education Centre
Location: Alsodorf, Germany
Industrial building construction year: 1902
Previous function: Power Station of Anna coal mine
Original building size: 3840sq m
Reconstruction year: 2014-2018
New program: Refectory, Auditorium, Youth Art



- Interior space, restoring the triangular steel girders, bricked-up window openings were restored and the existing windows refurbished
- contrast between the white aluminum panels and the original brick wall
- Climate buffer between the new cubes and the envelope of the building



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https://www.gmp.de/en/projects/10612/culture-and-education-center
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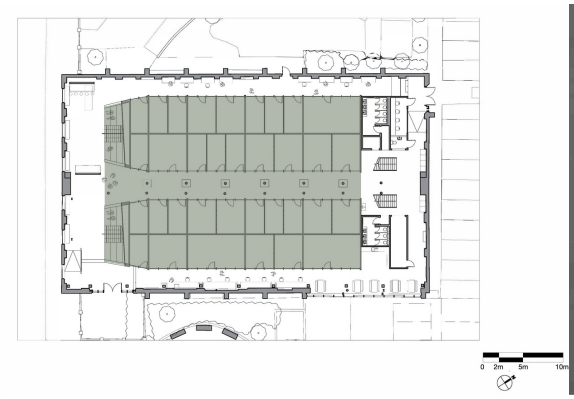
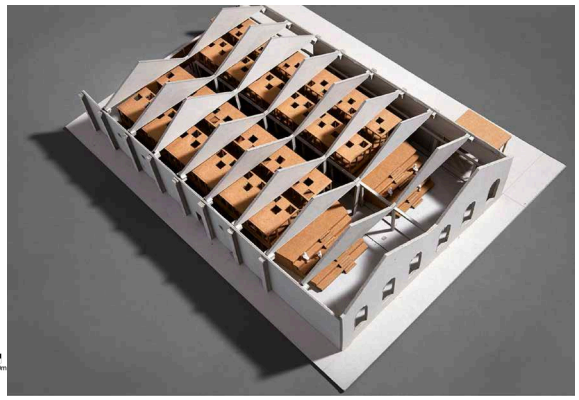
Appendix II

Building-within-a-building

The Forge Offices and Exhibition Space
Location: London, UK
Industrial building construction year: 1850s
Previous function: Millwall Ironworks
Original building size: 1700sq m
Reconstruction year: 2017
New program: A new headquarters and exhibition space for Craft central





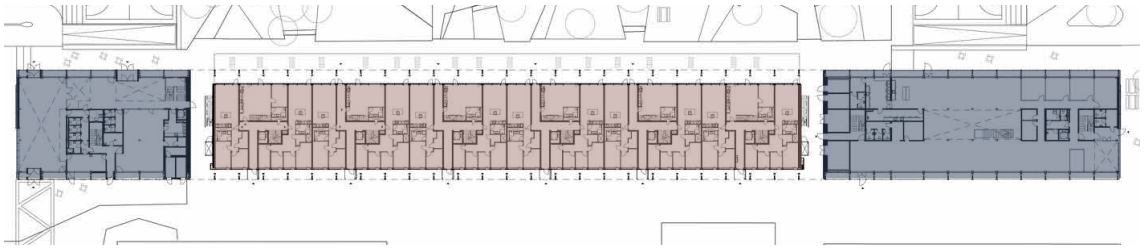
- Interior space, restoring original steel structure and the brick wall
- The choice of birch plywood emphasize the contrast with brick wall

Source:
https://www.archdaily.com/922922/the-forge-offices-and-exhibition-space-emrys-architects
https://www.dezeen.com/2018/02/04/emrys-architects-millwall-ironworks-artist-craft-studios-wooden-framework-london-uk/
http://eastlondononfoot.com/blog/2019/10/29/the-forge-new-industry-for-old

Appendix III

Building-beyond-a-building
Building-on-a-building

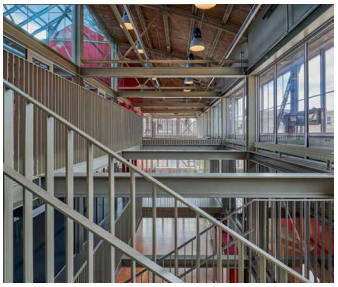
Valby Machinery Halls
Location: Copenhagen, Denmark
Industrial building construction year: Early 20th century
Previous function: a former industrial hall
Original building size: 4000sq m
Reconstruction year: 2014-2018
New program: Apartments, Office, Event space

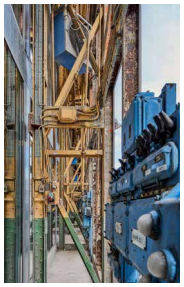


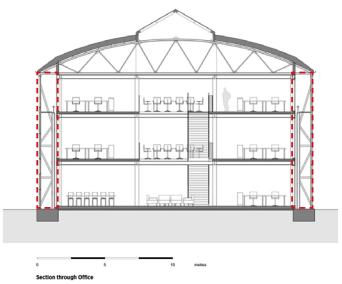
Building-beyond-a-building Building-on-a-buildng

- A new setback facade was redesigned in terms of sunlight can penetrate inside
- Using a steel construction, mounted on the new facade, the pace and the long, unbroken feel from the original facade are restored
- At both ends of the hall, a new interior building supported by an industrial steel structure has been inserted in line with the building's original expression.
- All lattice columns and steel profiles are made in the characteristic red color which is repeated throughout the building
- Public space located at opposite ends of the building, are insulated from the inside with a glass climate screen. Behind the glass, the traces of the hall's previous use can be seen.

West Elevation





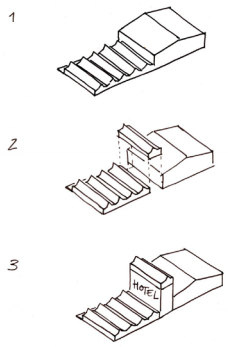


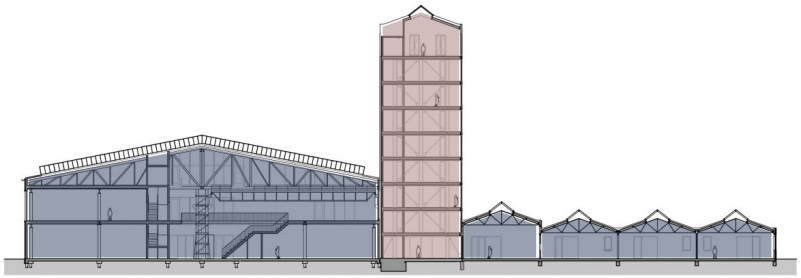
Source:
https://www.skyfish.com/p/cfmollerarchitects/1435828?predicate=label&direction=desc

Appendix IV

Building-beyond-a-building
Building-on-a-building

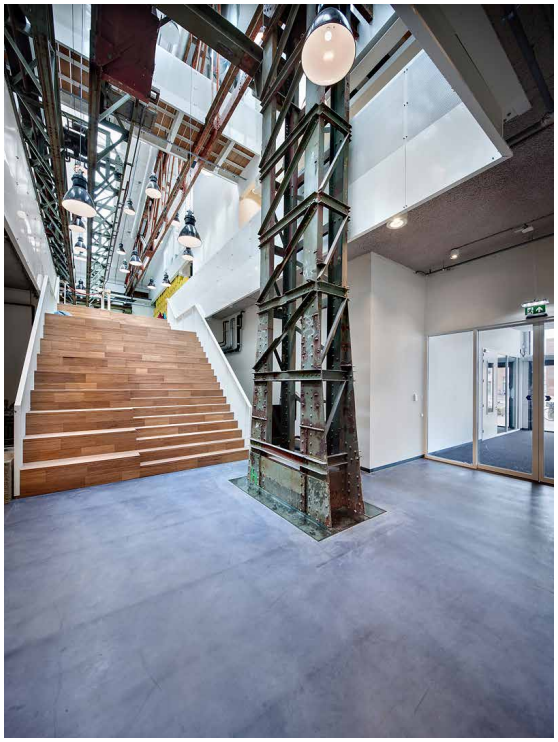
Smederij NDSM
Location: Amsterdam, Netherlands
Industrial building construction year: 1909
Previous function: a main forge- shipbuilidng industry
Original building size: 8412sq m
Reconstruction year: 2007-2014
New program: Office, Hotel, Restaurant

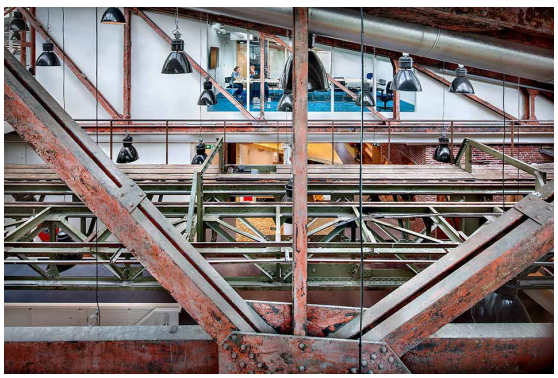




Building-beyond-a-building Building-on-a-buildidng

- The building facade division of the top space is consistent with the original building
- Restoring the monumental steel structure. Columns and trusses were only sandblasted and received no further treatment, which gives them a striking contrast to the white new interior.
- Different material emphasize the contrast between the top public space and hotel.



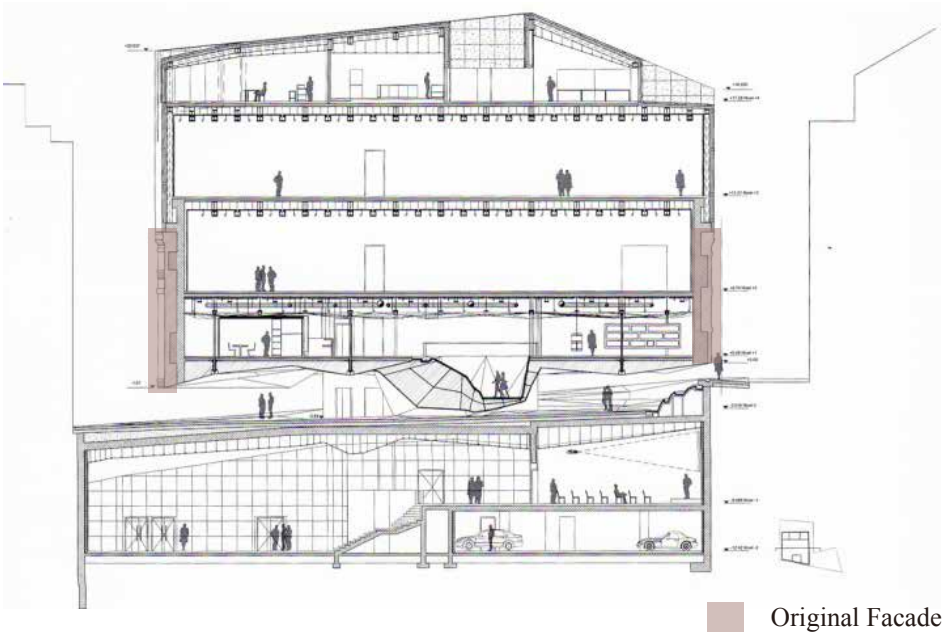


Source:
https://groupa.nl/projects/smederij-ndsm-amsterdam-nl/
https://www.gooood.cn/smederij-ndsm-by-group-a.htm

Appendix V

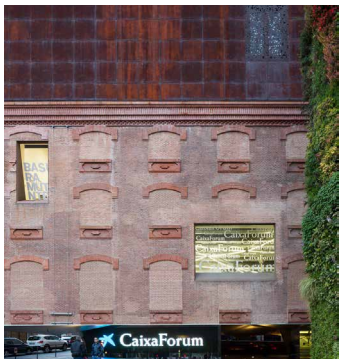
Building-beyond-a-building

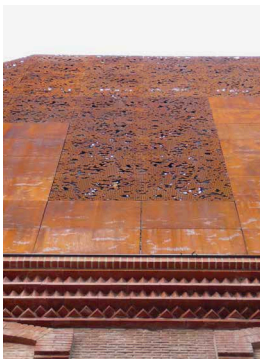
CaixaForum Madrid
Location: Madrid, Spain
Industrial building construction year: Not sure
Previous function: the Central Eléctrica Power Station
Original building size: 1934sq m
Reconstruction year: 2001-2008
New program: Gallery, Auditorium, Restaurant, Offices, Event room, Workshop



Original Facade

- The classified brick walls of the former power station were restored
- Cast iron plates that mirrored features of industrial architecture



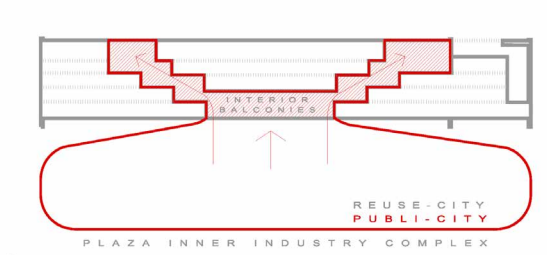


Source:
https://www.gooood.cn/caixaforum-madrid-by-herzog-de-meuron.htm
https://www.envolventesarquitectonicas.es/project/caixa-forum-madrid/?lang=en

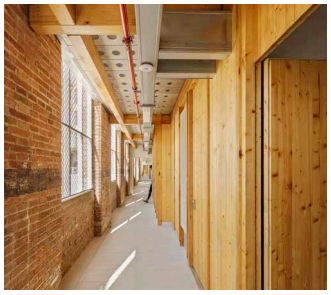
Appendix VI

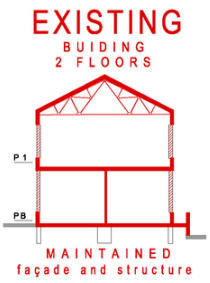
Building-on-a-building

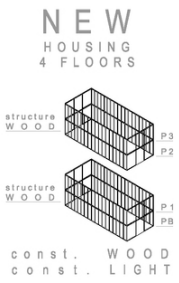
Social Housing Complex
Location: Barcelona, Spain
Industrial building construction year: 1905
Previous function: Warehouse building
Original building size: 1500sq m
Reconstruction year: 2019
New program: Social housing

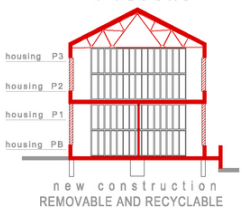


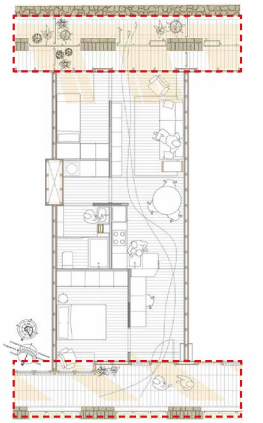
- The original facade has been restored and renovated
- The new construction is by assemblage, lightweight and reversible. Stuctural reuse of the two inner floors, and convert two floors into four
- Wood is used in all its forms: solid, agglomerated, cross laminated, etc.
- Facade and roof of the building as a thermic buffer for the housing units. Create in-between space to circulate air









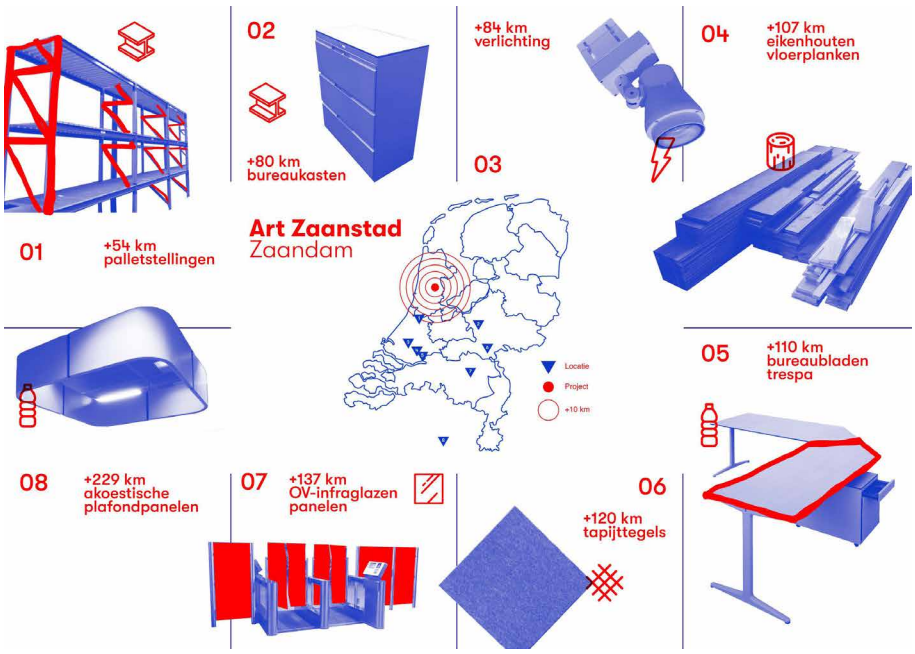


Source:
https://www.archdaily.com/950487/46-dwellings-in-the-former-fabra-and-coats-factory-roldan-plus-berengue?ad_medium=office_landing&ad_name=article
https://divisare.com/projects/419752-roldan-berengue-arqts-gael-del-rio-jordi-surroca-social-housing-complex

Appendix VII

Art Zaanstad
Location: Zaandam, Netherlands
Industrial building construction year: 1928
Previous function: Weapon Factory Hall
Original building size: Approx. 1000sq m
Reconstruction year: 2016-2017
New program: Museum with its own large collection

- The facade and structure are restored as it is before and the main entrance has been reintroduced
- Reuse materials from outside the site

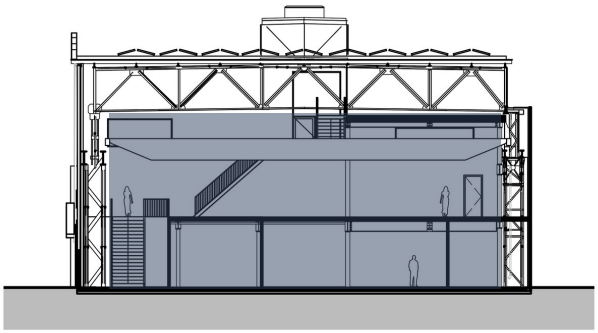


Source:
https://www.superuse-studios.com/projectplus/art-zaanstad/

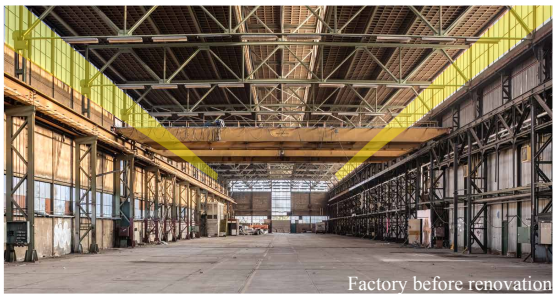
Appendix VIII

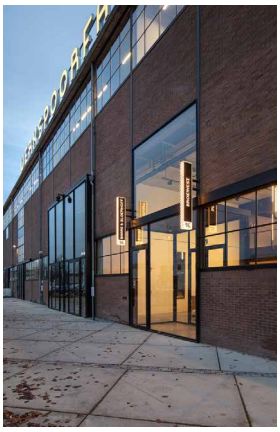
Building-on-a-building

Werkspoor Factory
Location: Utrecht, Netherlands
Industrial building construction year: 1913
Previous function: Industrial warehouse
Original building size: 4375sq m
Reconstruction year: 2019
New program: Business, Multifunctional space, Cafe, Office



- Several openings are added to the facade. The continuing steel window frames are restored.
- A modular building system of wooden blocks which can be easily repositioned is added


Factory before renovation

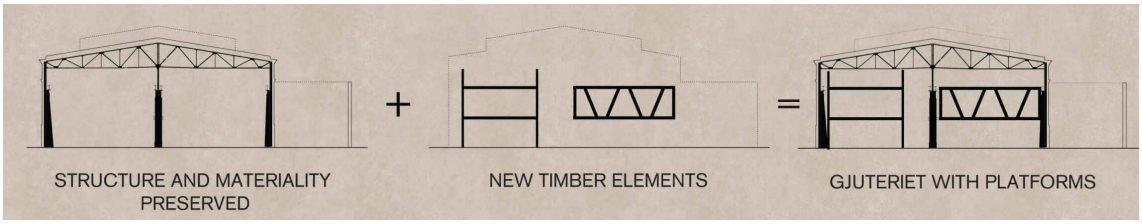


Source:
https://www.zecc.nl/en/project/2024/Werkspoor-factory-Utrecht
https://www.archdaily.com/948850/werkspoor-factory-zecc-architecten/5f764eb163c017bcc9000bee-werkspoor-factory-zecc-architecten-sections?next_project=no

Appendix IX

Building-on-a-building

Gjuteriet
Location: Malmö, Sweden
Industrial building construction year: 1910
Previous function: Shipbuilding factory
Original building size: 6030sq m
Reconstruction year: 2019-2023
New program: Workplace, Restaurant, Cafe

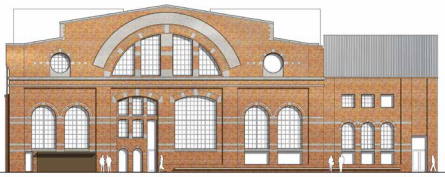


- Restore the north and south facade. Redesign the east and west facade and retain the elemnts
- Added structure which is detached from the walls and two of the newly volumes are hung from the remaining overhead crane runways
- The new construction is mainly made of timber which can lessen the load placed on the existing structure.
- Recycled bricks are used in the reconstruction facade
- Thermal insulation is placed on the inside and sandwiched in by another layer of recycled bricks.

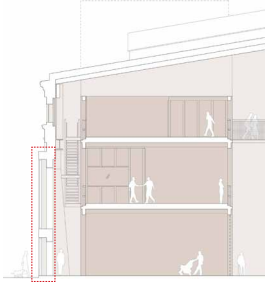
South facade before renovation

West facade before renovation

South facade after renovation



West facade after renovation

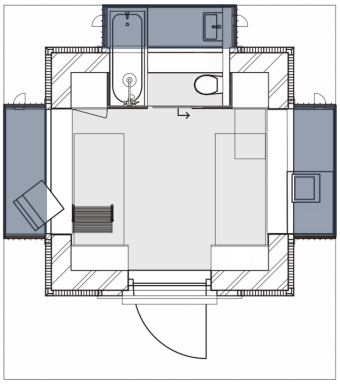


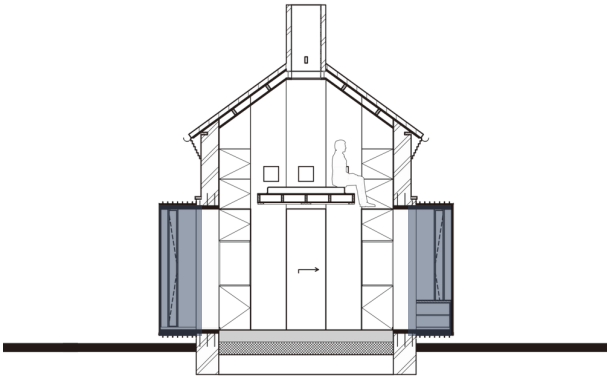
Source:
https://kjellandersjoberg.se/en/projects/project/gjuteriet/
http://tkbotnia.se/vara-projekt/gjuteriet/

Appendix X

Building-on-a-building

Transformation House
Location: Wirdum, Netherlands
Industrial building construction year: 1920s
Previous function: Transformer house
Original building size: 25sq m
Reconstruction year: 2020
New program: Contemporary Hiker's Cabin





Extension of facade

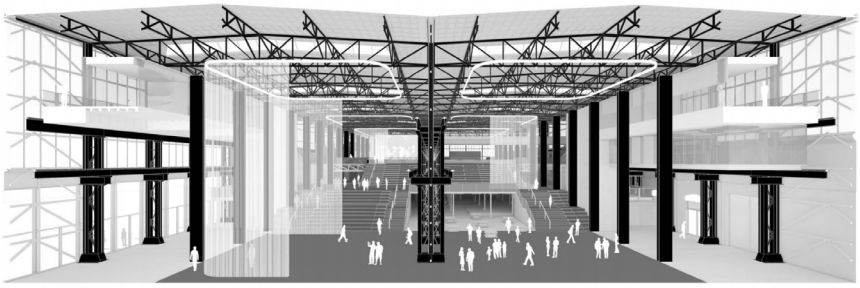
· some completely different modern elements, such as galvanized steel plates, were selected to emphasize the new extension

Source:
https://www.archdaily.com/960971/transformation-house-lautenbag-architectuur

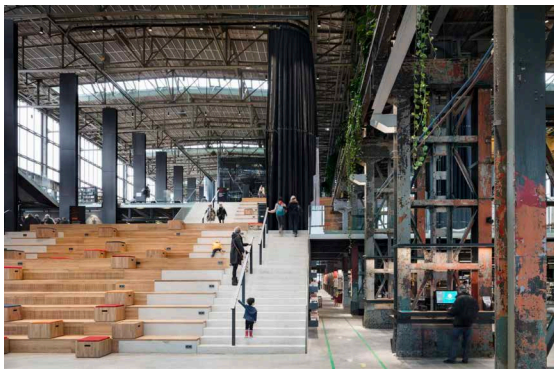
Appendix XI

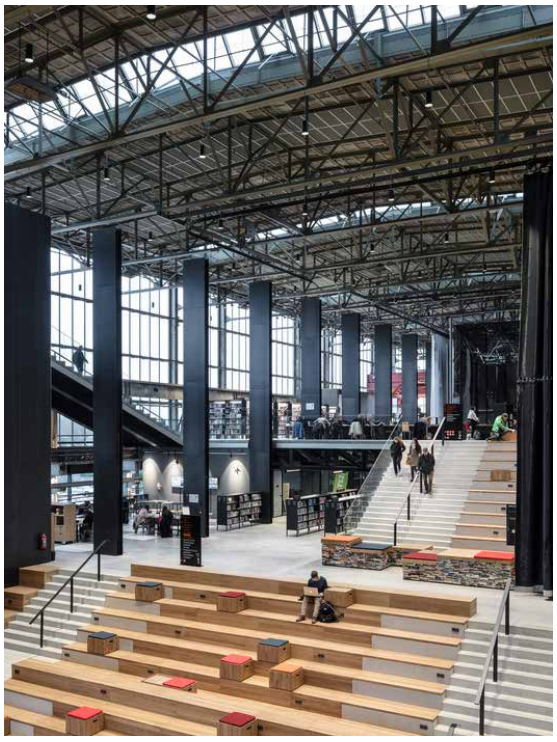
Building-on-a-building

LocHal Library
Location: Tilburg, Netherlands
Industrial building construction year: 1932
Previous function: Rail depot
Original building size: 5400sq m
Reconstruction year: 2019
New program: Library, Labs, Cafe, Exhibition



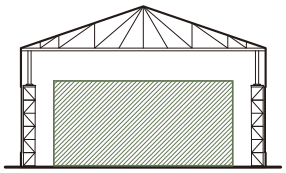
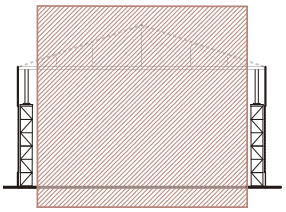
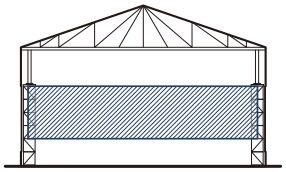
- Restore the original steel structure which minimize the amount of new structural elements. Part of columns are used for studying tables.
- Characteristic historical elements form an exciting combination with new oak material
- Adaptive climate zone system was introduced for insulation
- Heat the people rather than the entire area, seating on the bleacher stands will be heated and cooled





Source:
https://www.architonic.com/en/project/civic-architects-lochal-library/20085636
https://www.mecanoo.nl/Projects/project/221/LocHal-Library
https://urbannext.net/lochal-public-library/
https://issuu.com/civicarchitects/docs/2019_04_23_-_lochal_tilburg_-_prese

Appendix XII

	Facade	Structure	Material	Insulation
Building-within-a-building 	Restore and Renovate	Restore	Emphasize the contrast	Self-contained and generate climate buffer
Building-beyond-a-building 	Restore	Demolish	Emphasize the contrast	Totally new
	Redesign and echo the original expression		Echo previous function or material	
Building-on-a-building 	Restore and Renovate	Reuse	Reuse	Create climate buffer
	Redesign (functional leading and retain characteristics)	Restore	Recycle	Introduce new system
		Add new system	Introduce new materials	Detail design of facade