Research on the Transformation of Industrial Heritage into Residential Building
–Taking Barcelona as an Example

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The urbanization of China is developing rapidly, and the situation of construction and destruction without layout is very serious. In the modern city, many industrial heritages were dismantled completely. The negative impact is the separation of culture context and structure. And this, in a great degree, resulted in the waste of resources. With the changing from the industrial society to the post-industrial society and the adjusting of industrial structure, the traditional industry is fading away, more and more industry heritages are losing their production function, a lot of old industrial heritages are becoming useless. In the day of advocating the circular development, the reconstruction and recycle of the useless old industrial heritages become necessary. Multiform cultures of the context of post-modernism also affect the reconstruction and recycle of old industrial heritages, and offer the new mode and way in the mercantile situation. Hence, many industrial heritages, as a result, have been transformed into different forms such as creative industry park, "Loft", exhibition buildings, office buildings, leisure and entertainment places, residential buildings and so on through functional replacement.

The transformation of industrial heritage into public building provides the possibility for the diversification of urban space, but the market demand will eventually be saturated while excessive amount can also cause difficulties for lease. However, for residential buildings, the demand is huge, and this way can provide people a kind of dwellings with artistic value simultaneously. The transformation of industrial heritage into residential building has gradually become an important means of urban renewal and reconstruction. But viewing from China's relevant practice, the reuse of industrial heritage is confined to the field of public building which has just begun in the field of residential building. In contrast, relevant practice of foreign countries (such as Barcelona) is not only involved in the field of public building, but also in the ascendant in the field of residential building. While addressing a certain social housing problems, the value of industrial heritage can be more fully tapped and utilized.

In this paper, the applicability of industrial heritage transformation as well as the characteristics of residential building is used as clues. After studying the historical evolution and the corresponding
characteristics of related transformation in Barcelona and with the support from Barcelona related
transformation cases, it will analyze and study three cases which are totally different in the terms
of the relationship of the old and the new, that is, ‘installation’, ‘intervention’ and ‘insertion’. Then,
according to these cases, it will summarize a series of specific transformation strategies from four
aspects - urban design, space reconstruction, function improvement and skin replacement. At
last, compared with China's relevant transformation, with the guidance of the design principle, it
is expected to apply these useful design strategies for China's transformation of industrial heritage
into residential building combined with the current situation in the future and the application also
will be reflected on the design project in Wuhan, China. Finally, with the help of the main design
principle and these specific transformation strategies from Barcelona, the paper would provide
some meaningful help for the update of the city and the development of cultural undertakings in
China.
经济的发展和社会的不断进步，促使了“退二进三”的产业结构大调整，伴随着飞速发展的房地产建设，许多传统产业正逐渐衰退。城市中相当多的工业遗产正面临着推光式改造和改造再利用两种不同的命运。推光式改造虽然可以资源的利用率发挥最大效果，获取最大容积率，迅速更新城市面貌；但它破坏浪费了固有资源，也损坏了城市固有的文脉、资源及本土特色，造成一个地区或城市的的历史痕迹永久缺失。于是，为了延续城市的文脉，达到城市更新目的，同时实现经济利益的最大化，工业遗产的改造更新成为了目前建筑更新改造的热点。许多工业遗产通过功能置换的方式，被更新改造成为创意产业园、“Loft”、展览建筑、办公建筑、休闲娱乐场所等公共建筑或居住建筑等。

把工业遗产改造成公共建筑为城市空间的多元化提供可能性，但其市场需求终会饱和，数量过多还会造成招租困难。而对于居住建筑来说，随着中国的高速城市化，大中型城市的人口激增及城市用地不断扩张的现象极为普遍，因此在城市建设用地发展与居住建筑需求的方面产生了大量的问题，其需求量巨大，同时这种方式给人们提供了一种具有艺术价值的栖居。利用工业遗产改造居住建筑逐渐成为城市更新改造的一个重要手段。但从国内的相关实践来看，国内对工业遗产的再利用局限在公共建筑领域，居住建筑领域刚刚起步。与之相反，国外相关领域（例如：巴塞罗那）的实践不仅仅涉及公共建筑领域，在居住建筑领域方兴未艾。在解决一定的社会居住问题的同时，工业遗产的价值得到更充分挖掘与利用。

本文主要以工业遗产的适应性改造以及居住建筑本身的特性要求为线索。通过学习研究了巴塞罗那相关改造的历史沿革和理论发展，以巴塞罗那此类改造案例为支持，本文将主要分析在处理新旧建筑的关系上手法完全不同的三个工业遗产改造成住宅的案例。接着，由这些案例，进一步从城市设计、空间重构、功能改善造及表皮置换四大层面总结归纳从工业遗产到居住建筑的具体改造策略。再与国内相关改造案例相比较，以期运用这些设计原则和具体改造策略来指导国内相关改造案例的设计。最后，这些从巴塞罗那的优秀案例中总结出的经验将会在一个中国武汉的实际项目中得到运用和验证。通过这种运用和反思，希望真正能给国内工业遗产改造成居住建筑提供有益的参考。
RESEARCH ON THE TRANSFORMATION OF INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING
—TAKING BARCELONA AS AN EXAMPLE
1 INTRODUCTION
INTRODUCTION

1.1 Research background

The reuse of industrial heritage in the social development

Although the development of the society leads to the loss of the original production function of the industrial heritage, the simple removal and building something new are clearly not the most appropriate approach in terms of environment, economy and culture. (Fig. 1-1-1)

The industrial heritage had lost their original production function, but the buildings still contain the social resources which are worth being fully exploited and reused.

From the point view of location, at the beginning of the construction industrial buildings which had a certain history were often located in the urban fringe, but with the expansion of urban land, they were absorbed into it. Therefore the value of the land has been improved.

In terms of the traffic conditions, the requirements of the industrial products transportation are often prompted them to get a convenient transport system. From the point view of architecture group, large-scale industrial buildings always cover large areas, and have rigorous and effective functional organization structures.

From the point view of individual building, production devices and resources have higher requirements on the single spatial scale and structural strength of the single building.

And China’s industrial development started late, industrial constructions had short ages. The demolition will inevitably produce large amounts of construction waste, and make huge loss of social and environmental resources. Therefore, industrial heritage tend to have a higher recycling value.

Many abandoned industrial heritage conveys specific historical and cultural information. Due to the urban sprawl, many industrial buildings were abandoned now. And they were often built at earlier period which directly witness the history of industrial development in China. Meanwhile, as the product of the times, these industrial buildings convey the development and changes of construction techniques and ideas.
From the level of urban fabric, industrial building area has its own unique fabric, which is the valuable resource reflecting the city variety.

In the international arena, it had reached a consensus for protecting the industrial buildings as the cultural heritage for a long time, and it also made a clear definition of the industrial building in theory, such as "the International Committee of Industrial Heritage" (TICCIH) specified the "Nizhny Tagil Charter" in 2003.

In summary, the conservation and reuse of the industrial heritages have become the new social issues. For the architecture how to protect and reuse it has become an unavoidable problem.

As architecture heritage, the original design and construction of industrial heritage did not take the people as the starting point. There are significantly differences from other architectural heritage in terms of volume, scale, materials, etc. From this perspective, we cannot simply follow the conventional architectural conceptions and methods of the historical buildings’ protection and restoration in the past. In contrast, under the premise of the respecting to the original architectural features of the industrial buildings, fully excavating its reuse value as a building with historical details and style is the key to solve the problems on the protection and reuse.

The residential needs in the social development

With the rapid urbanization speed in China, the phenomenon that the population surging in medium-sized cities and urban land expanding are very common, which leads to a large number of problems in urban land development and the demand of residential building.

On one hand, urbanization makes the population growing, leading to the shortage of the urban housing supply. As economic development brings various advantages which makes such large amount of people influx into medium-sized cities, the first problem coming out with is about housing. The continuously rising housing price and the large amount of the high-speed developing residential projects in cities have undoubtedly indicated that there is a huge demand for housing in the large and medium-sized cities. However, the large-scale housing construction will definitely consume a large number of social and natural resources. Urban expansion swallows a large number of farming lands, and for the current resources status of our country which is of too many people but much less arable land, the development of the medium-sized cities’ urban residential
amounts appears to have been constrained by the natural resources and environmental factors which cannot be changed. Therefore, how to solve the housing problem in more effective and resource-saving way has become a social problem needed to be solved immediately.

On the other hand, with the urban space expanding, there are many idle industrial building lands. This phenomenon occurs mainly from the following reasons:

The high-speed development of social economy must be accompanied by the transformation of urban function.

For historical reason, many big cities in our country initially developed based on the large-scale industrial production, which were severed by lots of industrial buildings complex. In the social environment at that time, the values brought by the industrial building production were far greater than the consumption of the productive land resources and the environmental impacts. The production way of industry also has great changes. Nowadays, with the introduction of policies such as "retreat into three", large cities take the lead toward transforming to the "consumer city". Production behaviors in old industrial areas, either from their own aspect or from the aspect of the social economic and environment needs, are no longer in line with the pace of urban development, so it will go to demise inevitably.

The expansion of the cities leads to the adjustments of urban spatial structure and the changes of the land nature.

China's industrialization started late, most cities had formed the center of the city in the period of industrial constructions, so the industrial zones were often built at the borderlands of the cities. One basic feature of urban sprawl is constantly outward expanding of the urban lands, the industrial building areas which were formerly in the "edge" (or even suburban) areas are constantly surrounded by the expanding urban lands. Thus, there has been a mismatch relationship between the original industrial production’s land nature and the city's overall land nature, which leads to a relocation and even stop of the industrial production.

The current situation of the reuse of industrial heritage in China

In Barcelona, the reuse of industrial heritage has been an important task of the cities’ development and update. In China, with the appearance of Beijing “798 Creative Industry Park” and the large
number of industrial buildings in Pudong District, Shanghai built due to the Shanghai World Expo, the value and aesthetic way of industrial heritage have gradually been recognized by the society. (Fig. 1-1-2)

Viewed from the architecture transformation in Western countries including Barcelona, industrial heritage have strong adaptability to the new functions. In the area of public building, it is transformed to adapt to the business and exhibition at the architecture level, and it also makes a tremendous impacts at the city level. For instance, the Tate Gallery of British Art which is designed by Herzog & de Meuron, makes the most of the original volume and spatial characteristics of the industrial heritage, changing it to be the art and activity center and the city’s new landmark building. Meanwhile, in the area of residential building, the industrial heritage have also played a significant role, such as the transformation of the concrete cylinder to the twin residential buildings in Copenhagen, Denmark, and the conversion of the gas tank to the commercial and residential living building in Vienna, Austria, which get great utilization and economic effects. (Fig. 1-1-3)

Comparing to the domestic relevant practices, we can see that the strong adaptability of the industrial heritage has not been fully elaborated. After the 798, Nanjing 1865, Shanghai M50, Red Town and other similar projects appeared one after another, and at the same time there have been practices which transforms industrial heritage into offices, exhibition halls, shopping malls, hotels and other public buildings, reflecting the reuse of industrial heritage in our country only focused in the field of public building. (Fig. 1-1-4)

In contrast, the related practices in Barcelona not only refer to the field of public building but also make most use of the industrial heritage in the field of residential building. While dealing with the certain social residential problems, the value of industrial heritage could be fully tapped and utilized at the same time.

Why there are so many domestic transformation projects which only remain on the attempts of public building, but few are for the residential building? Of course, there are limitations caused by the system, conceptions and other practical factors. But as the reuse of architecture heritage, domestic research on the architecture level are about the significance of transformation, the research about how to transform especially for the residential building are not deep and comprehensive yet.
Fig. 1-1-1: The simple removal of the industrial heritage (Source: Google)

Fig. 1-1-2: The practices of transforming industrial heritages into public buildings in China (Source: Google)  
(Left: 798, Beijing; Right: Red town, Shanghai)
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--TAKING BARCELONA AS AN EXAMPLE

Fig. 1-1-3: The practices of transforming industrial heritages into residential buildings in China (Source: Google)
(Left: Zhongxin White-collar Apartment, Beijing; Right: Dongfeng TV Factory, Shanghai)

Fig. 1-1-4: The practices of transforming industrial heritages into residential buildings in Western countries (Source: Google)
(Left: New Concordia Wharf, London; Middle: The Gasometers, Vienna; Right: The Cement Factory, Barcelona)
INTRODUCTION

1.2 Definition of the core concepts

**Industrial heritage**

In the “The Nizhny Tagil Charter for the Industrial Heritage”, the International Committee for the Conservation of the Industrial Heritage (TICCIH) defined “Industrial Heritage” as “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.”

Industrial heritage can be divided into three types, that is, movable industrial heritage, immovable industrial relic and industrial building complex, and non-material industrial culture. Immovable industrial relic refers to the place of industrial activities; immovable industrial building complex refers to the industrial buildings area which is formed by the gathering of the industries. This thesis mainly focuses on this kind of industrial heritage.

The conception of the word “Heritage” in the “Industrial Heritage”, is often easy to be garbled with the same word in the “Historical Preservation”, which in turn is closely related to the protection and transformation measure of the industrial heritage. The term “Industrial Heritage” is prescriptive language referring to all the industrial relics which have no production function any more in general. “Cultural Relics Protection Law” makes regulation about the scope of the protected heritage, the Article V of which is “the material objects reflecting the various nationalities in different social system of social production and social life of the history”, indicates that the definition of the heritage is not limited to the ancient heritage, but also includes modern ones, while the valuable industrial buildings also belong to them.

From this we can know that the scopes of the cultural relics and industrial heritages are not in the same conception systems, but they have intersections relationship. Determining an industrial
heritage whether belongs to the cultural relics or not, primarily depends on its value and historical significance. Thus according to the provisions of "Cultural Relics Protection Law", some industrial heritage can be classified as the heritage, such as Daqing Oilfield, Mawei Shipyard and so on. In addition, a large number of industrial heritage do not belong to the scope of cultural relics, therefore, its valuation, protection standards, development modes and transformation method and some other points have big differences from the cultural relics. Therefore, the industrial heritage mentioned in this thesis does not include the buildings which have been included into the scope of the cultural relics.

Residential building

Residential building refers to the building for people to live and use during their daily life. It includes: houses, villas, dormitories and apartments.

The definition of the residential building in the relevant norms in China is that: for domestic residential people used buildings (including the residential space existed with other functions in the same building) are called as "residential".

Villa is a garden house built in the suburbs or in the scenic resort for leisure and relaxing. It’s a place to enjoy life besides the residence; it is the second home, not the first one. Now it is widely recognized that, besides the basic functions of "residence", villa is a kind of advanced residence mainly reflecting the quality and the enjoyment of life, which usually refers to a separate manor house.

Dormitory is a kind of residential building providing accommodation for the school students and single workers of mining enterprises.

As a kind of collective housing, apartment is widely known as the residential building unit in the Chinese mainland, in Hong Kong and Macao it is called as unit, which refers to a residential form with complete facilities, but is only a part of the architectural spaces. In the early stage, the apartments were high-rise buildings. In each level, there were numbers of separate single-family suites, which included bedroom, sitting room, living room, bathroom, toilet and kitchen, etc., and mainly sold for the middle-income senior staff and civil servants to live at that time. There are
also some apartments attached to the hotels which are provided for the domestic and foreign businessmen and their families who use it for short-term rental. Apartments are generally divided into residential apartments, serviced apartments. And the serviced apartments mainly exist as the forms of hotel apartments, business apartments, youth apartments, white-collar apartments, youth SOHO and etc. Compared with the villa, it is much more economical and practical.
INTRODUCTION

1.3 Research objectives and significance

Think about the transformation from industrial heritage into residential building.

Through the research of transformation from industrial heritage into residential building, based on the summary of the transformation of the industrial heritage above, focusing on the residential building space, explore the methods and design techniques, which has a certain theoretical value.

Enrich the framework of the related fields about the industrial heritage reuse.

In many problems of the industrial heritage reuse, the primary contradiction is the adaptation of new features to old buildings, while the problems in industrial heritage transformed into residential building are more representative. The main performance is the scale disparities. Therefore, focusing on the research of transformation design principle and strategies, it can play a representative role on general problems about the industrial heritage transformation and function replacement.
1.4 Research objects and content

Research objects

There are many theoretical researches on industrial heritage conservation and reuse. As residential building has its special spatial and functional requirements, the design principle and strategy of the transformation from industrial heritage into residential building is still at a relatively empty stage. In addition, the reuse of domestic industrial heritage has just started in the field of residential building, by contrast, the practice in related field in foreign countries (for example: Barcelona) is in the ascendant.

With this in mind, this thesis mainly takes the transformation of industrial heritage and the characters of the residential building as a clue. Supported by the relevant transformation cases in Barcelona it will summarize the main design principle and specific strategies of the transformation from the industrial heritage into residential building, which are the objects of this thesis.

Research content

The development of transforming the industrial heritage into residential building in Barcelona;
The case study of transforming the industrial heritage into residential building in Barcelona;
The design principles of transforming the industrial heritage into residential building in Barcelona;
The inspiration and significance of transforming the industrial heritage into residential building in Barcelona.
INTRODUCTION

1.5 Research methodology

Literature Research

By reading literatures about the backgrounds, it will research the development of the transformation from industrial heritage into residential building, and chronologically summarizes the characteristics of them in each historical period.

Case Study

Field Research

It mainly focuses on the excellent design cases in Barcelona which are transformed from industrial heritage into residential building. The basic research on the cases includes the relationship between the building and the environment, the interior and exterior spaces, structures, transportation, lighting & ventilation as well as the architecture skin before and after the transformation, focusing on the design attempt and the usages. Through field research, I could get firsthand information, then summarize and analyze them.

Thematic Interview

According to the questions which are preset in the research framework of the thesis, I will try to seek advices from the residents, professionals, and management agencies about the spaces implementations, related policies, and the means to deal with the contradictories, and then make an objective evaluation of the case.

Data Compilation

Though in-depth analysis of the cases, I will make it clearly about the basic information, design techniques, transformation strategies, current usage and constraints, and then summarize it in the form of table.

The methodology of case study is considered to be appropriate for this research for various reasons.
Firstly, the exploration of the specific strategies of transforming industrial heritage into residential building is achieved through the analysis of the ‘good practice’ examples. Secondly, research by the method of case study could give an opportunity to collect the data in a systematic way and validate data in different contexts, so that these design principles could be applied into other examples without any limits. In the meantime, this method also has some weak points. For example, there may be some subjectivity and unreliability of information due to the interlocutor’s subjectivity. But in this thesis, this could be avoided because there is no need for them to provide some incorrect information and all the data also could be verified in different ways.

**Comparing Research**

**Vertical Comparison**

The transformation of Barcelona an industrial heritage was effected by big events, which has several development phases. Through researching the transformation information from the industrial heritage into residential building in different periods, I will summarize its characteristics.

**Horizontal Comparison**

On one hand, through the analysis of the outstanding cases in Barcelona transformed from industrial heritage into residential building from the four aspects which are urban design, space reconstruction, function improvement and skin replacement, I will summarize its design principles. On the other hand, compared with the Chinese cases transformed from industrial heritage into the residential building, I will try to provide appropriate new ideas combined with domestic current situation.
INTRODUCTION

1.6 Research framework

Research on the Transformation of Industrial Heritage into Residential Building
--Taking Barcelona as an Example

Introduction
Research background, Definition of the core concepts, Research Objectives and significance, Research Objects and content, Research methodology, Research Framework

The development of transforming the industrial heritage into residential building in Barcelona
Relevant theory and practice of transforming the industrial heritage in Western countries
The historical review of the industrial development in Barcelona
Relevant theory and practice of transforming the industrial heritage into residential building in Barcelona

The case study of transforming the industrial heritage into residential building in Barcelona
Case study 1: Fàbrica Tort Can Planell
Case study 2: Passatge del Sucre
Case study 3: The Cement Factory

The design principles of transforming the industrial heritage into residential building in Barcelona

The inspiration and significance of transforming the industrial heritage into residential building in Barcelona
Relevant theory and practice of transforming the industrial heritage into residential building in China
The comparative analysis of transforming the industrial heritage into residential building between Barcelona and China
Project in Wuhan, China

Conclusion
2 THE DEVELOPMENT OF TRANSFORMING THE INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING IN BARCELONA
2.1 Relevant theory and practice of transforming the industrial heritage in Western countries

Western developed countries first experienced the industrial revolution and the development of modern industry, so a large number of buildings from industrial era have been left in the city. Therefore, the protection and transformation of industrial heritage began in the western developed countries. With the continuous development of economy, the constant adjustment of the industrial structure and the continuous enlargement of the city scale, the industrial heritage which occupies the superior location of the center of the city has become the obstacle of urban renewal and development. In the developed countries of Europe and America, the renovation and reuse of the old buildings has become a hot issue discussed in the architecture industry. Australia compiled “the Charter for the protection of places of cultural significance” in 1979, hereinafter referred to as “The Burra Charter”. In view of the protection of architectural heritage, the concept of “adaptive reuse” is put forward clearly, which means do the adjustment to a certain place to accommodate new functions. This practice is encouraged and promoted because there is no substantial weakening of the cultural significance of the place. Specifically to the industrial buildings, developed countries in Europe and America have experienced three stages in general.(Fig. 2-1-1)

Exploration and Budding Stage

At the beginning of the 20th century, with the rising of the consciousness of human history, humanistic thought and environmental awareness continue to strengthen. Countries around the world began to pay attention to the protection and renovation of historical buildings and historical sites. “Athens Charter” which is formulated in 1933 began to pay attention to the protection of ancient buildings. Due to the limitations of understanding, the “Athens Charter” focuses on how to preserve those buildings with very significant historical value, and it does not involve industrial heritage. Until 1964, “Venice Charter” was put forward, which indicated that there was a qualitative improvement in the protection of the buildings. The charter is divided into 6 parts which are definitions, protection, restoration, historical sites, excavation and publication, and there are 16 articles in the charter. But it does not fundamentally answer the relationship between protection and utilization.
In the 1950s-1960s, it is the exploration and budding stage for the transformation of the industrial heritage. During this stage of large-scale constant urban updating, a large number of industrial heritages were regarded as worthless waste and continued to be abandoned. But more and more people began to miss these ancient and dilapidated architectural heritages, and continued to put into practice of transformation. The United States which is the first country to set off urban renewal took the lead in this kind of change. The research and exploration of the transformation and reuse of the industrial heritage in the western countries represented by the United States started one after another. A large amount of successful works have been produced, and good economic and social benefits have been achieved.

**Development and Popularization Stage**

Since the 1960s-1970s, western countries began to move from the industrial age to the post-industrial age. With the change of urban function and the adjustment of industrial structure, the traditional industry declined gradually and gave way to the tertiary industry. The original factory, warehouse and other building facilities lost the original functions, and many of which are in idle or abandoned. This is the stage when the "LOFT" phenomenon is popularized gradually. The practice of transformation and reuse was carried out actively on both sides of the Atlantic, and even extended to other countries and regions.

SOHO which is located in New York is one of the industrial zones in New York in the second half of the 19th century. The “cast-iron type building” designed as the small factory and warehouse was built in 1869-1895 with exquisite and unique cast iron technology. However, the manufacturing industry in New York declined gradually after World War II, a large number of SOHO factory was relocated or closed. Many buildings were empty and ruined. SOHO resisted the wave of urban renewal in the 60’s, and some artists organized to protect it. They transformed the industrial buildings that had lost their original function into the form of the studio, living unit and other forms and had achieved success. SOHO’s experience of regeneration directly affected the revival of the traditional districts with industrial heritage, such as London Docklands and Dublin forbidden temple area.

During this period, the scale of transformation and reuse was expanding gradually, and the means of transformation and reuse is also more flexible. The government and enterprises began to change
ideas and pay attention to this kind of activities with positive significance. With the participation of many professional architects, larger and more complex transformation projects became possible. Many traditional industrial enterprises have been transformed into high-tech industries. Large tracts of old industrial areas in the city have been transformed into high-tech industrial areas, residential areas, scenic areas and public areas. Some of the old factories and their declining environments have been transformed into houses, shops, new enterprises, and various public buildings.

This trend began to spread rapidly in the middle of the 70's. After the mid-1970s, the awareness to the ecology, environment and resource was rising continuously. The main reason for this shift is the two oil crisis that occurred during 1973-1974 and 1979-1980. New buildings consumed a large amount of resources, and property developers had to seek a low-cost mode of construction, so that the reuse of industrial heritage has been given greater attention. During this period, the formulation of the “Nairobi proposal”, “Charter of Machu Picchu”, “The Burra Charter”, and other charters have all played a guiding and promoting role in the transformation of industrial heritage.

The most typical practice of transformation of industrial heritage in this period is Lowell city of the United States in the 1970s. Through the transformation of more than 100 industrial heritages, the current Lowell National Historical Park came into being. A large number of old park buildings which had lost the production function have been reconstructed and reused. For example, the Lowell textile mill has been transformed into a multi-purpose complex which contains 230 apartments, low-income and elderly housing, office buildings, kindergartens, restaurants, museums, as well as a reception center. The central courtyard has become an important place to organize various activities- the factory square. Another example is the renewal and transformation of London New Concordia wharf in the transformation and revival of the warehouse district of the British Isles since the mid-1980s.

Maturity and Practice Stage

After the late 1980s, with the increasing demand of culture and art, the boom in the reuse of the industrial heritage in a variety of flexible ways such as functional replacement was set off. The transformation of the industrial heritage represented by the “LOFT” phenomenon has been widely recognized. It is believed that this kind of transformation is an important category which is contained in the transformation and protection of old buildings. It is believed that this kind of activity expresses
new culture and social values, and a new concept of architectural heritage protection and urban construction. The attitude of the western governments and the real estate businessmen toward the transformation of the industrial heritage transformed from indifference, suspicion, and even disgust into encouraging, supporting and advocating. At this stage, the transformation object expanded to a large number of light industrial factories and a small number of heavy industrial factories which have been built since the industrial revolution, from the winery to flourmill, from Hydraulic mill to manufacturer, from the barn to power station. There are various types of transformation objects. At the same time, the types after transformation is also varied, such as office buildings, apartments, shops, art galleries, etc. The practical activities of transformation extended from single building to the renewal and transformation of the whole district or the whole factory. With the economical development, the scope of the transformation and reuse became larger; the types of the industrial buildings involved became broader. The transformation and reuse of the industrial heritage that lost the production function has matured gradually.

For the transformation and reuse of the industrial heritage, this stage is the time of large-scale popularization and diversification, when a number of successful works emerged. For example, four huge gas tanks in Vienna which was built at the end of nineteenth Century was transformed into an extremely distinctive, fully-functional living community, which contains residence, school apartments, shopping centers, office buildings and other ancillary facilities; Forster transformed a coal mine factory in Essen of Germany into a design center in Germany, etc. The unprecedented interest of people brought the transformation and reuse of the industrial heritage to a climax. Diversification and popularized reuse is an important feature of this stage. In terms of elated theories and laws and regulations, “Washington Charter” which is formulated in 1987 pointed out the historical towns, historical areas of traditional residential areas and environmental protection. In the 19th session of the Barcelona International Building Association (UIA) in 1996, the concept of “Terrain vague” was put forward, and pointed out explicitly that protection, management and regeneration is needed in the abandoned areas in the city such as industry area, railways area, docks, etc. In 2003, the “Nizhny Tagil Charter” made a clear provision to industrial heritage which is namely the definition of value, record and research of the industrial heritage, and listed industrial heritage and structures and the town and landscape where they are located as the protection target. Meanwhile, with the continuous improvement requirements of the spirit place in urban space, the research on the transformation of the industrial heritage will also rise to a new height.
The main international conventions on the protection and renovation of industrial heritage (Source: Author)

<table>
<thead>
<tr>
<th>Convention Name</th>
<th>Time</th>
<th>Publishing Agency</th>
<th>Place</th>
<th>Main Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Athens Charter”</td>
<td>1933</td>
<td>CIAM</td>
<td>Athens</td>
<td>Avoid road congestion and limiting the living environment.</td>
</tr>
<tr>
<td>“Venice Charter”</td>
<td>1964</td>
<td>ICOM</td>
<td>Venice</td>
<td>Make rules of the control require the area environmental, the principle of repairing, addition, none fill-up and the use of modern technology.</td>
</tr>
<tr>
<td>“Nairobi Recommendation”</td>
<td>1976</td>
<td>UNESCO</td>
<td>Nairobi</td>
<td>Legislative, administrative, education, information, international cooperation.</td>
</tr>
<tr>
<td>“Machu Picchu Charter”</td>
<td>1977</td>
<td>CIAM</td>
<td>Lima</td>
<td>Combine the protection and development, give new life to old building.</td>
</tr>
<tr>
<td>“Dublin Principles”</td>
<td>2011</td>
<td>ICOMOS</td>
<td>Paris</td>
<td>Pass through the common principles on industrial heritage sites, structures as well as the regional and landscape protection.</td>
</tr>
<tr>
<td>“Taipei Declaration”</td>
<td>2012</td>
<td>TICCIH</td>
<td>Taipei</td>
<td>Asia’s industrial heritage values, characteristics, and intended meanings.</td>
</tr>
</tbody>
</table>

Fig. 2-1-1: The main international conventions on the protection and renovation of industrial heritage (Source: Author)
<table>
<thead>
<tr>
<th>Main Measure</th>
<th>Protection Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Across the heritage area, improve the nearby living environment.</td>
<td>Began to pay attention to the protection of ancient buildings.</td>
</tr>
<tr>
<td>Requirements in the scope of the built heritage principle of repairing, addition, none fill-up and modern technology for protection, etc.</td>
<td>Historical monuments as well as the urban and rural environment of civilization or certain historical events.</td>
</tr>
<tr>
<td>Economic, technical, policy, research and international cooperation and social measures.</td>
<td>Prehistoric sites, historic towns, the old town, the old village and the similar group of monuments.</td>
</tr>
<tr>
<td>The protection and development, new life to old building.</td>
<td>Historical monuments, traditional culture and more extensive cultural content including outstanding contemporary architectures.</td>
</tr>
<tr>
<td>Financial means, resident participation, interdisciplinary research.</td>
<td>Traditional living environment of historic area and historic towns.</td>
</tr>
<tr>
<td>Of the Industrial Heritage value's definition, as well as the research and conservation measures.</td>
<td>Old industrial buildings and structures, production processes and production tools and the towns' landscapes of where it is.</td>
</tr>
<tr>
<td>Common principles on industrial heritage sites, the regional and landscape protection.</td>
<td>Not only emphasize the tangible heritages, but also pay more attention to non-material heritages.</td>
</tr>
<tr>
<td>Heritage is different from other regions.</td>
<td>Strengthen the Asian industrial heritages' values, characteristics and intended meanings.</td>
</tr>
</tbody>
</table>
2.2 The historical review of the industrial development in Barcelona

Nowadays, Barcelona is one of the most industrialized city-regions of Spain. In spite of Madrid’s economic development, Barcelona is still considered as the industrial capital of the country and an essential agent for the entry to Spanish economy in the European context to some extent.

Taking its historical development and geolocations into consideration, the Barcelona’s industrial layouts could be explained. Barcelona has served as an intersection of manufacturing, a vital center of commerce and trading, since the discovery of America. Owing to its strategic location, on the Mediterranean Sea and near Spain’s border with France, Barcelona had been inevitably becoming the dominating industrial and commercial center in Spain. Separated by several influenced events, Barcelona industrial development in modern times (from the industrial revolution to the 21st century) can be divided into several stages.

Before 1950: industrial development, social struggles and civil war

At the beginning of the nineteenth century, as the industrial revolution spread in the European continent, the Catalonia regions also entered the Industrial Age. As the capital of Catalonia, owing to its excellent geolocation and port condition, Barcelona became the pioneer in the industrialization process and the dominating industrial region in the country. Industrial development prevailed in the city of Barcelona, the main center of activity. And numerous small to medium companies related to the textile industry blooms in the surrounding cities such as Sabadell, Terrassa and Mataró. The rapid industrialized progress was also companied by strong social conflicts which led to a civil war at the beginning of the 20th century. Thought the Spanish Civil War (1936-39), Franco obtained the regime. From then to the 1950s, the city was in a period of economic depression under an economic and social crisis.

From 1950 to 1990s: Economic development and the arrival of democracy

Until the 1950s, its economics revive from the depression. From a view of history and politics, this
period can be divided in two sub-periods. The first stage was from the 1950s to the second half of the 1970s and the second period lasted for the 1980s decade.

In the first period, under the control of Franco regime, industrial development was accelerated. This period ends with the arrival of the effects of the economic recession (Middle East Oil crisis) and the downfall of Franco regime. The second period is about the transformation of the city-region under a new democratic political system and amidst dramatically economic depression. It ends by the opening of Olympic Games in 1992.

1) From 1950 to 1975: Industrial development and urban growth

From the 1950s, plenty of immigrants flooded in the city of Barcelona from the rest of Spain in order to be employed in the industries in Barcelona. The dramatic demand for new shelters of new residents brought out rapid urban development of Barcelona. The numerous arrivals of newcomers caused an integral transformation of the urban model. Like a coins have two sides, companied with the development, lots of low quality infra-housing and the construction of illegal houses by the immigrants appeared in unpopulated areas of different cities. From the 1960s onwards, some active neighbors’ associations call for providing basic social services and infrastructure for housing estates. Until the 1970s, the conflicts between the rapid development and the infrastructure deficit existed in Barcelona and its surrounding cities. However, since 1970s, the organisms such as Obra Sindical del Hogar and the Patronat Municipal de l’Habitatge de Barcelona began to construct several housing projects which met the housing demand on the whole.

2) From 1975 to 1992: Crisis, democracy and new events

From 1975, the emergence of some economic and political events influenced the development of Barcelona. In the economic aspects, the economic recession and a population decrease which was turned around until 1986 urged the industrial transformation which has initiated since the late 1960s in Barcelona. In the political aspects, with the downfall of Franco’s regime, the transition from autocracy system to the democracy political system was completed until 1981. This political instability exacerbated the economic depression.

In 1976, with Franco’s death, the autocracy came to the end and Spain began to adapt a
democracy political system. In Barcelona, the first democratic town council which was elected by people was confronted with a poor and lack of infrastructure city that caused discontent. The new city council had to set about this crisis and improve the living conditions in Barcelona.

At the same times, great industrial transformation and de-urbanization appeared in Barcelona. In the context of economic recession, the number of jobs decreased sharply, unemployed population increased. The industrial layouts also changed: the factories which occupied in the center of city and many aging facilities was abandoned, the industrial sectors were relocated in the periphery of the city. As the emerging sectors, the second and third industry and service industry began to take the place of manufacturing sectors in the center of city. In order to coordinate with the industrial transformation, the government set about adjusting land policy to enhance the effective of land use, the abandoned land by the industrial sector and the land insufficient with extensive use were developed. Meanwhile, the de-urbanization phenomena appeared in Barcelona. The center of city decayed with the living conditions worsen. Plenty of middle class moved to the rural region while the rate of low incomes population increased.

In 1986, two events provided paramount opportunities to changing the expectative of Barcelona as metropolitan region. One event, Spain’s joining the European Union, made the economic opening to the outside and improved the economic competitiveness. The other event, Barcelona’s nomination to organize the 1992 Olympic Games, would offer an opportunity for major urban renewal. Owing to the two significant events, Barcelona experienced an unparalleled economic and territorial development.

From 1990 to 2000: great transformations

In the 1990s, owing to the industrial transformation and the two great events in the last two decades, the economic pattern of the BMR changed extensively and the social transformations continued and intensified gradually. Barcelona made considerable progress in the urban restructuring of the city followed by the Olympic Games and the “Barcelona model” came up.

In October 1996, Barcelona Town Council announced that an unparalleled world event, namely, the Fòrum de les Cultures 2004 would be host in Barcelona. This event was designed for doing urban renewal and transformation which will provide a better condition to attract capital and
tourist. From then on, the event played a vital role in the global policy for Barcelona.

Undoubtedly, the successful host of 1992 Olympic Games influenced the city development dramatically. The success and the following development measure made it possible that turn Barcelona into an international city which is a desirable place to live, to visit or to invest. The city became a more and more attracting tourist resort and its reputation as a place with high quality of life was enhanced.
THE DEVELOPMENT OF TRANSFORMING THE INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING IN BARCELONA

2.3 Relevant theory and practice of transforming the industrial heritage into residential building in Barcelona

The main practice of transforming the industrial heritage into residential building in Barcelona originated from the district Poblenou. At the same time, there are also some relevant cases scattered in other districts of Barcelona, and most of them are separated cases. According to the research of the author, there are mainly eight excellent relevant cases in Barcelona. Four of them are located in Poblenou, one is in Sant Just Desvern, one is in Terrassa, and one is in Sabadell. (Fig. 2-3-1) (Fig. 2-3-2)

With regarding to Poblenou, the factories of the 19th century and 20th century in this district are constructed in the industrial revolution. The industrial development of Poblenou is due to sheer availability of land and the low prices as well as the construction of the railway in 1848. Gradually Poblenou had developed into the “the Manchester of Catalonia” which refers to the significant position in Barcelona.

To ensure the economic growth of Barcelona, the city should guarantee the quantity of the office and production space. But there was the land shortage in the central Barcelona until 1860s while the density of the built land is relatively low in Poblenou and it also has a good industrial tradition. All of these forced the increase of the industry around the main city including the Poblenou.

In order to sustain the economic growth of Barcelona and its profound shift towards tertiary-based economy, achieved during the last decade, the city has obviously to ensure sufficient amount of office and production space. Having the lowest density of the built land in the very city centre and many empty former industrial estates, the Poblenou district has been decided as a site for this operation by the Barcelona City Council. The area has other advantages as well beside its low density. Poblenou has a long industrial tradition and a special place in industrial culture of Barcelona and Catalonia. It also has an existing productive fabric, good traffic accessibility within metropolitan region and central location within the city. But later as the decline of textile sector made some building abandoned which used to be the space for warehouse, workshops or garages in the 1960-70s, and in the 1980-2000 the industrial buildings in the Poblenou showed a state of abandonment.
The urban transformations which were carried out in the late eighties and before the Olympics were the first large projects in Poblenou. And before this there was a regulation which had made some rules to deal with the industrial heritage in Barcelona including some buildings in Poblenou. Afterwards, modifying the 1976 General Metropolitan Plan classified the Poblenou district for predominantly industrial use, the Modification of the General Metropolitan Plan for the renewal of the industrial zones of Poblenou—such as the 22@ plan was a successful urban model for city transformation which could be said to be the most vital plan recently undertaken in the Barcelona metropolitan area. It aims at transforming the former industrial district in central Barcelona into a new district with multifunction of old industry, residential, knowledge-based societies and leisure.

For the four cases of transforming the industrial heritage into residential buildings in Poblenou, Vapor Llull is an emblematic building as it was the first major renovation of old factories of Poblenou and became a building of 18 lofts in 1997. From 2003 to 2005, three urban renewal projects (Passatge del Sucre, Can Gili Vell and Can Gili Nou) were approved by the Technical Commission of the City of Barcelona. The organization allowed the private real estate developers to reuse the abandoned factories as the new residential buildings, which is a pioneering effort for Barcelona. As a result, 139 lofts, 1 hotel and some offices are generated by degrees. In the whole transformation, the private real estate developers used some slogans such as “paying attention to the original elements such as volume, facade, heights, large windows, and structural elements” and “respecting the original architectural concept of industrial halls” to promote housing. Hence, the sale price of the loft was higher than the traditional housing which brought some additional value to them while protecting the industrial heritage.
Fig. 2-3-1: The positional distribution of the eight relevant cases in Barcelona [Source: Author]
<table>
<thead>
<tr>
<th>Type</th>
<th>Project</th>
<th>Original Construction Time</th>
<th>Transformation Time</th>
<th>Original Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residence</td>
<td>Vapor Llull</td>
<td>1902</td>
<td>1997</td>
<td>Vapor Factory</td>
</tr>
<tr>
<td>Residence</td>
<td>Can Gili Vell</td>
<td>1877</td>
<td>2009</td>
<td>Flour Factory</td>
</tr>
<tr>
<td>Residence</td>
<td>Can Gili Nou</td>
<td>1877-1880</td>
<td>2010</td>
<td>Flour Factory</td>
</tr>
<tr>
<td>Residence</td>
<td>Taller Gibert i Junyent</td>
<td>1911</td>
<td>2000</td>
<td>Textile Factory</td>
</tr>
<tr>
<td>Residence + Other</td>
<td>Viviendas en Fàbrica Tort Can Planell</td>
<td>The early 20th Century</td>
<td>2007</td>
<td>Factory</td>
</tr>
<tr>
<td>Residence + Other</td>
<td>The Cement Factory</td>
<td>The early 19th Century</td>
<td>1975</td>
<td>Cement</td>
</tr>
<tr>
<td>Residence + Other</td>
<td>Passatge del Sucre</td>
<td>1916</td>
<td>2010</td>
<td>Sugar Factory</td>
</tr>
<tr>
<td>Residence + Other</td>
<td>Fàbrica Pere Font i Batallé</td>
<td>1916</td>
<td>2001</td>
<td>Textile Factory</td>
</tr>
</tbody>
</table>

Fig. 2-3-2: The practices of transforming the industrial heritage into residential building in Barcelona (Source: Author)
<table>
<thead>
<tr>
<th>Function</th>
<th>Current Function</th>
<th>Designers</th>
<th>Before Transformation</th>
<th>After Transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory</td>
<td>Apartment</td>
<td>Cirici&amp;Bassó Arquitectura</td>
<td><img src="image1.jpg" alt="Before" /></td>
<td><img src="image2.jpg" alt="After" /></td>
</tr>
<tr>
<td>Factory</td>
<td>Apartment</td>
<td>BCA • Blanch</td>
<td><img src="image3.jpg" alt="Before" /></td>
<td><img src="image4.jpg" alt="After" /></td>
</tr>
<tr>
<td>Factory</td>
<td>Apartment</td>
<td>Antoni Vilanova i Eduard Simó</td>
<td><img src="image5.jpg" alt="Before" /></td>
<td><img src="image6.jpg" alt="After" /></td>
</tr>
<tr>
<td>Factory</td>
<td>Apartment</td>
<td>BAMMP Arquitectes i Associats</td>
<td><img src="image7.jpg" alt="Before" /></td>
<td><img src="image8.jpg" alt="After" /></td>
</tr>
<tr>
<td>Factory</td>
<td>Apartment</td>
<td>Cruz y Ortiz Arquitectos</td>
<td><img src="image9.jpg" alt="Before" /></td>
<td><img src="image10.jpg" alt="After" /></td>
</tr>
<tr>
<td>Factory</td>
<td>Private House + Loft Office</td>
<td>Ricardo Bofill</td>
<td><img src="image11.jpg" alt="Before" /></td>
<td><img src="image12.jpg" alt="After" /></td>
</tr>
<tr>
<td>Factory</td>
<td>Apartment + Loft Office</td>
<td>Jordi Garces</td>
<td><img src="image13.jpg" alt="Before" /></td>
<td><img src="image14.jpg" alt="After" /></td>
</tr>
<tr>
<td>Factory</td>
<td>Apartment + Loft Office</td>
<td>BAMMP Arquitectes i Associats</td>
<td><img src="image15.jpg" alt="Before" /></td>
<td><img src="image16.jpg" alt="After" /></td>
</tr>
</tbody>
</table>
3 THE CASE STUDY OF TRANSFORMING THE INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING IN BARCELONA
Fig. 3-1-1: The location of the Fábrica Tort Can Planell (Source: Author)

Fig. 3-1-2: The situation before (left) and after (right) transformation (Source: Cruz y Ortiz Arquitectos)
3.1 Case study 1: Fàbrica Tort Can Planell

The case “Fàbrica Tort Can Planell” is placed at the corner of Carrer de Turull and Carrer de Riego in Sabadell, Barcelona. (Fig. 3-1-1) It used to be a planell factory built at the beginning of the twentieth century, and after 2007, it was transformed into residential building including 16 apartments with 60 parking spaces by Cruz y Ortiz Arquitectos.(Fig. 3-1-2)

Urban Design

The factory is located in the old town of Sabadell. Within the scope of the service radius 500m, the facilities which could provide the basic life needs for the residents are enough including 10 supermarkets, 8 pharmacies, 10 banks, 16 education organizations, 20 transport points, 9 parks or gardens and so on. All of these guarantee the basic needs of residents.(Fig. 3-1-3)

Just focused on the site, the residential building is in the form of ‘L’ creating a new enclosed atrium inside. It ensures the continuity of the façade along the street and the new patio also gives the possibilities for residents to make some activities which could enhance the communication among the residents. The main entrance into the building faces to the Carrer de Turull while on the Carrer de Riego there is an entrance to underground parking. In this way, it well takes advantages of its position of corner and separated people and vehicles.(Fig. 3-1-4)

Space Reconstruction

Interior space

The old existing factory is a large space, so in order to transform it into a residential building the architects make some division on the vertical and horizontal direction. On the vertical direction, it is the partition between households. On the horizontal direction the space is divided into two layers while every household has an interlayer. Every unit is in the form of “loft”, and they are of the same layout with two layers.(Fig. 3-1-5)
Exterior space
The original factory is just a very small and simple volume, so the architects make expansion both on the ground and underground. (Fig. 3-1-6)

On the ground, firstly the architects create a diaphanous covered space which is adjacent to the pre-existing factory. Besides this space, a new volume with the function of residence also is added as an expansion. Thus, the function of residence is organized by the central shared space. The atrium inside the whole buildings is not only the common access, but also the important space carrying out the vertical and horizontal communication. Moreover, the new residential building and the central covered atrium inside enclose an open landscaped patio inside the block which could be access through the central atrium.

While for the underground space, the architects make an expansion of two layers underground as the parking spaces to meet the basic requirements for the residents living in the transformed building. In addition, in order to protect the foundation of the old factory, the underground expansion avoids it but is just close to it. To make this fulfilled an entrance for parking is needed on the ground. So besides the expansion on the ground mentioned before, the space of the existing building expands a little while the upper space also can act as the residential space.

Function Improvement

Structure System
In terms of the whole structure, most of the former structures are maintained except one short wall which used to be situated on the boundary of the old factory and the new addition volume. The removal of the old wall is the inevitable needs for space expansion. As the building has been transformed into residential building, the space has been changed. The structure for the new addition including the new floors and walls inside the old space and the new volume along the original building is all based on the old structure. The old and new structures are as a whole, the new is a kind of reinforcement to the old. Furthermore, the structure underground expansion avoids the original foundation and just follows the new structure of the new volume on the ground. (Fig. 3-1-7)
Transportation System
The main transportation system is solved through the central atrium. The main entrance exactly face to the atrium, while through the staircase in the atrium, it is possible to go up to second floor, then through the new added corridor along the old building, every household can get into their home. At the same time, it is also access to the underground space. Additionally, with regard to every unit, no matter the unit of the old volume or the unit of the new volume, there is a single-flight staircase inside to solve the traffic problem. (Fig. 3-1-8)

Lighting& Ventilation System
To this project, there are mainly four methods to solve the lighting and ventilation problem—window, part high space, atrium and skylight. The unit in the old buildings is divided by the rhythm of the existing windows, and every unit could be assigned to two windows which can easily provide enough nature light. At same time, the ventilation also can be solved through the windows on both sides. Moreover, as the form of “loft”, the part high space could enhance the effect of the ventilation. In addition, as one façade of the old building is faced to the interior space, both the atrium and the skylight above could avoid the problem and well improve the lighting and ventilation. (Fig. 3-1-9)

Skin Replacement
To this transformation, the entire building shows a state of symbiosis of the old and new. On one hand, the architects reserve most of the façade and nearly do no changes on them except the repaint. The old windows are all maintained and only been replaced with new glass. The expansion volume is designed according to the former industrial buildings. The position and form of the new windows are all the same with the old. On the other hand, the materials of the new volume are similar to those used in the construction of the existing building—ceramics, lime plaster, woodwork. In a whole, the old and new are nearly the same and it is difficult to distinguish them from one to another. (Fig. 3-1-10)

Conclusion
All in all, the architects try to maintain and preserve the existing building while transferring its character to the new addition that completes it. In spite of the presumed duality (industrial building
that has to be restored plus new residential building) they have opted for improving the whole by mixing the old and the new in a confident, intense way. In this way, it is not only a respect to the old but also an innovation to the new.
RESEARCH ON THE TRANSFORMATION OF INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING
--TAKING BARCELONA AS AN EXAMPLE

Fig. 3-1-3: The service facilities within the scope of the service radius 500m (Source: Author)

Fig. 3-1-4: The relationship between the building and the environment (Source: Author according to Cruz y Ortiz Arquitectos)
Fig. 3-1-5: Interior space (Source: Author according to Cruz y Ortiz Arquitectos)

Fig. 3-1-6: Exterior space (Source: Author according to Cruz y Ortiz Arquitectos)

Fig. 3-1-7: Structure system (Source: Author according to Cruz y Ortiz Arquitectos)
Fig. 3-1-8: Transportation system (Source: Author according to Cruz y Ortiz Arquitectos)

Fig. 3-1-9: Lighting & Ventilation system (Source: Cruz y Ortiz Arquitectos)

Fig. 3-1-10: Skin replacement (Source: Author according to Cruz y Ortiz Arquitectos)
Fig. 3-2-1: The location of the Passatge del Sucre (Source: Author)

Fig. 3-2-2: The situation before (left) and after (right) transformation (Source: Jordi Garcés)
3.2 Case study 2 : Passatge del Sucre

The case “Passatge del Sucre” is located on the Carrer de Ramon Turró in the District Poblenou of Barcelona, which is transformed from the industrial heritage. It used to be a sugar factory built by an agricultural company in the 1920’s and is a well-preserved traditional industrial factory with a long history. (Fig. 3-2-1) However, in the 22@ Plan of Barcelona, through carefully transformation design of architect Jordi Garcés, it has become multi-function, multi-dimension, multi-domain activity non-traditional residential buildings with the function of residential and creative office. Jordi Garcés makes the original lifeless abandoned industrial space transformed into 29 sets of loft to meet the needs of different groups. (Fig. 3-2-2)

Urban Design

The factory is located in the new district of Barcelona. Within the scope of the service radius 500m, the facilities which could provide the basic life needs for the residents are enough including 2 supermarkets, 9 pharmacies, 8 banks, 12 education organizations, 21 transport points, 8 parks or gardens and so on. All of these guarantee the basic needs of residents. (Fig. 3-2-3)

With regards to the site, all the buildings are based on the original factories and architect maintains the original environment. At the same time, both the two streets along the architecture group have the access to the site. The architecture group presents an "L" shape with a central enclosed rectangle courtyard. According to the rhythm of the roof truss, the old factory is naturally divided into seven parts as mentioned above. The entire architecture group presents semi-open attitude, and such a space layout could be naturally integrated with other buildings while maintains its own independence and integrity. It makes people having e a great desire to explore more. (Fig. 3-2-4)

Space Reconstruction

Interior space

For the large space inside the factory without any divisions, architect only does some divisions on
the horizontal and vertical directions according to the structure and space requirement. (Fig. 3-2-5)

Architect adds a variety of loft elements combined with residential and creative office into the industrial factory which used to be with simple function space, forming a kind of function combination fit for the modern people. From the type of transformation, it is divided into “A, B, C, D, E, F, G” seven types, 29 sets of apartments in total.

The internal structure and function of A, B, F are similar, which are a number of horizontal juxtaposition arrangement of standard loft apartments. Each unit of A and F is three-layer with part high space between the second floor and third floor. The first floor as a public activity space can be used as living room or office space and the private top two floors can be used as bedrooms. Each unit of B is only two-layer with part high space, and also the smallest of all units in this area. Due to the existence of the original structure, the unit of C is an independent two-layer large house with part high space, and along with the central courtyard it has a large area of lighting, suitable for a variety of types of people to live. Unlike A, B, F, the units of D, E, G are arranged on the vertical direction, which are one-layer or two-layer. Such a layout provides a larger area for households on each floor. In addition to the fixed kitchen and bathroom space, the rest of the space can be divided according to the needs of individual households. They are suitable for the people hoping to combine residence and office together that all activities take place together in a large space giving people the feeling of freedom. Among these three types, it also provides two-layer loft for the people who have more demand and G is the most spacious and comfortable type with part high space or balcony.

These seven types have different characteristics. For example, A, B, C, F are mainly for people who need independent studio, such as clothing designers, industrial designers, jewelry designers and so on. They need to work independently or relatively independent study space. The units few bother each other which could provide a quieter environment. The vertical arrangement of A, B, C, F and the horizontal division of interior space both well meet these requirements. On the contrary to A, B, C, F, the space division between the households of D, E, G is on the horizontal direction. Each unit has a complete large space and there is no further division of the interior space except the kitchen and bathroom. Such a free and complete space is more suitable for young people, or the people who are relatively free and random like painters. In the meantime, D, E are using the same traffic space that maybe architect hopes they could have more opportunities for communication.
Exterior space

The recombination design of exterior space is mainly reflected in three aspects: (Fig. 3-2-6)

Open up the bottom part of the unit E to form a bridge gallery as a new entrance for the project. This way can make sure its accessibility from the main street in the northwest enriching the feeling to the space at the same time.

Between unit A and B, remove parts of the roof of the unit A to form an open air corridor. Provided the entrance space for each household, it also makes A and B clearly separated, maintaining the independence and reducing the interference between each other. It also enriches the diversity of the space perception.

Do the addition in the unit D and G, increase the volume of these two parts as traffic cores and provide a roof terrace space. On one hand it can solve the traffic problem due to the necessary functional requirement, on the other hand it improves the form, while riches the facade comparing with the original buildings.

Function Improvement

Structure System

Under the premise of reserving the original steel structure of the factory, architect adds a completely new structure into the interior space. The new structure is completely out of the old structure which has its own system, forming an ambiguous relationship with the original walls showing a state of juxtaposition – “house in house”. Such a transformation measure not only reinforces the architecture structure itself, but also makes it possible for the architect to completely free to design within the interior space, which can be loyal to their own idea about the function arrangement. (Fig. 3-2-7)

Transportation System

There are mainly two ways to implement the necessary transportation system of the residential buildings. Since the A, B, C, F are independent units which have direct entrances to the outside, the traffic facilities are primarily used for the private households. Therefore, architect sets up single-flight stair in each unit which is simple, convenient and space-saving for the users going up and down. are one or two layers, so in these three individual masses, architect carves out some space and does
the addition to add a volume as the traffic core. (D&E share the same traffic core). Each apartment uses the traffic core at the same time. This kind of design saves public space, and maximizes the usable area of each house. In the meantime, the traffic core makes the building more varied in the form, while also strengthens the original structure system. (Fig. 3-2-8)

Lighting & Ventilation System
In this regard, the architect solves this problem mainly through the way of opening windows and using part high space. When designing how to open windows, architects fully considerate the shape and position of the original factory’s windows. According to the practical needs, parts of the windows use the old ones, and parts of the windows are newly built. For the windows’ holes which are not used as window any more, architect reserves the shape and fills it with red bricks. The new windows are consistent with the old windows on the shape and rhythm, which use large area of glazing glasses and dark metals as window frames, and also are reinforced by the steel beams above. By such processing, architecture facades look simple, unified, beautiful and generous. Therefore, in order to make the living space to get more natural lighting and ventilation after the transformation, skylights are also used in each section. Meanwhile, in order to increase the effect of skylights, architect uses part high space in A, B, C, F apartments, which further improves the lighting and ventilation system of the houses. (Fig. 3-2-9)

Skin Replacement
In the aspect of handling the material of the exterior façades, the architect reserves most skins of the old industrial buildings, while adding some new materials in some extension volumes or some parts of the skins which needs to be improved, such as the traffic cores or the walls around the windows. The new-added material, which is in coordination with the existing material, is red brick used in the same tiling method, while they are slightly different from the existing one in terms of the darkness of colors, the degree of unities and the texture respecting the degree of recency, which make the new-added one and the existing one visually concordant but distinguishable, enabling the whole façade harmonious with each other. To cope with the material of the windows, although all windows have been replaced by the new ones, the skeletons of the new are still made by steel which is used in the original buildings. The transformation of the architecture skin in respect of material and the form responses the history everywhere, while the strong contrast between the bright effect of the new glass and the sense of history of the peripheral old walls keep telling people
the new identification of the contemporarily-transformed factory. (Fig. 3-2-10)

Conclusion

Overall, it can be said that during the transformation process the industrial building is just providing the skin of space, which is a constraint to the architect who wants to make a difference. However, from the final result of this case, you will find that the original and the new both live in harmony with each other. The architect closely links the new residential space with old industrial buildings, which not only plays a role of strengthening the protection to the old factory but also takes full advantage of the restrictions. It is bold transformation to the industrial heritage and also respect to historical memory.
3 THE CASE STUDY OF TRANSFORMING THE INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING IN BARCELONA

Fig. 3-2-3: The service facilities within the scope of the service radius 500m (Source: Author)

Fig. 3-2-4: The relationship between the building and the environment (Source: Author according to Jordi Garcés)
The seven types of the residential buildings

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Typical level</th>
<th>Typical Area</th>
<th>Floor Plan</th>
<th>Section</th>
<th>Interior Space</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>3</td>
<td>165m²</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>B</td>
<td>6</td>
<td>2</td>
<td>102m²</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>2</td>
<td>175m²</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>1</td>
<td>125m²</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>3</td>
<td>1</td>
<td>129m²</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>6</td>
<td>3</td>
<td>139m²</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>3</td>
<td>1/2</td>
<td>193m²</td>
<td></td>
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</table>
Fig. 3-2-6: Exterior space (Source: Author according to Jordi Garcés)

Fig. 3-2-7: Structure system (Source: Author according to Jordi Garcés)

Fig. 3-2-8: Transportation system (Source: Author according to Jordi Garcés)
Fig. 3-2-9: Lighting & Ventilation system (Source: Jordi Garcés)

Fig. 3-2-10: Skin replacement (Source: Jordi Garcés)
Fig. 3-3-1: The location of the Cement Factory (Source: Author)

Fig. 3-3-2: The situation before (left) and after (right) transformation (Source: Ricardo Bofill)
THE CASE STUDY OF TRANSFORMING THE INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING IN BARCELONA

3.3 Case study 3: The Cement Factory

The Cement Factory which is situated on Av. de la Indústria, 14, Sant Just Desvern, Barcelona was found by Ricardo Bofill in 1973, and it used to be an abandoned industrial complex comprised of over thirty silos, a tall smokestack, four kilometers of underground galleries and huge machine rooms in good shape. (Fig. 3-3-1) Dating from the first period of the industrialization of Barcelona, it was not built at once or as a whole but was a series of additions as the various chains of production became necessary. The formal result was given, then, by a series of stratified elements, a process, which is reminiscent of vernacular architecture, but applied to industry. But nowadays it has been transformed into a mix-used facility with the head office of Taller de Arquitectura, the private house for Ricardo Bofill, exhibition space, archives, a modern laboratory as well as guest rooms in the midst of lush gardens. (Fig. 3-3-2)

Urban Design

The main function of this cement factory now is the studio and private residence for Ricardo Bofill, so compared with collective housing, the requirements to the service facilities are not critical. But around the industrial building there are many new-built residential buildings including famous Walden-7 which is also designed by Ricardo Bofill in 1975. Thus it is quite convenient to live and work here. (Fig. 3-3-3)

With regards to the site itself, the factory was abandoned and partially in ruins before the transformation. Due to the course of nature and the former program, it was full of the contradictions and the ambiguity, so the architect modified its original brutality and sculpted it like a work of art. And the transformation of the cement factory started with the demolition of numerous elements and structures of the old industrial building to leave hitherto concealed forms visible. At present, the whole complex stands in the midst of gardens with eucalyptus, palms, olive trees and cypresses. (Fig. 3-3-4)

Just as Ricardo Bofill said, “The factory is a magic place which strange atmosphere is difficult to
be perceived by a profane eye. I like the life to be perfectly programmed here, ritualized, in total contrast with my turbulent nomad life.”

**Space Reconstruction**

**Interior space**

The main functional spaces are concentrated on the ten soils and a gigantic space known as “The Cathedral” with its high, narrow windows and gothic-style arches. Ten silos remained became offices, a models laboratory, archives, a library, a projections room. The ground floor of “The Cathedral” is used for exhibitions, concerts and a whole range of cultural functions linked to the professional activities of the architect while the upper space is used for residence of Ricardo Bofill.

The interior space is incredibly raw with towering ceilings throughout. The architect just made some integration of interior space by removing some original wall while remaining all the former equipments. The abundant space and the height provided demonstrate inconceivable moderation; the interior space has not been crammed up with too many decorative elements; rather the interiors are deliberately appointed with casual contemporary elements. Carefully casual slip-covered white sofas, white canvas sling-back seating, tobacco colored leather sofas, large monochromatic rugs with no reference of detailing, the inconceivably tall curtains and many more elements add to the lofty style of The Cement Factory. The office area features spectacularly lengthy conference tables paired with leather seating and beautifully framed architectural prints which hang on the walls or are displayed on wooden easels.

The transformation of the interior space incorporated various architectural languages: Catalan Civic Gothic style and surrealist elements paying homage to the building’s industrial past, cohabiting with high-tech furniture within comfortable lofty spaces. Overall, the Cement Factory is a building with unique design and architectural elements; a lofty interior full of style. (Fig. 3-3-5)

**Exterior space**

According to the demand, the architect reserved ten soils and a gigantic space known as “The Cathedral”. With regard to these building, he nearly did no changes to the exterior space of the abandoned industrial buildings.
The disused factory was a compendium of surrealist elements: paradoxical stairs that climbed up to nowhere, mighty reinforced concrete structures that sustained nothing, pieces of iron hanging in the air, huge empty spaces filled nonetheless with magic, the absurdity of certain elements that hung over voids, compelling but useless spaces of strange proportion but magical because of their tension and disproportion. Elements of abstraction; pure volumes which reveal themselves at times broken and impure as well as elements of brutalism; abrupt treatment and sculptural qualities of the materials. Beside the building volume, he largely improved the surrounding environment with the greening and planting. Due to the sculpture with Catalan Civic Gothic style and surrealist elements, it was necessary to provide a green plinth to these volumes and plants would climb walls and hang from the roofs. In this way the entire architecture seems to blanking in the jungle. (Fig. 3-3-6)

Function Improvement

Structure System

The structure of the original building is reinforced concrete structure. In the process of the transformation, the architect reserved all the structure with good quality. As the space layout is allocated according to the former form of the building, he well took advantage of the old structure and just made some reinforcement for some less secure place. Moreover, even some remained structure sustained nothing now. (Fig. 3-3-7)

Transportation System

The dimension and the position of the soil are well suited for the transformation system. Thus, the architect put a spiral staircase into the soil to solve the problem. Apart from this, as the residential space is in the form of loft which well uses the form of the original building, he adds a white concrete straight stair inside the huge space forming a great contrast to the former architecture style. (Fig. 3-3-8)

Lighting & Ventilation System

The disused industrial buildings have the enormous spaces with a lot of large arched windows. As the architect maximized the respect to the original building, there is no need to open some new windows. The existing windows are totally enough to meet the requirements for the people living and working inside and the natural light throughout the day is of stunning quality. Moreover, the
space is very transparent and sometimes it is necessary to use the inconceivably tall curtains to maintain internal privacy. (Fig. 3-3-9)

Skin Replacement

The industrial building is a mixture of textures and forms, materials and impressions. The architect chose an implicit mode to deal with the transformation. The renovated construction incorporates various languages from history of Architecture, a cultured language in opposition to vernacular architecture with windows, doors, stairs and false perspectives and applied them to the exterior walls and some interiors. He reserved the original façade of the cement factory and just installed the windows with the glass. The entire building shows a mix-style of surrealism, abstraction and brutalism. In terms of surrealism paradoxical stairs that lead to nowhere, the absurdity of certain elements hung over voids, potent but useless spaces, of strange proportions but magical because of their tension and disproportion. In terms of abstraction, they are pure volumes, which reveal themselves at times broken and impure. In terms of brutalism, the architect used abrupt treatment and sculptural qualities of the materials. When you look from the outside, the industrial building seems to have no changes. However, in fact, inside the building, the architect used many new contracting elements to transform it into a complex of studio and apartment. (Fig. 3-3-10)

Conclusion

To sum up, the architect respected and retained the original architecture to the maximum extent just like shaping it as a sculpture. He would like to show the charm of the industrial building and guide people to recall the past of the cement factory. Yet, at the same time, the modern style of the interior space still can give people another experience differing from the exterior. From the point of view of the final transformation, this implicit mode is also a very excellent attitude to deal with the industrial heritage.
Fig. 3-3-3: The service facilities within the scope of the service radius 500m (Source: Author)

![Map showing service facilities within a 500m radius.]

Fig. 3-3-4: The relationship between the building and the environment (Source: Author according to Ricardo Bofill)

![Diagram showing the relationship between a building and its environment.]

### The Case Study of Transforming the Industrial Heritage into Residential Building in Barcelona

- **Within the scope of the service radius 500m**
- **Site**: 3
- **Supermarket**: 3
- **Pharmacy**: 5
- **Bank**: 6
- **Education**: 5
- **Transport**: 24
- **Park/Garden**: 11
Fig. 3-3-5: Interior space (Source: Ricardo Bofill)

Fig. 3-3-6: Exterior space (Source: Ricardo Bofill)

Fig. 3-3-7: Structure system (Source: Ricardo Bofill)

3 THE CASE STUDY OF TRANSFORMING THE INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING IN BARCELONA
Fig. 3-3-8: Transportation system (Source: Ricardo Bofill)

Fig. 3-3-9: Lighting & Ventilation system (Source: Ricardo Bofill)

Fig. 3-3-10: Skin replacement (Left: the original skin; Middle & Right: the new skin) (Source: Ricardo Bofill)
4 THE DESIGN PRINCIPLES OF TRANSFORMING THE INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING IN BARCELONA
4.1 The main design principle of transforming the industrial heritage into residential building in Barcelona

“When a building is reused, the most important and meaningful factor in the design is the relationship between the old and the new.” (Brooker & Stone, 2004: 79)

Date back to the 1960-70s, the relationship between the old and the new architecture was still not clear. At the same time, due to the influence of postmodernism in the 1980s, the modernist failed to keep pursuing the originality and novelty, and taking the current building environment and traditional methods into consideration is more and more important. People began to pay much more attention to the beauty of the traditional architecture and urbanism. As a result, the transformation which should well deal with the preservation of the old and intervention of the new increasingly appears in the main stream of architecture. Nowadays, the contextual design principle is easier to be identified which more likely choose to use the method of weaving both the old and the new to create an harmonious environment as well as make the preservation and integration to improve the industrial heritage. In a way, there is no doubt that the main design principle of transformation is the relationship between the old and the new. According to the degree of the integration between the old and the new, it could be classified into three categories, that is, ‘installation’, ‘intervention’ and ‘insertion’. And eight cases in Barcelona mentioned in the chapter 2 all belongs to these three categories. (Fig. 4-1-1) The detailed analysis of the mentioned concepts is as follows.

**Installation**

The design principle of ‘installation’ implies that the original building and the new element exist at the same time and there is no communication but clear distinction between them. This concept allows some parts of the original building be upgraded in a high technological level while other parts of the building have no changes. The original building could be restored without compromising or interfering with the new elements. In this level, the presence of the new element is the highest. These new elements usually are attached to the personal characteristics and style of the architects. One of the cases is “Passatge del Sucre”.

"When a building is reused, the most important and meaningful factor in the design is the relationship between the old and the new." (Brooker & Stone, 2004: 79)
**Intervention**

The design principle of ‘intervention’ implies a clear dependence of the new to the old. The original building fully accepts the new elements, put it more briefly, the two become one in the end. Specifically, all the physical features of the new elements including the size, shape or position follow the logical form of the old building. The architects may extract the main elements of the original building and then make some small additions, subtractions or changes to design the new elements. One of the cases is “Fábrica Tort Can Planell”.

**Insertion**

The design principle of ‘insertion’ implies an intense relationship between the old and the new while both the old and the new exist independently. The appearance of the original building is respected and preserved largely intact but the interior of the original building is remodeled to a large extent. For the new elements, they are independent but also decided by the original buildings in terms of the dimension, proportion, scale, rhythm and structural composition. In this situation, there is nearly no changes to the original buildings physically. The old and new are equally important, and they make dialogues with each other while shows their own unique personality. One of the cases is “The Cement Factory”.
<table>
<thead>
<tr>
<th>Relationship of the old and the new</th>
<th>Project</th>
<th>Original Construction Time</th>
<th>Transformation Time</th>
<th>Original Function</th>
<th>Current Function</th>
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<td>Can Gili Vell</td>
<td>1877</td>
<td>2009</td>
<td>Flour Factory</td>
<td>Apartment BCA • Blanch</td>
</tr>
<tr>
<td></td>
<td>Passatge del Sucre</td>
<td>1916</td>
<td>2010</td>
<td>Sugar Factory</td>
<td>Apartment + Loft Office Jordi Garces</td>
</tr>
<tr>
<td><strong>Intervention</strong></td>
<td>Vapor Llull</td>
<td>1902</td>
<td>1997</td>
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<td>Apartment BAMMP Arquitectura</td>
</tr>
<tr>
<td></td>
<td>Viviendas en Fàbrica Tort Can Planell</td>
<td>The early 20th century</td>
<td>2007</td>
<td>Factories</td>
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<td></td>
<td>Can Gili Nou</td>
<td>1877-1880</td>
<td>2010</td>
<td>Flour Factory</td>
<td>Apartment Cruz y Ortiz Arquitectos</td>
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<tr>
<td><strong>Insertion</strong></td>
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<td>The early 19th century</td>
<td>1975</td>
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<td></td>
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<tr>
<td></td>
<td>Taller Gibert i Junyent</td>
<td>1911</td>
<td>2000</td>
<td>Textile Factory</td>
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Fig. 4-1-1: The eight practices in Barcelona according to three design principles (Source: Author)
<table>
<thead>
<tr>
<th>Function</th>
<th>Current Function</th>
<th>Designers</th>
<th>Before Transformation</th>
<th>After Transformation</th>
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<td><img src="image2.jpg" alt="After" /></td>
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<td><img src="image16.jpg" alt="After" /></td>
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4.2 The specific strategies of transforming the industrial heritage into residential building in Barcelona

Once a project has been selected, on the basis of the main design principles mentioned above to express and determine the design ideas and characteristics, the further step of specific design could be completed on these following terms.

**Urban design**

The urban design of the transformation more or less refers to the relationship between the industrial heritage and the surrounding environment. As a new volume to the site, the replacement of an abandoned industrial heritage into residential building would make some influence to the surrounding area while also would be affected by them. All of these could be reflected on the design of the site plan. In addition, to make the transformation successful, the basic facilities which could meet the requirement of the daily life such as supermarket, pharmacy, bank, education organization, transport point, park or garden and so on should be sufficient.

**Space reconstruction**

The space reconstruction can be broken down in two aspects: interior space and exterior space. According the case study, in terms of the interior space, there are three methods on the whole-maintain original space, space division and space integration. In terms of the exterior space, the architects could make some expansion on the horizontal, vertical direction or make some underground space expansion. The total spatial logic follows the main design principle and it could choose to be preserved or changed but respect the logic of the original building, or completely altered.

**Function improvement**

It is the point which the requirement of the residential building is different and specific due to the unique characteristics of it. It could be fulfilled in three terms, that is, structure system, transportation
system and lighting & ventilation. In the aspects of structure system, there are mainly three methods: old structure retained, independent from the old structure, old structure completely replaced. In the aspects of transportation system, there are mainly four means: staircase, verandah, inner corridor and patio. And in the aspects of lighting & ventilation, window or patio or part high space could be used to solve the problem.

**Skin replacement**

Skin replacement mainly refers to the exterior façades which could give the most intuitive feeling to the people. In regard to the material and the shape of some elements on the facades, it could make good response to the design principle. ‘Installation’ is the juxtaposition of old and new; ‘intervention’ is the symbiosis of old and new; ‘insertion’ is the implicit mode.

These four terms mentioned above could well reflect the design principle of the transformation as well as specifically guide the design. As ‘Barcelona model’ has always been the study object to the countries in the worldwide, and all of these are summed up from the good examples of Barcelona, it can bring great assistance to other countries with the same situation.
5 THE INSPIRATION AND SIGNIFICANCE OF TRANSFORMING THE INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING IN BARCELONA
5.1 Relevant theory and practice of transforming the industrial heritage into residential building in China

The cases of ‘industry-residence transformation’ using integral-transformation method are quite rare in China. There are only 4 relevant cases which are truly linked with it. (Fig. 5-1-1) Mostly the developers transform the scattered and individual old industrial heritage into residential building due to the economic consideration, which is a bottom-up development pattern. Specifically, the businesses prefer the potential of the old buildings, including their favorable location in the center of old city, architectural style and industrial aesthetic, seeking for more economic returns with careful analysis of the need of property market and precise market positioning. According to the writer’s research, the projects of transforming industrial heritage into residential building are as follows:

The first type is temporary dwelling space, mostly including the hotels and collective apartment, such as Shanghai Motel269 Branch of Sinan Road converted from Shanghai The Third Thread Factory, Shanghai Pudong Tanfang Street White Apartment converted from elevator factory on the verge of collapse. These type of projects utilize the characteristic of homogeneous spatial structure of the multi-layer factory, placing the dwelling rooms into the multi-layer space. In the writer’s research, it can be found that the common problem of this renovation type is that the shape of original type of the industrial buildings can’t be respected, leading to the lost of most of recognition except the outline.

The second type is the model of commercial&residential loft, represented by Beijing 798 and Shanghai Suzhou River Industrial Renovation. The loft model is the earliest abroad sprang-up of reuse of industrial heritage derived from South of Houston Street in Manhattan. This type is developed from the model of artists’ spontaneous use of industrial heritage, then being transformed into the integral development model integrating work, business and living with their unique artistic temperament attracting relevant recreation industry, such as bar, gallery, café and so on. This residential mode is full of artistic sense and the flexibility of the space use. It is mostly emerged in industrial buildings with a certain scale due to the consideration of the atmosphere.
The third type is the collective apartments. Despite of the high development efficiency, due to some politic and economic reasons, the cases of this type is unusual in China, such as the workers’ dwelling houses transform from the old factories in Nanjing Zhuang Street designed by Jiasheng Bao in the 90s. If new residential buildings were built in this area, just 28 suites could be placed due to different restrictions in this project. In contrast to that, the designers placed 65 suites by converting the original industrial buildings as well as save about 2.5 million yuan in cost.

Fig. 5-1-1: The practices of transforming the industrial heritage into residential building in China (Source: Author)

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5.2 The comparative analysis of transforming the industrial heritage into residential building between Barcelona and China

As the industrial development of Barcelona started relatively early and the time to enter the post-industrial age is also relatively early, they started earlier in the field of industrial heritage transportation and reuse than China. However, as a kind of new thoughts and new methods to the reuse of industrial heritage, “from Industry to Residence” is a kind of new thing. Therefore, the common point between Barcelona and China is that both two countries started late in the field of this specific transformation. Barcelona started in the 80s while China began in the 90s. Although starting periods of two countries were similar, China’s industrialization process which was under the drive of the western countries was great-leap-forward and high-speed. This rapid development process makes China hardly have time to solve the problems brought by the post-industrial age in time. Hence, compared with Barcelona, there are still many gaps in terms of “from Industry to Residence” to China.

The differences of recycling notion

Foreign countries pay more attention to the value of the history and culture of the industrial heritage and location, and the environmental sustainability. Also, the characteristics of the reform such as the integrity, systematicness and environmental friendliness, and the construction of the environment and space, are the main considerations for them. On the contrary, at present stage of China, except the key cultural relics which are under the national law enforcement protection, for general industrial heritage, the reform process mainly concentrates in the using effectiveness and economy of monomer building itself which is lack of considering the overall improvement of city and community environment. Thus, some modification hardly adapt to the overall arrangement of the social development and urban planning. In addition, as the adjustment of the China’s industrial layout is carrying out under the background of large-scale economic structure adjustment and the reform of state-owned enterprises, also go through the process of industrial areas from the boom to the decline. Abandoned factories, broken barns and old industrial zone all gave people the impression of backwardness and decline which is far from the image that people want to live. Thus, in order to ensure the sale and rent of the living space after modified, developers will reduce the
exposure of the original purpose of buildings as far as possible.

The differences of recycling mode

According to the main body of the development and investment, the developing mode of the industrial heritage can be classified into "bottom-up" and "top-down" two categories. The former one refers to the protection and reform of the industrial heritage leaded by the civil power and the main body of the investment, whereas the latter one is leaded by the government, the developers or other development owners in the form of joint or transfer.

Most of the "from Industry to Residence" projects in Barcelona are carried out in the "top-down" pattern, where the government intervenes directly and corresponding development company is set up through negotiations. Projects are treated as the catalyst of the urban development and renewal. By this way, it is possible to transform and use the site and its architecture on a large scale and can be relatively easy to gain the implementation efficiency in a relatively short period, which can substantially promote the optimization and recombination of urban function and the improvement of the quality of life.

While in China, the practices of the overall transformation from Industry to Residence were rare. In most cases, developers transform the scattered and monomer industrial heritage to residence building due to pure economic reasons, which belongs to a "bottom-up" decentralized development mode. Specifically, enterprises take a fancy to the development potential of the old city center location advantage, architectural style or industrial aesthetics of the industrial heritage. Based on the careful analysis of the real estate market for accurate market positioning and meeting the demand of the market, enterprises try to obtain greater economic returns. This kind of developing mode and transformation is on a small scale, and difficult to get the recognition of the citizens, which hardly forms a demonstration effect in society and contributes to the emergence of more similar projects.

The limits of recycling type

Through the comparison of the relevant practice in Barcelona and China, it can easily observe the limits of the China’s recycling types which reflect in two aspects of reusing object and target. For
the type of reusing object, in China’s practice, almost all the cases are for the multilayer industrial heritage. Compared with the developed countries, there are many gaps of China’s old industrial heritage design and construction quality. It also indicates that China is lack of design theory and experience in “from Industry to Residence”. In addition, in the “bottom-up” development mode, the type of reusing target is restricted, which are mostly transformed by individual developers into budget hotels due to the pure economic reason. As the economic interests of transformation projects of low-rent housing and affordable housing is relatively small which hardly attract developers to develop independently. In addition, there is no transformation case into private house. (Fig. 5-2-1)

But from the building type, form and style of the industrial heritage, Barcelona has certain similarities with China. In addition, two countries have common with the demand for housing and social ideas on the identity. Thus, it does have certain feasibility and credibility to apply the experience of transforming industrial heritage into residential building from Barcelona to China.
THE INSPIRATION AND SIGNIFICANCE OF TRANSFORMING THE INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING IN BARCELONA

5.3 Project in Wuhan, China

Wuhan is located in the hinterland of China, the area at the confluence of two rivers, easy to approach to surrounded provinces. Its superior location provides itself with excellent development circumstance. Guibei modern industrial area is such a place that developed relying on the water transport conditions of Hanshui. However, for a variety of reasons, this area becomes an essential factor effecting the urban development.

Analysis and evaluation of Wuhan Cotton Factory

The history of the factory area

Wuhan Cotton Factory was the first state-owned cotton textile factory in Wuhan after the founding of new China. In 1880, Zhang Zhidong created Wuchang Political Situation and chose North Dabie Mountain as the location of Hanyang Iron Factory. In 1903, the factory was renamed as Hanyang Arsenal. The factory buildings were designed by Germans. All structure was brick-wood and the roofs were made by iron sheet tiles. In 1951, Wuhan Cotton Factory, which was the first large textile factory in South Central China after the founding of new China, was developed on the original site of the iron factory. It is also the biggest company in Guinbei Area now. With the implementation of Wuhan’s recent policy of ‘back into the third as the second’, some industries in Guibei modern industrial area began to spread outside the city. For example, the Cotton Factory will be moved to Yangluo New District. Besides, except several companies still producing separately, most factories collapsed one after another, or they rented their buildings to small companies as processing workshop or freight yard, other factories being laid idle. The whole area has been seriously declining with no vitality.

Current situation

Wuhan Cotton Factory is located in the south side of Han River and the north side of Gui Mountain, with Yue River on its western side and Nananzui on its eastern side. Han River confluxes
into Yangtze River, with the location near the central part of Wuhan, Hankou on its northern side and Hanyang on its southern side. Most industries in this area are traditional industries, storage and residential area. Storage area occupies 22%, main companies including Wugang Machinery Repair Plant, Han Special car factory, Wuhan No.2 Planting & Dyeing Factory and 824 Factory. Residential area represents 23%, places including Hannan No.2 Village, Hannan No.3 Village, Hannan No.4 Village, Wuhan No.3 Middle School, Qingchuange Elementary School. (Fig. 5-3-1) (Fig. 5-3-2)

Structure and function of the factory

The main production workshops in the industrial area remain their original states. Main existing factories are weaving workshops and spinning workshops. The factories are large space with the column spacing of about 7m. The main structure of them is reinforced concrete structure. The structural system is the bracket columns bearing cast-in-place concrete beams. The type of the roof is the skylight-bearing sawtooth roof, which is typical in textile factory. (Fig. 5-3-3)

Main design principle of the transformation

As mentioned in the previous chapter, the most important point to the transformation is the relationship between the old and the new, which could be considered to be the soul of the whole design. Thus it should be defined in the first place. Among the three different design principles which are ‘installation’, ‘intervention’ and ‘insertion’, to this project, the design principle of ‘installation’ would like to be chosen. For this case, to the industrial heritage itself, it is well reserved. But except the unique roof form and the original structure, the whole building occupies a large area as well as lives in the atmosphere of abandoned industrial heritage. The new element should inject some vitality to this area, and ‘installation’ which refers to the juxtaposition of the old and the new allows the highest level of autonomy of the new elements. The new elements could have their own spatial logic which means that it doesn’t take the characteristics of the original building into account and are dominant. Hence the original building and the new element may be confrontational. However, the final impression is that although there is a clear distinction between the old and the new, they both have their own characteristics and live in harmony with each other.

Specific strategies of the transformation
Under the guidance of the design principle of ‘installation’, the specific design could be developed around it as well as the four specific strategies- urban design, space reconstruction, function improvement and skin replacement.

Urban design

Within the scope of the site which belonged to the Wuhan Cotton Group Company, there are several obsolete factories of different characteristics including the target building. Through the field research and the literature research, according to the conservation value of every factory, some old factories will be reserved and others without necessary to protect will be removed. Then as the target building is expected to be transformed into youth residential, the surrounding buildings should provide it enough basic facilities for daily life. In other words, the site should be multi-functional, integrated. Forasmuch, in line with public level and the requirements of the residents, four main parts in the site are given different functions- youth community, civic center, studio and gym as well as some landscape. And according to the direction of the metro & footbridge, different entrances to the site are set up.

For the target building which will be transformed into youth community, it will get in-depth design. Since Wuhan cotton factory covers a large area and every house only requires a small area, the scale contrast illustrate that the whole building ought to be divided into different areas. Thus, according to the relationship between the building and the entrance as well as the traffic joint and possible continuation context, three paths are introduced into the building and the target building is divided into three parts naturally. Three parts are for different people as the privacy, for rental or long-term residents. Additionally, along the path there will be some public facilities and green area to enrich the youth community. For the studio and the civic center, some concept designs are also made. Some functional blocks with different features are divided to active the whole area.

Space reconstruction

In this point, it could be further divided into two terms, that is, the interior space and the exterior space.

With regards to the exterior space, the original space is a huge area basically without any partition
and only with several concrete columns. Now the whole factory is divided into three parts with different attributes. At the same time, within every part in order to fulfill the possibility to access to every house, the space is further divided into several portions through removing some parts of the original factory. To well organize the space and provide different possibilities for different residents, there are three different residential modes of different sizes, single-cell mode, semi-private patio mode and private patio mode. (Fig. 5-3-7) All the modes are following the logic of the original buildings. As the column spacing is about 7m which is quite fit for the residential space, an area (7mX7.2m) is seen as a single cell. To the single-cell mode, four units is just a cell and the cell unit is combined with the semi-open courtyard which will carry residents’ activities and neighborhood sociability. This mode is fit for the short-term residents and rental youth groups which prefer variable neighborhood. To the semi-private patio mode, every unit consists of three cells and the unit is combined with a larger semi-private patio. The scale to this unit is relatively bigger which is more suitable for young artists as they would like to make their own working space linked with the living space. The semi-private patio also will provide a pleasant space for artistic communication. To the private patio mode, similarly, one cell is a unit and the unit is combined with an enclosed patio which provides young groups private communication space creating harmonious group neighborhood.

With regards to the interior space, to such a huge open space, several strategies are applied to create different units, such as duplex, partition, reduction, expansion, heighten, adding patio, duplex & overhanging, balcony & overhanging and partition & overhanging. The variability of the organization of the interior space makes the space more flexible and interesting. (Fig. 5-3-8) (Fig. 5-3-9) (Fig. 5-3-10)

Function improvement

The function improvement of the transformation is made up of structure system, transportation system and lighting & ventilation. First of all, in terms of the structure system, the original structure is well retained while as the need of the new space, the new structure is clearly distinguishable, completely independent from the original one. The next, in terms of the transportation system, the path to access to every unit outside is created by the general plan. And inside every unit, some of them have a single staircase if they are in the form of ‘Loft’. Finally, in terms of the lighting & ventilation which is quite vital to the residential building, the original sawtooth skylight could be
well taken advantages of. Besides this, windows, part high space are also good means to solve the problem according to the practical needs. (Fig. 5-3-12) (Fig. 5-3-13) (Fig. 5-3-14)

Skin replacement

Due to the design principle of ‘installation’ which refers to the juxtaposition of the old and the new, the skin namely the exterior façade of the industrial heritage may have a big contrast. The new elements don’t follow the logic of the original building but has their own characteristics standing out of the old one whether in the terms of the form or the material. The original materials mainly are red brick and concrete while the new elements choose the material of colorful concrete and big glass distinguished from the original one. For the form of the new element, it just chooses some simple shapes or volumes. In the end, the overall style is of harmony and unity. (Fig. 5-3-11) (Fig. 5-3-15) (Fig. 5-3-16)

Experience and reflection of the project

Through the project in Wuhan, China, it would be found that the design principle summarized from the case study in Barcelona could be well applied to the case in China. As a result, the general applicability is verified. For a transformation project, the relationship between the old and the new indeed plays a decisive role in the whole process which also make influence to the following specific strategies design. In addition, during the application of the experience of Barcelona to the same situation in China, there are some design deficiencies. For instance, the evaluation of the industrial heritage is with a certain degree of subjectivity. These deficiencies would be improved in the further study.
Fig. 5-3-1: The location analysis of Wuhan Cotton Factory under different scales (Source: Author)

- **Wuhan Scale**: Wuhan is located at the junction of two rivers, has great advantages, and the site is just located at the junction.
- **Hanyang Scale**: Hanyang is Wuhan’s key development zone, built and becomes the connecting road network in all directions. The orange area is the Hanyang key development zone, and the Quibei leisure area is one of the key development areas.
- **Quibei Scale**: Site and Hanzheng Street are on both sides of the river, and the introduction of cross-river walk bridge can play the role of activation. Quibei area is on the south of the Han River, on the west of Yangtze River, besides the Gui mountain, forming a good landscape belt.
- **Site Scale**: Hanyang Industrial Park, Yue Lake leisure area and Qintai theatre introduce energy for the site.

Fig. 5-3-3: The dimension of Wuhan Cotton Factory (Source: Author)
Fig. 5-3-2: The current situation of the Wuhan Cotton Factory (Source: Author)
Fig. 5-3-4: Urban design (Source: Author)

Design Diagram of Site

- Site situation after concept plan
- Direction of the Metro & footbridge and possible joints
- Remove old factory which don't facilitate the transformation and planning after evaluating
- Factory emphasised the transformation

- According to the public level Function division
- According to the function and Publicity Set up different entrances
- Add landscape

Design Diagram of Youth Residential

- Relationship between the building and site entrance
- Traffic joint and possible continuation context
- Generate architectural form according to the context

- The rental is placed in the area of worst privacy for artists
- Divide functional blocks on the basis of public property and active paths
- Landscape buffer space between the public and privacy
RESEARCH ON THE TRANSFORMATION OF INDUSTRIAL HERITAGE INTO RESIDENTIAL BUILDING
--TAKING BARCELONA AS AN EXAMPLE

Fig. 5-3-5: The models of the Wuhan Cotton Factory (Source: Author)
Fig. 5-3-6: The master plan of Wuhan Cotton Factory (Source: Author)
A: Single-cell Mode Generation

Reserve the original structure of the factory and combine the cell unit with the semi-open courtyard to make the courtyard to be the space carrying residents activities and neighborhood sociability; Combined with instability of short-term residence and rental youth groups to create variability neighborhood.

B: Private Patio Mode Generation

Combined the living cell unit with the patio, enclosed patio provides young groups private communication space creating harmonious group neighborhood; One cell as a unit, adopt the mode of duplex&balcony&overhanging to create variability of interior space and good view perspective.

C: Semi-private Patio Mode Generation

Combined the living cell unit with the patio, pleasant-scale patio provides long-term residence of young artist groups open space for artistic communication; Three cells as a unit, equipped with studios that can accommodate 4-6 people to live or work; interesting interior is consistent with tastes of young artists.

Residential Unit Cell Transformation Strategy

According to the original structure of the factory, proposed transformation strategies that can be implemented; Combined with the needs of short-term residence and rental youth groups to the living space, adopt the mode of duplex&partition&overhanging to transform a unit to four living units.
Fig. 5-3-8: The ground floor plan of Wuhan Cotton Factory (Source: Author)
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B. Section

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Fig. 5-3-15: The aerial view of Wuhan Cotton Factory (Source: Author)
Fig. 5-3-16: Small perspective view (Source: Author)
6 CONCLUSION
The transformation of industrial heritage has been a heated issue during the process of urban renewal nowadays. And the transformation of industrial heritage into residential building is a vital branch of it, which attracts more and more attention. However, the relevant research or practices in China is few while in Barcelona there are lots of comprehensive research and excellent practices about it. In the meantime, the requirement of this kind of transformation is urgent which not only could contribute to the reuse of industrial heritage, but also address a number of housing problems. Thus, this thesis makes a research from this perspective.

Firstly, through the relevant research results around the world as well as related literature, this paper made a definition of industrial heritage and residential building. Then, it studied the development of transforming industrial heritage into residential building in Barcelona. The development of this specific transformation is inextricably linked with the industrial revolution and urban development, especially after the Post-modernism, industry gave way to the tertiary industry and began to migrate out of the city center, as a result of which the city had been left a large number of idle or abandoned industrial heritage. From the current situation, many of them had been well transformed with some new functions including residential buildings.

In the process of transformation, the crucial point is the relationship between the old and the new which determines the soul of the architecture. According to some outstanding cases in Barcelona, there are mainly three main design principles to deal with the industrial heritage, that is, ‘installation’, ‘intervention’ and ‘insertion’. All of them respect the past of the industrial heritage while chose different ways to add something new when the building were given the new function of residence.

With the guidance of the design principle, the thesis summarized a series of specific transformation strategies from four aspects – urban design (the relationship between the architecture and the environment), space reconstruction, function improvement and skin replacement. These strategies were all collected from large number of different related cases in Barcelona. In the terms of urban
design, it not only need to meet the requirements of the basic life for the residence living here, but also need to live in harmony with the surrounding by the way of maintaining the original volume or improving the environment or creating more links with the surrounding. In the terms of space reconstruction, to the interior space and exterior space, it can choose to make some space division or reoccupy the original space. In the terms of function improvement, different measures could be used to solve the problems of structure, transportation and lighting & ventilation. And in the terms of skin replacement, the material, the form and shape are essential.

Finally, compared with the relevant cases in China and combined with the current situation of China, the thesis provides some useful design principles of transforming the industrial heritage into residential building to China and applies the research results to the design project in Wuhan, China. This verification also made the results more reliable, which could give some guidance to the relevant practice in China.
ACKNOWLEDGEMENTS

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