THE CREATION OF A NEW NEIGHBOURHOOD COMMUNITY IN A FORMER INDUSTRIAL HERITAGE AREA

BY MIXING AND MATCHING

A Sustainable Residential Regeneration of Nanjing Chenguang 1865 Science-Technology and Creativity Industrial Park

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ABSTRACT

Industrial heritage is the remains of industrial culture which are of historical, technological, social, architectural or scientific value. Sustainable regeneration, renovation and reuse of old industrial heritage buildings can form a design process to develop their potential adaptability under the guidance of the concept of sustainable development. Good structure and large space make this kind of building can be redesigned and endowed with new functions even after losing their original function. This approach can not only save resources, reduce waste, continue our feelings for historical buildings, but also add "lifetime" to the old industrial buildings and promote the renewal of old factories, old industrial district or even the whole city. Foreign countries already have relatively mature skills in transforming old industrial buildings, but China has just realized the seriousness of the problem. Generally speaking, there is gap and insufficiency between domestic and abroad. The major problems in China are: narrow scope of transformation, monotonic transformation method, lack of systematic theory guidance and lack of respect for the historical and cultural factors.

This thesis aims at the conservation and regeneration (or renovation) of old industrial building. According to theoretical guidance and many example case studies to conclude the relative design and reform possibilities on the basis of systematic analysis, the summary of the overview of the development at home and abroad and intrinsic motivation in China. Then summarizes the targeted strategy and design method of reusing and reforming old industrial building. Finally, make a proposal for Nanjing Chenguang 1865 Science-Technology and Creativity Industrial Park by using the transformation strategy and the proposed design method. To achieve a goal that former industrial heritage area can be regenerated into a neighbourhood community suitable for both the young generation and the old to live in.

So the thesis is trying to answer the following questions in a broad and general way: Why is the conservation and regeneration of industrial heritage building so important around the world nowadays? What are the opportunities to make full use of these old special structure architectures in a sustainable way? Which methods does China apply to protect and reuse of old industrial heritage buildings? Which principles can be used in neighbourhood design? How has the living space for households developed in China? Which principles can be used in neighbourhood design?

The research question of the whole thesis is:
How to change Nanjing Chenguang 1865 Science-Technology and Creativity Industrial Park into a neighbourhood suitable for living?

In order to answer these questions, some theoretical documents will be used. From three aspects: Aesthetic: to keep and reuse typical characteristics of industrial heritage building; Economic: to transform
old buildings; Functional: to create livable neighbourhood community. Firstly the necessity of industrial heritage protection will be stated, after that is conservation and regeneration measures including the transformation strategy and principles. Neighbourhood development is also an important theoretical part, using theoretical support like Carmona’s book. Neighbourhood community is the envisioned functional attribute of the design industrial heritage area after transformation. Whether the chosen site can be regenerated into neighbourhood community successfully depends on it. However, this study will also draw lessons from some successful cases. For instance, Beijing 798 Art Zone; Gasometers, Vienna, Austria; Tianjin Glass factory, etc. Along with the analysis and investigation of the selected design area. Therefore, as a process in urban renewal, the conservation and reuse of old buildings get more and more attention by the world. In China, the large population base; the difficulty of employment; the gap between the rich and the poor caused by economic development; the aged tendency of population... These problems caused a lot of troubles, such as poor living situation, bad neighborhood development, rising house price... So how to mix and match the regeneration of old abandoned industrial building (or area) and residential area organically together will be an interesting and worth further exploring subject.

KEY WORDS:

industrial heritage, conservation and reuse, sustainable regeneration, residential transformation, urban design, neighbourhood community, Nanjing Chenguang 1865 Science-Technology and Creativity Industrial Park
ACKNOWLEDGEMENT

Finally, this thesis is finished. It has draw a full stop at this stage of my two years' master study and life. For me, it is a wonderful chance taking part in this exchange study programme between Blekinge Institute of Technology and Nanjing Forestry University. It is my great honor to spend my most precious time on this campus, under the influence of brilliant and talented teachers.

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Chapter 1. INTRODUCTION

1.1. Background

1.1.1 The concept and theoretical basis on industrial heritage
The construction in developed countries generally go through three processes: new construction, renovation and conservation. Early in the middle of the 19th century, western countries have attached great importance to the transformation of old buildings, and have obtained many achievements. Number of industrialized countries, including Britain, Germany, the United States, France and so on, carried out protection work in the protection work of industrial heritage buildings in the 1950s. Since 1980s, renovation of old buildings have been becoming a hot trend around the world. Many international organizations were also actively promoting the protection activities of industrial remains. The International Committee for the Conservation of the Industrial Heritage (TICCIH) was even founded by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1978.

The International Committee for the Conservation of the Industrial Heritage (TICCIH) approved of The Nizhny Tagil Charter in 2003. The definition of industrial heritage from The Nizhny Tagil Charter is:

“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.”

Almost all industrial heritage were built during the historical period since the second half of the eighteenth century (The Industrial Revolution) up to and including the present day, also including its earlier pre-industrial and proto-industrial roots.

1.1.2 The evaluation standards of industrial heritage
There is no international standards for identifying industrial heritage, the UNESCO listed six main basis for assessing the industrial heritage are the same as the ones for assessing cultural heritage: should be 1) masterpiece which can on behalf of human creative genius; 2) shows the value of the humanities within a certain period of time or in a certain cultural areas, such as the development of architectural or technology, monumental art, town planning and landscape design; 3) an unique or at least some kind of typical
testimony of surviving or already disappeared cultural tradition; 4) an outstanding representative of a certain type of architecture, technology system or landscape, showing a significant stage in human history; 5) can reflect the interaction between culture, human activities and nature; 6) have directly relation with the certain events, traditions, beliefs, or works of art and literature.

The industrial heritage which recognized by the UNESCO including three levels from the aspect of spatial morphology: Level 1 refers to important industrial production facilities, including coal, precious metal mineral resources, salt mines, steel mills, printing plant, etc. Level 2 refers to material or energy transmission lines, including water pipes, railways, canals and ancillary facilities. Level 3 refers to industrial complex areas or industrial towns.

1.1.3 The scope of industrial heritage in China
After modern China opening up to the world, the foreign capital industry built a lot of modern factories. During the westernization Movement, officials and private capitalists established Chinese national industry and the Chinese socialist industry which have left a lot of distinctive industrial architectures. They are the main body of China’s industrial heritage.

The industry development of modern China can be roughly divided into seven stages. (Kongjian, Y. Wanli, F. 2006) (Table 1)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Time</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>1840-194</td>
<td>The beginning of China's modern industry. Some industrial categories appeared slowly.</td>
</tr>
<tr>
<td>②</td>
<td>1895-1911</td>
<td>China's modern industry preliminary developed. The &lt;Treaty of Maguan&gt; allowed foreign capital factories open factories across the country. Chinese lose its exclusive rights of industrial manufacturing.</td>
</tr>
<tr>
<td>③</td>
<td>1912-1936</td>
<td>Rapid development period of private industrial capital, overseas Chinese and military top brass become important industrial investors, modern industry development gradually became independent.</td>
</tr>
<tr>
<td>④</td>
<td>1937-1948</td>
<td>Difficult development time during the Anti - Japanese War. A large number of industrial and mining enterprises were migrated. But it had a short recovery after the war.</td>
</tr>
<tr>
<td>⑤</td>
<td>1949-1965</td>
<td>Socialist industrial preliminary developed in China (early PRC), went through the rational development and industrialized Great Leap Forward.</td>
</tr>
<tr>
<td>⑥</td>
<td>1966-1976</td>
<td>A rough period, Industrial production stagnant and even retrograde.</td>
</tr>
<tr>
<td>⑦</td>
<td>Nowadays</td>
<td>Rapid development period of the socialist modern industrial, Industrial structure adjust which prompting reposition of many industrial districts.</td>
</tr>
</tbody>
</table>

Table 1
Each stage of development has different participators who set up the industries, different popular industry and typical industrial heritage of that period. Stage 1: 1840 - 1884. During that period, the foreign capital operating independently in the shipbuilding, the export processing, the light industry, municipal services and public utilities. For example: Guangzhou Huangpu shipyard. The Westernizationists of the Qing government operating the military industry, the civilian industry, the light industry, infrastructure and utilities. For instance: Jiangnan Manufacturing Bureau. And some Chinese-foreign equity joint venture and comprador business. The number of industrial heritage formed during this period is very large.
Stage 2: 1895 - 1911. During that period, foreign capital became the main force of investment in China. Key areas of investment was still concentrated on shipbuilding, mining and other industries related to people’s livelihood.

![Image 1-2: Jiangnan Manufacturing Bureau](image12.jpg)
Source: www.chinesefirearms.com

Stage 3: 1912 - 1936. The investment in China dominated by Japanese aggressive forces. Chinese industry gradually moved towards autonomous development. Stage 4: 1937 - 1948. During the anti - Japanese War, major cities in East China were occupied by Japan, So the national government and the patriotic national capitalists made the factories moved Inland which promote the development and industrialization of the southwest. Stage 5: 1949 - 1965. After the founding China carried out the socialist transformation with the assistance of Soviet experts constructed a number of large - scale heavy industry, initially formed a relatively complete modern industry system. Stage 6: 1966 - 1976. During the Cultural Revolution, the development of the southwest region, the formation of a number of new industrial cities. Stage 7: 1977 untill now. Chinese industry had sustainable and stable development. Industrial ownership structure has undergone great changes, and it created a diversified industrial economic structure. With the deepening of the industrialization process, traditional manufacturing activity was reduced in the process of industrial restructuring and left a lot of industrial heritage.

The protection and reuse of industrial heritage is a subject that has been gradually concerned in China in recent years. After went through demolition and reconstruction, Chinese academics recognized a problem that the legacy of old buildings are the inevitable result in urban development, how to inject new vitality through the transformation way to complete the rebirth of the old
buildings have become a ‘front-burner’ issue in recent years. So a large number of theory and engineering practice of renovation and protection of old buildings have sprung up. After year 2000, the development of urban reuse of old buildings in China was even more rapid, especially in economically developed cities.

1.2 Research question and Aim

This thesis is trying to answer the following questions in a broad and general way:

◊ Why is the conservation and regeneration of industrial heritage building so important around the world nowadays?
◊ What are the opportunities to make full use of these old special structure architectures in a sustainable way? Which methods does China apply to protect and reuse of old industrial heritage buildings?
◊ Which principles can be used in neighbourhood design? How has the living space for households developed in China?

The research question of the whole thesis is:

◊ How to change Nanjing Chenguang 1865 Science-Technology and Creativity Industrial Park into a neighbourhood suitable for living by using the principles or theories to support this kind of sustainable regeneration design?

This thesis aims at the conservation and regeneration (or renovation) of old industrial building. According to theoretical guidance and many example case studies to conclude the relative design and reform possibilities on the basis of systematic analysis and summary of the overview of the development at home and abroad and intrinsic motivation in China. Then summarizes the targeted strategy and design method of reusing and reforming old industrial building. Finally, make a proposal for a certain site - Nanjing Chenguang 1865 Science - Technology and Creativity Industrial Park (Hereinafter referred to as Nanjing 1865 industrial park) by using the transformation strategy and the proposed design method. To achieve a goal that former industrial heritage area can be regenerated into a neighbourhood community suitable for both the young generation and the old to live in.

1.3 Theoretical foundation

In order to answer the research questions, some theoretical documents are used. Mainly from three aspects: Aesthetic: keep and reuse typical characteristics of industrial heritage building; Economic: transformation of old buildings and residential transform mode of industrial heritage building; Functional: create a livable neighbourhood community in a former industrial heritage area by mixing and matching.

As a result, the necessity and significance of industrial heritage protection will be stated firstly, after that is conservation and regeneration measures including the transformation strategy and
principles of old (industrial) buildings. Because of functional regeneration, the Industrial heritage area is going to be transformed into a living community. The main referenced thesis is a Chinese one which is called *A New Mode of Industrial Heritage Residence Reuse in China* written by Zhu Huichao. Also with some relative documents about reuse of industrial buildings, sustainable regeneration (or renovation and reuse) of industrial heritage buildings, sustainable development both in China and foreign countries. Neighbourhood development is also an important theoretical part. Because it is the envisioned functional attribute of the designing industrial heritage area after transformation. In this part, the main theoretical support are Carmona’s book ‘Public Places - Urban Spaces The Dimensions of Urban Design’, ‘Cities for People’ written by Jan Gehl and other thesises about neighbourhood community development in Chinese.

Under these theoretical guidance, I may have the clear clue to make the analysis of the example cases and the chosen area. Then come out a relatively complete regeneration design of Nanjing 1865 industrial park.

1.4 Thesis outline

This thesis consists of seven chapters:

Chapter one is the introduction. First of all, the background of industrial heritage is introduced, including the concept, the theoretical basis, the evaluation standards and the scope in China. Secondly, the research questions and aims are stated. After that a brief theoretical foundation is summarized while the using theories and concepts will be presented in details in the third chapter. Finally is the general thesis outline.

Chapter two is the methodology. The main methods - literature guidance and descriptive study are introduced in this chapter, along with case study method including the process and evaluation.

Chapter three is the literature review, where the theories are systematically stated from three aspects: Aesthetic, Economic and Functional. Also the most important and useful literature *A New Mode of Industrial Heritage Residence Reuse in China* is detailed recommended and presented.

Chapter four is the opportunities to industrial heritage building. In this part many example cases are described and analyzed.

Chapter five is the analysis and assessment of the chosen site. It is the case study, based on the investigation, showing the current situation and the problems. Also with the motivation of writing this thesis, explaining why choosing this topic.

Chapter six presented the design proposal. It gives the improvement of the site - Nanjing Chenguang 1865 Science - Technology and Creativity Industrial Park according to the analysis in chapter five.

Chapter seven is the conclusion of the whole thesis, with the evaluation of the theories and the design proposal. And the prospects for development and solutions to the problems will be also summarized.
The following diagram indicates the structure:

The Creation of a New Neighbourhood Community in a former Industrial Heritage Area by Mixing and Matching

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**Introduction**

- Research on industrial heritage and industrial heritage building
- Concept and evaluation standards
- Conservation Regeneration
- Transformation strategy and principles
- Good living space and scale
- Good life quality
- Functional and aesthetic
- Aesthetic
- Economic
- Functional

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**Residential Transform Mode of Industrial Heritage**

- Sustainable development

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**Example study**

Case analysis and design proposal on Nanjing Chenguang 1865 Science-Technology and Creativity Industrial Park

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**Conclusion**
Chapter 2. METHODOLOGY

The intention of this methodology part is to supply the understanding of the methodology to readers, along with the relevant research approaches adopted in this research. The reason of adopting research approaches and reason for case selection are also explained in this chapter. This Thesis is mainly focus on the regeneration of old industrial heritage area including its buildings. The final goal of it is to do a redesign of a former manufacturing bureau(also called Arsenal) - Nanjing Chenguang 1865 Science - Technology and Creativity Industrial Park. And the particular approach, as stated before, is to transform the area into a neighbourhood community for both young and old generation by changing its function. With the purpose of doing a better research, neither theoretical guidance nor practical operation can be omitted.

2.1 Research Method

The methodology can be divided into three parts: Documentation review/ Literature guidance; Descriptive study and Case study.

In order to achieve the final goal, the main method is Case Study while Literature guidance and Example case analysis are served for it. Among these three progress, the first one goes to "Literature guidance (literature review)" which is definitely necessary. In this part, useful theories and information are chose and gathered systematically to serve the theoretical basis as for directing the analysis approach and the fulfilment of the final design. It also provides principles and strategies for application. The second process is "Descriptive study (Example case analysis)". Because I suppose that example case analysis can be regarded as an approach that is suitable for studying a phenomenon in a specific or similar situation. Several cases are selected from both domestic and overseas which can typically reflect my research topic. Strength and weakness can be concluded and apply to the following case study - project site analysis. Then the experience from the descriptive research and the case study could lead a relatively mature design.
2.2 Theoretical Guidelines

Theoretical Guidelines, which is detailed presented in chapter Three - literature review, require relevant literatures to the research topic. They should have suitable qualities and be managed in a systematic way. In addition, the literature review including generalization, comparison, comment and discussion related to the research field of the same topic, so different literatures and comparative data are needed to be collected from various perspectives.

The reason to choose "literature review" as a kind of method is that it can be regard as a tool to organize and analyze the related knowledge and viewpoints about the research topic so that the concepts and provided ideas as well as guidelines or stratages could guide this research. This thesis is a relatively innovative problem - solving research based on industrial heritage and redesign for a specific site - Nanjing 1865 industrial park, so theoretical guidance is more important for scientifically analysis and study. Under the background of these professional predecessors' work, the problems are usually complicated and resulted from various facts. Therefore, references should be gathered from a broad scope.

After reading and selecting point of views which are needed according to the research topic, three main concepts are summarized to analyse industrial heritage regeneration: Aesthetic, Economic and Functional which can be expanded as three main aspects: Keep and reuse typical characteristics of industrial heritage building; Transformation of old buildings and Residential transform mode of industrial heritage building; Livable neighbourhood community.

As a result, firstly the literature review focuses on the necessity, value, significance and principles of industrial heritage protection. Then comes the brief explanation of Sustainable design and Sustainable method in reusing old building. The articles and journals on relevant theories are collected and read. The former two aspects are highly mentioned when discussing industrial heritage regeneration or transformation, the problems in re-using industrial heritage can be analyzed from these perspectives then to solve them in a comprehensive way. The last one, Livable neighbourhood community, is the target function for the final design. So theories like: "what characteristics a good neighbourhood community need", "livable elements for neighbourhood community", "principles for neighbourhood design" are referred to.

In order to get these theories, these major bibliographic databases and searching engines have been searched: school library, China Knowledge Resource Integrated Database (CNKI), Baidu elibrary and Google scholar. Key words to be searched are: "industrial heritage", "conservation and reuse", "sustainable regeneration", "residential transformation", "neighbourhood community" and "Nanjing Chenguang 1865 Science - Technology and Creativity Industrial Park".
In summary, the results of searched literatures are books, journals, dissertations and research reports. The books provide theories, arguments and guidelines relevant with industrial heritage and its conservation and reuse. Current issues and discussion about industrial heritage protection can be found from the journals. And if some special concept or information about cases need to be look up, materials are searched on the internet like Wikipedia and google search engine to support those literatures. All these literatures are helpful in organizing the theoretical framework and all these mainstream theories give effective guidance, where I could conclude which principles or strategies can be used to analyse the following Illustrated cases as well as to support this kind of sustainable regeneration design.

2.3 Case Study

First I should explain the reason to choose example case analysis and case study as the main method in this research. As several previous scholars have proposed the definition and advantages of case Study: Thomas offers the following definition - "Case studies are analysis of persons, events, decisions, periods, projects, policies, institutions, or other systems that are studied holistically by one or more method. The case that is the subject of the inquiry will be an instance of a class of phenomena that provides an analytical frame-an object- within which the study is conducted and which the case illuminates and explicates." (Thomas, G. 2011)

While Francis proposes the definition: a case study is a well-documented and systematic examination of the process, decisionmaking and outcomes of a project, which is undertaken for the purpose of informing future practice, policy, theory and/or education. And he also declares that this method is particularly useful in professions such as landscape architecture and planning because real world contexts make more difficulties to empirical study. (Francis, M. 1998) Robert thinks that case study is a research strategy that needs empirical inquiry which is always used for investigating the phenomenon in the context of real life especially when the limits between the phenomenon and the context are not evidently. (Robert, K. Y. 2009)
As this research is to study "How to change Nanjing 1865 Industrial Park into a neighbourhood suitable for living". Therefore, the similar empirical examples around the world are selected to understand the phenomenon more clear. A phenomenon is mostly in the context of real life, which should be combined into the real world. In order to study deeply in it, I also need a real case to research on and to see whether I can put forward a result to the real life by using the principles and theories to support this kind of sustainable regeneration design. Thus "case study can also be regarded as a study process of one single event that takes place within special conditions or particular circumstances". (Stake, R. E. 1995)

2.3.1 Reason for example case selection
Actually the example case analysis, which I used in this thesis, belongs to a kind of descriptive study. Descriptive study is the method that author gives description and explanation to existing phenomenon, rules and theories through his or her own understanding and validation. It is the general narrative of various theories, explain more of others' arguments, which is in essential scientific research. It can directionally put forward questions, reveal shortcomings, describe the phenomenon and introduce experience. Among its plentiful instances, there are investigations with different unraveling situation; descriptions of the practical problems and viewpoints of certain status, etc. In this paper, the case analysis are all concentrated in the fourth chapter.

The beginning of industry remains' transformation in foreign countries and China is respectively since the 1980s and the last century. Considering it has become a typical dominant mode of protecting remains of industrial buildings, there will be a series of successful precedents can be draw lessons from. So I have chosen several examples and each one has its reason to be selected. I am accounting for them as follows.

The Beijing 798 Art Zone is the first example because there is an old factory which has the same "zigzag roof" as the one in Nanjing 1865 industrial park. And I intend to do a more detailed interior design on that one in 1865 industrial park. Moreover, 798 Art Zone is one of the biggest successful case of group of old industrial heritage building transformation in modern China, its design has a lot of inspiration for my project. The three 'Railway parks' are well regenerated in to three natural park for leisure. Their design concepts are worth learning. And from the perspective of different countries, it can be seen that processing methods on the same types of things are different between the Chinese and the Westerner. As for "The Ruhr", it is typical universally recognized example of successful transformation in industrial area. From my point of view, once it comes to industrial transformation or reuse, "The Ruhr" must mentioned and learnt from. However, the next few examples are the priority among priorities. Because they are under the residential transformation mode of industrial heritage. Especially "The Tianjin Glass factory (the "Crystal City"). It has just the same intentions as my thesis. It is one of the few
success story in China that to transform industrial heritage area and its building inside into residential community. They are good examples under different protection and transformation modes which can give me design inspiration and enlightenment.

2.3.2 Reason for choosing case
As stated before, the case study is conformed to conduct my research. It starts with an investigation, then analysis is done to declare the problems and to assess the site based on the theories in literature review and example case study, after that a design proposal is presented to give a detailed solutions and the re - birth to "Nanjing Chenguang 1865 Science - Technology and Creativity Industrial Park".

For both subjective and objective reasons, I decided to choose this case of the industrial heritage site - Nanjing 1865 Industrial Park, which locates in Nanjing Qinhua District, as my application case in this thesis. The reasons are as follows: First of all, I was born and raised in Nanjing, it is my hometown which means I am very familiar with its culture, history and life style. I believe this kind of emotion may have a positive effect on my research to be more attached to the existing contexts of the whole city. In addition, I have four years' Landscape Architecture study experience in Nanjing Forestry University and more than one year Urban Design study experience in BTH. I have studied so many related planning strategies and documents of reconstruction in my research field of this thesis during these years. The experience help me to think about my research and redesign from more different and proper angles.

Image 2-1 : Intern working environment
Source: Photoed by author
Moreover, I once worked as an intern in a private advertising company in the year 2013. That company is located in the zigzag roof old factory in 1865 Park. So I was once contact with the internal structure of the old building, I get more familiar feeling to it even to the whole area. Secondly, I am representing the idea of young generation. People in this modern age are with unabashed individuality, always seeking difference and innovation. Yearning to live in a loft is popular among the youth in China. Last but not least, aging problem is very serious in the world. China is no exception, the country begins to practice plans for the elderly people. My design aim is not only to turn the old industrial area into a residential community but also suitable for young and old generation to live.

![Image 2-2 : Gate of Nanjing 1865 Industrial Park](image)

Source: Photoed by author

### 2.3.3 Data collection and analysis

In order to answer the research questions and make in-depth analysis on Nanjing 1865 Industrial Park, it is necessary for me to collect and select adequate and abundant data that associated with the area, along with the necessary investigation to have a fully understanding of the site. After that, an elaborate site analysis is important which is in the fifth chapter. The collection data was mainly based on research articles and professional reports. Site investigating is the most helpful to collect the reliable materials like maps and photographs. In order to analyze the local context, several aspects needed to be mainly focused on, for example, the location, land use, traffic system, green space, etc. The process of analysis is to organize the results from investigation as well as to form the foundation of the design proposal. Then form a whole assessment of the case. The pros and cons of the site is listed and depicted. Therefore the goals and objectives are raised according to the problems from assessment.

Finally comes the design proposal. It is conducted on the basis of investigation and analysis. But its essence is renovation and transformation rather than a re-design. The case study method can collect a lot of data and have a deep research into many details so as to solve the problems in elaborate solutions. However it still has its limitations. One case study cannot present the general issue, its data and problems only shows the specific condition. The solution expressed in the design proposal is a possible solution but not a universal one. (Shan, L. 2014)
Chapter 3. LITERATURE REVIEW

The main methods of the thesis: theoretical guidelines, Descriptive study / example case analysis and case study, are generally introduced in chapter two. Theoretical framwork will be systematically described from three aspects in this chapter:
1) Aesthetic: Keep and reuse typical characteristics of industrial heritage building; 2) Economic: Transformation of old buildings and Residential transform mode of industrial heritage building; 3) Functional: Livable neighbourhood community (for young and old generation).

3.1 Respect the context and architectural heritage

3.1.1 Necessity of Industrial Heritage Protection

The heritage architectures represent the very best of our past. They also provides a huge resource that can play an important role in the future of our towns, cities and rural areas in terms of the stimulus provided to regeneration and the promotion of sustainable development. Heritage Works are valuable asset that has an important role to play as a catalyst for regeneration (Liz, P. Mark, A. Simon,T. 2013. P2).

They concluded several positive qualities and benefits that heritage assets can add to a regeneration scheme:

• Historic buildings give people a sense of place. Because they create a focal point that people can relate to and are familiar with. They feed people’s interest in the past.
• Historic buildings may be well loved local landmarks which the community identify with and will rally around to support or save.
• Historic buildings have historical and cultural relationship which can be developed through the regeneration.
• Historic buildings can assist in achieving sustainable development objectives.
• They may attract tenants/occupiers who would not be interested in a less distinctive building.
3.1.2 Value and Significance of the industrial heritage development in China

The Nizhny Tagil Charter for the Industrial Heritage (TICCIH, 2003) listed the values of industrial heritage which can be concluded as: historic value; social value; technology value. Firstly, industrial heritage have great historical significance to recognizing industrial activity processes, they are built very early and they are pioneering industrial landscape which can show the originator of a certain industry category. Industrial heritage were dominant in the industry and on behalf the advanced level the productive forces. It is a symbol of the industrial reform, the production technology and the form of innovation management. Usually these industrial architecture that is associated with significant historical or political events; Secondly, industrial heritage recorded the daily life of the masses, they are the basis of social identity and social sense of belonging. So they also have social value; Thirdly, they have the technical and scientific value in terms of mechanical engineering, technology, architecture and planning, therefore, they have aesthetic value in the aspect of planning and design of factories, building structures, which reflects the specific esthetic orientation derived from certain period of industrial production; Industrial heritage also have inherent uniqueness in terms of factory locating, layout of workshops, etc.

With the passage of time, industrial heritage buildings increasingly shows their unique value, they can also play a more important role in social and economic benefits. To make full use of spatial morphology of large industrial building and the texture of wood, masonry and other natural materials, to transform and reuse of the unique structural system can not only form active cultural landscape, can effectively improve the function of urban services, but also enhance the historical ambience of the city and reflecting the concept of sustainable urban development. Industrial heritage is important because they have unique value, although some of them have completely lost their initial production capabilities and economic benefits. Therefore, I would especially like to mention the industrial heritage constructions which were built during the period of the republic of China.

Image 3-1-1: The Presidential Palace in Nanjing
Source: www.baidu.com
As mentioned before, the most part of Chinese industrial heritage buildings were built during the late Qing Dynasty and the Republic of China. They, reflecting the history of modern Chinese architecture, recording the history, are precious material culture heritage.

Nanjing is the capital of China, in the period of the republic of China. As a result, its building of the time is not only numerous but functioned for various aspects, such as politics, economy, culture, social life and so on. The building type is complete as well. The building design, structure and style reflect the influence of western architectural styles and the Chinese traditional architectural features. The integration of Chinese and western architectural technology and style act evidently in the buildings of the republic of China in Nanjing. They fully demonstrate the Chinese architectural evolution, from traditional to modern, which have significance in the history of architecture development. Up to today, most of the old buildings are well-preserved. They constitute the unique city style and features. Nanjing Urban Planning Bureau has carried out a 3 year plan (from 2006 to 2008) for conservation and utilization of old building which built during that time. (Mou, T. 2008) In consequence, Nanjing is vividly described as "the base of the buildings of the republic of China".

In general, the structure of the buildings of the republic of China is brick-concrete. As a kind of construction material, "Black bricks" have been widely applied. Other basic characteristics of the buildings of the republic of China are arch, zigzag roof and so on.

Image 3-1-2: The application of "Black brick" and "zigzag roof"
Source: Photoed by Author

In recent decades, seeing from a global perspective, both in abroad and domestic attached great importance to the protection of industrial heritage. Such as the protection and reuse of the Ruhr, the well-known German industrial heritage site, and the overall conservation planning programme of Beijing798 art zone, etc. Which will be mentioned as example research cases in chapter four. They all epitomizes the strengthen of industrial heritage protecting concept among the general public and organizations around the world.
3.1.3 Conservation and Regeneration

Conservation
Since 1945 until recent years, most of the countries regard preservation and conservation as a consistent and comprehensive practice. Many current urban design approaches are attempt to respond to the existing sense of place, stressing 'continuity with', rather than a 'break from', the past. (Carmona, M. 2012)

Lynch, K. (1972) argued that the key to conservation was to "disentangle it from the idea of preserving the past". According to Lynch's questions, Tiesdell, S. (1996) listed the more common justifications about the purpose and practice of conservation. They are seven key benefits that Historic Preservation Offers:

① Aesthetic value: historic buildings and environments are valued because they are intrinsically beautiful or have scarcity value;

② Architectural diversity and contrast: urban environments are valued for the architectural diversity that results from the combination or juxtaposition of many buildings of many different ages;

③ Environmental diversity and contrast;

④ Functional diversity: a diverse range of different types of space in buildings of varying ages enables a mix of uses. Older buildings and areas may offer lower rents that allow economically marginal but socially important activities to have a place in the city;

⑤ Resource value: Whether beautiful, historic or just plain practical, buildings may be better used than replaced. The reuse of buildings constitutes the conservation of scarce resources, a reduction in the consumption of energy and materials in construction, and good resource management;

⑥ Value for continuity of cultural memory and heritage: visible evidence of the past can contribute educationally to the cultural identity and memory of a particular people or place, giving meaning to the present by interpreting the past;

⑦ Economic and commercial value: Historic buildings usually possess scarcity, which can present opportunities for tourism." Coupled with tax and other incentives the cost of utilizing them is often lower than for other alternatives.

Rossi (1966, 1982) discussed the idea of a city's "collective memory", where urban form was a repository of culture from the past and for the future. In this fast developing world, visual and tangible evidence of the past is valued for the sense of place and continuity it conveys. Particular value is placed on the sense of place and the relative permanence of its character and identity, such as the buildings of the republic of China, some essence of thier characteristics is still maintained although the time flies.
Regeneration
“The best way to conserve a heritage building, structure or site is to use it... Adaptation links the past to the present and projects into the future” Heritage best practice is for new work to be able to be removed at a later date, so that adaptive reuse does not preclude future conservation. Actually here, the "reuse", "regeneration", "transform" of the old ones refers to "Adaptive reuse" them which means the conversion of a building, site or precinct from one use to another. Where the site being reused has heritage value the new use should support the ongoing interpretation and understanding of that heritage while also accommodating new functions.

Image 3-1-3: Adaptive reuse on '4th + Linden', California
Source: [http://buildipedia.com/](http://buildipedia.com/)

3.1.4 Transformation strategy and principles of industrial heritage
The method of transforming industrial heritage buildings can be roughly divided into three: transformation of partial elements; transformation of spatial form and transformation of structure type.

Transformation of partial elements
That means to redecorate the old buildings partially, such as changing the doors, windows, walls or materials, but still retain the basic features of the original industrial buildings. Some components can be added as needed, auxiliary facilities such as elevators, to accommodate new requirements. This type of 'to be transformed' old industrial building has larger space scale, better lighting, ventilation, drainage, moistureproof, heat insulation and other tectonic system. This way of transformation can keep the most morphological characteristics of old industrial architecture.

Transformation of spatial form
This kind of transformation is to create the buildings space again by re-dividing the original interspace into several small spaces. Retaining the original main structure, and in the meantime, doing constructional adjustment. This type of industrial building also has large internal space, most of them use giant steel support structure to form large open interspace with fewer pillars. Usually they are
one-floor factory or warehouse. It preserves the landscape characteristics of industrial buildings.

**Transformation of structure type**
Some old industrial buildings have damaged structure and bad loading capacity. Under this circumstance, only architectural appearance can be kept. We have to re-shape various forms of space to meet various needs. Build a new system of structure to provide perfect supporting facilities, add necessary building components, such as stairs, entrance, etc. This kind of transformation is based on keeping the surface of old industrial buildings.
### 3.2 Sustainable design

#### 3.2.1 Sustainable development

This concept was first proposed in 1980 by the International Union for Conservation of Nature (IUCN). Then governments and international organizations are widely accepted and used it after 1987.

Sustainable development is an organizing principle for human life on a finite planet (Wikipedia). It is a development model which can not only meet the demand of people nowadays but also does not damage the demand of future generations. In the meantime, under the condition of protecting the environment. In other words, the sustainable development is the coordinated development of economy, society, resources and environment. They are in an inseparable system to achieve the purpose of economic development and to protect the natural environment, so that the future generations can live and work in peace. The concept of ecology is an important source for sustainable development. Ecology may stand for "Energy" or "Environmentalism". Environmental protection is an important aspect of sustainable development. The core issues of sustainable development to be solved are: population, resources, environment and development. The core idea of sustainable development is: human being should coordinate problems between population, resources, environment and development, pursuit for better development without compromising the interests of others and the future generation's.

The concept of sustainable development includes not only environmental, but also economic and social, sustainability. Us urban designers need to have regard to social impacts and long-term economic viability, as well as environmental impacts. (carmona, 2003)
3.2.2 Sustainable design

Sustainable design is a kind of design strategy based on sustainable development. Also can be called "green design", "environmental design", "environmentally sustainable design", "environmentally conscious design", etc (Wikipedia). It asks for the harmony between people and the environment and is mainly reflected in the design field of the establishment of a lasting consumption pattern, the establishment of sustainable communities or the exploitation of persistence energy, etc.

Sustainable design is reflected in four attributes: the natural attribute, social attribute, economic attribute and attribute of science and technology. As for natural attribute, it is seeking an optimal ecosystem to support the ecological integrity, so that the human living environment could be sustained; As for social attribute, it can improve the quality of our lives; In terms of economic attribute, it is maintaining the quality of the natural resources and maximizing the benefits of economic development at the same time; And as for attribute of science and technology, sustainable design is a more efficient technology to make natural resource consumption decrease and to reduce waste and pollutants. (Baidu Encyclopedia)

While sustainable design practically applied on urban planning and architecture, urban planners are interested in achieving sustainable development or sustainable cities use various design principles and techniques when designing cities and their infrastructure. They usually use the following concepts: Smart Growth, an urban planning and transportation theory, it avoids urban sprawl and advocates compact; Transit-oriented development (TOD), walkable, bicycle-friendly land use, including mixed-use development with a range of housing choices. TOD attempts to maximise access to public transport and thereby reduce the need for private vehicles. Public transport is considered a form of Sustainable urban infrastructure. New Urbanism emphasize diversity of land use and population, as well as walkable communities which inherently reduce the need for automotive travel (Wikipedia).

One of the principles among Sustainable design is:

Design for reuse and recycling: "Products, processes, and systems should be designed for performance in a commercial 'afterlife'." (Anastas, P. L. Zimmerman, J. B. 2003)
3.2.3 Sustainable method in reusing old building

At present, the idea of sustainable development is gradually becoming the consensus of human society. Its essence lies in considering political, economic, social, technological, cultural, aesthetic issues comprehensively and putting forward integrated solutions. Sustainable design brings a new campaign to promote the progress of building science and creation of architectural art. The sustainable reuse of the city's old buildings because they can no longer meet the needs of the society in aesthetic and function aspect. But they still have potential economic and cultural value which can be realized by using the following techniques: function transformation, space re-division, structure transformation and expansion, etc.

'unlike a landscape that will mature over time, a building, unless well cared for, will do the exact opposite - it will deteriorate' (Tibbalds, F. 1992, p. 72)

For Duffy (1990), a building can be seen as a series of layers of longevities. Brand. S (1994, p. 13-15) extends and develops this idea to create a series of six systems: • Site • Structure • Skin • Services • Space plan • Stuff. The systems are differently paced: 'site' and 'structure' are the slowest; 'stuff' and 'space plan' the quickest.

“The retention of older buildings, either in their entirety, or simply by re-using components in-situ and allowing for their thermal upgrading in benign and sympathetic ways, can provide excellent finished results which are fully in accordance with the principles of building conservation and sustainability. In many cases, the process of careful adaptation and re-use can produce new buildings and spaces of the highest architectural quality”. (English Heritage, March 2011)

Some buildings will last longer than others for a variety of reasons, including their financial and symbolic; design, construction and appearance. Such buildings also become particularly meaningful to residents and visitors, and often symbolically represent the city.

Image 3-2-1: Convent de Sant Francesc's Afterlife
Source: http://style.sina.com.cn/des/design/2012-10-08/0901106748_2.shtml

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3.3 Neighbourhood

Recent developments of the concept of neighbourhood design have consistently emphasised the principle of mixed use, which is considered valuable for environmental and social sustainability purposes. Neighbourhood is the basic unit of the city and the important part of urban development. After a long time planning practice, it has become an effective tool to city renewal and transformation. Neighborhood is also the most basic unit of urban settlements. It not only emphasises on the geographical and physical features but more emphasises on interaction relationship between people, emotion attribution and other social psychological characteristics. Thus, the definition of 'Neighbourhood' is: a region with clear boundary; community spirit and social networks formed from a longtime when people living together and interact with each other. (Shenjing, H. Yuting, L. 2005)

The "neighborhood unit", which Perry (1929) advocated, provides a variety of necessary facilities such as community centers, shops and so on so as to organize various neighborhood activities. His aim is to make disperse people which influenced by the urban life to gather together through the core of settlements. For this purpose, Perry proposed that each neighbourhood unit should contain four basic elements: ① an elementary school; ② small parks and playgrounds; ③ small stores; ④ a configuration of buildings and streets that allowed all public facilities to be within safe pedestrian access.

Image 3-3-1: Clarence Perry's neighbourhood unit
Six physical attributes were also specified by Perry (1929):

1. size - the population required to support one elementary school;
2. boundaries - arterial roads would bypass rather than penetrate the unit;
3. open spaces;
4. institutional sites at the central point, so that the sphere of influence coincided with the unit;
5. local shops located on the edge of the unit, so that larger units would be formed at junctions;
6. an internal street system proportional to the expected traffic load. His neighbourhood unit can be regarded as a mean of systematically organising and developing city areas.

While Duany and Plater Zyberk came up a new neighbourhood concept - "New urbanist neighbourhoods":

• Compact, pedestrian-friendly, mixed-use and identifiable areas that encourage citizens to take responsibility for their maintenance and evolution. • Daily living activities within walking distance, allowing independence to those who do not drive. • Appropriate building densities and land uses within walking distance of transit stops, permitting public transit to become a viable alternative to the automobile. • Interconnected networks of streets, encouraging walking, reducing the number and length of automobile trips, and conserving energy. • A broad range of housing types and price levels, bringing people of diverse ages, races, and incomes into daily interaction. • Concentrations of civic, institutional, and commercial activity. • Schools sized and located to enable children to walk or bicycle to them. • A range of parks.

Image 3-3-2: Duany and Plater Zyberk's "New urbanist neighbourhoods"
Source: Carmona, M. Heath, T. Tiesdell, S. Oc, T. 2010 p. 144
(Duany et al 2000)
Neighbourhood can be seen as providing identity and character, creating or enhancing a sense of place. It provides a relatively pragmatic way of planning urban areas. An increasing number of the pursuit of a more sustainable model of development have proved that neighbourhood can be designed to be more self-sufficient. Providing opportunities for work and recreation closer to home. Furthermore, neighbourhood can be seen as a means of creating areas of greater social interaction. Neighbourhood design has often been associated with the environmentally determinist idea that certain layouts, forms and land uses assist the creation of 'communities'.

I will summarize the main factors of what a good neighbourhood community need from the following five aspects:
- Good urban living space;
- Good living scale;
- The functional and aesthetic;
- Provide good ways and quality of life;
- The principles of neighbourhood design.

### 3.3.1 Good urban living space

Jacobs and Appleyard (1987) concluded five physical characteristics of a impeccable urban environment:

1. Livable streets and neighbourhoods.
2. A minimum density of residential development and intensity of land use.
3. Integrated activities-living, working, shopping-in reasonable proximity to each other.
4. A manmade environment that defines public space, particularly by its buildings (as opposed to buildings that mostly sit in space).
5. Many separate, distinct buildings with complex arrangements and relationships. The livable streets and neighbourhoods appears in the first place which indicate its importance in urban development.

![Image 3-3-3: Figure-ground diagrams of Parma and Saint-Die](image)

Source:
Carmona, M. Heath, T. Tiesdell, S. Oc, T. 2010 p. 78
(Rowe and Koetter, 1978, pp. 62-3)
These diagrams show the different patterns of traditional and modernist patterns of urban space. The plan for Parma (left) shows buildings as constituent elements in a generalised, highly connected mass which defines a small-scale, finely meshed street grid. The street pattern consists of small grids. The plan of Saint-Die (right) represents modernist buildings as separate pavilions. The buildings are set within a 'super block' system (perhaps 2 - 3 square kilometres in area). In what can be considered 'ideal' systems, they are paired in a particular way: small blocks and buildings enclosing space. (Carmona, M. Heath, T. Tiesdell, S. Oc, T. 2010)

Combined with good habits and daily routines, good space and critical mass are prerequisites for processes in which small events can blossom. (Gehl, J. p.65)

As the basic unit of city life neighbourhood should provide good living space including: Convenient transportation; Comfortable environment; Considerate community service; Complete education system; Pleasant scale, etc. Thus the next part is about living scale.

### 3.3.2 Good living scale

‘If one or more urban planning scales must be neglected, under no circumstances can it be the small scale: the human landscape.’

- Jan Gehl

‘A perfect room for a good talk about daily subjects. Wanting to provide a good social distance determined the size of the hot pots in the city’s thermal baths’

- Reykjavik

Scale is proportional relationship between building and people and the feeling people get from this kind of proportional relationship. Scale has been used as a means of defining urban design, with urban design being commonly considered as the intermediate scale between planning and architecture. (Carmona, M. 2003).

Living space pay more attention to human interaction with each other and with the environment. It emphasis more on the visual aesthetic experience and all kinds of leisure activities during daily life, in human scale. The forming elements of residential neighbourhood spatial scale including visual factors and functional factors. The scale must meet basic measure of standard and strive to humanization.
The part 'Good places, fine scale' in Jan Gehl's book *Cities for people*, writes: The experience of comfort and well being in cities is closely tied to how city structure and city space harmonize with the human body, human senses and corresponding space dimensions and scale. Unless good places and a good human scale are provided, crucial city qualities will be lacking. Events, exchanges and conversations take place when there are comfortable, inviting places to stand and sit.

Gehl (2010) once said: "The battle for quality is on the small scale." Small scale means eventful, intense and ‘warm’ cities. Warm, intense contacts between people take place at short distances. Small spaces and short distances convey a corresponding experience of warm, intense city environments (Kyoto, Perth, Farum) in this kind of delightful small-scale, we can see buildings, details and the people around us at close range in narrow streets and small spaces. We can experience them with great intensity. We feel the scene as warm, personal and welcoming.

### 3.3.3 The functional and aesthetic

A mature design should be functional and aesthetic no matter in which design field. Firstly, people's need for the living environment and living conditions are diverse, the physical demand come first, followed by safety demand, leisure demand, social demand and aesthetic demand which means the design should give full consideration to create complete facilities and relevant services. In order to give convenient and comfortable life to the residents. The Public buildings in neighbourhood community including commercial, cultural and educational, transportation facilities, etc.

Mixed neighbourhoods also provide greater diversity of building form and scale, making the area more visually interesting, with greater scope for local distinctiveness and character. (carmona,2003. Pp118)

Throughout history, art has made a valuable quality contribution to city space through monuments, sculptures, fountains, building details and decorations. Art communicates beauty, monumentality, remembrance of important events, comments on life in society,
fellow inhabitants and city life, together with surprises and humor. Now as ever, city space can serve an important function as an interface between art and people. Under the circumstance of creating a new neighbourhood community by transforming a former industrial heritage area, there must be specific aesthetic value that should be kept and applied to the new design.

3.3.4 Provide good ways and quality of life
Residential neighbourhood should have comfortable street space, which can meet the requirement of people walking and vehicles. At the same time, it also has an open traffic network linked together with the city traffic. In addition, it may have all kinds of necessary infrastructure such like: Community health service center; Public space; Playground; Fitness facilities and so on. Neighbourhood community is also a blend of residential, commercial, cultural, service, diversification of streets, community landscape, series of parks and open space system. Certainly it can provide good quality of life.

Lynch (1981, p. 118 - 19) identified five performance dimensions of urban design:
① Vitality, the degree to which the form of places supports the functions, biological requirements and capabilities of human beings. ② Sense, the degree to which places can be clearly perceived and structured in time and space by users. ③ Fit, the degree to which the form and capacity of spaces matches the pattern of behaviours that people engage in or want to engage in. ④ Access, the ability to reach other persons, activities, resources, services, information, or places, including the quantity and diversity of elements that can be reached. ⑤ Control, the degree to which those who use, work, or reside in places can create and manage access to spaces and activities.
3.3.5 The principles of neighbourhood design

Communication

What "Human landscape" is: City for people to walk, sit down, listen and communicate. Jacobs, A (1987) suggested that Cities should encourage participation of their citizens in community and public life. Successful public spaces are characterised by the presence of people, in an often self-reinforcing process.

Gehl (2010) concluded necessary, optional and social activities:
• Necessary activities are an integrated, non optional part of every day. Here we have no choice. • Optional activities are recreational and fun. City quality is a decisive prerequisite for this important group of activities. • Social activities include all types of contact between people and take place everywhere people go in city space. So the neighbourhood should provide residents chance, directly or indirectly, to talk or in touch with each other. Young people hang out by entrances and on street corners to follow along with - and perhaps join in - events. Girls look at boys and vice versa - throughout their lives. The elderly is the absolute protagonist in community neighbors. On the one hand, due to the aging problem, the proportion of the elderly population increasing. On the other hand, because the elderly live without burden, so they can make full use of their time. Older people follow the life and activities of the neighborhood from their windows, balconies and benches. City furniture can be designed and set up to offer a wealth of conversational opportunities - as wanted and needed. They can make a valuable contribution (a talkspace) to meetings in urban space.

Edward T. Hall (1990) described four distinct communication distances in The Hidden Dimension:
• Intimate distance - 0 to 45 cm (0 to 18 in.)
• Personal distance - 45 cm to 1.20 m (18 in. to 4 feet)
• Social distance - 1.20 to 3.70 m (4 to 12 feet)
• Public distance - more than 3.70 m (12 feet)

Image 3-3-5: A communication between neighbourhoods
Source: Gehl, J. 2010 p. 72
Transportation
A suitable road system should present a network structure, which can provide more route choice, avoid traffic congestion.

The neighbourhood community, which giving priority to pedestrian, is a desire place for living, working, studying, leisure and entertainment.
Engwicht (1999) proposes 'Five Rs' of traffic reduction: ① replace car trips with other travel modes; ② remove unnecessary trips by combining purposes; ③ reduce trip lengths; ④ reuse saved space; ⑤ reciprocate by acting collectively for mutual benefit. The first three are strategies for residents, whom through simple strategies can reduce their car use by 25-50 per cent without significant impact on lifestyle. The last two are for streets, neighbourhoods and cities.

Parking and servicing
Despite arguments for reducing private cars, parking is still a requirement of current living situation that is likely to remain for the foreseeable future. Space for parking is required within all environments. Parking lots needs to be: sufficient to cater for contemporary needs; convenient for all users, including those with disabilities; attractive by limiting its visual intrusion; safe and secure.
3.4 Residential Transform Mode of Industrial Heritage

Residential Transform Mode refers to the old buildings (generally not residential ones) which are transformed suitable for human habitation without changing their land use. Also include comprehensive transformation: main function for residence along with commercial, leisure, office and other functions. One on hand, most of the cities in China is still in the industrialization period, but some developed cities have entered the post-industrial time. So a large number of vacant industrial heritage buildings and land have been left, and, due to problems such as system of property rights, they have not been re-used well. These old buildings occupying a good locations in the centre of the cities, there are a lot of outstanding historical buildings included.

On the other hand, rapid urbanization lead to rapid growth of urban population, making the demand for housing has been in a state of tension especially in China. Although the government keep making efforts by constructing low-rent housing and other affordable housing to ease the pressure, it did not play good results. Therefore, the two factors (reuse of idle industrial heritage in the central city district and the urgent needs of living space) can be combine together.

The significance of residential reuse industrial heritage buildings will be as follows:

Safety

A neighbourhood community should be accepted by its residents and make them a sense of belonging by mixing of different types of residence and accommodating the residents of the various social strata. But security is the premise.

The contribution to our sense of security is a good city layout that makes it easy to find the way around. It is a mark of good urban quality when we can directly find the destination we’re looking for without hesitation and detours. Signs and directions and good lighting at night are crucial elements of the relationship between city structure, sense of locality and feeling of security.

Urban areas with mixed functions provide more activities in and near buildings around the clock. Housing in particular signifies good connections to the city’s important common space and a marked reinforcement of the real and perceived safety in the evening and at night. So even if the street is deserted, lights from windows in residential areas send a comforting signal that people are nearby. (Gehl, J. p. 99)
First of all, it can respond effectively to intense land resource problems after rapid urbanization; in the second place, it will promote the healthy development of the real estate and benefit to the protection of vulnerable groups' interests; besides, it also can effectively promote the urban renewal, promote the benign adjustment of the structure of the old city. As a result, this approach is easier to make people pay attention to it. In the meantime, an effective protection way of historical value industrial buildings.

3.4.1 Suitability Evaluation of Residential Transformation of industrial heritage buildings

Not all of the industrial heritage buildings are suitable for residential reuse, so there is a suitability evaluation framework (Huichao, Z. 2013). There are three major aspects summarized in this evaluation system: Outer environment of industrial heritage, own conditions of industrial heritage, costs and benefits of industry remains' residential transformation.

Making the investigation and evaluation of an industrial heritage building is the foundation that designers, developers and government department to control project cost, operation process and alteration type. Britain has a set of rigorous system and database which can be used for effective selection and hierarchy 'reconstrucable' industrial heritage building. The most important is to make an initial assessment of industrial heritage buildings about their recycling potential and tendency. Because different transformation ways suitable for different architecture conditions. Such as some industry remains are suitable transformed into hotels or apartments for rent while others are more suitable for affordable housing, apartments for the elderly, etc. (see Table 2 below)

- Outer environment of industrial heritage indicates its ecological environment. Infrastructure or the public service facilities are effective elements to reuse implementation. Ecological environment
condition determines whether the industrial heritage building can be transformed as residential one. Highly contaminated industrial remains are prohibited from being converted into residential buildings. Therefore, after pollution control and up to the standard, some of them can be transformed. Industrial heritage buildings' municipal supporting are relatively perfect, generally their standard are higher than that of ordinary residential land. As long as the proper conversion they can meet the requirements of general residential building. The more complete surrounding public service facilities are, the more suitable for residential transformation. That means, commercial, education, medical treatment, sanitation facilities and other public buildings should be within its 800m radius.

• Current condition of industrial heritage building is also an important aspect of re-use suitability. Internal space form restricts the direction of transformation, large space building is more suitable for habitation. Structure of industrial heritage remains should include: durable years, structure type, the original design load, the existing actual affordable load, structural damage, foundation bearing capacity and so on. These are the realistic basis of industrial construction and reform. As a result, appropriate, necessary structural reform and fire protection design should be adopted. Building materials directly affect not only the heat preservation, anti-noise and even fire safety but also the comfort of living. Natural ventilation and lighting is also the indispensable aspect of residential building. Many industrial buildings have ventilation shafts or are equipped with ventilation equipment, the existing conditions to a large extent can be reused. In reconstructing high historical value and cultural industrial architecture should notice the inheritance and continuity of history, pay more attention to the culture rather than the economy. Residential transformation of historical industrial heritage building should retain or highlight its industry characteristics.

• To estimate the costs and benefits is necessary because any practice of protection and reuse is under the drive of profit. In general, the reuse of industrial heritage has certain advantages, compared with new buildings in investment, construction period, expecting earnings, etc.

Image 3-4-2: Bakery and warehouse transformed into private villa
Source: Project of Jackson Clements Burrows Pty Ltd Architects
<table>
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<tr>
<th>Evaluated Projects</th>
<th>Description</th>
<th>Suggestion of Transformation</th>
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<tbody>
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<td>Infrastructure conditions</td>
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<tr>
<td>Ecological and cultural conditions</td>
<td>Land, channel, noise pollution, outer space and vegetation condition</td>
<td></td>
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<tr>
<td>Public service facility</td>
<td>Kindergarten, primary school, secondary school, hospital and market, etc (within 1000 m²)</td>
<td>Classification according to the integrity and status, then make a decision whether to reuse.</td>
</tr>
<tr>
<td>Land-use structure</td>
<td>Surrounding land for industrial, commercial, entertainment and other function</td>
<td></td>
</tr>
<tr>
<td>Inner space</td>
<td>Space capacity, characteristics, layer and height</td>
<td></td>
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<td>Building structure status</td>
<td>Structural style, Security and load conditions</td>
<td></td>
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<td>Historical and cultural significance</td>
<td>What kind of style, historical position, the particularity of modelling, integrity and quality</td>
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</tr>
<tr>
<td>Specific reuse types: living function types of judgment</td>
<td></td>
<td>Real estate residential, apartments, housing, hotels, LOFT and so on</td>
</tr>
</tbody>
</table>

**Table 2**

**Investigation and evaluation of the Feasibility of industrial heritage building residential transformation**
3.4.2 Residential Transformation of industrial heritage buildings in China

Post-industrial era is more emphasis on personality, so personalized living space has become the new demands of modern life nowadays. How to use low carbon environmental methods under the existing basis, combining with the unique culture, the original spirit of place, cadastral continuation of other factors, to obtain the users' recognition and how to enhance users' satisfaction, sense of belonging and pride of their residence is the important connotation of industry remains' residential reuse.

The scale of the distribution of industrial heritage can be divided into two types: area and single building. The kind of transformation prefer to a whole area of the old industrial area or block in order to achieve comprehensive development purpose to make it become the city's new residential area. Such Industrial Area is generally have proportional mature, green environmental friendly, pollution-free external environment and bigger space capacity scale as 10-15 hm².

Also targeted transformation can be put into practice for some distinctive, cultural industrial heritage buildings with outstanding history. Especially emphasizes building indoor space by creating certain capacity of living space.
3.4.3 Space Adjustment on Residential Transformation of industrial heritage buildings

• Architectural composition

• Road system: modify on the basis of original roads and adjust measures to local conditions, road design conform to site feature, dynamic and static traffic partition, set enough parking space.

• Public space: public space for community including building envelope and green space, establish more positive spaces through the reconstruction to create safe open space which full of vitality.

• Landscape: Combining with the existing external resources, using industrial heritage buildings' outline and dimension sense; protect and make use of the good green resources; renovate dilapidated and polluted ecological environment; ecological sustainability

• Building interior space: Building internal space will be made adjustment in order to meet the needs of living.

The Modification methods of the internal space are indicated in the following table: (see Table 3)

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Add</td>
<td>Generally refers to build new construction on roof</td>
<td></td>
</tr>
<tr>
<td>Division</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interlayer</td>
<td>The most common is the transformation of some warehouse type building</td>
<td></td>
</tr>
<tr>
<td>Expand</td>
<td>In order to expand the construction area or enclosed space</td>
<td></td>
</tr>
<tr>
<td>Space Middle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Court</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corridor</td>
<td>Design corridor shape according to the building shape. The corridor form including: the cloister, unilateral, open or enclosed.</td>
<td></td>
</tr>
<tr>
<td>Roof garden</td>
<td>Industrial heritage buildings have huge space, rugged construction. It is possible of garden design.</td>
<td></td>
</tr>
</tbody>
</table>

Table 3
3.5 Summary

On the whole, this chapter is a comprehensive overview of several writers within the field of urban and architectural design. Preservation, conservation, various design methods of transformation and neighbourhood design principles are discussed from these three aspects on regeneration - Aesthetic, Economic and Functional.

Firstly, from Aesthetic, How and why to keep and reuse typical characteristics of industrial heritage building are illustrated. The Value of industrial heritage building, the necessity and significance of industrial Heritage Protection are concluded.

Secondly, from Economic aspect, the way of transforming industrial building are stated. The related important concept - sustainable design is explained and extended to sustainable method in reusing old building. The specific mode, which can be called "Residential Transform Mode" for transforming the industrial buildings, is introduced in detail to show how this method works. It is a really helpful theoretical guidance and closely related to this thesis.

Thirdly, the functional part is about the neighbourhood community. In this part, the principles of neighbourhood design is stated from several aspects including good living urban space; suitable living scale; functional and aesthetic; living quality; factors of "livable" building, etc. All the targets are pointing to design a livable neighbourhood from human scale. Jan Gehl (2010) said: "If we are to realize the dream of lively, safe, sustainable and healthy cities, we must begin with a thorough knowledge of the human scale."

In general, these theories are selected systematically and earnestly from books and academic journals from the field of urban planning and architectural design, which are academic authorities, and may be the oriented leader to the final design.
Chapter 4. OPPORTUNITIES TO INDUSTRIAL HERITAGE BUILDING

Since the 1980s, the transformation of industry remains has become the project that European and American architects generally involved in. And it has become a typical dominant mode of protecting remains of industrial buildings. Industrial heritage studies in China approximately appeared from the last century and at the beginning this century and lasts until now.

The previous chapter is about the literature review. Example studies will be indicated in this chapter in six major transformation modes of industrial heritage. The following cases are chosen from both domestic and foreign countries which their practical experience can be learned from. So in the design part the advantage of the chosen site can be enhanced and disadvantage can be avoided.

For the sake of making better understanding of these example cases, amount of literature and documents are referred, these major bibliographic databases like Google Scholar, Wikipidia, Wenku Baidu, such websites and books related to architectural design and landscape design are searched.

4.1 Protection and transformation mode of industrial heritage

4.1.1 Museum mode (Art Zone or Creativity Industrial Park)
- Take ‘798 Art Zone, Beijing, China’ as example

Background of transformation
The place now called the 798 Art Zone, formerly known as The 718 Joint Factory, where gathered several factories. It used to be a state-run electronics factory and one of the biggest project in the 1st "five-year plan" (the Chinese national strategy project) during the 1950s. Many important parts of Chinese first atomic bomb and the first artificial satellite were produced here. This place was known as the cradle of Chinese electronics industry. It was designed and built by Germany and the Soviet with typical "Bauhaus style" which was very rare around Asia at that time.

It witnessed the industrialization process in New China. After the 1990s, because of the difficulty adapting to the market economy, a large number of laid-off workers were left and the factories were abandoned. Since 2002, some farsighted artists found this place, with a little modification, and turned these dilapidated plants into gathering places.
Specific contents and design method of transformation
The group of artists and cultural institutions began to stationed in 798 factory area, they rent and transformed vacant factories as a venue of artistic creation. Then it gradually developed into a polymeric modern space of art centers, galleries, studios, design companies, restaurants and bars and formed its "Soho" and "Loft" lifestyle, known as "base of post-modernist art " and "folk art village". (Lei, L. 2009)

Usually artists build interlayer when reforming these old plants so as to produce different feelings and give new interpretation or their comprehension to the industrial buildings. The artists always want to be in line with their works when transforming the building, many of their sculptures have the similar cold feeling with the old plant building. They keep the mottled red brick walls, the crisscrossing pipelines, also the slogan of that period. Graffiti everywhere manifesting the freedom status inside the artists. Even some abandoned old pipes were simply painted and transformed into the exhibits.
**Evaluation of transformation**

From the perspective of architecture, the transformation is successful. The artists found the forgotten history piece of Beijing, and reformed it actively with their unique artistic vision and influence to make those splendid architecture become the focus of the world again. Such practice and discovery is actually a kind of originality, it provides a kind of architectural train of thought and an effective business method. It also enriches the idea of transforming old buildings. People can clearly see the tremendous vitality from old industrial heritage building.

But 798 Art Zone is not the invention of Chinese artists, its pattern is similar to the SOHO model in New York. It is only the spontaneous behavior of a group of artists without organization, so the reform is not a complete project. 798 Art Zone has no overall planning. Parking lots are just casually along the road or between buildings. People are even feel difficult to find a restaurant in the zone. The artist are lack of the awareness of the landscape design for the whole district and there is no infrastructure transformation, such as the transformation for road system, vegetation, old circuit, security strengthen, and the establishment of street lamps, etc.

**4.1.2 Public leisure space mode**
- **Take three ‘Railway parks’ as example**

The Xiamen Railway Park, the High Line Park and the Schöneberger Südgelände Nature Park are three typical leisure parks transformed by abandoned railway. They have their own characteristics and are all highly praised.

**Railway Park, Xiamen, China**

The total length of this old railway is 4.5 kilometers including the tunnel. It used to be the extension of Yingxia railway and has been abandoned for many years. Although it has been forgotten, to some extent it also preserves the initial memory of Xiamen traffic development. This old railroad has long history and rich cultural background. Its unique geographical location, beautiful natural landscape and convenient traffic conditions makes it become a rare treasure of the city. Until 2011, Xiamen government decided to renovation this old railroad in a modest way to transform it into a linear park for public recreation and fitness.

![Image 4-1-3: Railway Park](http://www.google.com)
In accordance with the cultural schema partition, the entire railway is divided into four zones from north to south: Railway culture zone, Living zone, Experience zone and Recreation zone and they are all attractive.

Railway culture zone: from Wenzeng road to Wanshou road, 850 meters. This is a place for recreation and communication with small specific stores which are transformed by the old railway houses. Furthermore, there are other railway landscape facilities and outdoor furnitures such as small platform and compartments which can evoke the memories of the "old days".

Living zone: from Wanshou road to Huyuan road, 1,040 meters. This part is called Living zone because its surrounding residential areas, which is why the landscape design here is highlighting the pleasure of life. The sculptures with history and culture are the unique spot of this park.

Experience zone: from Huyuan road to Siming road, 1,382 meters. There is a long-abandoned railway tunnel, about 700 m. This tunnel is turned into a chic exhibition for civil defense science and Xiamen Railway History.

Recreation zone: from Siming road to Heping pier, 550 meters. This area combines the tracks, built cafes, tea houses. Tired tourists, who walked a long way can have a rest and relax here.

Image 4-1-4: Railway Park
Source:http://www.google.com
**High Line Park, New York, the United States**

The High Line is a 1.6 km linear park built on a 2.33 km section of the elevated former New York Central Railroad spur called the West Side Line, which runs along the lower west side of Manhattan; the overhead railway is designed to pass through living blocks which can avoid passenger railway and subway and not to affect ground transportation. It directly connected factories and warehouses, allowing trains traveling through buildings, to transport and unloaded milk, meat and other products. In the mid 1980s, High Line was experienced a crisis of demolition. But with the protection of FHL organization, High Line finally survived, its steel structure are still intact in the end.

Starting in April of 2006, New York government began to carry out the project of High Line. It has been redesigned and planted as an aerial greenway by James Cornerfield Operations and Diller Scofidio + Renfro. The project is divided into three stages. The entire park starts from Gansevoort Street northward to the 30th Street and then turn west and ends at Javits Convention Center on the 34th Street. It has nine entrances. The opening hours are from 7 am to 10 pm.

“Agri-Tecture” concept is the foundation of the whole design strategy. The design of ground pavement and planting systems presents a constantly changing ratio between hard and soft which bring a wealth experience for the users. The main landscape is the wide variety of plants which can provide the park with rich color all the year round.

*Image 4-1-5: Plan and node of High Line Park Design
Source: http://www.google.com*
The design features are:
1) Respect the site's own characteristics. Its simplicity, linear and practicability can get well with grass, shrubs and moss and merge with steel and concrete.
2) Pavement system. They use strip concrete panels as the basic unit with tapered seams, leaving open interfaces between them so that plants can grow out of the hard concrete slab. The pavement design is so called a plow-type landscape. It creates a unique texture that pedestrians can feel no distance and be naturally integrated into it.
3) Make everything slow - down. The designers give a relaxed atmosphere - infinity of space and time by creating the long staircase, sinuous paths, deep and serene environment. Which allows visitors wander by.
4) Carefully handled ratio scale. They avoid large scale but adopt a more flexibly subtle approach. Public spaces are alternately stacked along a succinct track. People can appreciate different landscape and landmark buildings along the way such as the Statue of Liberty, the Empire State Building, the Rockefeller Center, etc, as well as the new visual scenery of whole New York city and the Hudson River.

This design is full of modern fashion elements and makes full use of a variety of materials. It is an amazing built Hanging Garden.

Image 4-1-6: High Line Park Landscape
Source:http://www.google.com
The Schöneberger Südgelände Nature Park located at the centre of Berlin, cover an area of 18 ha with a triangle shape. The core area is the Nature Conservation zone, the rest is Landscape Conservation zone. The Tempelhof switchyard, a typical derelict railway site, was gradually scaled down after the Second World War and completely shut down in 1952. In the space of just 50 years a diverse, species-rich natural oasis developed in the heart of a major city, with rich dry grassland, jungle-like woodland and herbaceous vegetation. This jungle forest can now be explored by foot. Thanks to the efforts of many concerned citizens and with the financial backing of the Allianz Environmental Foundation, this magical place was made accessible to the general public. Certain buildings and structures dating back to the railway era such as the “Brückenmeisterei” (an administrative building) and the water tower are still preserved. The 50 metres water tower, as a symbol, is visible, from a distance. Constructed in 1927 it magnetizes visitors and photographers. With its permanent illumination during the festival of lights it has been a real illuminating spectacle.

The concept of converting the old station as nature conservation park was officially recognised in 1999 and began to promote. The first priority of the design team (Berlin ÖkoCon & Planland) was to analysis the site and find out the biggest challenge. Their design principles and targets are mostly from three aspects: the spacial form, the traffic design, and heritage protection.

Designers divided this space into three types, not only can enhance biodiversity, but also attract the public with this kind of changing natural space; Berlin citizens can easily get to the park. For internal traffic, designers transformed old rail tracks into walking trails decorated by a variety of original materials. At the same time they paid attention to reduce the impact of human activities on nature,
walking trails built above the old railroad tracks as possible to achieve a balance of conservation and development. They focused on site history and culture heritage protection. As a representative of the early 20th century German railway industry and technology, many elements have been retained, conserved and re-used.

Image 4-1-8: Schöneberger Südgelände Nature Park (reuse old metal)
Source: www.google.com
4.1.3 Comprehensive development mode
- Take ‘The ruhr’ as example

The Ruhr, or the Ruhr district, is an urban area in North Rhine-Westphalia, Germany. It is one of the world's largest industrial zones.

It covers a total area of 4435 square kilometers with a population density of 2,800/km², it is the largest urban agglomeration in Germany. It consists of several large, industrial cities bordered by the rivers Ruhr to the south, Rhine to the west, and Lippe to the north. In the Southwest it borders the Bergisches Land. In the south of the Ruhr, between the ruhr river and the Emscher river, factories, residence and dense transportation network are intertwined, forming a continuous urban belt. Now the Ruhr refers to Regionalverbands Ruhr (RVR). Consists of Bochum, Bottrop, Dortmund, Duisburg, Essen, Gelsenkirchen, Hagen, Hamm, Herne, Mülheim, Oberhausen, die Kreise Recklinghausen, Unna, Wesel and Ennepe-Ruhr-Kreis (Guotang, C. 2005).

The Ruhr is a manufacturing base of German energy, steel and heavy machinery. After the second world war, under the tide of a new round of industrial revolution, coal and steel crisis broke out in this industrial area which lasted for 10 years. Aiming at this situation, the German government has adopted a series of measures to promote the transformation of the economic structure and revival of the area. Among the reviving strategies, Industrial heritage Protection and

Reuse has played an important role in highlighting the region cultural characteristics. It helped to create a unique impression of the Ruhr. The industrial heritage protection method used by The Ruhr is effective and diverse. The industrial heritage protective reuse modes of The Ruhr are as follows:

- Protective reuse of individual buildings and facilities

  1. the common practice in reusing Ruhr’s industrial heritage is to update them into museums:

     Use the internal space of old buildings or facilities for permanent display of industrial production, industrial products, industrial culture, workers life and working environment, etc; building or equipment itself as exhibits which displaying and conveying industrial technology to the visitors; provide visitors with dynamic museum experience.
② use the internal space (of buildings and facilities) and support structure as exhibition space.
③ some large scale industrial buildings were transformed into conference hall or multifunctional activity center used to hold concerts, parties, etc.
④ some old industrial facilities were transformed into sport equipments, office buildings, hotels and catering space.

- Protective reuse of group of buildings and facilities
  ① fully exploit the potential of every building and facility then give them new features. Try to make them provide more scalable performance so that to achieve comprehensive utilization of the whole site.
  ② to integrate the protection of industrial heritage and the spatial organization and layout of post-industrial landscape to create a multifunctional post-industrial landscape park where people can have industrial and cultural experiences.
- Route Industriekultur (RI) "Industrial Heritage Trial"
The Ruhr planning agency planned a regional tour route, throughout all tourist attractions.
The main attractions: Join 15 cities, 25 important industrial sites (including six national museum☆ and 14 view point (see Table 4 below). (Dexiang, L. Fuying, L. Tao, Z. 2007)
Transportation: Link the road network of 400km ring road and 700km bike road. Parking lot are set in every main tourist attractions, some of them also offers bicycle rental service.

<table>
<thead>
<tr>
<th>City</th>
<th>Industrial Attractions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essen</td>
<td>The Zollverein Pit ⅩⅡ, The Zollverein Coking Plant, Villa Hügel, Ruhrland Museum☆</td>
</tr>
<tr>
<td>Bochum</td>
<td>Hall of Century, German Mining Museum☆, Railway Museum Bochum-Dahlhausen☆</td>
</tr>
<tr>
<td>Dortmund</td>
<td>Zollern Ⅱ/Ⅳ Colliery, Hansa Coking Plant, German Occupational Safety and Health Exhibition(DASA)☆</td>
</tr>
<tr>
<td>Duisburg</td>
<td>Duisburg inner Harbour, German Inland Waterways Museum☆, North Duisburg Landscape Park</td>
</tr>
<tr>
<td>Hamm</td>
<td>Maximilian Park</td>
</tr>
<tr>
<td>Unna</td>
<td>Linden Brewery</td>
</tr>
<tr>
<td>Hagen</td>
<td>Hohenhof, Westphalian open-air Museum☆</td>
</tr>
<tr>
<td>Witten</td>
<td>Nightingale Colliery and Mutten Valley</td>
</tr>
<tr>
<td>Hattingen</td>
<td>Henrichshütte steelworks</td>
</tr>
<tr>
<td>Mulheim an</td>
<td>Aquarius Water Museum</td>
</tr>
<tr>
<td>der Ruhr</td>
<td>Electricity Museum</td>
</tr>
<tr>
<td>Recklinhausen</td>
<td>Rhineland Industrial Museum, Gasometer</td>
</tr>
<tr>
<td>Oberhausen</td>
<td>Chemical Industry Estate</td>
</tr>
<tr>
<td>Marl</td>
<td>Old Henrichenburg Shiplift</td>
</tr>
<tr>
<td>Waltrop</td>
<td></td>
</tr>
<tr>
<td>Gelsenkirchen</td>
<td>Nordstern Park</td>
</tr>
</tbody>
</table>

**Table 4**
And the protected contents are as follows:
• protect the whole structure - To conduct a comprehensive protection on overall layout structure (including functional partition structure, spatial structure, transport structure, etc.), space nodes and other elements.
• protect industrial facilities - Such facilities including all kinds of factory, warehouse, chimney, water tower and other buildings; blast furnace, gas tank and other production equipment; railway, pipeline and other transportation or power transmission equipment, etc.
• protect site environment - For instance, contaminated soil and vegetation among it, surface traces formed in the process of industrial production, industrial solid waste and so on.

**Evaluation of transformation**

After nearly 20 years of reform, the Ruhr industrial area has been thoroughly remolded itself and taken on a new look. It obtained both ecological quality, cultural quality and economic benefits. This dying industrial landscape area become a giant museum of history and technology and the best entertainment place. Ruhr renewal plan has strong regional characteristics, every district has its local plan and design to form unique landscape according to its own characteristics. The overall plan includes the following basic elements:
• Land reclamation; • Carry out maintenance, improvement and reuse of existing buildings; • Old and new building design based on protection of ecological environment; • Industrial production structure transformation by using the environmentally friendly methods; • Highlight the architectural design, because it is an important element in environmental, social and economic regeneration strategy.

The success of the Ruhr is mainly manifested in the following aspects:
• Diversified industrial structure. No matter from the scale of the enterprise, or from the scope of the industry and services, all showing the trend of diversification; • Cooperation mode shift from hermetic to more open; • Introduction and expand innovation activities; • Set up diversified infrastructure which advantageous to the innovation activities, including education, research institutions and financing services, etc; • Flexible management, including the
cooperation between local government and different departments, industry and other stakeholders.

So after 20 years of updates, the Ruhr developed very well and it creates a new way for the other old industrial areas' transformation.

4.2 "Liv"able" industrial heritage

In addition to the above transformation modes, the way to transform the old industrial heritage building into residential buildings is more closer to social life of human. What is more, it has become a brand new and innovative way in building function conversion and a kind of surging reform method among design field.

An early discussion of 'Robustness' was by Stanford Anderson in his book On Streets (1978). Anderson argued that "physical settings can be interpreted both as 'potential' environments providing a range of environmental possibilities and opportunities and that, at any moment in time, what is achieved is the 'resultant' or 'effective' environment." For him, the 'latent' environment consisted of the environmental possibilities (whether recognised or not) not currently being exploited.

For example, when industrial lofts were constructed, their later residential use was not anticipated. For instance, the New Concordia Wharf in London, As industrial lofts and warehouses converted to residential apartments. It contains both 'artistic' and 'bohemian' qualities. To convert such buildings is not just a consequence of the
building’s functionality but also its character. Here 'Robustness' refers to a function of the relationship between a building's form and the uses it accommodates. Many land uses are relatively adaptable and can be accommodated within a variety of forms.

4.2.1 Loft living and Studio apartment
- Take ‘Gasometers, Vienna, Austria’ as example

Background of transformation
The Gasometers is made up of four gas tanks (72.5 meters high, 64.5 meters in diameter) and a control room. They used to be the main source of gas supply in Vienna. The tanks were founded in 1886 and continued expansion before the World War II. They were the symbol of Vienna's advanced technology. Since the 1970s, Vienna started switching to use natural gas. Until 1986, the gas tanks were all abandoned and the internal devices were also removed gradually. Only left their classical facade.

Because of unique interior structure of old industrial buildings, once they converted into residential buildings, there will be flexible spaces which can be full of imagination.

Image 4-2-1: New Concordia Wharf, London, UK
Source: FIGURE 9.3 (carmona, 2003)
http://www.urbanspaces.co.uk/development-guides

Image 4-2-2: Gasometers, Vienna
Source: http://photo.zhulong.com/
In 1989, Austrian architect Manfred Wehndon began to research how to reuse them. The original idea was to develop them as residential areas. But with the expansion of the city, transformation of the Gasometers became an important point in the overall program, as an important part in the community revival. In the joint efforts of French architect Jean Nouvel, the COOP HIMMELBLAU, Manfred Wehdorn and Wilhelm Holzbauer, the Gasometers have been given a new life. The gas tanks were turned to a complex with multi-function.

**Specific contents and design method of transformation**

This project, called "Gasometer City", which is built in 2001 with a total area of 95,000 m².

The four huge gasometers form this important landmark and witness the early Austria brilliant heritage in industrialization. Attached to the gasometer, on its surface, the traditional brick façade is then responding the industrial building rough aesthetics which formed a unique scene called "barn with window". In 1981, after stop using these four jumbos, how to re-use them has become an important topic of public discussion. In the late 1990s, the transformation of these four gas tanks become the most important initiative among the overall renewal plan of the region: A symbol of regional public center and representative. After the proposal(to transform them into museums and cultural facilities) was rejected for financial reasons the authorities in Vienna held a grand international design competition and finally decided to turn it into a urban complex of social housing, student dormitory, shopping center and concert hall.

The four architects who won the renovation project are big names in architecture field, each of them was responsible for one gas tank. Under the stringent design conditions, they did their level best. The bottom of these four tanks were linked to each other through commercial pedestrian street and shopping area.


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After transformation, the "Gasometer City" is consists of four gasometer mansions (Building A, B, C and D) and a recreation center (Building E) with approximately 20,000 m² Shopping center, 6,000 m² Convention Center, 10,000 m² Archive, 2000 m² Entertainment center, as well as nearly 800 sets of all kinds of apartments, 2,000 parking lots and other ancillary functions space. (Table 5)
<table>
<thead>
<tr>
<th>Building</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking lot</td>
<td>1 floor (approximately 74)</td>
<td>2 floor (approximately 300)</td>
<td>5 floor (approximately 350)</td>
<td>2 floor (approximately 420)</td>
<td>(approximately 800)</td>
<td>About 2000</td>
</tr>
<tr>
<td>Commercial Space</td>
<td>3 floor (approximately 6252 m²)</td>
<td>1 floor (approximately 2914 m²)</td>
<td>2 floor (approximately 4450 m²)</td>
<td>2 floor (approximately 1960 m²)</td>
<td>(approximately 1960 m²)</td>
<td>About 20000 m²</td>
</tr>
<tr>
<td>Convention &amp; Exhibition space</td>
<td>About 6000 m²</td>
<td>About 6000 m²</td>
<td>About 6000 m²</td>
<td>About 6000 m²</td>
<td>About 6000 m²</td>
<td>About 6000 m²</td>
</tr>
<tr>
<td>Residential, Office</td>
<td>9 floor (128 suites)</td>
<td>12 floor (138 suites)</td>
<td>9 floor (92 suites)</td>
<td>8 floor (114 suites)</td>
<td>478 suites</td>
<td>10409 m²</td>
</tr>
<tr>
<td>Archives</td>
<td>5 floor (10409 m²)</td>
<td>5 floor (10409 m²)</td>
<td>5 floor (10409 m²)</td>
<td>5 floor (10409 m²)</td>
<td>5 floor (10409 m²)</td>
<td>5 floor (10409 m²)</td>
</tr>
</tbody>
</table>

**Table 5**

58
Building A is the starting point for the "Gasometer City" and the joint-point to the main city of Vienna. Its core function is Shopping Mall. Building B is transformed by the COOP HIMMELBLAU. They kept the original appearance of the tank consistent with the other three; the difference is that a 18th floor apartment was built attached to it, at the side which facing to the Guglgasse street. The apartment building shaped simply like a "shield", its metal and glass reflect the blue sky which gives "Gasometer City" a brand new and brighter look. Reconstruction of Building C embodied the mature thinking from Manfred Wehndorn of his retrofit scheme. The overall plan is: at the bottom is a five-story parking lot with a two-story shopping mall above it; upwards the three-story is for office and upper six-story is for residents, arranged in a circular form along the tank wall. Its core function is also for shopping. On one side, it connects to the Building B's Sunny Hall; on the other side, Building E is connected by a promenade. The most characteristic design in transformation Scheme of Building C is Wehndorn particular emphasised on the performance of traditional residential design in Vienna. Building D is residential and the Vienna archives of Urban and Rural. Although it is a member of the four tanks, its function and transport is relatively independent. Building E is completely modern which become a new part of the "Gasometer City". Its square shape, colorful glass walls which formed a stark contrast to the old gasometers. It connects to the other gas tank's shopping center through a long corridor. These five buildings have each own independent function but are connected as a whole through a horizontal tie (shopping space). Spatial form of old building have a perfect combination with the new implant features.

Image 4-2-5: Section of four gas tanks
Source: http://photo.zhulong.com/proj/detail11888.html

**Evaluation of transformation**

The "Gasometer City" is a successful case of reusing old industrial building. Firstly, the designers have brought out the best in each other both in old architectures and new function; Secondly, they continues the history and culture; Thirdly, development and utilization of old buildings is a way to protect historical heritage, suitable development have given birth to heritages. This program deald very well with the organization between old space and new function. It is the pursuit of sustainable development. It well-shaped a new landmark and preserved history and make the gasometers suitable for modern life and can be clearly identified their former function from appearance.
4.2.2 Low-rent apartment

**Wool warehouse, Brisbane, Australia**

It is a three-story old wool warehouse. The Australian design studio Woods Bagot was responsible for the project, to transform this warehouse into low-cost housing for the low-income groups in the city. Woods Bagot maintaining the building facade but carefully designed interior structural and function. They added steel structure systems inside the warehouse, and split it into 155 apartments. Ensure that each household has at least two rooms. There are still some apartments exclusively for families which have more people.

In addition, Woods Bagot specially designed a floor as landscape corridor as well as a landscape atrium, which has greatly improved the living quality, but also provide a space for residents to communicate with each other. This apartment have become the most popular in Brisbane.

4.2.3 Neighbourhood community

Industrial heritage buildings are usually form as group layout. So there are two scale types in industrial heritage residence reuse way: complex buildings and individual architecture. Several examples of the individual industrial heritage building residential reuse have been analyzed above. The following will be the case analysis of residential reuse in industrial heritage complex.

**Glass factory (the "Crystal City"), Tianjin, China**

**Background of transformation**

The base of the "Crystal City" once belonged to Tianjin glass factory. The factory was a large state-owned enterprises built in 1968. Now it has moved to the Binhai district. Although the old factory moved out it still left many monuments, such as factory buildings, fire hydrants, chimneys, rail track, and more than 400 old trees, etc.

The real estate projects completed by the Vanke group where located in No. 518 Jiefang Nanlu, Hexi District in Tianjin. The total area is approximately 384100 m².

![Image 4-2-6 : Vanke "Crystal City"
Source: www.google.com](image-url)
Specific contents and design method of transformation

By analyzing the current situation, Vanke group formulated the guiding ideology that development should fully respect the base environment. They established the "reservation, Comparison, Superposition" development policy. "Reservation" refers to some valuable historical relics from the old glass factory, make them as important landscape elements in new community life; "Comparison" refers to the old and new material naturally be placed in the same space, so as to produce a strong contrast; "Superposition" refers to the continuation of a variety of environmental factors, make the new and old things combine together.

- Design purpose
This former site of Tianjin glass factory has a wealth of vegetation resources -- hundreds of trees, and other remains such like old plant, huge lifting workshop, existing transporting rails and chimneys. The Vanke way to develop this area based on the continuation and preservation of the history. So they are perfectly kept and reused.

- Design concept -- Retain and Inherit
The base of "Crystal City" is flat, its elevation is consistent with Jiefang South Road's. Vanke group retained the trees on both sides of the road effectively and the previous main roads are also be kept which formed a new transportation skeleton. Along the tree-lined walking trail, from the community entrance extended to the center club, one old rail with the crossties is fully preserved.

- Design features
Vanke group spare no effort to keep the old industrial relics. Those old winches, rail, hydrant, steel frame are repainted and then being placed among the lush environment, like modern sculptures; while many retained refractory bricks are also used as landscape wall. They have been given a distinctive connotation of "History and Culture". Once living here, no matter external or internal will have strong psychological sense of belonging. The overall design is full of logic and humanity. In the community, old and new buildings and the environment bring out the best in each other, and full of fun.

Image 4-2-7 : Vanke "Crystal City"
Source: www.google.com
This community has a structured transport system. Landscape road, landscape elements changes with the layout of the building, all levels of road composed a good circulation system. Structured driveway, sidewalks, ring road, the path ensure efficient traffic flow and safer, more pleasant area for living.

**Evaluation of transformation**

The "Crystal City" project respected the base environment, continued the urban context with lot of innovations. The Vanke group paid attention to the unifying of marketing strategy, the overall planning and design details, they enable residents to feel comfort not only by sensory experience but also by the psychological experience. Environmental elements from old glass factory fused with the urban context spawning a "new neighborhood" space that combines the landscape, ecological and cultural significance. Pleasant residential scales and whole intimate environment makes it an absolutely a model of transforming industrial relic.
4.3 Summry

In sum, there are four modes of Protection and Transformation Mode of industrial heritage. The Museum mode (Art Zone or Creativity Industrial Park), Public leisure space mode, Comprehensive development mode and Residential transform mode. While the last mode is the most crucial one. The cases from each mode is typical, among them there are three from domestic and four from abroad as the foreign countries have more experience and more earlier precedent in this respect.

Which can be learned from the similar - shaped case "Beijing 798 art zone" is how to handle the large factory space with sloping roofs. Although the 798 art zone has a totally different function from the design site, its situation shows the the way treating the abandoned industrial area in China today. And it is a famous and relatively successful Renovation Case. The three railway parks are showing the different transformation technique from different countries on sites of the same nature. From these cases, different characteristics of countries can be clearly recognized. But they all keep the old rail track and create public place for leisure in common. Moreover, the designers of them use the old leaving industrial material to manufacture new landscape around: for example, the Schöneberger Südgelände Nature Park has the metal edge of the path made by the old railway. The world-famous "Ruhr" is chosen either because it including nearly every transform mode of the industrial heritage no matter for single building or architectural complex. And it should be the firstly come up with when hearing industrial heritage transformation. It has so much experience worthy of learning because it fully exploit the potential of every building and facility then give them new features. Try to make them provide more scalable performance so that to achieve comprehensive utilization of the whole site.

Now come to the final mode, "Livable industrial heritage"- the Residential Transformation Mode of industrial heritage. Three kinds of example cases are picked: Loft living and Studio apartment; Low-rent apartment and neighbourhood community. Experience that can be learn from is how to change the industrial function in order to meet the condition of "livable". The "Crystal city" presented a brand new and innovative way in building function conversion and a kind of surging reform method among design field, furthermore, a pioneer practice in China which give the hope of a development prospect.

In conclusion, these cases are all successful and, to some extent, give inspiration to the following design. The common design approaches are: keep the old building or their typical characteristics for maximum protection; adapt design to local conditions; use the remaining material as far as possible.
Chapter 5. PROJECT ANALYSIS

As stated before, the chosen case - "Nanjing Chenguang 1865 Science-Technology and Creativity Industrial Park" will be introduced in this chapter by the method of case study.

5.1 Location

Nanjing

Nanjing, located in the lower Yangtze River drainage basin and Yangtze River Delta economic zone, is the capital of Jiangsu province. Its geographical coordinates is 31°14' N-32°37' N, 118°22' E-119°14' E. The city has 11 districts, with a total area of 6587.02 km². With a total population of 8.16 million (including the urban population of 6.55 million) by the end of 2012, Nanjing is the second largest city in the East China region (after Shanghai).

Nanjing has a prominent place in Chinese history and culture, having been the capital of China for several periods. It is a political, economic and cultural center of Jiangsu Province, as well as one of the hub cities for national integrated transport. Furthermore, a science and education center. As a result, it has long been one of China's most important cities.

Image 5-1-1: Nanjing Municipality
Source: Shan, L. 2014 p.51
Nanjing Chenguang 1865 Science - Technology and Creativity Industrial Park
The park locates in NO.1 Zhenxue Road (or NO. 388 Yingtianjiajie), Qinhua District, southeast of the Nanjing urban area, next to the urban and rural junction. It is not very far from the city center and has a really good location.

It has very rich historical and cultural resources around. A famous scenic - "Confucius Temple" is 1.2 km away from it. The recently built and very popular archaize block - "Laomendong" is about 15 minutes walk from the site. Additionally, the Zhonghua Gate and ancient city wall are separated from the park by the Qinhua River which flows from east to west. To the northwest of the park, is the archaeological site of Dabaoen Temple where the Nanjing Urban Planning Bureau is making a recovery of it. Also the Yuhuatai Martyr Memorial Park is located to the southwest of the park.
Image 5-1-3: Scenics around the park
Source: Made by Author

Lao Men Dong
Dongganchangxiang Park
Zhonghua Gate
Yu Hua Tai Martyrs Cemetery
5.2 Historical background

The previous function of "Nanjing Chenguang 1865 Science - Technology and Creativity Industrial Park" is the Jinling machine manufacturing bureau which was mainly built by the time of the Westernization Movement and the republic of China since 1865. It indeed represents the start of China Weapon Industry and initiates the beginning of Nanjing modern industrial development.

After 140 years of continuous development, more than 40 factory buildings were built in different historical period (the late Qing dynasty, the republic of China until the late 1980s). At the beginning of the 21st century, along with the rapid development the city, the government decided to give inling machine manufacturing bureau a protective redevelopment. So it was transformed into Nanjing Chenguang 1865 Science - Technology and Creativity Industrial Park which covers an area of 210 km² including 110 km² of construction area. Among these old well-kept industrial, cultural relic buildings, there are 7 from Qing dynasty and 24 from the republic of China time. The following map shows the detailed description of the majority of heritage buildings in the park.
<table>
<thead>
<tr>
<th>NO.</th>
<th>Time</th>
<th>Structure</th>
<th>Proportion</th>
<th>Original function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1934</td>
<td>Reinforced Concrete</td>
<td>3309.6</td>
<td>Hose company workshop</td>
</tr>
<tr>
<td>2</td>
<td>1934</td>
<td>Reinforced Concrete</td>
<td>8236.3</td>
<td>Machining room</td>
</tr>
<tr>
<td>3</td>
<td>1937</td>
<td>Brick-wood</td>
<td>819</td>
<td>Computer installation</td>
</tr>
<tr>
<td>4</td>
<td>1936</td>
<td>Brick-concrete</td>
<td>1584.1</td>
<td>Science and technology library</td>
</tr>
<tr>
<td>5</td>
<td>1937</td>
<td>Brick-concrete</td>
<td>1586.2</td>
<td>CNC machining room</td>
</tr>
<tr>
<td>6</td>
<td>1986</td>
<td>Brick-concrete</td>
<td>2132.1</td>
<td>Quality Department</td>
</tr>
<tr>
<td>7</td>
<td>1937</td>
<td>Brick-concrete</td>
<td>1586.2</td>
<td>Office building</td>
</tr>
<tr>
<td>8</td>
<td>1987</td>
<td>Brick-concrete</td>
<td>1984</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>1937</td>
<td>Brick-concrete</td>
<td>1590.4</td>
<td>Store room</td>
</tr>
<tr>
<td>10</td>
<td>1937</td>
<td>Brick-concrete</td>
<td>1586.1</td>
<td>Office building</td>
</tr>
<tr>
<td>11</td>
<td>1937</td>
<td>Brick-concrete</td>
<td>1367.1</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1979</td>
<td>Brick-concrete</td>
<td>918</td>
<td>Office building</td>
</tr>
<tr>
<td>13</td>
<td>1986</td>
<td>Brick-concrete</td>
<td>912</td>
<td>Office building</td>
</tr>
<tr>
<td>14</td>
<td>1979</td>
<td>Brick-concrete</td>
<td>912</td>
<td>Office building</td>
</tr>
</tbody>
</table>
Sloping roof, Grey brick wall, arch shaped windows, Mortar paint, Concrete beam and column, ... These characteristics make those heritage buildings have distinct identification. The construction entity themselves reflect obviously the Social and cultural traits from the old times as well as design concept of the architecture designers: a combination of Chinese and Western elements; the open spirit of eclecticism, adjust measures to local conditions and integration of Construction technology and art.

Image 5.2.2: Year of construction
Source: Made by Author
Nanjing, used to be the capital of the republic of China, so called the "Base Camp" of Republican buildings. It is gratifying that some of the buildings are left and kept. No matter retaining in the form of single or building group they were divided into 15 conservation zones, installing by an axis, and form a whole protection system of buildings from the republic of China.

While in the area of 1865 Industrial Park, there are 24 industrial heritage buildings from that time which is a relatively precious historic resource. It is well worth protecting them and considering how to make them useful in the present days.

Image 5-2-3 : Republic time buildings in Nanjing
Source: Made by Author

- Tandem axis
- Conservation Zone of Republic time building
- key protected Building
- Group of Republic time buildings
- Nanjing 1865 Industrial Park
5.3 Site in its urban context

The planning positioning of 1865 industrial park is a famous comprehensive creative industry center. It is divided into five zones: Creative research and Development; Business; Science and technology Exhibition; Art creation and Leisure zone.

Image 5-3-1: Function Zones
Source: Made by Author
Traffic
The public transport around is relatively convenient. There are three bus stations near three entrances of the park separately. The "Zhonghuamen" Station, one of Metro Line NO.1, is 15 or 20 minutes walking distance. The Metro Line NO.8 and NO.3 is under construction. In the near future, there sure will be a nearest metro station around.

But there is no bus station inside the industrial park, as it occupies a large territory. If it is transformed into a neighbourhood community, the residents will feel long distance walking in their residential area.

Image 5-3-2: Public transportation
Source: Made by Author
The whole industrial park area is surrounded by two main roads of Nanjing city. The red one, runs from east to west, is the south part of the inner ring where the Yuhualu Overpass locates above it. The left red line, runs from north to south, is the East Trunk Road.

The road design and road hierarchies are reasonable, because of the replanning in recent years. Due to its current function, a complex, Science-Technology and Creativity Industrial Park, the road system can not meet the standard of a residential neighbourhood.

For safety, the roads should separate the pedestrian and vehicles and should have accessibility to everywhere.

Image 5-3-3 : Road System
Source: Made by Author
**Infrastructure**

There are many schools nearby which laid a good foundation for this kind of residential transformation. Clearly from the following map, there are five primary schools surrounding the site which is well enough from the From quantity and distance although one of them is in the demolition area.

However, only two kindergartens and one middle school. Once the site changed into a neighbourhood community, there should be kindergarten nearby, especially the community is mainly for young and old generation.

And adding one middle school can be taken into consideration.

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Image 5-3-4 : Surrounding Educational Environment  
Source: Made by Author
Because blocks of old buildings to be demolished. The environment around is not satisfactory. Firstly, in spite of there are some residential blocks, the number of stores, supermarkets is far enough. Secondly, the nearest hospital is the community clinic, it cannot reach the regular medical treatment level and the standard hospital is in about 1000m away. Thirdly, no bank or ATM nearby which is not convenient.

The parking places are for the industrial park now, there should be adjustment for them.

- Hospital
- Parking lot
- Shopping or Market
- Bank or ATM

Image 5-3-5: Infrastructure
Source: Made by Author
There used to have a long-distance bus station and a train station, as a transport hub, this area is a little bit in chaos. But it will still have chance to be organized.
5.4 Site with buildings judged existing and suitable to demolish & proposed new buildings

Building density

"The prerequisite for street life was the building density, which encouraged many people to get around the area by foot. Only when there is a certain amount of life on foot in front of the houses does it become meaningful and interesting to spend time on the public side of the houses. In areas with front yards and outdoor terraces in front of the housing units, but primarily car traffic on the roads, almost no one stayed outside in front of the residences."

- Jan Gehl

About the current layout of the buildings, the density is a little bit low for a residential area. But as the industrial heritage buildings have their special feature, large structure, which decide their fate. On the one hand, the building density should be increased, on the other hand, those big heritages should be well kept and transformed. Thus, there should be a balance between these two conditions.

Image 5-4-1: The layout of existing buildings
Source: Made by Author
Ceiling Height

Most of these old factory buildings are no more than three storeys. And the highest building is five or six storeys. That means in order to make the whole site less monotonous, some actions should be taken. Such as: add new higher buildings, add layers to the old ones, etc.

Image 5-4-2: The layers of existing buildings
Source: Made by Author
Buildings that should be rearranged or demolished

Waterfront Landscape
Change Housing Layout
Dabaoen Temple
Under construction

Image 5-4-3: Preliminary Conception to existing buildings
Source: Made by Author
Image 5-4-4: Key protected Heritage buildings
Source: Made by Author
5.5 building structure
The factory building, which I choose to do the residential transformation on, is a rectangular shaped with zigzag roof. It covers a large area, its construction ratio is about 92.8 * 93.3 * 5.77m and the highest point of the steeple is 9.17m. This industrial heritage building was built in the year 1934, the republic of China. It used to be a one storey factory for machine making and processing with a dimension of 8236.3 m². It is no doubt a huge space which has wide truss span.

Although reconstructed inside, the column grid structure can still be concluded. The original module of the columns is: 6m * 6m or 3.6 m * 6m.

Image 5-5-1 : Location and ideal original layout plan of the building
Source: Made by Author
The building locates in the Creative research and Development Zone of the Industrial Park. It has typical architectural style of the republic of China and besides, Bauhaus style: brick - concrete, big windows, steal structure, simple and unified appearance, integration of technology and art.
The "Finder Art District" is now occupied this big building. There are four functional areas of the District: Modern Exhibition Hall; Traditional Exhibition Hall; Artistic Workshop Area; Supporting Service Area. The private art studios, collection of selected Oriental and Western modern art works can be found here.

Image 5-5-3 : Finder Art District
Source: Photoed by Author / Google
The building, in the typical Bauhaus architectures and the perfect LOFT artistic space, being an ideal site for LOFT - living fans whose among the young people mostly. For the purpose of residential transforming, in spite of the transformation method, some Architectural design principles need to be considered and abide by, such as:

**Scale**
"The principle of putting small spaces into a larger space is another method of combining large space and modest human scale."

"small scale can be brought into the large space literally by parachute"

- Jan Gehl

**Access**
As all buildings need some links to the outside world, the number of access points - and egress points, in case of fire - governs how readily a building can adapt to a variety of uses. Building height is a particular constraint in this respect.

**Room shape and size**
Room sizes need to accommodate a broad range of activities and be capable of subdivision (which may relate to window positions) or connection to create larger spaces. In domestic buildings, for example, rooms that are 10 - 13m² in area can serve as bedrooms, kitchens, living rooms or dining rooms. Dwellings with rooms of this size prove relatively robust in changing from, for example, family houses to a number of smaller flats (Moudon, 1987). Brand (1994, p. 192) also contends that the rectangle is the only configuration of space that grows well, subdivides well and is efficient to use. (Carmona, M. Heath, T. Tiesdell, S. Oc, T. 2010 p. 256)

**Three useful rules from Alexander's rules of Organic Growth**

Rule 4: Every building should create coherent and well-shaped positive urban space in such a way that the space, rather than the building, becomes the main focus of attention. To help achieve this aim, there should be a hierarchy of urban elements with pedestrian space prioritised, followed by buildings, then roads and finally parking.

Rule 5: The layout of large buildings should be arranged so that the entrances, main circulation, main divisions, interior open space, daylight and movement within the building are all coherent and consistent with the position of the building in the street and in the neighbourhood.

Rule 6: The construction should be such that the structure of every building generates wholes in the physical fabric through the appearance of their structural bays, columns, walls, windows, building base, etc.
5.6 Design Motivation

What does "Mixing and Matching" mean here?
"Mix" means to bring or combine together different elements or open (a place) to members of all races and ethnic groups while the explanations of "Match" are: bring two objects, ideas, or people together; make correspond or harmonize; make equal, uniform, corresponding, or matching. "Mix and Match" is a terminology in the fashion field which means get different styles, different materials, different levels of stuffs pieced together according to individual tastes. The reason I choose this word because the chosen design area used to be an industrial factory area (arsenal). The design targets to create a livable neighbourhood community for both young and old generation which has a totally different function from its former one. It should fulfill two "mix and match"s: 1. residential neighbourhood and industrial heritage area; 2. young generation and old generation. These four elements should be harmonious blend into each other.

Although it is rarely used, I think this "transboundary" word can perfectly indicates the idea of my original purpose.

The situation in China
In developing countries, rapidly rising population caused many problems and challenges. In many regions, the new urban housing problem leads to the spread of the large informal housing densely populated, the primitively constructed and lack of almost all forms of service. Pressures can also lead to overpopulation of existing housing area, it overwhelm utilities, transportation system, public spaces and parks. What is more, in new residential area, high-rise and cluster of buildings are being built at the great speed near big cities, the public space nearby is usually under - dimensioned and in poor quality. The common feature of most city dwellers in developing countries is that they are living in a modest standard. It is in these housing areas, high population density and low economic resources, outdoor space has great impact on living conditions. In many areas, culture, tradition and climate decided the various outdoor activities which is always play an important role in living conditions and life quality. In these cities in particular it is important to ensure the future availability of enough well-functioning free space: parks, squares and opportunities for expression in existing and new urban districts (Gehl, J. p.215).

In China, the large population base; the difficulty of employment; the gap between the rich and the poor caused by economic development; the aged tendency of population... These problems caused a lot of troubles, such as poor living situation, bad neighborhood development... Furthermore, the house prices in the city seemed soaring up without limit these years. It is difficult to buy a house now, especially the young generation. Meanwhile, the pension industry has been supported and developed by Chinese policy.

With the development of economy and the adjustment of industrial structure. A large amount of old industrial buildings have been left
and even been abandoned. Therefore, as a process in urban renewal, the conservation and reuse of this kind of building get more and more attention by the world. Good structure and large space make this kind of building can be redesigned and endowed with new functions. This approach can not only save resources, reduce waste, but also add "lifetime" to the old buildings. Foreign countries already have relatively mature skills in transforming them, but China has just realized the seriousness of the problem. Generally speaking, there is gap and insufficiency between domestic and abroad. China's major problems are: narrow scope of transformation; monotonic transformation method; lack of systematic theory guidance and lack of respect for the historical and cultural factors.

In recent years, the trend of the renovation method of old industrial building in China is the so called 'creative industrial park'. Large quantities of industrial heritage building or district have been converted into this kind of place. As old industrial heritage usually located in urban areas. Urban land for resident is so tense and expensive. So it should be interesting and worth further exploring to mix and match the regeneration of old abandoned industrial heritage building (or area) and residential area organically together. As stated before, in China, most industrial heritage buildings are left over from the period of the Republic of China. Nanjing, the Six Dynasties ancient capital, which is a city with a long history and culture. It is also one of the birthplace of Chinese modern industry.

Image 5-6-1: “Difficult to buy a house”
Source: http://www.enorth.com.cn
5.7 Summary
Strengths and Weaknesses of the site

**Strengths**
- good location in the city
- rich resources of cultural relics
- historic
- convenient transportation
- good vegetation

**Weaknesses**
- building quality
- few bus station
- not reasonable road network
- imperfect service building
- imperfect living condition
- low building density
- humdrum building height
- few public space

As the target is a neighbourhood suitable for young people and the elderly, public open spaces like are more important to be taken into consideration. On one hand, the need and energy for many recreational and creative activities is increasing, which can often take place in common city space. A great deal of creativity has been unleashed in our society: people play music, sing, dance, play, exercise and engage in sport as never before in public space. On the other hand, the number of senior citizens is rising sharply. They represent a new group with needs for walkable infrastructure. They need to be physically active, take long walks, try walking, bicycle more, etc. In addition, the old people have all the free time, they need more neighbourhood communication. Last but not least, children’s play has always been an integral part of city life. Enough space should be served for these kind of demand.

**Possibilities**
To create Neighbourhood community for young and old generation to live in, a better place where is able to meet the requirement of human scale landscape. Provide the chance of walkability everywhere in the neighbourhood.

Also Carmona (2010) has concluded that an urban space should be robust and resilient. A set of key properties should be: Open, Flexible Varied, Comfortable and Sociable, to support the different types and patterns of social activity.
### Goals & Objectives

#### Goals

1. Arrange function zone
2. Make better traffic condition
3. Unified design
4. Optimize the green space
5. "Livable" industrial building
6. Building density
7. Increase public space
8. Provide a better balance of demand for community services and facilities
9. Making neighbourhoods more robust

#### Objectives

1. Divide residential area according to the new design
2. Arrange road network, add necessary bus station
3. Unified characters of buildings, pavements
4. Add more vegetation, create waterfront leisure landscape
5. Suitable structure and scale
6. Increase building density, avoiding the same type
7. Add squares, communication area
8. Schools, recreation facilities, care for elderly people, childcare, shopping
9. Add streetlights, assisting surveillance, by people coming and going throughout the day and night
Chapter 6. DESIGN PROPOSAL

As has discussed in chapter 3, the methods, principles and stratages of residential transform mode and the neighbourhood design and the experiences learned from the example case studies in chapter 4, aiming at solving the problems concluded in the previous chapter. The main goal of this design proposal is going to pay main attention to the following aspects in the design process:

1. Traffic. Improving the road system with more specific partition. Add new bus stations. Provide walking-friendly environment to the residents and increase the security of the roads.

2. Residential transform mode on one industrial heritage building. This historical building will be functional replaced which still have its typical appearance characteristics instead of being removed. New inner structure will be create.

3. Increase the building density in this area. Low density gives people feeling like large scale, uncomfortable, cold, inhospitable of a place. Increasing the building density in a living area may let the residents love to live in.

4. Renewal Spaces. Try to functionally revive the existing spaces and implant new public spaces which can increase people's participation.

5. Public Services. Add new functional infrastructures and service buildings, such as education, social security, shopping, ... Which are daily needed to provide more convenience for the residents.

6. Safety. Provide More streetlights along roads, streets to improve the vitality and to enhance the sense of security of people who live here.

7. Consider more of the young and old generation. Create leisure space, outdoor recreation place, communication space, accessible facilities.

8. Add Green space. Create more green space and develop the waterfront landscape to.
The new function zone is consist of five main parts: Youth apartment block, Apartment for the aged, Conventional residential area, Infrastructure and Landscape.
6.1 Traffic

The road network is forming a good and orderly way than before, road hierarchy is more reasonable. The layout of road system is more neat.
Add three bus stops based on the original situation. People can easily get on a bus closer to their house especially for the old people. They do not have to walk a long way. The design of the bus stops is more modern.
6.2 Site ground planning

Because of keeping the facade of these industrial heritage buildings from the time of the republic of China, the style of the pavement material should be antique too.
More green space promote more of the living quality of the whole neighbourhood area.

They not only provide recreation places for the children, relax area for the eld but also make everyone take part in social life, enjoying their living environment.
6.3 Building interior

Reconstruction of Prolate space  Reconstruction of Large space

‘Life, space, building - in this order. First life, then space, then buildings.’

‘small scale can be brought into the large space literally by parachute’

‘The principle of putting small spaces into a larger space is another method of combining large space and modest human scale.’

- Jan Gehl

So this large-scale factory building is re-divided into many small loft apartments inside.
This big collection space of the lofts has 10 entrances now. Four main entrances and six secondary ones. Because it occupies a large area, emergency exit is really necessary.
The inner space of the building is accessible. The entrances are not far from every apartments.
Each entrance hall, no matter the space is big or not, is providing a communicate space where placed comfortable seats. Young people can social there arbitrarily. Also, in this building, a cafe bar, a mini market and a small gym are equipped with.
This loft apartment is on behalf of all of the apartment inside. They are having the cover area of 45 m² on average. The inner space of each can be randomly divided as the owner likes. Each apartment is ensured a window at least to guarantee the day light and ventilation.
Another prominent feature of this building is it has a small courtyard which provide a more open communicate and leisure space.

It also can be a good emergency evacuation space.
6.4 Infrastructure

The Public spaces including the playground for children, the outdoor exercise space, the squares, the leisure space, the waterfront landscape belt and the parking lot.
Leisure space
Lighting is crucial once night falls.

Good lighting on people and faces and reasonable lighting for façades, niches and corners is needed along the most important pedestrian routes to strengthen the real and the experienced sense of security, and sufficient light is needed on pavements, surfaces and steps so that pedestrians can maneuver safely.
Chapter 7. CONCLUSION

In my thesis, the main research question of the whole thesis is 'How to change Nanjing Chenguang 1865 Science-Technology and Creativity Industrial Park into a neighbourhood suitable for living by using the principles or theories to support this kind of sustainable regeneration design.' which has been stated in Chapter one.

With the purpose to answer this question, there are three sub-questions need to be resolved as well. The first one is "Why is the conservation and regeneration of industrial heritage building so important around the world nowadays", the answer is in the part of 3.1, the significance and importance of conservation and regeneration of industrial heritage building have been discussed. The second one is "What are the opportunities to make full use of these old special structure architectures in a sustainable way? Which methods does China apply to protect and reuse of old industrial heritage buildings?". It has been answered in 3.2 and the whole part of Chapter four. The third sub-question is answered in the rest of Chapter 3. The analysis and elaboration from the whole text and together with Chapter 6 - design proposal answered the main question. Through the summary of literature review and the analysis of those carefully selected examples, several application strategies have been concluded. The experiences are not only learned from empirical example, consideration of the current situations of China should also be taken in the meantime. From chapter five, case study, the current situations of the application site Nanjing 1865 Industrial Park has been researched and analyzed where I introduced the historic development and current existing issues and problems in detail of the site. The design proposal is to resolve the existing issues and problems, moreover, realize my conception.

7.1 Result and Limitation of Design Proposal

Result
The design proposal, which a renewal project of a former industrial heritage area locates in city downtown, is not only reuse this area but also takes a functional twist - change it into a neighbourhood community. Specifically, the design aims at regenerating old industrial heritage buildings instead of demolishing them all. Do the creative organization and re-planning in the cluster of such kind of
architectures. On the base of evaluation whether can be transformed into livable building groups. The design proposal followed eight factors: Walk-friendly community; Residential transform mode; Building density; Create public and open spaces for people to enjoy; Complete infrastructure; Increase security feeling- add More streetlights to provide a safer environment for residents and enhance their sense of belonging; Elderly and young generation care; Green space, improve the living conditions environmentally. In spite of the planning, a specific building redesign is presented which shows how residential transform mode applied in real.

**Limitation**
Firstly, I choose example analysis and case study as the methodology, those two themselves have limitations. Problems in the case shows only the specific condition, which means it can not present the general issues. The emphasis on other cases are different according to the practical situation. And the design proposal which led by case study is conducted by one person, it may more or less reflect one person’s empirical experience. Secondly, because of the limitation of the capacity and time, lots of ideas can not come true thus the design proposal is not that perfect.

### 7.2 Conservation and Urban renewal
Culture is the accumulation of history, Retaining in the buildings and integrating in our life. Protect the history and culture of a city is a right way of urban development. Once they are well-preserved, the city is sustainable and attractive. Therefore, the a city’s sustainable development and its renewal process must pay attention to the construction of history and culture.

The Residential Transform mode of Industrial heritage building surely can be regarded as one of the sustainable development strategy of urban design. The Industrial heritage buildings are carrying the historical memory of the industrial development of a city which also shows the human civilization. They are heritage of great value.

Depending on unique structure and large size, Industrial heritage buildings are the important target of urban renewal. Unfortunately, many old industrial buildings were demolished, this kind of approach and attitude is cutting off the expense of history. What should be done is respecting and protecting history while develop our cities.
7.3 Prospect of Residential Reuse of Industrial Heritage

Building in China

The Residential Transform mode of Industrial heritage building is totally a new mode in China, although many cities are carrying out the revival action of old industrial buildings. Although most of the cities in China is still in the industrialization period, but some economic center cities have entered the post-industrial time, a large number of vacant industrial buildings and land appear. But most of the regeneration is to transform the building or building group into creative park so as to promot investment.

The current issue in China, as we all known, is: Rapid urbanization makes rapid urban population growth and make the demand for housing in a state of tension. As there are idle industrial heritage buildings in the downtown, why not transform them into residential buildings. Under this situation background, the residential transform mode of industry remains has very important significance. It can not only release the tense of land use, but also protect the interests of vulnerable groups. What is more, these huge,"cold-looking giants" will be involved in our daily life and become more welcomed. This mode has gone through many years practice in western countries, while in China, there is few projects, which means it will have great room for development in China.

However, the vacancy in Chinese management and policy make this kind of mode not easy to be implemented. Therefore, improving laws and regulations, improve the management mechanism is one of the basis factor. Government should actively promote public policies to encourage this kind of development.

Residential Reuse of Industrial Heritage Building in China should have a bright future.
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APPENDIX

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