Exploration of Adaptable Protection Transformation and Vitality Regeneration Path for Old Boiler Houses in Universities

Yan'an Liu, Qi Zhao *, Rui Zhang, Yun Wang

Northwest University of Technology, Xi'an, Shaanxi 710000

*zhaoqi5082@163.com

Abstract. This project is located within the residential area of Dongda Town in Chang'an District, Xi'an City, China. The project involves the old boiler room supporting the original building, which has been completed for 15 years. With the gradual development and formation of surrounding conditions, the functions of this building have gradually retired from the historical stage and become vacant. The original building's buildings, large equipment, process flow lines, trace environment and other facilities remain intact. Based on the protection and preservation of the original state-owned assets, while also reactivating the functions, supporting facilities, and related auxiliary values of the land, it is planned to carry out protective improvement and renovation on the industrial building and surrounding environment of this equipment, and provide a preliminary design plan.

Keywords: Boiler room renovation; Old buildings; Function settings.

1. Introduction

With the gradual acceptance of the concept of sustainable development, the renovation, renovation, and reuse of old buildings are receiving increasing attention and attention both domestically and internationally. Many new concepts and technologies are often first reflected in higher education institutions. Compared with other old building renovations, the renovation of university buildings has both similarities and its own characteristics.

2. Background of Old Building Renovation

2.1 Research Overview at Home and Abroad

The research on the renovation of existing buildings in Western countries has been relatively early, and the theoretical and practical research results are relatively rich. The relevant design methods and technical applications are relatively mature. Scholars such as Brolin have discussed the theory and practice of architectural renovation. Charles (2011) proposed that the renovation of existing buildings should balance issues such as structural aging and the coexistence of old and new buildings, aiming to explore the unity of old and new buildings. At the same time, as early as the 1970s, Western countries had already paid attention to the ecological design of buildings, and focused on developing green design methods and technology applications. Foreign countries have shown a trend towards green and ecological renovation of existing buildings, and have strictly controlled building energy efficiency. They have also incorporated special content such as recycling resources, regional environmental improvement, and intelligent system control. In 2006, James Douglas' book "Adaptive Renovation of Buildings" was released, which comprehensively introduced the relevant projects of adaptive renovation of existing buildings through case analysis and proposed that adaptive renovation should comprehensively consider and pay attention to the ecological aspects of buildings.

In recent years, under the guidance of diversified demand, domestic universities have gradually begun to attach importance to the adaptive renovation of old buildings, especially industrial heritage, and have conducted research and practice on green renovation technologies and strategies. Liu Junhao (2020) conducted a design study on the renovation and reuse of industrial relics in university buildings. In order to save resources and inherit historical context, he chose to renovate and reuse the industrial relics left behind on campus. He summarized the renovation measures for different structural types of industrial relics on campus, and conducted a horizontal qualitative analysis of three domestic cases

from four aspects: structural treatment, functional replacement, spatial shaping, and ecological technology, Summarize the transformation design strategies for internal design, external design, and ecological energy conservation; Wang Shasha (2012), Huang Jinhui et al. (2015), Liu Junyi et al. (2017) used the renovation of the boiler room at China University of Mining and Technology as an example to explore the renovation concept, technology, and strategy from different perspectives; Zhang Yuling (2022) proposed three design modes for renovation and renovation of old buildings in universities, including overall preservation, partial addition, and appropriate demolition, in response to issues such as negative external space, outdated internal space, and low thermal performance. He also proposed three strategies: original design of external environment, integrated design of internal functions, and optimized design of building ecology; Yi Ruoletai et al. (2008) systematically introduced the design strategy of transforming the idle boiler room of the Youth Political College of Inner Mongolia Normal University into a library, using the concept of integration to solve the multiple contradictions in the adaptive reuse of old industrial buildings and regional creation, and elaborated on the core strategy of introducing skylight, which has positive significance in improving performance, presenting materials, shaping the sense of time and spirituality in industrial building renovation; Li Jiangling (2019) relied on the practice of the Green Transformation Project of the Waste Heat Center of Xijian University, and through comprehensive research methods such as literature research, investigation research, comparative research, and simulation analysis, combined with the development status and case practice of green transformation at home and abroad, based on the current project status research, demonstrated the feasibility of project implementation and proposed green transformation design strategies The green transformation strategy system includes green transformation technology strategy and transformation design green evaluation.

2.2 Project Overview

The project is located in the residential area of the eastern part of the Chang'an Campus of Xi'an University of Technology, Dongda Town, Chang'an District. The project involves the supporting old building of the boiler room in the original building. The boiler room building itself occupies a large area and has a lot of indoor space. The original boiler room pipeline equipment is too expensive to dismantle and transport, and cannot be rebuilt after dismantling. The appearance and internal structure of the building are relatively new, and the water, heating, and electrical conditions are complete, fully meeting the reuse needs. Demolition is a huge waste.

The purpose of this development and renovation is to improve the service functions of the campus and family residential areas, enhance the vitality of the area, solve the problems of insufficient living supporting facilities and logistics office space in the family residential areas, and upgrade and transform the idle boiler rooms in the family residential areas.

3. Current situation research

3.1 Introduction to Project Location

This project is located in the northeast corner of the family area of Northwest Polytechnical University Chang'an Campus. The north side is the second phase of the family area, the southwest side is the first phase of the family area, and the south side is the Engineering Technician College. The land is relatively remote. How to reduce the problems caused by geographical disadvantage is a major challenge faced by design.

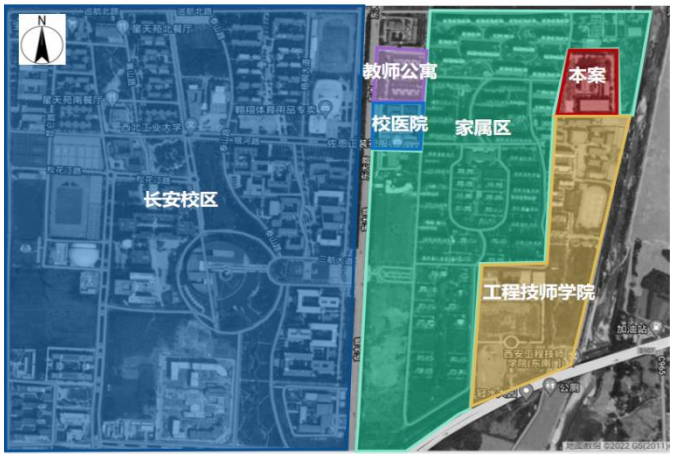


Figure 1, self drawn by the author

The target service group for this case can be preliminarily determined based on the geographical environment: family members of faculty and staff (parents and children), young teachers and doctoral students, and students from our school. From this, it can be seen that the service group positioning of this case is relatively diverse, covering multiple age groups, and has a high cultural level.

3.2 Determination of renovation scope

From the perspective of fully utilizing buildings, overall renovation can provide more comprehensive services and bring higher economic benefits. Architectural appearance: Overall, it is relatively new, with the facade mainly paved with red tiles, and the building structure is a frame structure; Overall structure: including boiler room, auxiliary building, induced draft fan room, slag storage room, and chimney (as shown in Figure 2).

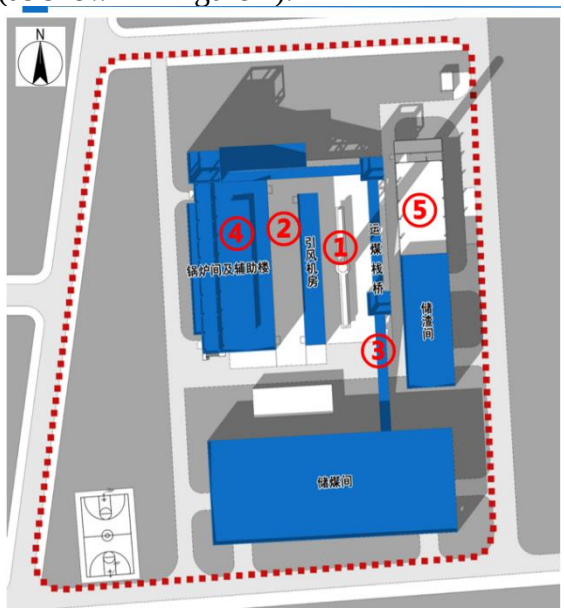


Figure 2, self drawn by the author

The special structure in this project: 1. The chimney is about 80 meters high; 2. Build a platform for dust removal equipment; 3. The coal transportation channel is winding and narrow, with significant height differences; 4. The funnel shaped structure of the boiler room on three or four floors; 5 Deep pits in sediment tanks.

4. Function settings

4.1 Functional positioning (based on user classification)

4.1.1 Logistics and property department staff, required functional space: office meetings, equipment and material warehouses, vehicle placement;

4.1.2 New campus faculty and family members, required functional space: community cafeteria, fruit and vegetable market, cultural exhibition hall;

4.1.3 User: Both of the above are included, and the required functional space includes fitness and sports venues, retail businesses, and simple meals and tea drinks.

4.2 Functional positioning

The project has a large space, and the specific functional location distribution is as follows (Figure 3). The functional settings follow a series of setting principles.

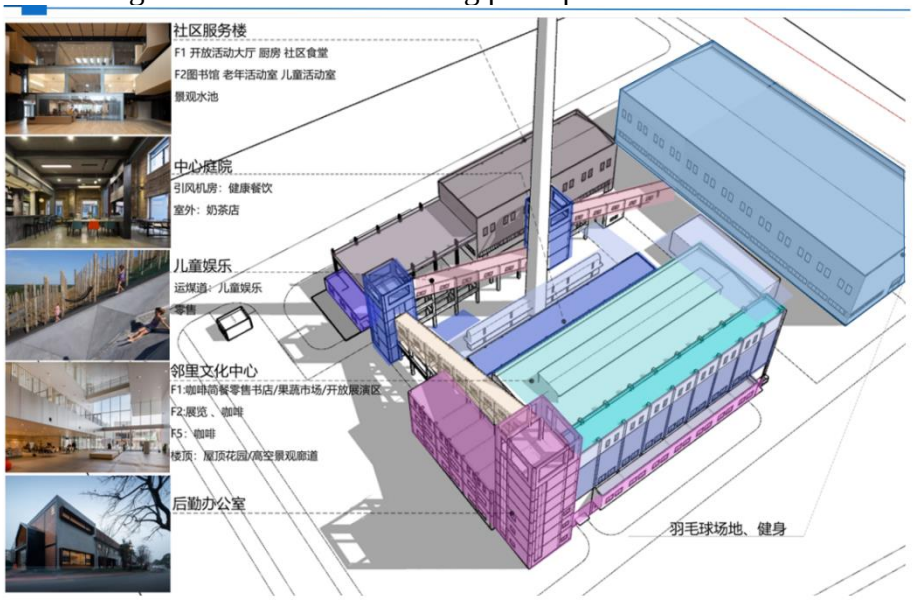


Figure 3, self drawn by the author

4.2.1 Boiler room and first floor of auxiliary building

Functional settings: fruit and vegetable markets, retail businesses, cultural and creative bookstores, light meals and tea drinks, exhibition entrance hall, office entrance hall

Space structure characteristics: The lower floor height below the boiler equipment is suitable for arranging markets and retail businesses with low requirements for floor height; Due to the natural height structure formed by equipment reservation, it has good spatial permeability, and the linkage layout function of the upper and lower layers can effectively utilize this structural feature.

Functional layout logic: As the most accessible indoor space for the crowd, it adopts a composite functional layout, mainly focusing on commercial content for community consumption, while also arranging the exhibition hall on the second floor and the entrance hall of the office building.

4.2.2 Boiler room and second floor of auxiliary building

Functional settings: display space, office space

Spatial structure characteristics: There are large boiler rooms on the second floor of the original building, which have equipment and high dismantling costs, and can be considered for preservation. The second floor of the auxiliary building features an office layout and an open space.

Functional layout logic: When the equipment on the second floor of the boiler room is reserved, the surrounding space formed is suitable for display space; Utilize the existing office layout to arrange the office, and the open space can serve as a meeting room.

4.2.3 Boiler room and auxiliary building third and fourth floors/roof

Functional settings: office space, roof garden

Spatial structure characteristics: The third floor of the auxiliary building is an office layout; The roof of the auxiliary building has a good view of the park.

Functional layout logic: The third floor of the auxiliary building still has the spatial layout of an office, which can be arranged. A rooftop garden can be set up on the fourth floor to provide independent outdoor leisure space for internal office staff.

4.2.4 Boiler room and auxiliary building on the fifth floor

Functional settings: high-altitude exhibition gallery, tea drinks

Spatial structure characteristics: As a part of the coal transportation channel, the spatial form is unique. It is not easy to arrange regular usage functions.

Functional layout logic: Combined with spatial characteristics, it can serve as an exhibition gallery with a straight path. At the same time, due to the good indoor view, appropriate tea drinking spaces can also be arranged.

4.2.5 Slag storage room

Functional settings: community restaurant, community activity room, and community library

Space structure characteristics: There is no internal separation, and the space has a high height. Considering the full utilization of the space side, two or three layers of interlayer can be added locally.

Functional layout logic: mainly providing certain convenient community services for the community living population, to meet the new functional needs that arise in the use of residential areas.

4.2.6 Sedimentation tank

Function setting: Landscape water pool

Spatial structure characteristics: The depth of the water tank is relatively deep, and the filling treatment cost is high. It can be safely treated as a landscape water tank.

Functional layout logic: Provide core landscape for the park.

4.2.7 Induced draft fan room and surrounding outdoor areas

Function setting: Simple meals and tea drinks

Space structure characteristics: The building space structure is narrow and long, and the outdoor space is irregular, which can be comprehensively considered. By demolishing some walls and adding enclosures to connect indoor and outdoor spaces, a flexible spatial layout is formed.

Functional layout logic: Combining the complex and small size of the space, arrange leisure spaces such as simple meals, tea, and drinks, making the area the vitality core of the park.

4.2.8 Coal transportation channel

Function settings: Storm Corridor, Children's Activities

Spatial structure characteristics: The spatial structure conditions are special, not only with structural problems such as slope and height difference, but also with spatial organization problems such as excessively long and unobstructed flow lines.

Functional layout logic: The special spatial structure is similar to the requirements for outdoor activities for children, and the low elevation part can be considered for renovation. The high elevation section, due to its connection with the boiler room and tower, can serve as a weather bridge connecting the building and the outdoor.

4.2.9 Outdoor green space

Function settings: sports field, small square

Spatial structure characteristics: Starting from the full utilization of space, combined with existing basketball courts, other small sports fields are arranged around as a response. Dismantle the existing fence to directly connect the green space with the building.

Functional layout logic: oriented towards the target audience, people need a comfortable outdoor space environment; Secondly, the connection between the various buildings in the boiler room is not very close. A corridor bridge can be set up to connect the various building clusters, enhancing the connectivity of the entire space and creating more comfortable spaces.

5. Subsection

In the context of the construction industry transitioning from incremental to inventory, the exploration, development, and design of existing building assets is a new approach for some cities to revitalize themselves. Through the scientific control of the entire process by architectural designers, it can not only meet the needs of project stakeholders, but also ensure the quality of buildings, ultimately achieving a win-win situation. The success of the project has also provided us with many experiences and inspirations.

Acknowledgements

Author Introduction: Liu Yan'an (1972-), male, Han nationality, born in Lantian, Shaanxi, holds a master's degree and is an associate researcher. His main focus is on the Campus Construction Planning Research Fund Project: Key Project of the 2023 Development Strategy Research Fund of Northwest Polytechnical University (2023FZZ12)

References

[1] James Douglas．Building Adaptation．Butterworth-Heinemann（2nd Edition）[J]，April 20，2006.

[2] Esko Miettinen．Use of Steel in Housing Renovation[M]．The Finnish Constructional Steelwork Association Ltd.，1997.

[3] Charles Bloszies．Old Buildings[M]．New Designs．Princeton Architectural Press，2011.

[4] Yi Ruoletai, Zhang Pengju. The Integration of Multiple Strategies Guided by Sky Light: Design Considerations for Transforming the Boiler Room into a Library in the Youth Political College of Inner Mongolia Normal University [J]. Architectural Practice,2021(11):56-61.

[5] Ma Deyu, He Long, Wang Zhiqiang. Research on Design Strategies for Renovation of Existing Buildings under Market Turn: Taking the Renovation Design of Xing'an Boiler House as an Example [J]. Architectural Techniques,2023,29(01):104-107.

[6] Li Jiangling Research on the Green Transformation Strategy of Xijian University's Waste Heat Center [D]. Xi'an University of Architecture and Technology,2019.

[7] Liu Junhao, Jiang Changzheng. Research on the Teaching Reform Design of Industrial Relics in Universities: Taking the Architecture Museum of Inner Mongolia University of Technology as an Example [J]. Anhui Architecture,2019,26(12):59-61.