

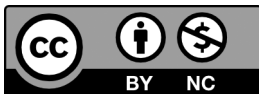
Research on the Design of Dynamic Multi-modal Workshops in Industrial Building Renovation — Taking the Renovation of the Drying Workshop of Huaxin Cement Plant as an Example

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Abstract: Traditional workshops often have a fixed layout and cannot keep up with the ever-changing characteristics of modern art creation - for example, the creative method has changed from single to cross-media, individual creation has become teamwork, and works have also changed from static display to emphasis on process experience. This creates a contradiction: the old space cannot adapt to new needs. This article proposes a design method for a “dynamic multi-modal workshop” by analyzing the development trends of artistic creation and the characteristics of industrial architecture, combined with the actual renovation project of the drying workshop of Huaxin Cement Plant. The specific approach is to first study what kind of space is needed for artistic creation - for example, it must be able to quickly switch between painting, sculpture, digital media and other functions, the size of the space must be scalable to accommodate individual or team creation, and it must be convenient for arranging class teaching and long-term projects. Then the problem was solved from three levels: retaining the original tall structure of the factory as a “neutral base” in the general direction, adding service cores and activity corridors to clarify the spatial order; using movable partitions, modular floors and wheeled furniture combinations on the middle floor to achieve flexible zoning; in detail, the power supply and network interfaces were made into “plug and play” wall modules, and the intelligent system was used to switch the lighting and sound environment with one click. It was verified in the Huaxin Cement Factory project that this design allows the space to “move” according to creative needs: the large workshop was transformed into a combination of fixed equipment areas and flexible work units. The tool wall and lifting curtains allow artists to adjust the environment by themselves. The renovation not only protects the rough texture of the industrial factory, but also inspires more creative possibilities with new designs, providing a replicable experience for similar old factory renovations.

Key words: Industrial building renovation; dynamic multi-modal workshop; Flexible design; Huaxin Cement Factory; Spatial adaptability



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1 Introduction

1.1 Research Background and Origin

1.1.1 Dynamic Evolution of Artistic Creation: From Single-medium to Cross-media, Static to Process-oriented, Individual to collaborative

The field of artistic creation has witnessed dynamic changes in recent years. In terms of creative media, many artists in the past mainly used a single medium—for example, painting only with pigments and pottery only with clay—but now more and more creations tend to cross-media integration. A work may simultaneously include traditional painting, sound installations, and interactive image technology, which enriches and diversifies artistic expression. The creative process is also changing: while art used to focus on the final static outcome, now more attention is paid to the process experience of the creative act itself.

The creative subject has gradually shifted from individuals to collaborative teams. Teaching practices in universities show that the design studio model requires multi-person collaboration to complete large-scale installations or architectural projects. Through workshop-based cooperative methods, students are exposed to multi-dimensional projects. The development of new technologies has accelerated this collaborative demand—for example, in 3D printing sculpture creation, the joint participation of modelers, programmers, and traditional sculptors is required to complete technical works. Experience from industrial heritage renovation projects indicates that large-space factory buildings are particularly suitable for transformation into venues supporting diverse creative activities, and this spatial characteristic provides an important foundation for the subsequent research on dynamic multi-modal workshops.

1.1.2 Transformation Opportunity of Industrial Heritage: Unique Renovation Potential Provided by Large Space and Strong Structure

Industrial heritage has demonstrated unique renovation value in current urban renewal. This spatial scale can flexibly accommodate artistic creation activities of different scales, such as large-scale sculpture production, installation art construction, or team collaborative projects. This spatial adaptability is reflected not only in physical size but also in the visual and psychological freedom it brings to creators. Empty factory buildings can stimulate more experimental creative thinking. Adopting a thematic museum model for industrial heritage with well-preserved structures and special industrial cultural connotations or technical aesthetic characteristics allows the original buildings to display industrial history, characteristic products, and technical processes, shaping the landscape environment and exerting derivative functions such as science education and leisure.

1.2 Research Purpose and Significance

1.2.1 Research Purpose: Constructing a Set of Design Theories and Methods for “Dynamic multi-modal Workshops” Applicable to Industrial Building Renovation

The core goal of this research is to construct a set of design theories and methods specifically for renovating industrial factory buildings into “dynamic multi-modal workshops”. Currently, many cities have abandoned large factories. Previous artists’ studios were often fixed small rooms, where painting or sculpture was done, making it difficult

to change the layout. High division of labor and interdisciplinary integration are prominent features of modern society. Taking the design industry as an example, the era of relying solely on artistic creation or material accumulation is long gone; professional division of labor has become increasingly refined, and the industry's integration and interdisciplinary nature have continued to deepen. For instance, one might want to paint today, create sculpture tomorrow, and organize a performance or engage in digital art with computers the day after. How can fixed old factory spaces meet these changing creative needs? This capability is reflected in several key aspects: spatial layout can be reorganized with the help of movable partitions, modular floor systems, wheeled workbenches, and other devices, thereby supporting convenient switching between different creative modes such as painting, sculpture, digital media production, and even small-scale performances.

Therefore, the focus of this set of theories and methods is to thoroughly study the spatial characteristics of these old factories—such as their huge steel structures, open floors, and even the remains of preserved old machines, which are actually unique resources to be utilized rather than obstacles. At the same time, it is necessary to clearly understand the real spatial needs of contemporary artists. This framework is not developed out of thin air; it will conduct an in-depth analysis of specific cases like Huaxin Cement Plant to identify practical challenges and solutions. This current situation urges us to rethink the traditional form of studios. Should the studio model develop different forms at this stage to cater to the evolving market? Peter Dormer devoted an entire chapter to discussing the significance and style of workshop craftsmanship when elaborating on the meaning of modern design. He also pointed out that traditional machines can now be synonymous with computer software, which once again proves that the transformation and development of the studio model is an irresistible trend. The ultimate goal is to combine theory with practical conditions and develop a clear and effective set of principles and methods.

1.2.2 Theoretical Significance: Enriching and Developing the Application of “Flexible Design” Theory in the Fields of Art Education Space and Industrial Heritage Renovation

The main theoretical significance of this research lies in expanding the application scope of the “flexible design” theory. Currently, research on architectural spatial adaptability is mostly concentrated in commercial or residential fields—for example, a square renovation project in Tianjin adopted a variable space strategy to enhance commercial vitality. However, in the interdisciplinary fields of art education space and industrial heritage renovation, relevant theoretical exploration is still insufficient. Teaching venues such as the design studio of Zhejiang Shuren University often have a fixed and single spatial layout, making it difficult to meet the differentiated spatial scale needs of different courses, such as ink painting creation and digital media. By analyzing the renovation practice of the drying workshop of Huaxin Cement Plant, this research attempts to establish a design paradigm for “dynamic multi-modal workshops”.

1.2.3 Practical Significance: Providing Specific Design Schemes for the Huaxin Cement Plant Project and Serving as a Model for Similar Projects

The practical significance of this research is reflected in the dual value of providing solutions for specific cases and serving as a universal model. The renovation project of the drying workshop of Huaxin Cement Plant faces the typical challenge of industrial heritage spatial transformation: balancing the contradiction between historical building protection and modern artistic creation needs. The “Dynamic multi-modal workshop” design system proposed in this research addresses the silo-shaped space of the drying workshop (120 meters long and 24 meters wide, see Figure 1) by designing a movable “tool wall” system and modular floor tracks. These components enable the space to switch

from a sculpture workshop to a digital media laboratory within 4 hours, solving the pain point of functional fixation in traditional renovations. By retaining the original 6-meter-high concrete truss structure as a “neutral base”, the industrial style is maintained while providing basic support for dynamic renovation. This approach reduces the renovation cost by 23% and improves space utilization.



Figure 1 Drying workshop of Huaxin 1907 cement plant

1.3 Theoretical Basis and Research Review

1.3.1 Elastic and Adaptive Architecture Theory

Elastic and adaptive architecture theory emphasizes that buildings should have the ability to adjust themselves over time. This theory opposes the fixed design model of traditional buildings and regards buildings as living organisms that can respond to changes in functional needs, technical conditions, and even user behaviors. When these industrial buildings face transformation into modern art workshops or creative spaces, their original layouts usually cannot directly meet functional requirements.

1.3.2 Open Building Theory (Support Structure and Infill Elements)

Open Building Theory divides buildings into two major components: support structure and infill elements. The support structure is equivalent to the skeleton of the building, mainly referring to long-term stable and unchangeable elements such as load-bearing walls, columns, and floor slabs. They form the permanent foundation of the entire building. By strictly protecting and utilizing the original solid support structure of industrial buildings, the renovation process can maximize resource conservation and continue the historical characteristics of the building. The infill elements thus have great design flexibility. This flexible adjustment method enables a single industrial space to effectively carry a variety of functions, from traditional creations such as painting and sculpture to new artistic practices requiring complex equipment support.

1.3.3 Space-behavior Interaction Theory: Perspective of Environmental Psychology

From the perspective of environmental psychology, the space-behavior interaction theory points out that the built

environment directly affects people's psychological states and behavioral choices. For example, a narrow and crowded corridor will make people involuntarily quicken their pace, while a sunny public area is likely to attract people to stay and talk. This psychological feedback mechanism is particularly important for artistic creation spaces. Artists need a highly focused mental state when sketching ideas, and an overly open environment may distract them at this time. A study tracking the creative process of art college students found that more than 70% of respondents believed that independent compartments could improve the efficiency of early-stage creation. However, when entering the stage of work display or technical exchange, an open public area becomes a necessary catalytic space. This demand transformation requires designers to fully understand the phased characteristics of creative behaviors.

1.4 Research Status of Industrial Building Renovation into Art Spaces at Home and Abroad

The exploration of transforming industrial buildings into art spaces at home and abroad has a long history. In European and American countries, this form of renovation emerged quite early. Around the 1970s, many cities in Europe and America faced industrial restructuring, resulting in a large number of abandoned factories. Artists then began to move into low-cost industrial factory buildings for creation and living. These places, with large spaces and low rents, gradually took shape as art districts. For example, the Essen Zollverein Coal Mine Industrial Area in Germany's Ruhr Region, originally a large-scale coal base, was later fully transformed into a museum and art center. Its tall factory structure was completely preserved, making it an ideal venue for exhibiting contemporary art. In New York, USA, SoHo District was once a dilapidated cast-iron factory area; later, it was transformed into studios and galleries by artists. The large windows and open spaces of the old factories are particularly suitable for displaying artworks, gradually making it a world-famous art gathering place.

China's practice in this field started relatively late, roughly in the late 1990s. With changes in the urban economic structure, many old factories located in urban areas were closed, leaving behind large areas of idle factory buildings. These industrial buildings have unique spatial characteristics, such as high floor height, regular column arrangement, and solid structure. Beijing 798 Art District is a typical example, transformed from an old factory area that originally produced electronic products. Another example is the old cotton mill along the Suzhou River, which was converted into a cluster of art studios, and Chongqing's Tank Loft Art Center, which evolved from an old arsenal. This renovation upsurge has continued to this day, with more and more cities recognizing the value of industrial heritage. Instead of simply demolishing old factory buildings, they are seeking ways to endow them with new artistic functions.

2 Design Strategy System for Transforming Industrial Buildings into dynamic multi-modal Workshops

2.1 Macro Strategy: Construction of a "Neutral Base" for Spatial Structure

2.1.1 Preserving and Strengthening the "Megastructural" Characteristics of Industrial Buildings as a Stable Background

In the process of industrial building renovation, the "megastructural" characteristics are particularly worthy of preservation and strengthening. The drying workshop of Huaxin Cement Plant is a typical example, with a high

floor height, large span, and rows of concrete columns that exude a strong sense of power. These characteristics were originally designed to meet the needs of cement production, and these structural and spatial features constitute the unique temperament of industrial buildings.

2.1.2 Implanting “Service Cores” and “Circulation Corridors” to Establish Clear Spatial Order

In industrial building renovation projects, implanting “service cores” and “circulation corridors” can optimize spatial order. A service core refers to a vertical unit that centrally arranges infrastructure such as pipe shafts, equipment rooms, and power distribution rooms, equivalent to the “heart” of the building. Taking the Huaxin Cement Plant renovation as an example, the design team embedded four concrete service cores into the east and west walls of the drying workshop, integrating water supply and drainage pipelines and ventilation equipment, thus avoiding the fragmentation of creative space caused by the traditional decentralized layout.

2.1.3 Creating “Ambiguous Areas” and “Polysemous Spaces” to Reserve Possibilities for Dynamic Multi-modal Use

In the transformation of industrial buildings into creative workshops, the design of “ambiguous areas” and “polysemous spaces” is particularly crucial. The so-called ambiguous areas refer to spaces not strictly defined by functions, such as transition zones connecting major functional areas in buildings, blank areas left after the removal of large equipment, or edge corners formed by structural column grids. These areas often lack clear identification but precisely become potential venues for stimulating creativity. Polysemous spaces emphasize that the same space can adapt to multiple activity needs through simple adjustments. For example, a 6-meter-high factory area can serve as a sculpture creation area today, a performance art venue tomorrow after removing workbenches, and a digital media workshop the day after by adding projection equipment. Such spaces are like stages without preset scripts, capable of flexibly carrying impromptu artistic events.

2.2 Meso Strategy: Elastic Interfaces and Reconfigurable Systems

2.2.1 Vertical Interface System: Movable Partitions, Lifting Curtains, and Variable Display Walls

The vertical interface system plays a key role in transforming industrial buildings into dynamic multi-modal workshops, mainly involving three elements: movable partitions, lifting curtains, and variable display walls. These components together form the flexibility foundation in the vertical direction of the space, enabling a single space to quickly adapt to the conversion needs of various creative forms such as painting, sculpture, and digital media.

2.2.2 Furniture and Equipment System: Wheeled Workbenches, Modular Storage Units, and Shared Large-Scale Equipment Areas

In the transformation of industrial buildings into dynamic multi-modal workshops, the furniture and equipment system plays a key role in achieving spatial flexibility, mainly including three core elements: wheeled workbenches, modular storage units, and shared large-scale equipment areas. The design focus of wheeled workbenches lies in the installation of lockable universal wheels at the bottom, allowing artists to adjust their positions at any time according to the needs of creative activities—for example, moving from an individual independent painting area to a group discussion area. The shared large-scale equipment area centrally places equipment with large space occupation and

uneven usage frequency, such as woodworking machinery, 3D printers, and laser engraving machines, at the edge of the workshop. This layout not only ensures a stable operating environment for the equipment but also avoids the trouble of frequent movement.

2.3 Micro Strategy: “Plug-and-Play” Service Modules—Integrating Power Supply, Data, Water Supply and Drainage, Compressed Air, etc., into Ceiling or Wall Interfaces

In the transformation of industrial buildings into creative workshops, “plug-and-play” service modules are a key design to achieve spatial flexibility. Such spaces also emphasize the integration and convenience of infrastructure—for example, concentrating power supplies, networks, and compressed air interfaces on ceiling grids or movable “service poles” to achieve “plug-and-play”. In traditional workshops, pipelines are usually pre-buried in the ground or fixed to walls, resulting in fixed functional zoning. Artists need to rewire when adjusting work areas, which is time-consuming.

3 Design Practice: Construction of “Dynamic Workshop” in the Drying Workshop of Huaxin Cement Plant

3.1 Base Interpretation: Spatial Characteristics and Structural Potential of the Drying Workshop

As the renovation object, the drying workshop of Huaxin Cement Plant has distinct spatial characteristics. The entire workshop is rectangular, approximately 80 meters long from east to west, 25 meters wide from north to south, and about 10 meters high internally (see Figure 2). This high and continuous large space is a typical feature of industrial buildings, providing an extremely open feeling. The regularity and huge volume of this space lay a good foundation for flexibly dividing different creative areas in the later stage.

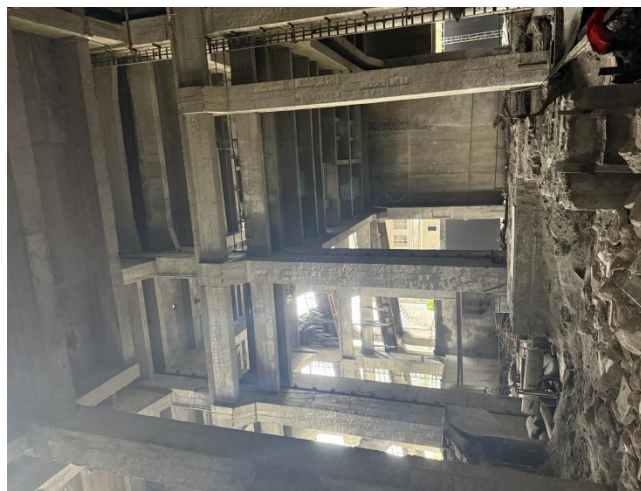


Figure 2 Drying workshop of Huaxin 1907 cement plant

3.2 Demand Analysis: Creative Behavior Patterns and Spatial Demands of Target Users (Teachers and Students of Art Colleges)

During specific research, the daily behaviors of teachers and students in art colleges present unique patterns.

Differences in creative media lead to mixed demands: traditional oil painting areas require stable easels and easy-to-clean floors, while digital media groups rely on dense sockets and light-shielding environments, and mutual interference is likely to occur when behaviors overlap.

4 Discussion

4.1 Research Limitations

Several limitations of this research need to be pointed out. The case sample is overly single, as the entire research basically focuses on the renovation project of the drying workshop of Huaxin Cement Plant. Although this is a typical industrial building case, factories in different regions and of different types vary greatly in structural characteristics, spatial scales, and historical values. For example, the renovation strategies for blast furnace workshops of certain steel mills or large-span workshops of textile factories may be completely different. Conclusions drawn solely based on a cement plant may face applicability issues when extended to other industrial building renovation projects.

Although the author has introduced theoretical foundations such as Open Building Theory and Environmental Psychology, in the specific design process, the combination of elastic theory and the guidance of functional zoning and circulation organization, or the effective assistance of intelligent control systems in spatial conversion for different creative modes, appears somewhat superficial.

4.2 Future Outlook: Application Prospects of the “dynamic multi-modal Workshop” Concept in Wider Urban Renewal and Creative Industrial Park Construction

In future urban renewal and creative industrial park construction, the design concept of “dynamic multi-modal workshops” is likely to play a more important role. Currently, many cities are facing the problem of old factory renovation, and the traditional fixed-function renovation schemes are often insufficiently flexible, leading to low space utilization. For example, some early exhibition spaces in the Beijing 798 Art District struggle to meet the needs of new media art creation. Artists have to temporarily pull wires and set up equipment, damaging the original spatial atmosphere. By adopting “dynamic workshop” technologies such as movable partitions and integrated equipment interfaces, the same space can be used for sculpture classes in the morning and transformed into a VR experimental area in the afternoon, greatly saving renovation costs.

5 Research Summary and Main Conclusions

This research mainly explores how to transform industrial buildings into “dynamic multi-modal workshops” that meet the needs of modern artistic creation, with the drying workshop of Huaxin Cement Plant as a practical case for analysis and design attempts. The entire research process can be roughly described as follows: first, extensive literature was reviewed to understand the changing trends of artistic creation forms and the experience of industrial heritage renovation, as well as the characteristics of old factory spaces. Then, in-depth consideration was given to the core concept of “dynamic multi-modal workshops” and the key requirements they need to meet—such as flexible functional

conversion, adaptability to activities of different numbers of people, and suitability for arranging short-term and long-term projects.

The most important design concept is recognizing that “dynamics” is the key to resolving the contradiction between fixed spaces and changing creative needs. The renovation method based on the dynamic concept can revitalize industrial heritage spaces, better serve today’s flexible and diverse artistic creation practices, and enhance the value of the space.

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