Selection of Facade Forms and Materials in Modern Pharmaceutical Industrial Parks — Taking Suzhou Wuzhong Biopharmaceutical Industrial Park Phase I as an Example

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Abstract: The design of building facades is influenced by multiple factors such as the functional structure of the main body, material characteristics, environmental conditions, and the needs and cultural cognition of people in the building. The choice of facade forms and materials for modern pharmaceutical industrial parks requires the application of scientific design theories in combination with the development of the modern pharmaceutical industry and pharmaceutical industrial parks. This paper discusses the elements and strategies of facade forms and material selection in modern pharmaceutical industrial parks from the perspectives of planning and construction, as well as the theories of facade forms and material selection in architectural composition, taking Suzhou Wuzhong Biopharmaceutical Industrial Park Phase I as an example.
***Keywords*:** modern, pharmaceutical industrial park, facade forms, material selection

1. Introduction

China's modern pharmaceutical industrial parks are industry clusters formed following local economic development strategies and the development of contemporary pharmaceutical industries. They are industrial infrastructure projects that incorporate modern biopharmaceuticals, modern Chinese medicine industries, modern intelligent healthcare, and other new pharmaceutical technologies, pharmaceutical companies, pharmaceutical talent, and pharmaceutical investment. The choice of facade forms and materials in the construction of modern biopharmaceutical industrial parks greatly affects the functional expression and overall architectural style of the industrial park.

2. Overview of Planning and Construction of Suzhou Wuzhong Biopharmaceutical Industrial Park Phase I

2.1 Planning and Construction of Modern Pharmaceutical Industrial Parks

Industrial parks are special geographical areas and environments planned and constructed by enterprises or local governments to achieve industrial goals and promote economic benefits. Under local policy support, industrial parks gather industry-related technologies, talents, and capital through clustering effects, which promotes technological innovation, service model innovation, and industrial chain innovation within the parks. Through innovation-driven development, industrial parks can drive positive regional industrial economic development.

The planning and construction of modern pharmaceutical industrial parks are closely related to local pharmaceutical industry development plans and the characteristics of local pharmaceutical enterprises. In the functional planning and design process of the pharmaceutical industrial park, it is necessary to comprehensively consider the industry positioning, land use demand, factory demand platform services, public supporting facilities, transportation, living environment, and other multidimensional factors, with an emphasis on synergy. According to the characteristics of settled and expected enterprises, the industrial park should be well-divided into industry segments, functional areas, and overall design styles.

2.2 Suzhou Wuzhong Biopharmaceutical Industrial Park Phase I Planning and Construction

Suzhou Biopharmaceutical and High-end Medical Device Cluster is the winner of the third round of advanced manufacturing industry clusters announced by the Ministry of Industry and Information Technology. Suzhou Wuzhong Biopharmaceutical Industrial Park is one of the industrial parks under the "1+N" layout strategy of Suzhou Biopharmaceutical. Wuzhong Biopharmaceutical Industrial Park focuses on the digital development of Suzhou Biopharmaceutical, actively develops AI pharmaceutical industry, biopharmaceutical and health industry, highlights the development of industrial internet, medical testing and other characteristic productive pharmaceutical services, and develops modern pharmaceutical industrial parks through macromolecules, clinical safety evaluation, AI medical treatment and other aspects.

Suzhou Wuzhong Biopharmaceutical Industrial Park Phase I project covers an area of 59 acres and has a construction area of 100,000 square meters. The industrial park is planned to provide office and production space for accelerator-stage enterprises in the biopharmaceutical and medical device industries, and strives to become an accelerator carrier for them. The enterprise features are reflected in companies in Phase III/ pilot production stage of the pharmaceutical R&D process and in the pilot and finalization stage of medical device R&D. The Phase I project plans to provide highly integrated, flexible basic spaces that can support various functions such as offices, R&D laboratories, and workshop production for such enterprises. In view of the development positioning and functional requirements of biopharmaceutical industry in Wuzhong, the original layout of the industrial park, and the intensive and green trend of modern architectural spaces, the planning and design of Phase I project consists of six accelerator carriers, two of which are stand-alone carriers and the other four are connected in a checkerboard layout. The space between the buildings serves as both a landscape space and a logistics loading and unloading site.

The project is based on a minimum leasing unit of 2000-3000 square meters, which includes office areas, experimental spaces, pilot areas, and production areas. Through the bidirectional conversion of space, the experimental area and production area can be flexibly converted according to the needs of the owner, achieving a flexible, applicable, and efficient interior space, allowing tenants to freely combine the modules they need.

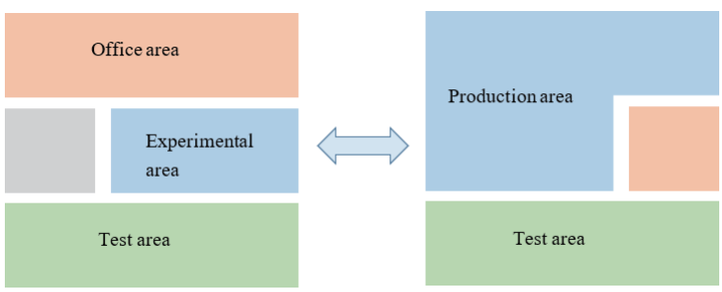

Figure 1. Bi-directional conversion space
— A test and production area design that can be converted in both directions according to the needs of the owner.

3. Aesthetic Design Logic of Building Facade Forms and Material Selection

The architectural composition form and material expression determine the main style of the building, and the facade form and material selection in architectural composition involve a relatively complex aesthetic design logic.

3.1 Architectural Composition

Architectural composition originates from visual arts and is based on human visual and psychological perception. It employs architectural elements, geometrical elements, Gestalt psychology, environmental psychology, color psychology, and optical illusions. By combining visual elements such as shape, color, light and shadow, texture, space, volume, and scale, it uses composition methods like proportion selection, scale control, rhythm creation, symmetry and asymmetry, structure and component relationship, consistency, similarity, and contrast to achieve the formal and practical beauty of architectural design composition.

Architectural composition design needs to meet environmental requirements, structural and technical requirements, functional, circulation and space requirements, and acoustic, light, and thermal requirements. It also needs to coordinate and unify the relationship between parts and the whole while pursuing formal beauty, considering the economic benefits of the composition, and adapting to the aesthetics and social culture of architectural understanding in the current era.

3.2 Building Facade Composition

Building facades include exterior and interior facades. The exterior facade comprises all the peripheral protection parts of the building, serving functions such as protection, connecting the building's interior, and decoration. Building facade composition studies the vertical and horizontal composition methods and principles on the two-dimensional facade of the architectural form[3], without considering the perspective relationship and visual distortion of human eyes. It accurately reflects the design thinking of the relationship between external elements of the building. Facade composition focuses on the design of expressive facades of buildings or buildings facing squares and streets, as well as the facade expression of the parts or nodes of the building or structure, and the facade layout and design from a certain angle of building groups, clusters, or landscapes[2].

The facade of a building group clearly reflects the relationship between buildings and their surroundings, the height dif-

ference between the ground and buildings, and the relationship between the facade components and the overall structure[2]. Various design techniques such as staggering, skin, cantilever, frame, grid, chamfer, interpenetration, rotation, stretching, repetition, segmentation, overlay, biomimicry, excavation, slotting, dividing, scattering, and variation are often used to achieve the overall architectural composition characteristics.

Figure 2. Example of industrial park building facade treatment

3.3 Architectural Style

Style refers to the common characteristics among a category of things, and people's grasp of style mainly comes from the psychological feelings brought by the modeling characteristics of objects. Different style features can be generated through the structure and combination of color (hue, brightness, saturation), shape (volume, contour, proportion), and texture in modeling[3].

Table 1. Characteristics of Modernist Style

Modernism	Practical, efficient, geometric, visual conflict, minimal decoration
ArtDeco	Emotional, natural, diverse lines, contrast, figurative
Postmodernism	Diverse styles, exaggerated, emphasis on environmental integration, humanistic, commercial

Contemporary industrial park construction basically follows the modernist architectural style.In the modernist style, modernist architecture embodies the Bauhaus concepts of "practicality" and "efficiency." The building facade is a manifestation of function and logical relationships, displaying a strong sense of geometry. The design focuses on facade detail processing and the connection of structural nodes. It often uses contrasts of solid and void, color, texture, light and shadow, and lines to create visual conflict. It requires high construction quality, utilizing smooth walls, simple eave treatments, variously sized glass windows, and minimal decorative lines for building modeling.

The Art Deco style uses emotional, natural, and elegant organic lines, mechanical, collective, and purely decorative lines, contrasting colors, breaking conventional or ancient cultural forms, symbols of speed, power, and flight, concrete sun rays and fountain forms, and the stepped profiles of skyscrapers to create a traditional yet innovative architectural style.

Postmodernist style, on the other hand, forms a contemporary diversified architectural style development through diversified architectural styles. Postmodernist style, while respecting the existing environment, pays more attention to the innovation of urban texture and context. It uses non-traditional forms of expression, and through a strong pursuit of aesthetics and personalized innovation, it conveys a more humanistic personal sentiment while also having a strong commercial advertising effect.

3.4 Building Facade Material Selection

Modern building facades are mainly presented in the form of curtain walls. The curtain wall material determines the overall facade effect of the building. Curtain walls are non-load-bearing and are hung on the exterior side of the main structure in the form of lightweight walls. They have the advantages of good decorative effects, lightweight, and fast installation. Materials are the material basis for ensuring the quality and safety of curtain walls. Based on the premise of material safety, quality compliance with construction standards, and service life, the decorative effect of materials (including shape, color, texture, pattern, light effect, etc.), the integration with the main functional role of the building, construction difficulty, and green energy-saving properties of materials become important criteria for material selection.

Building facade materials mainly include exterior wall coatings, metals, wood, glass, ceramics, concrete, bricks, and stones. The selection of building facade materials mainly includes the choice of building exterior wall brick and stone masonry effects and coating surface color, texture, and pattern effects; the design of roofing tiles for waterproofing, aesthetics,

and safety requirements; the choice of visual material and treatment methods for rainwater systems; and visual design of doors and windows based on functions such as protection, opening, and daylighting. Building colors often reflect the overall appearance of a city, historical context, regional culture, and the spirit of the times[4].

From the decorative function of building materials, the selection of building facade materials needs to combine the functional characteristics of the building's main body, and apply the constituent elements of materials such as color, texture, tactility, and area in the building facade design and human perception. Through the visual elements of the building facade materials, such as shape, color, light and shadow, texture, space, volume, and scale, the general principles and methods of color matching, and various ways and means of building facade composition can be utilized to achieve the design purpose of the building.

4. Suzhou Wuzhong Biomedical Industrial Park Phase I Building Facade Forms and Material Selection

Combining the development characteristics of modern pharmaceutical industrial parks, the development trend of building facade materials at that time, and the aesthetic principles of architectural composition, facade forms, and material selection, the facade design and material selection of Suzhou Wuzhong Modern Biomedical Industrial Park Phase I emphasize the integration of biology, medicine, and technology, as well as the design innovation of materials, processes, and composition.

4.1 Composition and Facade Forms

Figure 3. Wuzhong Biomedical Industry Park Phase I

In the facade design, the modern, biological, and medical-related design concepts are extracted from the modern biopharmaceutical industry concept. Dynamic biotechnology characteristics are derived from the development of AI medical, macromolecular biotechnology, and clinical trials in the Wuzhong Industrial Park. From the architectural style and trend of Wuzhong city, the visual coordination requirements of modern, technological, and biological elements are extracted. The urban energy-saving and sustainable development concepts are explored from the national green ecological development strategy. Furthermore, from the social and cultural cognition of Chinese people, design language features such as white, block surface, simplicity, and organic elements are extracted in the context of biological, technological, and medical cognition. Ultimately, the architectural composition style of Wuzhong Modern Biopharmaceutical Industrial Park is formed through the comprehensive understanding and processing of architects.

From the perspective of architectural form, the first phase of the Wuzhong Modern Biopharmaceutical Industrial Park meets the usage requirements of the pharmaceutical industry, adheres to the industrial land-saving principle in policy, and responds to the “industrial upstairs” model proposed by the National Development and Reform Commission. The accelerator unit in the project adopts a high-rise factory building form over 30 meters. The architectural composition is based on the white, simple, and linear design of biology and medicine, incorporating glass elements with a sense of technology and transparency. In the overall segmentation, linear block segmentation is used to reflect the seriousness and rigor of medicine. In detail processing, rhythmic and layered facade treatment is used to enhance the expression of the agility of biotechnology.

Figure 4. Facade design of Wuzhong Biomedical Industry Park Phase I

4.2 Material Selection

In the selection of exterior facade materials, based on the protective and decorative functions of facade materials, and based on the green, modern, technological, biological, and medical characteristics of this biopharmaceutical industrial park, as well as the innovative design principles, the mainstream and innovative GRC panels and tempered glass were chosen as the main building facade materials at that time.

Considering the construction technology level at that time, the project boldly adopted the new composite wall material, GRC panel. Compared with other curtain wall materials such as anodized aluminum panels, prefabricated concrete panels, and concrete coatings, GRC panels can have their color freely adjusted, and they perform excellently in terms of material strength, toughness, impermeability, fire and weather resistance, as well as thermal insulation and sound insulation performance. Functionally, GRC panels are lightweight, high-strength, easy to install, have a good texture, and strong anti-fouling and anti-deformation capabilities, improving the performance of the building curtain wall. The easy-to-clean surface effect of GRC panels not only facilitates curtain wall maintenance but also ensures the high cleanliness requirements of pharmaceutical buildings, presenting a good service life and diverse decorative effects for the entire curtain wall.

Two standalone factory buildings use large areas of glass material for the exterior facade. The daylighting performance of the glass provides good natural lighting for building production and office spaces. The use of energy-saving glass greatly improves the energy utilization rate of the entire building. The sense of transparency and lightness created by the glass adds a lot of points to the technology and intelligence of the building facade.

In general, compared to traditional color steel plates, GRC panels' plasticity and lightness have a more modern technological sense, and their integration with glass meets the functional requirements of the biopharmaceutical industrial park. The interaction between GRC panels and glass curtain walls forms a contrasting beauty and unified coordination of the building's main facade, making the first-phase building more dynamic, presenting a clean and innovative representative image of emerging technology industries, and conveying a natural, environmentally friendly, and sustainable green design concept.

5. Facade Form and Material Selection Strategy for Modern Pharmaceutical Industrial Parks

In summary, the architectural facade form depends on the main functions of the building, architectural features, environmental atmosphere, and architectural humanistic care and low-carbon green nature. The architectural facade form and materials basically determine the overall style of the building. The facade form and material selection of modern pharmaceutical industrial parks need to emphasize modernity, biology, technology, medicine, and organic characteristics, ensuring building safety and quality requirements while also paying attention to the decorative effect of the building facade, its organic combination with the main functions of the building, and its low-carbon energy-saving utility.

5.1 Facade Design Strategy for Modern Biopharmaceutical Industrial Parks

Considering the characteristics of modern biopharmaceutical industrial parks, from the perspective of architectural visual design, the facade design of modern biopharmaceutical industrial parks needs to extract functional and stylistic elements from design analysis elements such as pharmaceutical industry and industry chain features, modern AI intelligence

and biomedical technology characteristics, modern aesthetic cultural cognition of people in the architectural region, and surrounding architectural environmental styles, cultural environmental features, seasonal characteristics, and people's visual tendencies. Then, based on Gestalt psychology, environmental psychology, color psychology, and optical illusion effects, using visual elements such as shape, color, light and shadow, texture, space, volume, and scale in architectural facade design, applying design thinking to facade effect design, and using composition methods such as proportion selection, scale control, creating rhythm, symmetry and asymmetry, structure and component relationships, and consistency, similarity, and contrast to achieve the formal beauty and practical beauty of the architectural facade composition.

5.2 Material Selection Strategy for Modern Biopharmaceutical Industrial Parks

The relationship between architectural materials and architectural styles is interdependent and mutually influential. The advancement of building material technology drives the development of design innovation, while the need for design innovation promotes the continuous updating and technological progress of building materials. The selection of building materials for modern biopharmaceutical industrial parks, functionally speaking, needs to meet the safety requirements of biopharmaceutical production, satisfy the functional requirements of the building's main body to carry industry development, and ensure the health and safety of personnel and enterprise production. Materials that provide a comfortable, quiet, modern, technological, and innovative visual language for enterprise production and management personnel are required. In terms of material application, we need to have the innovative spirit to challenge existing application models, endowing materials with new ideological connotations and application methods, while ensuring the energy-saving performance, durability, and health of materials meet the building's requirements standards. In the integration of materials with the environment and the building's main body, the performance requirements of various building materials under time, season, natural environment, and pharmaceutical production environment corrosion conditions, as well as the coordination of material service life, need to be comprehensively considered.

In material application, attention should be paid to the functional characteristics and visual texture shaping of natural materials such as wood, stone, and natural fibers, as well as artificial materials such as concrete, plastic, and synthetic fibers. It is necessary to highlight the architectural style in combination with the main functional characteristics of the building facade, emphasize the people-oriented concept, highlight the sensory stimulation and feeling shaping for people, focus on local environmental climate characteristics, architectural historical context inheritance, and emphasize the future-oriented nature of the building with an emphasis on the role of ecological green and sustainable concepts in material application. Furthermore, the innovation of material application should be highlighted, and the material selection and design application innovation of the building facade should be carried out.

6. Conclusion

In summary, the facade form and material selection in modern biopharmaceutical industrial parks need to comprehensively consider various requirements such as pharmaceutical industry characteristics, industrial park functional integration, architectural aesthetics, construction costs, building material characteristics, and building energy conservation and environmental protection. Architects need to consider and systematically balance various factors based on the specific project reality, and constantly innovate and create new facade forms and material application possibilities in the balancing process.

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