Site Planning and Architectural Conceptual Design of a Electronics Factory Based on the Component Method

Dai Haiyan, Zhang Hong, Han Chunnan, Meng Bing

Key Laboratory of Urban and Architectural Heritage Conservation at Southeast University, Ministry of Education China, School of Architecture, Southeast University, 2 Sipailou, Nanjing 210096, China

230159304@seu.edu.cn

Abstract. With the rapid development of the society and the economy, the urbanization have brought a lot of big impacts to China’s urban construction. The construction mode of large resource consumption is not consistent with the goal of sustainable development. At the same time, the number of workers in the construction industry is difficult to meet the needs of a large number of construction projects, and the labor cost is growing rapidly. Therefore, the architectural products need to be transformed and we need to build a sustainable urban construction system. By analyzing the transform under urbanization and traditional architectural design methods, the paper research the component method. Then, we show the application of this in site planning and architectural design. The project is in Jiangsu Province, China. The first work of the project was site planning. At this stage, the construction site requirements of prefabricated buildings were specially considered. After that, we entered the stage of architectural conceptual design, where designers used the component method to decompose the component system into several levels. The first level includes four functional systems, which are structure functional system, enclosure functional system, decoration functional system and equipment functional system. This paper mainly introduces the structure function system and enclosure function system. We hope that through the practice of component method, on the one hand, it can provide a method to link the design content of urban planning and architectural design; on the other hand, it can prepare for city information model.

1. Introduction

In the context of global sustainable development, urban construction methods that consume huge resources are inconsistent with sustainable development goals, and construction products need to be improved [1-3]. This article introduces the influence of prefabricated buildings on site planning and the application of component methods in architectural design. The project is located in Jiangsu Province, China, with a planned area of 3.8ha. It is an equipment R&D, production and service base for a microelectronics company. The first task of the project is site planning. At this stage, special consideration was given to the site requirements for prefabricated buildings. After that, we entered the stage of architectural concept design, where designers used the component method to decompose the component system into multiple levels. The first layer includes four functional systems, namely the
structural function system, the enclosure function system, the decoration function system and the equipment function system. This article mainly introduces the structural function system and the enclosure function system.

2. Site planning

2.1. Base Overview
The base is located in the southeast of China's North China Plain. It has a temperate monsoon climate with four distinct seasons. The base belongs to a municipal economic and technological development zone. The base is adjacent to city roads to the south, east and north, and a factory to the west. The base has convenient transportation links with the central area of the city, and the transportation conditions are superior. The current construction volume is small, the land is open and the site is relatively flat (Figure 1).

2.2. Planning principles
2.2.1. The principle of sustainable development. The plan fully considers the sustainability of development. Through the orderliness of the road system, the componentization of the building, and the multi-functionality, it is not only convenient for the recent rolling development, but also adapts to the new needs brought by the long-term knowledge economy development and changes, so that the factory area it has a high degree of flexibility and variability.

2.2.2. The principle of ecological priority. Ecosystem is a collection of natural and artificial elements in an artificial environment, which is characterized by interdependence within the environment. In the planning, the ecological system of the park will be rebuilt in combination with internal conditions and external environment.

2.2.3. People-oriented principle. The factory area should get rid of the image of the previous industrial area and create a high-quality artificial environment with a strong humanistic atmosphere. The
comprehensive high-quality R&D and production functions should be reflected in all aspects such as buildings, roads, landscapes, squares, and sculptures.

2.3. Planning structure
It is planned to form a "ring" road skeleton network, and the base is divided into five groups by the road skeleton: R&D exhibition group, production service group, integration center group, assembly center group, and machining center group. The layout is divided and integrated, which is conducive to the formation of high-efficiency factory activity space. (Figure 2, 3)

2.4. Planning the land layout

2.4.1. R&D demonstration group. Located at the southeast corner of the base, facing the main entrance on the south side, it is the core area of the R&D function and an important window for the external display of the factory. The group takes the landscape square as the inheritance of the spatial series, the R&D center as the spatial climax, and the Chuangye Plaza behind the R&D center building as the end. The building is rectangular, with an atrium, and the style reflects the breath of the times at the forefront of science and technology.

2.4.2. Production service group. It is composed of a complex building and the surrounding leisure activity square. The group integrates the indoor environment with the outdoor environment to provide a vigorous space for production and scientific research, and create a first-class R&D and production environment. The building is in the form of high in the front and low in the back, with high and low staggered, combining virtual and real. The building adopts modern style, simple and bright. A sky garden is set on the roof of the building to provide ecological activity space.

2.4.3. Integration Center Group. Located on the north side of the complex building, near the secondary entrance on the east side of the factory area, it is composed of the integration center.

2.4.4. Group assembly center. Located on the northeast side of the base, it consists of a 1-story grid structure assembly center, a 1-story frame structure power center, and a 1-story grid structure warehouse. The large space formed by large bays and large floors has a high degree of flexibility, which is convenient for multi-plan division of space and future functional updates. The architectural style is light and rich, changing the image of a traditional industrial factory. The plan emphasizes courtyard greening and provides a beautiful ecological environment for enterprise production.

2.4.5. Group of machining centers. It consists of a machining center and a parking lot.

![Figure 2. Perspective view](image-url)
2.5. Prefabricated building and site design
The component system of the prefabricated buildings determines the technical method decision of the site design. Planning and design needs to ensure the assembly and transportation safety of prefabricated buildings in the on-site stage, operation and maintenance stage, and seamlessly connect the site design major with the majors in urban and rural planning, road transportation, municipal administration, architectural design and other majors. The design content includes:

a) Site zoning: Arrange the assembly site in the on-site stage, operation and maintenance stage.

b) Physical layout: Considering the site conditions, complete the diversified combination design of prefabricated houses as products, especially the space requirements of the transportation assembly site for the building spacing.

c) Road layout: Arrange transportation and traffic flow lines in the on-site stage, operation and maintenance stage. Formulate appropriate road construction indicators, road width, turning radius, height limit, road bearing capacity, etc. should meet the normal traffic requirements of transportation vehicles.

d) Parking arrangement: When arranging the parking lot, consider the overall planning of the assembly site requirements at each stage.

e) Vertical layout: the building floor elevation is connected with the vertical positioning system of the prefabricated house.

f) Municipal engineering planning: the positioning of roads and buildings should be connected with the plane positioning system of prefabricated houses. The connection of various engineering pipelines of pipeline installation and pipeline network integration with the internal circuits of prefabricated buildings.

2.6. Road system design
The employees in the factory are mainly R&D personnel and industrial technical workers. On average, each job attracts a small amount of traffic, and the amount of travel is mainly concentrated in the...
morning and evening peaks. Therefore, the road traffic planning principle is: establish an integrated transportation system, and the interior of the park is not smooth. Ensure the comfort of the park; internal traffic should promote "green" traffic to reduce traffic pollution.

2.6.1. Motor vehicle system planning. The ring road outside the factory area constitutes the main traffic road network, and the pedestrian traffic space is arranged in the middle of the ring road, which reduces the interference between groups and forms an efficient and fast motor vehicle transportation system. The entrance plan is divided into three: the main entrance on the south side, the secondary entrance on the east side, and the freight entrance and exit on the east side. The width of the road in the area is 7 meters, the flow line is smooth, the priority is clear; the road, public activity venues and building entrances fully consider the use requirements of different groups of people, and meet the barrier-free design measures.

2.6.2. Pedestrian system planning. The pedestrian system takes the central landscape avenue as the axis and is closely integrated with the greening system to form a complete grid-like ground pedestrian system in the factory area.

2.6.3. Static transportation system planning. The plan takes into account the parking requirements of motor vehicles and bicycles, and arranges belt parking along the east side of the road, and arranges a ground parking lot on the north side of the machining center.

3. Architectural Design

3.1. General idea
According to the specific shape characteristics of the plot and the requirements of the design task book, it emphasizes the flexible design of the architectural space, the functional composite of the shared space, the integration of the architectural environment and the landscape, and the coordination of the economic practicality of the building. Strive to make the buildings in the factory area possible to become a leisure work complex with more diverse functions and richer spaces. It not only meets the convenience of work and life, but also forms a cultural exchange center, increasing the cohesion and sense of belonging of the community. The height and scale of the building are suitable for creating ecological and landscaping factory areas, and can provide a space atmosphere that stimulates creativity. The interior of the building adopts a large space as the main body, which is conducive to meeting the long-term functional needs in the future. The large span of 48 meters in the factory building is convenient for internal process design.

3.2. Graphic Design
Architectural graphic design pursues economical applicability, flexibility, reasonable function, and smooth flow of people. The building has good lighting, orientation and ventilation, and is neat and practical. The building space is divided efficiently and compactly, the structure is clear, and the greening and leisure space are reasonably introduced to serve the office staff while improving the indoor micro-environment.

3.3. Facade design
Use concise and lively methods to interpret the beauty of the architectural structure. Under the control of the modular combination, the building group has a strong sense of rhythm, and the color of the main building is refreshing and bright, highlighting the cultural connotation of the factory area.
3.4. Component method architectural design

The architectural design of the factory adopts the architectural design of the component method. The building component system is broken down into a multi-level structure. The first level includes four functional bodies, which are structural function bodies, enclosure function bodies, decoration function bodies, and equipment function bodies. The structural function body plays the main load-bearing structural function. The envelope function forms the climatic boundary between the inside and outside of the building and separates the space inside the building. The decoration function body makes the interior space of the residence form a decoration interface through decoration components and modules. The device function body contains the settings of various performance devices. The architectural design of this factory is in the conceptual design stage. The project started the planning work with 3 mature building products, mainly using the structural function body and enclosure function body models in the component models accumulated by the team for design, and further refined the planning to the level of building components. The constructive detailed planning organized under the architectural product model can refine the space to the depth of construction from the beginning, speed up the design work progress, increase the feasibility of planning, and reduce the cost of design work (Figure 4, 5).

![Perspective view](image1.png)
![Sectional view](image2.png)
![South elevation view](image3.png)
![West elevation view](image4.png)
![North elevation view](image5.png)
![East elevation view](image6.png)

Figure 4. R&D center architectural plan design drawing
3.5 Pre-assessment of green buildings
Sustainable development is the common development theme of mankind. The transformation of urban planning and architectural design from a traditional high-consumption development model to an efficient and green development model is one of the key stages to realize the sustainable development and transformation of the construction industry [4, 5]. The pre-assessment of green buildings in the building design stage is an important policy measure for the development of green buildings from the perspective of construction management. This design also carried out a pre-assessment of green buildings (Table 1, 2).
Table 1. Green building pre-assessment conclusions of the integration center (design stage)

| Evaluation index | Land saving and outdoor environment | Energy saving and energy utilization | Water saving and water resource utilization | Material saving and material resource utilization | Indoor environmental quality |
|------------------|-------------------------------------|-------------------------------------|---------------------------------------------|------------------------------------------------|-----------------------------|
| Control item     | Evaluation result                   | Satisfied                           | Satisfied                                   | Satisfied                                    | Uncertain                   |
|                  | Weigh-wi                            | 0.16                                | 0.28                                        | 0.18                                          | 0.19                        |
|                  | Applicable total score              | 100                                 | 81                                          | 86                                            | 64                          |
|                  | Actual score                        | 56                                 | 75                                          | 70                                            | 57                          |
|                  | Score-Qi                            | 56.00                               | 92.59                                       | 81.40                                        | 89.06                       |
| Score-Qi          |                                     |                                     |                                             |                                               |                             |
| Actual score + uncertain total score (actual score + Bonus item + uncertain score) | | | | | 80.33 |
| Green building grade | Three-star (greater than or equal to 80 points) | | | | |

Table 2. Pre-assessment conclusions of warehouse green buildings (design stage)

| Evaluation index | Land saving and outdoor environment | Energy saving and energy utilization | Water saving and water resource utilization | Material saving and material resource utilization | Indoor environmental quality |
|------------------|-------------------------------------|-------------------------------------|---------------------------------------------|------------------------------------------------|-----------------------------|
| Control item     | Evaluation result                   | Satisfied                           | Satisfied                                   | Satisfied                                    | Uncertain                   |
|                  | Weigh-wi                            | 0.16                                | 0.28                                        | 0.18                                          | 0.19                        |
|                  | Applicable total score              | 100                                 | 81                                          | 86                                            | 64                          |
|                  | Actual score                        | 56                                 | 75                                          | 70                                            | 57                          |
|                  | Score-Qi                            | 56.00                               | 92.59                                       | 81.40                                        | 89.06                       |
| Score-Qi          |                                     |                                     |                                             |                                               |                             |
| Actual score + uncertain total score (actual score + Bonus item + uncertain score) | | | | | 70.21 |
| Green building grade | Two-star (greater than or equal to 80 points) | | | | |

4. Conclusions
Through the practice of site planning and architectural design of this factory, we can find that component-based architectural design is an important method to connect site planning and architectural design. The component system of the prefabricated building determines the technical method decision of the site design. The site design major is seamlessly connected with the majors in
urban and rural planning, road transportation, municipal administration, architectural design and other majors. The architectural design in the factory adopts the component method architectural design, which meets the design needs of prefabricated buildings and also provides support for green building evaluation.

Acknowledgment(s)
This work was supported by the Key Laboratory of Urban and Architectural Heritage Conservation, Ministry of Education, Southeast University (KUAL1605B, KLUAHC1905).

References
[1] Y. Wang, et al. "Analysing factors affecting developers' behaviour towards the adoption of prefabricated buildings in China." Environment Development and Sustainability, 2021.
[2] Y. Gao, et al. "Prefabrication policies and the performance of construction industry in China." Journal of Cleaner Production. Vol. 253 PP. 1-13, 2020.
[3] A. Kylili, and P.A. Fokaides. "Policy trends for the sustainability assessment of construction materials: A review." Sustainable Cities and Society 35(2017). Vol: 35 PP. 280-288, 2017.
[4] K.L. Lok, "Prefabication and barriers to entry—a case study of public housing and institutional buildings in Hong Kong." Habitat International. Vol: 30 PP. 482-499, 2006.
[5] W.P. Jiang, L.R. Luo, and Z.Z. Wu, et al. "An Investigation of the Effectiveness of Prefabrication Incentive Policies in China." Sustainability. Vol: 11, 2019.