

Research on the Construction Strategy of Information Model for Manchuria Style Architecture and Its Application

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Abstract

“Manchuria style architecture” is an important landmark of colonial architecture in modern China. It shows the combination of western classicism and oriental national style in specific historic context. Its sturdy structure and superb technology are of great academic significance for studies of cross-regional building spectrum. Based on the building information modeling technology, the mapping analysis and three-dimensional reconstruction of Manchuria style architecture is conducive to promoting the routine administration of life cycle information management of historic buildings. Besides, the stirps models date base of the building components established in the research process will provide a multi-dimensional and more accurate database for the study of modern architecture heritage with reinforced concrete frame structure. As research continues, the real-time detection information transmission interface and the virtual historic building situation will be constructed, which will open up new opportunities for the studies of the preventive conservation, cultural value and educational value of historic buildings in China.

Keywords: *building information model, Manchuria style architecture, life cycle of architectural heritage, information management, virtual historic building situation*

1. Introduction

With the urban economic development and change of industrial layout, the protection and management of urban historic buildings have been in an awkward position --- their maintenance repairs depend on local fiscal expenditure but fail to produce the corresponding economic benefits; it has high research value and communicates special emotions to some citizens, but cannot make a comeback in a reasonable way. How to use information model technology to conduct in-depth study of these precious architectural heritages and carry out effective digital reconstruction and information management to create substantial social value in the dynamic monitoring and prevention conservation process has attracted the attention of historic buildings researchers^[1].

Currently, the domestic historic buildings protection has gone through the primary stage, that is, reasonable exploitation and utilization based on the original construction maintenance, and gradually entered another stage, the architectural heritage application and life cycle management and maintenance. Conduct research, mapping, recording, protection, *etc.* for historic buildings in different stages and access to the complete information resource. Then carry out 3D reconstruction and management through building information model technology and the information

will be beneficial to the conservation and reuse of historic buildings^[2]. Based on design parameterization, data visualization, statistical automation, collaborative work and data seamless transfer and other technical characteristics of building information model software, a multi-dimensional historic building information management platform could be established. As the building information model technology regards information as the management object, its basic unit set is the strips models date base constituted by building component elements. By embedding or linking all kinds of non-geometric information to the corresponding component attributes, the information management system with the three-dimensional model as indexing catalog can be established to effectively use data comparison, detailed table query, component extraction and other analysis functions^[3].

2. Research Significance

Manchuria style architecture refers to a number of military buildings constructed by Pseudo Manchuria government in the city of Changchun, which was administrated by Japanese Kwantung Army in 1930s. Due to the special historic background, they have captured the attention of architectural history experts. Nevertheless, the wording of Manchuria has always been controversial in the academic community, of which some people believed that it is the continuation of the Japanese imperial crown style in overseas, for this name was proposed by Shimoda Kikutaro in 1918 National Assembly Hall bid, the combination of Western classical building and Japanese style roof. The building elevation often gives people a strong overwhelming impression, and the base planning is also used as "Ri" or "Ya"(structure of Chinese characters), which is a metaphor for the aggression and expansion of Japanese militarism^[4]. However, the appearance of the existing historic buildings in Changchun area is different in elevation from that of buildings in Japan during the same period (such as the contour curve and architectural detail component proportion and ornaments form of Chinese style roof).Therefore, this could not be confused. While other people believed that after Japanese imperialism invaded and occupied Northeast China, Changchun was determined as the new capital, the military, political and cultural center. Therefore, the buildings were designed by Japanese architects after careful investigation, which combined the characteristics of Chinese local architecture elements and the prevailing classical revival and eclectic techniques in Japan. This could highlight the unique dominant position of this "new capital", different from the "Imperial crown style" during the same period. Numerous historic materials indicate that in 1932, Toshikata Sano, the expert of bogus National Construction Bureau Advisory Committee and architecture and urban planning expert of Tokyo Imperial University, had 11 project proposals for construction of the new capital, where the 9th item reads as follows: shops, residence and general buildings should have colorful style and let nature take its course, and for any kind of government building, it should be convenient as far as possible, and shape and connotation, coupled with the atmosphere of Manchuria should be regarded as the benchmark^[5].Therefore, it is not difficult to acquire the conclusion that this kind of building has its unique style. Although they are not in large numbers and their influence is limited, the Manchuria style buildings have great significance for the information model reconstruction due to its unique cultural connotation and colonial aggression warning role.

The current protection and information management of Manchuria style architecture is mainly to establish management data base of historic data, daily maintenance information, mapping, text content and pictures. Some problems such as the uncorrelated information between different data, long-established information, errors, omissions and contradictions of information expression way, *etc.*, may lead to the low efficiency of professionals in the interpretation, analysis and identification of the data, which cannot guarantee the smooth transmission of

data information flow in various links. Therefore, to utilize the building information modeling technology to reconstruct the historic buildings, the primary task is to overcome the phenomenon of “Information Island” in traditional management mode. The building information model technology is based on 3D component, and its intuitive level is an incomparable advantage compared with traditional data table. The real-time monitoring and information input by GPS, laser scanning, temperature and humidity measurement technology will bring us a new and dynamic protection way of historic buildings^[6].

3. Case Study

3.1. Case Selection

The State Council, the Ministry of public security, the Ministry of justice, Ministry of economic affairs, Ministry of communications and judicial organs of the original puppet Manchukuo, located in Xinmin Street of Changchun City, are the most representative of Manchuria style architecture. They constitute the subject of puppet government office buildings of the “new capital” and lay the basic architectural style, which reflect the political intentions of Japanese militarism to establish “a new country” and “unify five nations” in the form and connotation^[7].

For the reconstruction of the information model in this paper, the State Council of puppet Manchukuo is a case in point. It is located at the northernmost tip of Xinmin Street. Now, it is the basic teaching building of Medical College of Jilin University. It was built in July 1934, and was used for the former office building of general hall and the senate. As the central organ of puppet Manchukuo, it was used for administrative affairs. As an important institution of Japanese militarism enslaved the northeast of China, it is of great significance for the history research.

This building has a reinforced concrete frame structure and a tower roof, and its front gate towards the west. The planning is like the shape of “Shan” (structure of Chinese characters). The courtyard is a square and the main building is constructed on a central north-south axis, slightly closer to the East side. There are a total of six floors with four floors on both flanks (ground floor). The height is up to 44.8m, the highest building in Changchun at that time. The exterior facade has stable and elegant design. The roof with double-hipped roof type has multiple-level of details and could meet the oriental aesthetic image, handsome and elegant. The most advanced ceramic veneer technology in 1930s is used in the exterior walls of the buildings, and the brown gradient ceramic tile gives us a lasting and fresh feeling until today. The floor, stairs and retaining of indoor hall are all made of the yellowish terrazzo and green natural marble with exquisite craft and superior quality^[8]. The perfect combination of building structure, surface decoration and interior space fully demonstrates the unity of modern architectural art and technology. The most representative “Manchuria style architecture” in the time when Northeast was Japanese-occupied was basically formed and perfected. The related 3D information model construction will assist the further research of the cause of formation of this architectural style and the establishment of the shared database of architectural components.

3.2. Modeling Process

A. Information collection and analysis

The text information of the research object comes from the Archives of Jilin Province. The historic pictures are provided by the Northeast Architectural Culture Research Center of Jilin Architecture University, while the plane and elevation construction drawings are missing. Through the collation and analysis of existing data, the complete construction

data of this building is acquired, which lays the solid theoretical foundation for the reconstruction of the building information model. By means of 3D laser scanning, close range photogrammetry and manual measurement and other techniques, more complete architecture nomenclature and its component size, material and the damage information could be acquired as well as a variety of architectural record results including point cloud, 2D CAD drawings and internal and external space photos, *etc.*

B. The creation of the graphic component and stirps data base

Graphic component and stirps are the basic elements of building information model, among which the stirps classification and component attribute setting method are the key steps to realize the information transmission in the software. Depending on the architectural typology theory, this paper regards the structural features of “Manchuria style architecture” as the basis and uses the fundamental components including doors, windows, relief, line angle, crown house, stairs, lamps and lanterns to create graphic component model for stirps data base. Then the material structure information is put into each stirp to realize the informatization process of model which cannot be achieved by the traditional 3D reconstruction technology. Detailed graphic component model make the research of Manchuria style architecture more microcosmic and specific^[9].

C. Construction of the complete model

First, Figure out the axis net and elevation information of the center documents of the State Council of puppet Manchukuo and determine the basic modeling rules and order (mainly including the column grid, the beams and wall structures, as well as the information type of building structure model). Use Autodesk Revit to conduct information model building. Fix the insertion position of each component in the axis net, load the stirps models from the basement to the building roof, and then modify and add the instance attributes of components. Complete the final setting of the model at each phase in different views. The information model of State Council of puppet Manchukuo is shown in Figure 1.

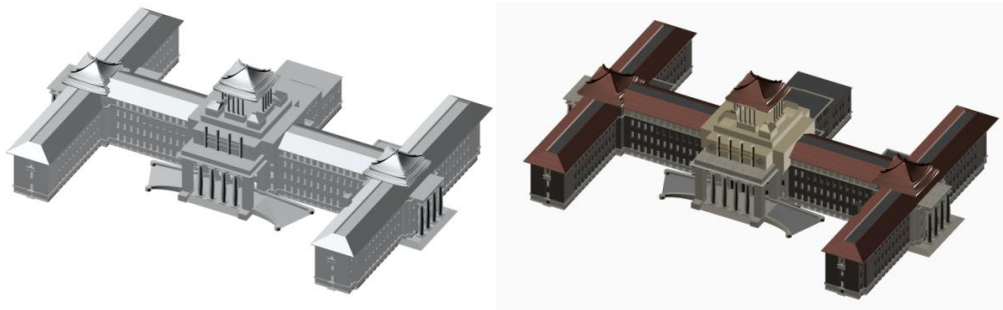


Figure 1. Building Information Model of State Council of Puppet Manchukuo

3.3 The Extension of Information Model of Manchuria Style Architecture

A. Life cycle information management

After the information processing of Manchuria style architecture, the virtual building which are corresponding to the actual building could be generated. The model comes with the “situation information” reconstructed by mapping, the “historic information” that could be queried with historic, cultural and scientific value, the “maintenance information” used for the overall planning of the future protection, management and show, and the “monitoring information” under the normal state and affected by external intervention. The information transfer and secondary development of building information model software can fully guarantee the rapid data integration, sharing and

updating of buildings, including its detection, repair, renovation and management in each period ^[10].

B. Network access browsing and information search

Historic buildings are the accumulation of human civilization and architecture culture. The abundant historic information has high research and education value. Not all the people from different areas could visit and research the buildings; the graphic information provided by networks and books is too flat. Therefore, the network data platform for Manchuria style architecture information model contributes to the remote viewing of buildings. People could view the interior of the virtual building through a network terminal (desktop computers, mobile phones or PDA) to selectively acquire some related information and generate data tables for download.

C. Opening and application of stirps models data base

By virtue of the high-speed network and high-performance CPU, users all over the world could quickly have access to, store and calculate data, which is also conducive to the information sharing of historic building database. The cloud data center of historic building based on the research institutions in universities enables users to register and download data and stirps models by the user channel. Open interaction port and modeling background script, so that the research, design and teaching on buildings with geographical characteristics will be more intuitive and vivid.

D. Create the virtual historic building situation

The real construction of the virtual 3D world by building information model for Manchuria style architecture could be used to interact, save, edit and manage the physical information. The virtual reality and augmented reality technology could also be used to present the historic activities, characters and climatic environment of buildings ^[11]. Based on the historic facts, carry out electronic manipulation of time and space to form real educational experience way. Therefore, the cultural value of warning architectural heritage, such as Manchuria style architecture could be organic inheritance by means of the internet and digital technology.

4. Innovative Significance and Application Research

4.1 Exploration of Modeling Rules of Historic Building

At present, there are no preparation standards and modeling rules of historic buildings. Due to the different construction age, complex types and construction ways, and in order to facilitate future communication, this research defines and establishes a set of modern modeling rules of historic building information model with reinforced concrete frame structure by the case study, namely: the separate creation of building components, the modeling sequence of standard floor of columns, beams, plates and wall, the unified adjustment of information after stirps models is inserted. However, for the stirps models with high precision, it is necessary to utilize the standard component families and in-place family to set their own names and attributes. The accuracy must be guaranteed by original data research, and establish a broad consensus. Then it can be transplanted and promoted in the construction of similar heritage models. In addition to the modeling rules of the single model, there are three important phased information models corresponding to the life stage of historic buildings.

A. The quasi-design model

Based on the data investigation and analysis of the situation of historic buildings, this stage is to eliminate structural deformation, ignore the damaging disease and restore the missing part of buildings. The purpose is to get the model which is closest to that after the first overall repair or reconstruction (it is difficult to establish a comprehensive model in the early stage due to the lack of data in the evolution process; however, the information

of this stage could be stored and expressed in this quasi-design model). The most important point is that this model can be used to express the relative historic period, to

B. The situation model

This model is to express the investigation materials, disease, *etc.* and the corresponding remedial measures. On the basis of the quasi-design model, modify the properties of components, such as staging, disease and material, *etc.* to get the model which could describe the missing components, structural deformation and damaging diseases as well as the preliminary restoration measures. This model is the basis and foundation for protecting historic buildings in the future.

C. The repair model

In this model, the deformation and damage of the building has been reduced in the renovation project. It expresses the component replacement, repair, homing, *etc.* in the restoration process. The restoration stage of the State Council of puppet Manchukuo has not yet started yet, so the model of this stage will be generated progressively based on the construction in the future. After rigorous daily monitoring and management, the new situation model and repair model will be established based on the development of the building in the future projection project.

4.2 The Function to Automatically Generate the Query Data and Table according to Different Requirements

For various kinds of information in the model, users of the database could adjust the parameters by themselves. The filters of the software could be used to conduct fuzzy query. No matter for the attribute information in a standard module, or tagging parameter attributes which is perfected in the late stage, the data list can be automatically generated. The detail drawings of the building and components, the relevant historic and cultural information *etc.*, could be queried, compared and analyzed by users according to different requirements. It provides a basic platform for the multi-angle research, alteration repair, management and maintenance for the Manchuria style architecture in the future. The information query of the 3D building model components is as shown in Figure 2.



Figure 2. Information Inquiry of State Council of Puppet Manchukuo

The information storage in the historic building information model is largely achieved by the parameter setting and assigned values to the instance in the project. To achieve the record, statistics and management of the parameter information of the stirps models date base in the project, part of important parameters must be set as the “shared information”. This setting means to add an extra parameter for a certain class element. When it is necessary to read the value, it is read as the normal parameter. In order to facilitate information management of historic buildings, the specific “shared information” which can be extracted reads as follows:

A. Geometric information

Reflect the various geometry sizes and spatial relationships of building components, such as length, width, height, thickness, and the height, width, thickness of cross-section and column spacing, step frame, *etc.* However, what should be paid attention to is that parameters which have been set as the shared information should reflect the size of contour feature of the component rather than the small size such as chamfering.

B. Property Information

Reflect other properties in addition to geometric data, such as name, origin, age, style characteristics, *etc.*

C. Damaging information

For the heritage building, the important information also includes diseases and injuries on buildings, that is, the injury degree, causes, scale, like length, area, volume, and the number and proportion of defective components, recorded as the damaging information.

D. Intervention information

As there is damaging information, the reasonable intervention is necessary. The intervention information records the survey and design of protection project and the design scheme of construction, the effect after specific construction measures and post-processing, including treatment measures, treatment status, treatment effect, the length, area and volume of treatment, and the number and proportion of the components.

E. Extended information

The extended information includes information related to the historic buildings and their projection, such as document links, image links, Web links, point cloud links and other links providing external links (URL).

4.3 Virtual Scene Creation of Historic Buildings and Development of the General Education Function

The domestic early virtual historic construction projects focus on the digital reproduction and display of the physical form of building sites. Many participants are experts and scholars in the field of digital technology, who emphasize the dominant role of digital technology^[12]. However, the State Council of puppet Manchukuo case study aims to achieve more interdisciplinary and cross-cultural fusion of theory and techniques on the basis of virtual scene creation of building information models. With the involvement of more researchers in architecture, geographic information science, history, the Internet and information technology, it can extend the research in the field of Manchuria style architecture and spawn new interdisciplinary research foundation. The follow-up function development is planned to include the following aspects:

A. The dynamic changes of virtual building environment

The building environment includes the interior and exterior environment. In the real world, the sunshine is changing from dawn to dusk and the light in the room is accompanied by the alternation of natural and artificial lighting, with subtle changes of lighting effects and atmosphere of architecture and interior. When these dynamic changes in climate are simulated in the virtual environment, the environment is more authentic and viewers can also feel the flow of time in the virtual environment.

B. The introduction of emergencies

Some unexpected events often occur in the real world, even just a suddenly passing stranger. These incidents make people themselves aware of the environment. Of course, it is unlikely to have so many “accidents” in a virtual building environment, but several appropriate virtual emergencies will definitely enhance the experience of those insipid virtual journeys. For example, in the site of State Council of puppet Manchukuo, a lot of Manchukuo government military and political officials worked here and important historic events happened here. When visitors walk through the hallway and stairs inside the building, it can increase the realism of virtual reality and bring some stories and

educational meanings to them by appropriately arranging for virtual historic figures to pass or have a simple exchange of information.

C. The object and the environment in a state of being used

In the virtual context of historic buildings, the construction of 3D model and the material texture are usually clean, but this kind of cleanness makes the virtual environment unreal. Therefore, in the process of transforming the building information model into the virtual context, the objects and environment should be in a state of being used. The mottled texture on the wall, several books scattered on the ground, unfinished the draft letter on the table, alternating brightened and dimmed light will make users be personally on the scene.

D. The introduction of time dimension

In the real world, the passage of time could be perceived by the sunrise, the growth of plants, and the course of event and so on. In a virtual environment, it is also necessary to sense the time. In addition to the illumination change in a day, the evolution of some virtual characters and the historic cultural activities could be used to emphasize the time dimension in the virtual context. Of course, it can be artificially controlled, such as the pace change, fast forward and rewind, or the cycling, which is one of the differences between virtual reality and enhanced reality.

5. Conclusion

The protection and information management of historic buildings in China have undergone a long period of exploration. Studies of information model construction based on the State Council of puppet Manchukuo make up for the blank field in China. After two years of research, we have basically worked out the mapping and information model construction rules and methods of the modern architectural heritage with reinforced concrete frame structure. The stirps models date base of Manchuria style architecture in the city of Changchun has been established. With the advancement of the protection project, the in-depth study will continue. Then, we will try to achieve information transmission and conversion interface between the real-time detection equipment and information model in the hope of improving the construction of virtual context of historic buildings. The achievements will definitely improve the routine design, construction and renovation, and information management of historic buildings. The shared downloading based on the information model of the historic buildings and stirps models of components is gradually promoting the research and dissemination of Manchuria style architecture culture.

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