

Research on The Optimization of Spatial Pattern of Traditional Residential Buildings in Lingnan Based on Spatial Syntax Calculation Analysis

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Abstract. Historical buildings are the carriers of urban appearance and culture, and it is of practical significance to renew and activate in accordance with modern needs. Taking the historical buildings in Foshan Lingnan Xintiandi as an example, based on the space syntax calculation and analysis of the old residential space, the spatial pattern characteristics of the traditional Lingnan residential buildings in the sheltered style are analyzed, and the space syntax is used to optimize the space to meet the needs of catering operations. In order to provide a reference for the renewal and activation of historical buildings under the equal emphasis on function and humanity.

Keywords: Lingnan buildings, traditional residential buildings, spatial syntax, Visual Analysis

1 Introduction

At present, the mission of urban renewal has shifted from increment to inventory, and from speed and quantity to quality. During this period, many scholars put forward new theories and models for urban renewal and historical building protection. On the macro level, there is a dual urban repair theory that focuses on the parallel of urban repair and ecological restoration ^[1]; in the middle view, there is a "natural urban renewal and sharing" model that focuses on community public participation in the improvement of the human settlement environment ^[2]; At the micro level, there is an emphasis on the authenticity of the architectural style and the spirit of the place, and it points to a small-scale, low-cost, and short-period historical building "micro-renewal" model ^[3]. It can be found that with the deepening of the research horizon, the research objects gradually focus on the cognition and feelings of people from the city and nature. In the theory based on human experience, Bill Hillier proposed to link human intuition with science, and reproduce human spatial experience through spatial models such as axis and line segments, convex space and visual space, thereby describing the spatial experience ^[4].

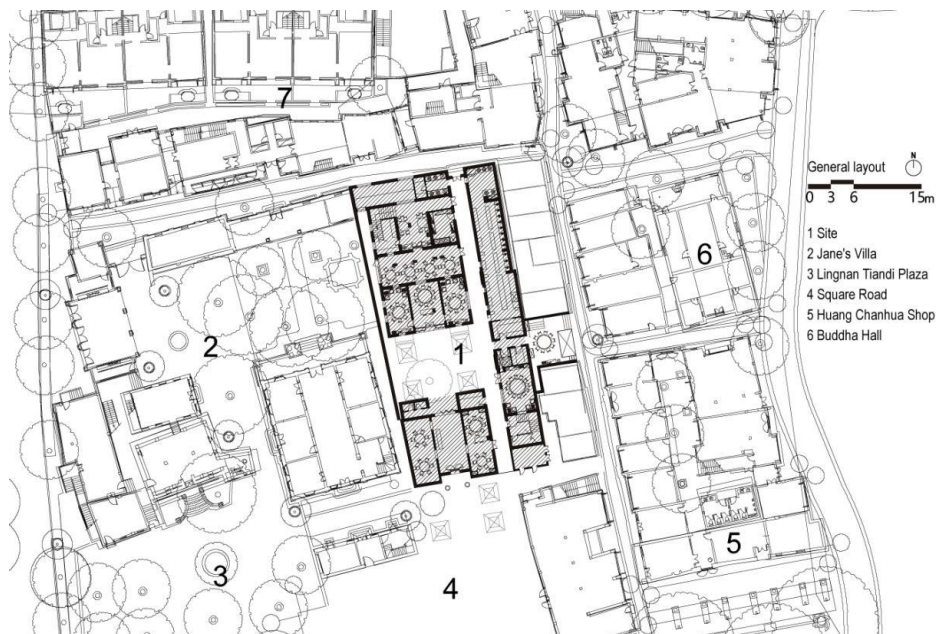
Based on previous research, this article takes Lingnan Xintiandi, Foshan City, Guangdong Province, China as an example, analyzes the characteristics of Lingnan residential buildings, from a micro perspective, uses space syntax to optimize the spatial pattern of historical

buildings to meet the needs of catering business space.

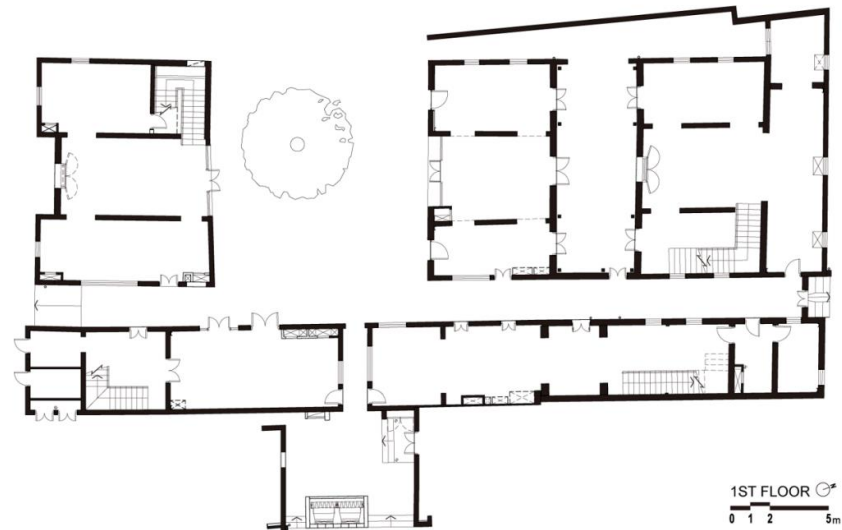
2 Status Quo Features and Space Syntax

2.1 Current characteristics

The original building of Foshan Lingnan Xintiandi Wumi Congee Restaurant is a Lingnan sheltered residential building. It sits in the northwest and faces southeast. The residence courtyard is composed of the main seat and the east shelter (Fig.1, a). It has two floors and a hard mountain roof. The herringbone gable is made of Qishun and Yiding clear water gray bricks. The facade of the building has gray plastic with colorful flower and bird patterns, which has the artistic characteristics of traditional Lingnan architecture. Its main features: (1) The structure of the house. The hard-mount purlin is used as the structural load-bearing structure, and the purlins are inserted into the double-cornered wall. The layout is flexible, the structure is simple, and the wall is load-bearing, but the rooms are smaller in size, and the building's seismic capacity is poor, which brings challenges to space reuse. (2) The layout of the guard house. Its advantage is to use the tunnel formed by the guard house and the main seat to form a cold lane function, and convection with the hot air of the hall and patio, which is conducive to regulating the indoor air and reducing the indoor temperature. It has a traditional building area in the Lingnan area with hot summer and warm winter (Fig.1, b) [4]. (3) The second-floor corridor. The main block and the second floor of the shelter building are connected by a corridor to make the space on the second floor open. A common practice among traditional residents in Lingnan is conducive to the communication and life of the residents, taking care of each other, making full use of the building space and becoming a multi-functional building (Fig.1, c).



(a) Foshan Lingnan Xintiandi Location



(b) Floor plan before renovation(1F)



(c) Floor plan before renovation(2F)

Fig.1 Location and floor plan before renovation

2.2 Space syntax analysis

In the original one-floor plan, each building has a staircase leading to the second floor, and the buildings open more doors. For example, there are doors on all four walls of the room on the left side of the main room, and the permeability is high. The analysis results of the global depth and global integration degree (Fig.2, a-c): (1) The space with the highest global depth value is the upper right room of the front building and the left room of the guard house, followed by the rooms on both sides of the front seat and the right row of the main room. The rooms and the rooms at the left and right ends of the guard house are, conversely, the patio,

the laneway, and the hall space between the front seat and the main room. (2) The space with the highest global integration value is the patio, corridor, and main hall hall. On the contrary, it is the room in the upper right corner of the front seat and the two sections of the guard house. (3) According to the above two indicators, it can be seen that the road convenience is the lowest in the first floor, and the space with the highest privacy density is mainly the right row room of the main house and the two ends of the front seat and the guard house. The space with the highest road accessibility is mainly the patio, Lanes, halls and other public spaces.

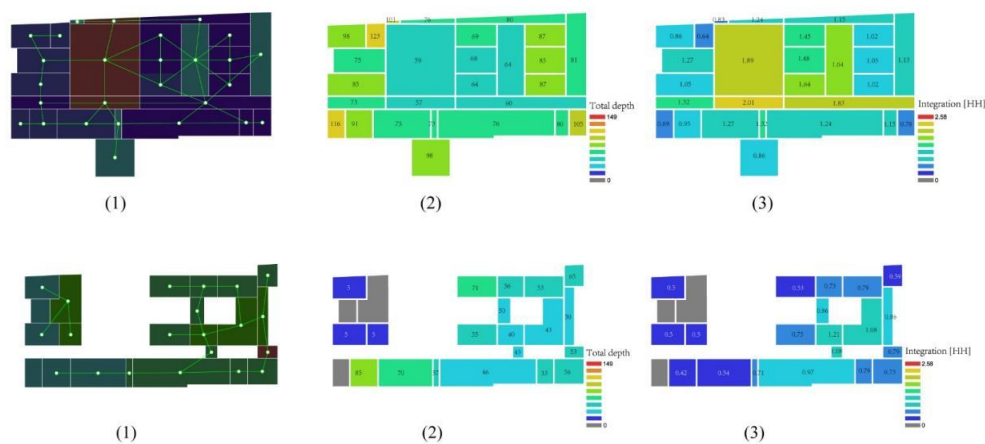


Fig.2 Syntactic analysis before renovation (connection, global depth and integration)

In the original two-story plan, the front building space is isolated, and part of the main building is hollowed out, creating a sense of depth in the first floor space, and is connected to the shelter through a corridor, reflecting the ingenuity of traditional residential design. The analysis results of the global depth and global integration degree (Fig.2, d-f): (1) The space with the highest global depth value is the room at the left end of the guard house, and vice versa is the room on both sides of the front seat. (2) The space with the highest global integration value is the room on the lower side of the main house, and vice versa, the room on the upper left corner of the main house, the rooms on both sides of the front seat, and the room on the left end of the guard house. (3) According to the above two indicators, the front seat of the second floor is a space island. Road convenience is the lowest, and the spaces with the highest privacy density are mainly the rooms on both sides of the front seat, followed by the rooms on the left side of the main house and the rooms at both ends of the guard house. The space with the highest road accessibility is mainly the challenge of the main house and guard house.

2.3 Optimization of spatial pattern

Through the spatial syntactic analysis of the first and second levels of the original state, it is found that: (1) The distinction between spatial features is not clear. The spatial syntactic global depth and global integration value of each room in the first floor plan are relatively average, and the convenience and accessibility of the road are not distinguished by the use and attributes of each room. For example, for the main bedroom with high privacy requirements,

there are multiple entrances and exits, which are similar to the left lobby in terms of global depth value. (2) The accessibility of the second floor space is low. In the second floor plan, there is a spatial island phenomenon in the front seat, and the connection between the main building and the protective corridor is relatively simple, which is prone to congestion. (3) The space utilization rate is not high. There are multiple stairs in the first floor plan, occupying indoor space and not using traffic organization. However, there are more empty spaces in the second floor, which makes the indoor space fragmented, which is not conducive to the full use of space.

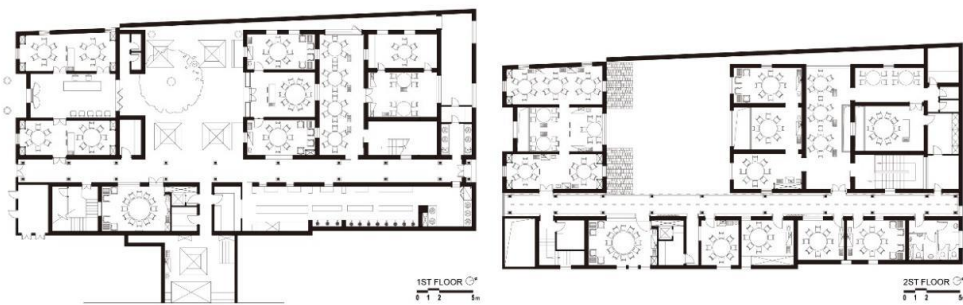


Fig.3 Plan after renovation

Based on the above conclusions combined with the actual needs of the project as a dining space, according to the five basic principles of the design of the dining space: technical principles, individualization principles, demand-oriented principles, adaptability principles, and economic principles. Summarize the design strategy of historic buildings as modern dining spaces (Fig.3):

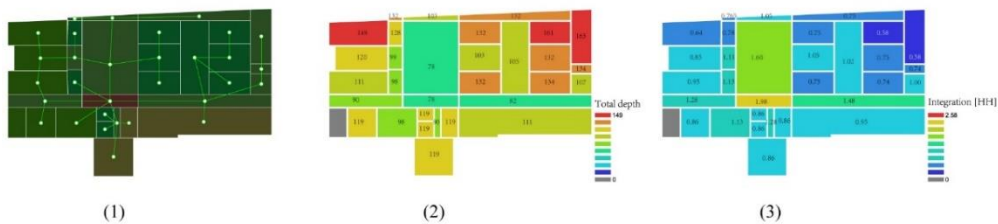
- (1) Technical repair and transformation. Due to historical reasons, the brick walls, wooden components, and load-bearing structures of the original buildings have hidden safety hazards, and they lack basic supporting facilities such as drainage systems and sewage pipes. Therefore, they are repaired and remodeled at the initial stage of the design to make them safe. It is suitable for the needs of modern use.
- (2) Individualized intervention. Wumi porridge is a traditional Shunde delicacy and part of Guangdong's thousand-year porridge culture. It is characterized by delicious ingredients and long cooking time. In order to meet the individual needs of traditional cuisine, a fish tank and kitchen are set up on the small patio of the mansion, that is, on the right side of the main house .
- (3) Demand-oriented space setting. The dining space in modern catering is mainly composed of halls and wing rooms to meet the needs of different groups of people. In this project, a small room in the historical building is set up as a side room, and unnecessary openings are closed at the same time to strengthen the characteristics of the space. Part of the stairs is removed to make the traffic organization clearer and more reasonable, and at the same time make a certain amount of usable space for catering activities. The large public space is set up as a dining hall to meet the needs of the public.
- (4) Regional style adaptability. In the Donghuali ancient building complex, this project is

consistent with the surrounding buildings. The overall material, color and form of the building are not adjusted. The traditional cultural elements are extracted in the interior design, and the space atmosphere is used and strengthened. The geographical features are blended and echoed.

(5) Economic optimization. Regarding the problem of emptying and insufficient space accessibility in the second floor plan, the economic principle of minimal intervention is adopted, and the emptying ground is laid with wood material consistent with the original floor. While conforming to the original architectural style, it avoids major demolition and large-scale construction. While increasing the available space. Corridor bridges are set up between the main building and the guard house to connect the second-floor planes of the three buildings in the mansion, avoid the phenomenon of space islands, and increase the utilization rate of space.

3 Space syntax verification

Optimize the design through the above five design principles, use the space syntax to verify the optimization, and obtain the analysis results and values of the spatial connection, the global depth, and the global integration degree (Fig.4). Compare the results of spatial syntax analysis before and after optimization design: (1) Strengthen the spatial characteristics. After the first floor plan is optimized, the overall depth of each room has been significantly improved, which is conducive to creating a good dining box atmosphere. The corridors, patios and other public spaces on each floor are obviously different from the rooms, and the spatial characteristics have been strengthened, which is conducive to the organization of the flow of people and the division of space functions. (2) The accessibility of the second floor is improved. After the improvement and optimization of the corridor on the second floor, the global integration of the corridor, the shelter and the front seat rooms has been significantly improved, the accessibility of each room has been increased, the phenomenon of spatial islands has been avoided, and the problem of crowd congestion has been reduced. The comfort of space usage is improved. (3) The available space is increased. The empty ground on the second floor is filled, and the long space of the guard house is divided into several equidistant rooms for use as dining rooms, which increases the overall usable space and avoids the waste of space caused by "gray space".



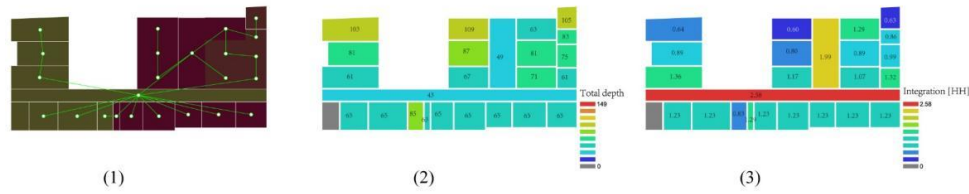


Fig.4 Syntactic analysis after renovation (connection, global depth and integration)

4 Conclusion

This study introduces in detail the parameter indicators and analysis process of space syntax on the spatial pattern of historical buildings. By establishing a convex space model, the characteristics of the space can be obtained scientifically, and the effect of the design can be verified again after the design is optimized.

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