EVIDENCE-BASED DESIGN FOR A BETTER CONNECTED RIVERSIDE: LONGHUA-GANG AREA IN SHANGHAI

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ABSTRACT

Longhua-gang is one of the three important branches of famous Huangpu River, in Xuhui district in Shanghai. The riverside area was a suburb of this metropolis and is now included in the main built-up area due to rapid expansion of the city in the last 20 years. The master-plan of Shanghai set up a goal of striving for the excellent global city. It is aiming to give access to the public to no less than 95% of the waterfront. Most of Longhua-gang's waterfronts are occupied by private sectors. Therefore, the local government initiated an urban regeneration project to improve the accessibility and vitality of its riverside. This is a new type of commissioned project which is not related to a specific site or certain action, but is aimed at the improvement of the overall public space. The planners then acquired the services of syntactic modeling specialists to facilitate this aim and also collect evidence for design proposals. There is a standard method to establish a movement model in Space Syntax and use it to explore the impact of different layouts on movement. The challenge of this project was to develop tactics for a low budget project. To make a concise model, the authors applied the principle of natural movement and pervasive centrality, setting up models with two variables focusing on the changes of network permeability. This interpretive model is well accepted by local government for its visual representation of spatial structure and its power of disassembling the effects of interventions.

Keywords: Riverside, urban regeneration, evidence-based design, sDNA, Space Syntax

INTRODUCTION

According to master-plan of Shanghai (2017-2035), the waterfronts belong to the living category within its built-up area opening for the public should be no less than 95%. "Longhua-Gang" is a branch of Huangpu River, located in Xuhui district in the southwest of Shanghai. It is 3.5 km in length, and 22-47 meters in width. Comparing to the vision depicted in Shanghai 's master-plan, this riverside area need a thorough upgrading in terms of its spatial structure, communal facilities provision, and public space quality. Therefore, the local district government initiated a consultation project for its regeneration starting from Oct. 2019.

This is a new type of project appeared only in recent years, which do not answer to a concrete goal, but have an exploration nature. Designers' team did a survey and found this task is extremely challenging. There are only 35% of the waterfront is open for the public, the rest of them are either occupied by the gated housing estates, or isolated by many kinds of private institutions (fig 1).

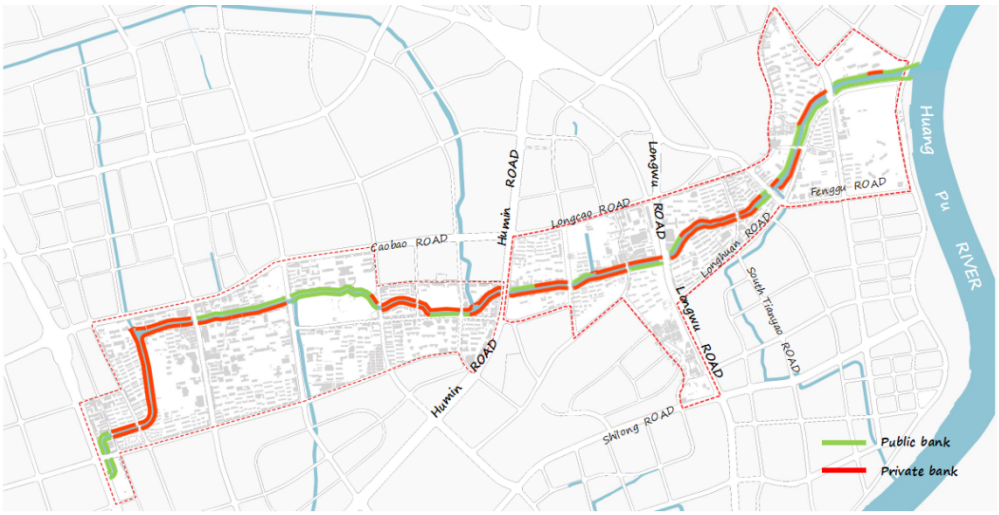

Figure 1 the site location and the private and public banks

To reopen the waterfront paths for the public, there should be decisions to change the private paths into public ones. And where to open and reconnect the waterfront is a knotty problem. This type of intervention will bring benefits for the general public, while harm certain interest of the site been selected. Therefore, the urban planners are willing to incorporate evidence-based design approach, more specifically, spatial modeling, to justify their proposed scenarios.

This paper will introduce the endeavor we made in this project. The main reflection is as following - as there are constrains of time and funding, the spatial modeling tactics which supporting design practice should be different from the ones working for research projects.

Longhua-gang is one of the three important branches of Huangpu River in Shanghai. This area was the suburb of Shanghai with typical fringe belt landuse, such as the Longhua Memorial Park of Revolutionary Martyrs, Shanghai Southern Railway Station, the Crematorium and Funeral Parlour, Longhua Temple, etc. While, by the rapid expansion of the city in the last 20 years, it is now an integrated part of the built-up area - the landuse type changed, and the building density increased. However, it still contains some feature of suburb, such as big land parcels and urban tissue collage.

The first task of the planners is to produce a report for the Longhua-gang riverside area, to describe the current situation and evaluate the problems, and then to give suggestions for regeneration strategy and key sites for the implementation in the near future. The focus site of this task is the front low of urban blocks from the 3.5 kilometer's river channel in its both sides, with a total area of 223ha.

After the consulting team provided the first stage report, the planners got a basic understanding of the configurational law, that the context of a place will influence its local usage. They then decided to enlarge the site to the second and third rows of urban blocks from the river and made a total area of 870ha. Therefore, the new spatial model also works for another agenda of the local government - the non-motorized traffic network of this area. As this report gave a good visualization of the urban structure, they think this method can answer a direct question. There is a high profiled construction project of three new streets would happen in 2020, which are near the old railway station storage yard (fig 2). The east side of this developing site is cut off by a highway Longwu Road. Should a footbridge previously used by railway station re-opened to the public to cross this highway? And what is the effect of this intervention?

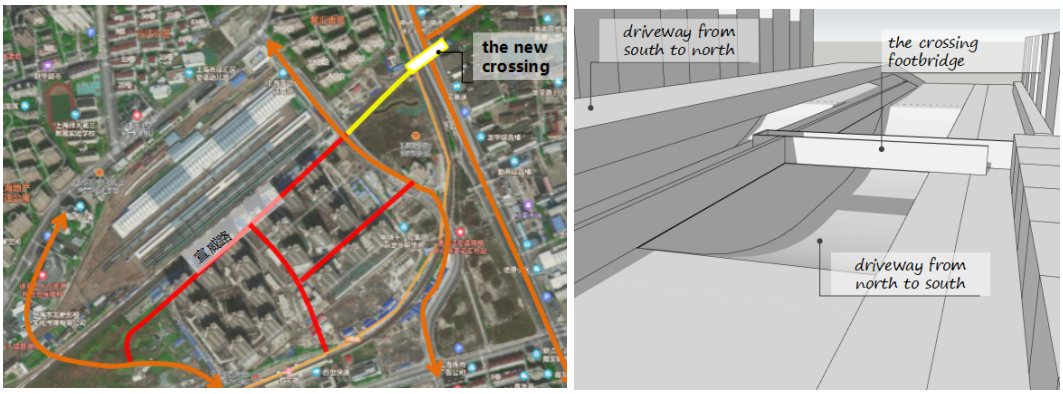

Figure 2 the three new streets and the new connection

METHODOLOGY AND STAGE ONE

The methodology of spatial modeling supported evidence-based-design can be divided into three steps. First, behavior data collection (pedestrian and non-motorized traffic). Secondly, street network model construction and variables verification by statistics method to explain the existing movement. The last step, to test the design scenarios and give prediction for their future usage. The timetable of this project is show in table 1. As the boundary of the site was enlarged and additional questions were asked, there are four reports submitted by the consultant.

Table 1. time table of the project and the division of three stages

	Spatial model consultant				*Urban planner*
stage 1	*cooperation started*	*16-Nov-19*			
				18-Nov-19	*Provide field observation document*
	field work 1 - movement data collection	*13-Dec-19*			
				8-Jan-20	*suggestion for further observation*
	***Report-1:** the current public space and public life / spatial network mapping*	*9-Jan-20*			
	field work 2 - confirmation of spatial connections	*10-Jan-20*			
	Produce interpretive model (single variable)	*12-Jan-20*		*13-Jan-20*	*Decide the test alteration from three options*
stage 2	***Report-2:** 1st spatial model (single variable)(compare current /model-B)*	*20-Jan-20*			
	***Report-3:** 2nd spatial model (two variables - compare current /model-B)*	*15-Apr-20*			
stage 3				*17-Apr-20*	*Second task (enlarge the site, test a new link)*
	***Report-4:** 3rd spatial model (enlarged site - compare current/model-B/ model-C)*	*12-May-20*			

To construct a reliable spatial model, movement data collection by the gate count method is needed. Due to the limitation of funding, the consultants only collect two rounds of movements at 19 gates in a fine weekend day, 10*2 minutes per gate. In total, 4993 people were recorded by these 380 minutes observation by two observers. It was constituted by 2657 pedestrian, 633 riders of bicycle and 1703 riders of electro-bike. By visual diagnose, gender and age types information are also recorded. The 19 gates are carefully selected by the researcher. They are not only essential for construct the model, but also related to possible alterations for the regeneration. Among the 19 gates, there is a gate (Z5) which is on a semi-public route. It is a path within gated housing estates, whilst well known to the local people as popular shortcuts for daily uses.

The movement observation itself could help the designers to understand the characteristic of the public space and public life. First, the distribution of pedestrian and bike volumes were quite different. The gates which have a low proportion of pedestrians usually coincident with poor quality of urban features. Secondly, as the Riverside Promenade on the riverside of Huangpu River was observed in the same day as the benchmark (less than 1 km away from our site), the result confirmed a conjecture that there is a significant drop of public space vitality when the river turns to the Longhua-gang branch. And this implied that the riverside of Longhua-gang has a great potential to upgrade its popularity. Lastly, the proportion of different gender and age groups were not balanced. Much more male adults were using the streets. It suggests that these places have serious problems at either the aspect of safety or human dimension.

The field trip confirms that this site is constituted by fragmented urban tissues and have poor permeability in many locations. To obtain a spatial model which can help us to make rational decision about future intervention, interpretive model for movement is needed. And this task can be done by two steps. First, draw a street network for further analysis. Second, find the suitable variables by statistical method.

The spatial model used in this project is spatial design network analysis (sDNA) (Cooper et al., 2016). This tool shares similar principle with space syntax theory and can be directly used in GIS platform. To draw a spatial network for this site, a complete street network of Shanghai is used as the base-map[1]. The site and its surrounding area with 30 minutes' walking distance are redrawn to achieve a correct representation of spatial connections.

There are two challenges for a consistent way of mapping. First, the networks for vehicle, bikes, and pedestrian are different. In the end, we decide to draw a mixed pedestrian and non-motorized traffic network, because the other option (create two models) would be too complicated for this low budget project. Second, this area has a very complicated composition of public-private routes. Due to historical reason, some residential compounds have accesses which open to a private path of another compound. This is because that the gated community management was a later intervention, and the old way of land parcel division did not foresee the change (Sun 2017). Therefore, if we only map the public streets, a lot of active lanes will be dismissed by that definition. In this consideration, we decided to map the lanes within the semi-public housing estates. While, an extra turning line would be drawn at the gate to represent the cognition price of entering a controlled gate.

[1] This map is provided by Haofeng Wang (Shenzhen University) from his previous research outcome.

An interpretive model was then tested in sDNA and statistical analysis made based on the observation data. Betweenness centrality in different radius is used to represent permeability. It measures the density of shortest angular paths between all nodes in the network (within a given radius) passing through a link. It is found that the highest correlation is found between the spatial variable "betweenness R2400" and "sum of pedestrian, bike, and electro-bike" in the regression analysis (R^2=47%).

This result is presented in report-2 to give confidence to both planners and local government that the configurational spatial model is valid for this site. And the visualization of spatial structure can help the design team to obtain a better understanding of the site (fig 3).

Figure 3 visualization of spatial structure by color

Based on this single variable model, three sets of new linkages are given to the planner as the possible locations for improving spatial connection. And the feedback was to focus on the current blocked route Tianyao-bridge Road, to make two new connections on the route, which are the justified connection on the local plan but not been implemented yet.

The work done in stage 1 established a foundation for the planners to understand the basic logic of configurational analysis. In stage 2 and 3, improved interpretive models are made and design scenarios are tested based on them. Difficulties are encountered and solutions are found out accordingly. The following section will explain the process.

STAGE TWO AND THREE: FROM INTERPRETIVE MODEL TO DECISION MAKING SUPPORT

After the first stage's model been presented in report-2, the following work is to refine the model, aiming at assistant the decision-making process of urban regeneration. A standard method to do so, is to identify the key components of urban elements which are influential for the public life along the riverside, and then make a multi-variable model.

However, establishing a reliable multi-variable model is a time consuming work (collection of more data and complicated statistical analysis), which could not be feasible for a consultation project in China. The authors then thought about a different approach, that is to distort the actual movement volume to the equivalent of "natural movement", by which to eliminate the influence of both urban function and public space quality. More specific, to halve the volume at four gates which located on street segments near popular functions, and to increase the volume at another three gates which located on semi-private lanes by 1.5 times.

In the second stage, we tried to make an interpretive model by two types of spatial variables - configuration of the network in the radius of pedestrian scale and bicycle scale. This is a predetermined goal of model-making. In the theory of space syntax, there is a notion of "pervasive centrality" (Hillier 2009). It is believed that multi-scale centrality should be seen as a pervasive function in cities, not simply as a hierarchy of locations. Through a well-defined process of self-organization, a multi-scale pattern of linked centers arises in cities based on the relationship between the grid structure and movement at all scales. Therefore, the spatial model should at least include two variables of different scales to represent this principle.

After this two-variable model been decided, there is another consideration to choose the pedestrian scale spatial variable. There is always an opinion that the syntactic value is too abstract for designers to understand. In this project, we consider to select a small-scale spatial variable based on metric distance instead of angular distance. sDNA provides a variable "len-radius", which means the sum of segment length within a certain radius. This is a more intelligible concept not only for designers but also for local government. By statistical analysis, a mix index of len400-1200 meters is picked out as the small scale variable, and betweenness radius 7000 is picked out as the larger scale variable. The R2 is 54% in the model, and the two variables have a T ratio of 2.24: 2.21, which means they are almost equally important account for the movement distribution.

$$\text{len-mix-400-1200} = \text{length400} + (\text{length1200} - \text{length400})/4$$

This combination is valid not only statistically, but also make sense for the prediction of design scenarios. The new linkages be proposed will bring two types of benefits. Firstly, in the surrounding area of these new accesses, there will be more activities because the new access encourages more journey by increasing permeability (the effect of mix-len-400-1200). The second benefit is more subtle to be understand. If we place the new linkages in the right place, they can not only increasing the local segments' catchment area, but also to enhance the hierarchy level of this particular route in the whole system, which means besides local journeys, it can also attract longer distance journeys to passing by this route. And the variable Btw7000 is the right indicator for this effect. This clear division of two types of benefits gives the planners a useful thinking tool to identify the right locations for making changes. As shown in model B, there are new connections on the Tian-yao-bridge Road route been created as shown on the plan (fig 4). And the predicted outcome of these change is a superimposed effect from two variables. In this case, the R7000 betweenness measure is a crucial factor for this route.

Figure 4 visualization of spatial structure by colors

In the third stage, the client asked us to test another change and compare the outcome with model B, so does model C be created. It is found that the improvement of model C is relatively weaker

comparing to the change brought by model B. This puzzle could be decoded by this two-variable model. Although the local permeability can be increasing by create a new link to connect the east part of the urban area. But as the three new streets and the new link are localized changes, they cannot change the importance of this route in the bigger network (radius 7000m). Therefore, the improvement of this intervention is limited to a certain degree. And the solution for this disappointment is then straight forward. If the benefit of these three new streets should be maximized, changes should be made a bit further away from its immediate surrounding area. In its south, there is an opportunity to passing through the Metro Station Shi-long Road and connect to a main street Dong-quan Road. In this northwest, there is an opportunity to connect to Bin-nan Road which turn west in a mild angel to a lively riverside street Guan-sheng-yuan Road. By adding these two additional new connections, the importance of the route at radius 7000m, could be upgraded significantly by a visual inspection, and that will amplification the influence of the high profiled project enormous (fig5).

Figure 5 the tested node and the proposed two new connections

When these two linkages were proposed to the local government, they found this proposal an illuminating idea. They asked the team to check the feasibility of these new linkages and will consider its implementation. The real change will take place start from 202 in two phases.

CONCLUSIONS

The consultants applied the methods used in space syntax research to help the designers make decisions in an urban regeneration project. It developed some tactics to facilitate a low budget consulting project, which compromises strictness whilst achieving efficiency that is crucial for the design process. **First**, a behavior observation conducted in a systematic manner could be useful no matter how brief it is. It can provide not only baseline data to establish an interpretive model, but also an objective overview to define the problems on site. **Secondly**, in the modeling stage, there are three lessons to be learned. To develop a consistent way to draw axial lines, we need to understand the characteristics of the site. In this case, the semi-private routes are essential. To save the time for establishing a valid interpretive model, we distorted the actual movement into natural movement (eliminate the effect of content on the street segment), then asking the designers to consider the results of future predictions as a pure outcome of spatial connection but not the function and spatial quality. As planners have certain right to choose the function or section type on a street segment afterwards, this was not a difficult request for them. The last lesson for making the model is how to find the proper

variables for the site. To make a concise model, the multi-scale centrality is represented by two variables (one in the pedestrian scale, the other in the bicycle scale), and the statistical analysis indicates what the extract radii are. Besides, to gain better comprehension for the meaning of the variables, we replaced the small scale syntactic variable by a standard network analysis variable - sum of reachable segments' length within a certain radius.

The two variables' model turned out to be persuasive for the planners to understand the key contribution of the Space Syntax theory - to understand the local-global relationship or the dual network effect of foreground and background. The spatial consultant and the urban planner then gave evidence-based design proposals to the local government as a team, optimizing the spatial design for the regeneration of Longhua-gang area. The visualization of the future street network aliveness could enhance the confidence of local government to give their consent for the design proposal.

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