#82

A SYNTACTIC COMPARATIVE RESEARCH ON THE OLD AND NEW AXES OF GUANGZHOU, CHINA

MICHELLE XIAOHONG LING
South China University of Technology
arlingxh@scut.edu.cn

XIUXIU SHENG
South China University of Technology
2252582427@qq.com

ABSTRACT

While the urban morphology of Guangzhou is characterized by two urban axes formulated at different historical periods, there is a need for research to review their relationship with the rest of the city and evaluate their structural performance within the overall urban layout, notably when the urban fabric of Guangzhou has been increasingly criticized as fragmented and isolated in nature. In comparison with previous studies focusing more on their physical forms, visual aesthetics, transportation organization at a local scale, this study carries out a comparative analysis of the two axes in terms of their geometric characteristics, spatial permeability and ductility, topological accessibility by applying the methodology offered by space syntax. Through investigating their configurational properties and how they play a role in the overall urban structure, this study aims to identify some problems occurring in the process of urban development, in addition to providing valuable reference for future preservation and revitalization of the axial areas.

As a result, the study reveals that the old axis of Guangzhou demonstrates a better spatial permeability, higher topological accessibility and intelligibility at both local and global levels; by contrast, the new axis is featured as insufficient spatial permeability and displays an inferior controlling role in the overall urban layout owing to its relatively fragmented development pattern and inconsistent spatial logic with the rest of the city irrespective of the fact that it was built to be a new CBD of Guangzhou and even of the Pearl River Delta Region.

KEYWORDS

Urban axes, geometric characteristics, spatial permeability and ductility, topological accessibility.

1. INTRODUCTION

As an important element of urban design, the axis always functions as the main line of direction, motion, growth, or extension (Definition in Oxford Dictionary). In most circumstances, the line is implicit, serving as an organizing principle to which compositional elements are referred. Reviewing the history of human society, the axis plays an important role in the process of urban development. Hence, it comes as no surprise that numerous famous cities of the world, including Washington D.C., Paris, and Beijing, are characterized by their urban axes.

The building of axis somehow originated from human's respect to the laws of nature, which are always represented as the aesthetic of symmetry, regularity and order. Therefore, in the

original built environment, building layouts were inclined to face north-south, reflecting people's psychological worship to the Sun, as well as meeting the demand of getting enough sunlight in their daily lives. With the development of society, axes began to bear upon more functions, and gradually evolved as a device to establish certain social orders and to symbolize the power of control by emphasizing specific direction, spatial hierarchy and sequence; while in modern society, being influenced by modernist planning principles, the axis has become a design method to organize various functions, spaces, traffic and landscape, promoting urban activities and stimulating economic development (Wang, 2003). Acting as a skeleton of urban spatial structure, axes can epitomize the historical process of development or cultural tradition of particular cities. Also, urban axes can help build up a city's image by providing iconic public spaces for visitors and local citizens. In this sense, to understand the characteristics of urban axis and its relationship to the rest of the city is important for both research and practical purpose.

Owing to the significance of axes, there have been a number of authors who paid their attention to the development of axes and their possible implications for functions. For example, Li (2003), Zheng and Li (2008) studied the axis of Beijing regarding its origins, form and relationship with the whole city and finally identified some problems occurring during the process of urban development. Similarly, Tang et al. (2000) investigated the new axis of Guangzhou from three aspects: its development pattern, planning concept and design principles. By contrast, some other authors analysed urban axes mainly based on their values in historical and cultural preservation and revitalization (Duan, 2003; Zhao & Cao, 2007; Yang, 2007). Indeed, these studies are insightful and can provide valuable references for the studies in other cities. However, it is noticeable that most of them emphasized the surface characteristics of the axes themselves, lacking of attention to their underlying structure and their relation to the rest of the city by embedding them into the urban system as a whole. Also, from previous studies, it is still unclear if and how the geometrical differences of various axes have brought some implications for social aspects.

The necessity of investigating axes systematically is also supported by the fact that, with few exceptions, cities always came into being through a process of growth and change over a long period of time so that they display neither spatial nor functional simplicity (Hillier, 1996). Morphologically, this process has resulted in a continuous and interconnected spatial system through the organization of elements such as buildings. Within this system, morphological elements including axes are not homogenous and isometric, but unique and differentiated from each other with reference to the whole (Hillier & Hanson, 1984). Based on the research purpose as set, this study then chooses Guangzhou, the largest city in the south of China as the study case. Through carrying out a configurational analysis by using the theory and methods provided by space syntax, the structural and functional performance of the two axes of Guangzhou are examined and compared both systematically and precisely.

2. THE URBAN AXES OF GUANGZHOU

Having the history of over 2000 years, the urban development of Guangzhou has aroused the interests of a number of authors. Owing to its natural environment and special historical background, Guangzhou has established a series of urban axes, which comprises of the Pearl River as a landscape axis running from west to east and three north-south oriented axes formulated in different periods of time, namely the ancient axis, the modern axis and the contemporary axis. Since the shape of the ancient axis is implicit, it has been seldom discussed among researchers. Eventually, this study mainly focuses on the properties of two axes: the modern (also named as the old axis) and the contemporary (the new axis) axes for further study purpose.

The old axis is located in Yuexiu District and is about 0.9 km long. Starting from the Yuexiu Mountain, the old axis is mainly composed of Zhongshan Memorial Hall, City Government, the People's Park, Qiyi Road and Haizhu Square from north to south, ending by the Pearl River (Fig. 1). Visually, the plan layout of the old axis is relatively orderly and regular, defined by a variety of important buildings. Also, the spatial pattern of the area appears to be more continuous, leading to a continuous streetscape within the district.

By contrast, the new axis of Guangzhou with a total length of 4km starts from Guangzhou East Railway Station, followed by East Station Square, CITIC Plaza, Sports Centre, Hongcheng Commercial Plaza, Liuyun Residential Area, and Zhujiang New City form north to south and finally ending with the Pearl River (Fig. 1). In comparison with the old one, the new axis features on large-scale development patterns, largely manifesting the top-down urban planning principles.

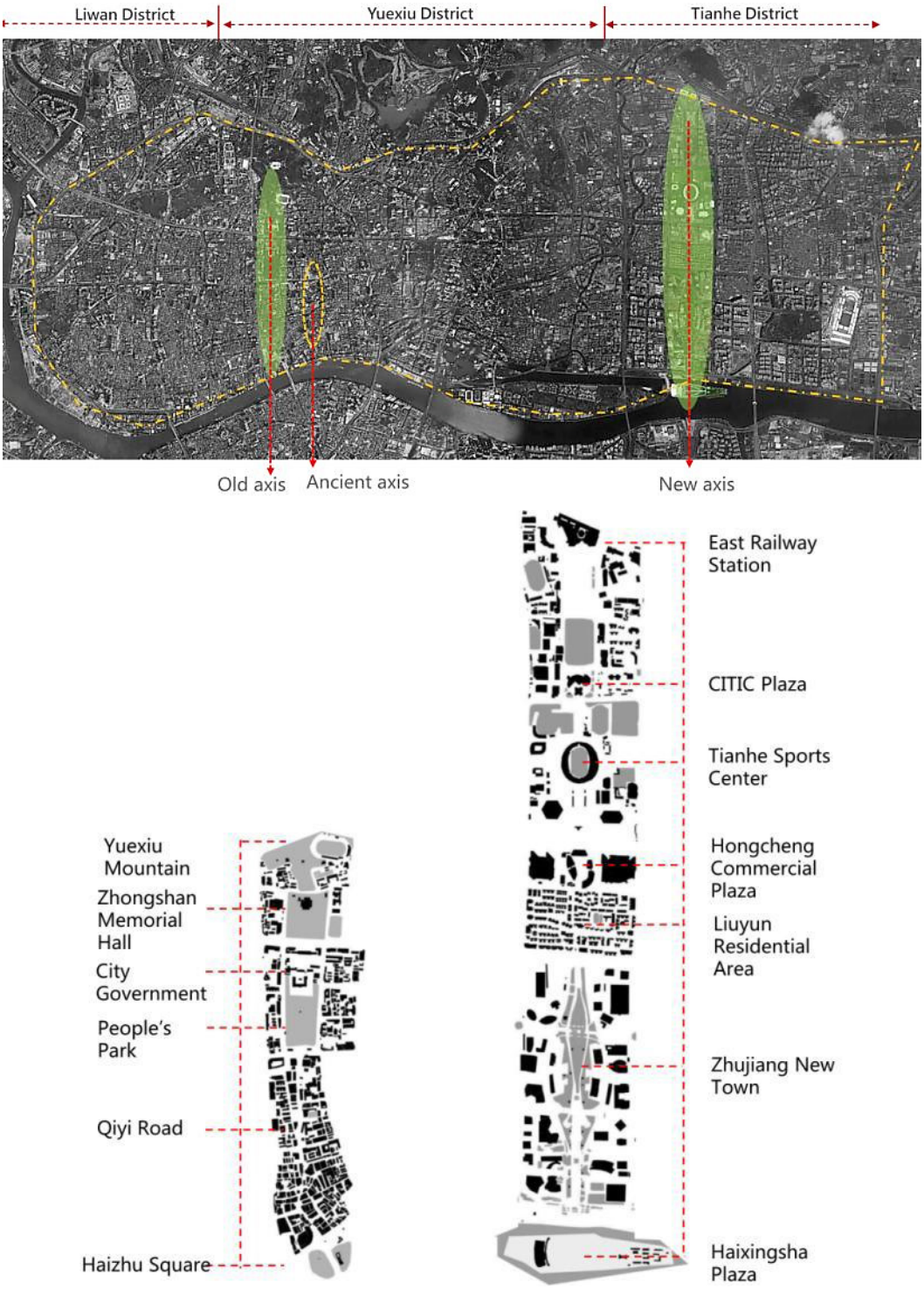

Figure 1 - The location (above) and composition of the old and new axes of Guangzhou

3. COMPARISON OF SURFACE PROPERTIES OF TWO AXES

Prior to the con gurational analysis, the surface characteristics of the two axes are analysed. First, the traditional axis is about 0.9km long and 0.24 km in width. On average, its block size is about 200 * 200, but the block occupied by the People's Park is 200 * 320. In the old axis area, the urban fabric tends to be diverse and compact, accommodating the developments at di erent scales. For example, the northern part is mainly occupied by Government buildings, resulting in larger-scale street blocks, while to the south of Zhongshan Road, it mainly accommodates a variety of small-scale commercial and residential developments.

Br contrast, situating in the central area of the Tianhe District, the new axis of Guangzhou is about 3-4km long and 0.7km wide. Being organized in a strict symmetry manner and aligned with numerous landmark buildings, the new axis is considered as a re ection of the centralized planning principles. Inside this area, the average block size is 400*400, with the Tianhe Sports Complex being 600*800, three times larger than the People's Park. Also revealed by the gure, the urban fabric of new axis exhibits a relatively fragmented pattern, lacking of continuity and coherence as displayed by the old one.

As far as land use pattern is concerned, signi cant di erences can be found between the two axes. While the old one, where the ancient city of Guangzhou was located, accommodates a considerable number of historical heritages and traditional culture resources, the new axis mainly comprises of contemporary commercial and o ce buildings with the aim to form the new CBD of Guangzhou even of the Pearl River Delta Region.

When concerning the street network and its density, it is found that the street network density of the old axis is 0.028m, higher than the new axis of 0.024m, implying that the network of old axis area can o er a higher level of accessibility than the new one.

From above geometrical analysis, some problems can be raised:

- As a typical development model of Guangzhou, both old and new axes have taken on various roles and functions. However, as an important metropolis of China, Guangzhou has decided to adopt a dispersed and multi-centre model for its future spatial development, which seems self- contradictory to the establishing of city axes, thus may raise continuous debates in the society.
- Historically, the old axis was located in the geographical centre of Guangzhou, thus accumulating rich historical heritages and cultural resources in surrounding areas. Nowadays, its geographical advantage has been weakened by the development of the new axis, but as part of the city memory and symbolizing the local tradition and culture, its meaning is ever-lasting. Therefore, it would encounter the issue of renewal and preservation in the future.
- From the beginning, there is no geographical signi cance for the building of the new axis irrespective of the large-scale development pattern initiated and operated by the municipal government. As mentioned, it is somehow self-contradictory notably when the dispersed and multi-centre development pattern have been adopted over the past several decades. In this sense, it is fair to infer that the new axis will face the issue of optimization and improvement in order to t itself better into the overall urban structure. In light of these issues, it is imperative for research to achieve a precise understanding of the spatial structure of the two axes and their current performance.

4. CONFIGURATIONAL ANALYSIS OF TWO AXES

The con guration analysis in this section is carried out based on the segment analysis provided by space syntax. Two major con gurational properties of the urban system are to be measured, they are integration and choice, which will be devised to identify to-movement and through-movement potential respectively. More speci cally, the comparative analysis of two axes is focused on several morphological characteristics, including the distribution of integration and choice values, the accessibility and ductility of pan-axis area, the intelligibility and synergy.

Considering the urban characteristics of the Guangzhou city, three metric radius are selected to constrain the analysis, they are 800m, 3000m and n. As a result, a number of graphs are generated through Depth X.

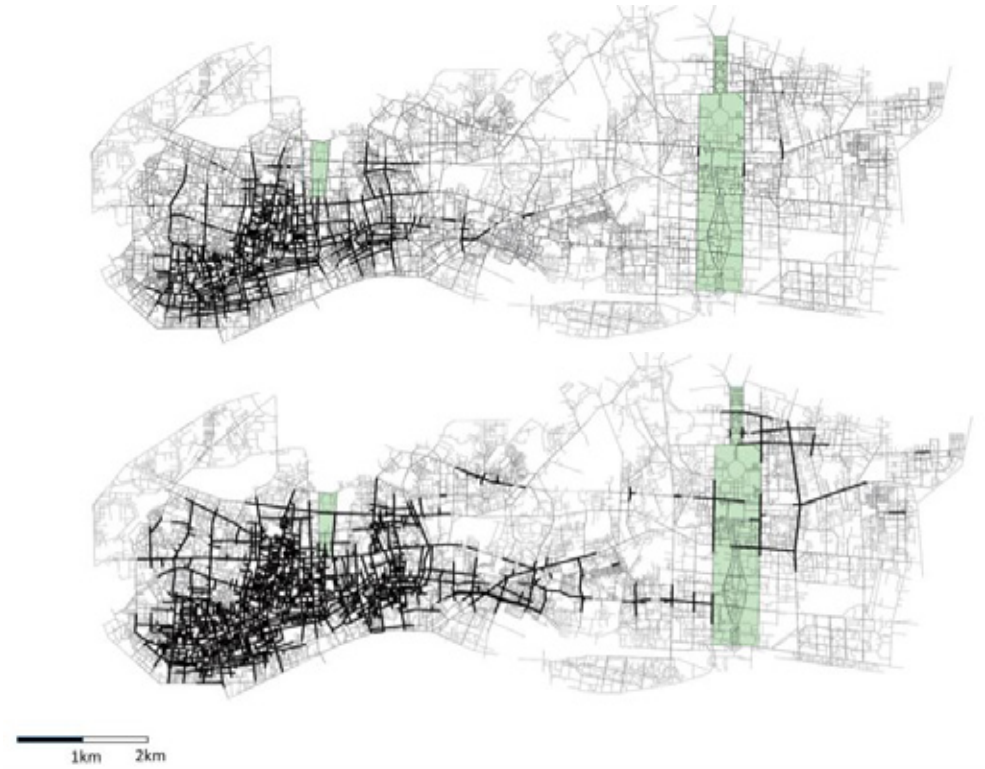

Figure 2 - Distribution of the 10% (above) and 20% integration of r800m

Figure 3 - Distribution of the 10% (above) and 20% integration of r3000m

Figure 4 - Distribution of the 10% (above) and 20% integration of radius n

4.1 RELATION TO THE INTEGRATION CORE

When concerning the R800m integration of the whole city (Fig. 2), the analysis shows that the 10% most integrated segments are distributed as patches, mainly concentrated in the historical areas- the Liwan and Yuexiu District, with a small percentage of segments distributing in Tianhe District. Also, it is found that the south section of the old axis belongs to the 10% syntactic core, implying that these streets are the most accessible places at the local level. When the percentage of the core is expanded to 20%, more segment lines of the old axis become part of the core; while in the new axis area, more lines, such as Guangzhou Avenue, Liede Road are included, forming an incomplete grid pattern.

When the metric radius is set as 3000m (Fig.3), representing the mesoscale of the urban structure, the analysis shows that the 10% most integrated segments tend to form two distinct clusters. One is featured as dense and deformed grid pattern located in the historical areas (the Liwan and Yuexiu District), with the other appearing as big and regular grids concentrated in the Tianhe District. In the historical areas, the core has slightly shifted northward and is characterized by long street segments rather by short and dense lines as displayed by the R800 integration. Also revealed by the figure 3, the old axis tends to be completely embedded within the syntactic core, demonstrating a strong to-movement potential and good gathering functions; while in the new axis area, the lines with high integration value are mainly located along Tianhe Road and Huangpu Road, both of which are running from west to east, as well as along Guangzhou Avenue, Tiyu Xi Road, Linhe Road and Tianhe east Road running from north to south. When the study investigates the 20% syntactic core, more street segments are included and the connection between two clusters becomes stronger.

According to space syntax, the integration of radius n (Fig. 4) represents the foreground structure of the city, offering traffic potential for vehicles. As a result, the analysis shows that the integration of Rn is characterized by a bidirectional grid pattern. In the historical districts, the west-east roads function as skeleton, being connected by numerous north-south streets as

branches. However, to the east of Guangzhou Avenue, the most integrated lines tend to form a complete and uniform grid pattern, far extending to its east.

From the above analysis, it may be summarize:

- With the increase of metric radius, the distribution of segments with high integration values changes from a number of scattered patches into a complete grid pattern, covering most of the major roads.
- With the increase of metric radius, an increasing number of lines in the old axis belong to the syntactic core. At both the community scale and the global scale, the old axis embodies a better traffic potential of arrival, theoretically having a good capability to gather social activities. At the mesoscale such as radius 3000m, its spatial structure performs the best, implying that it is likely to be the most accessible place in terms of pedestrian and light traffic movements.
- The accessibility of the new axis is not strong at the local and community levels, indicating that it cannot gather pedestrian movement as the old axis. However, with the increase of metric radius, most of the major roads of the area demonstrate high integration values, subsequently formulating a complete network to support vehicular traffic. Another characteristics revealed by the analysis is that except for the major roads, the integration value of other streets did not show significant changes no matter what metric radius is selected, implying that the its background structure is relatively lacking in the new axis area.

4.2 RELATION TO THE CHOICE DISTRIBUTION

Choice is an expression of through-movement potential of the street network in space syntax. The smaller the metric radius is selected, the closer the choice is to the pedestrian behaviour, whereas the bigger radius is more associated to the movement of vehicles. Consequently, the analysis of radius 800m(Fig.5) shows that the southern part of the old axis exhibits a good through-movement potential, implying that the area around Qiyi Road theoretically has high potential to gather social activities; while in the new axis, only Tianhe Road and Huangpu Road display high choice values.

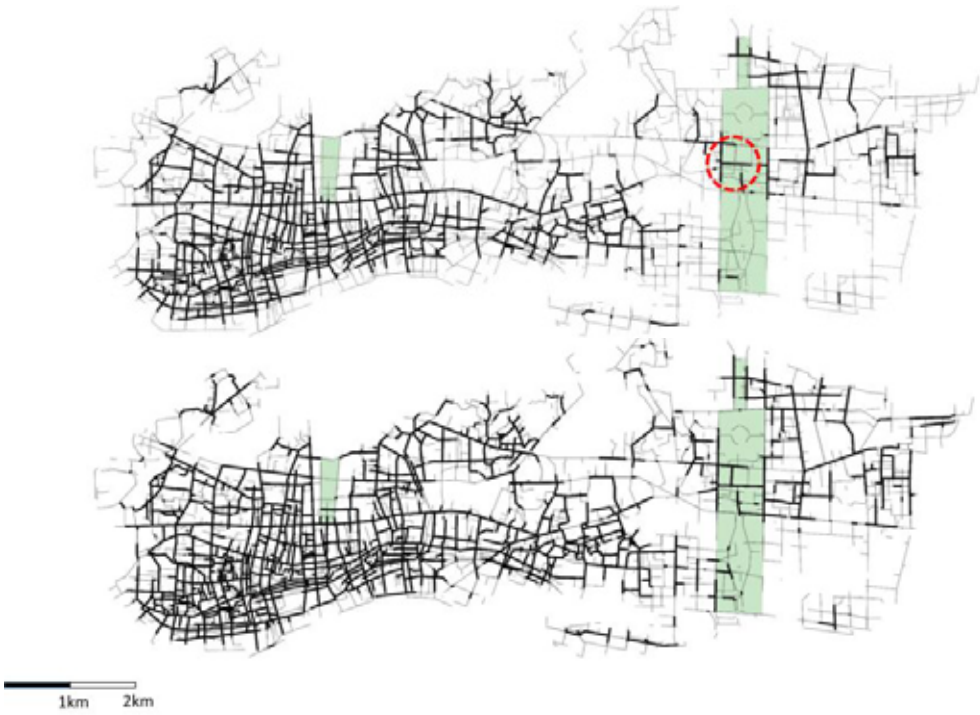

Figure 5 - Distribution of the 10% (above) and 20% choice of r800m

When it comes to the radius of 3000m and n(Fig.6), the corresponding figures illustrate that the segments with high choice values tend to cover most of the major roads of the city, implying that the road network of Guangzhou was stratified more for the movement of vehicles. Unsurprisingly, as far as the two urban axes are concerned, most of their major roads are characterized by high choice values.

Figure 6 - The 10% choice of r3000m

4.3 COMPARISON OF NACH, NAIN, INTELLIGIBILITY AND SYNERGY OF THE TWO AXES

The analysis in this section shows that the average NACH (the normalized choice value) of the old axis is much higher than the new one. At the radius of 3000m, the NACH of the old axis is the highest (Fig. 7). As to NAIN, the normalized integration, the average value of the traditional axis is slightly higher than the new axis. Another finding of the analysis is that the average NAIN value of the old axis increases with the metric radius, but no significant changes can be found for its maximum values.

When comparing the intelligibility of the two axes (Fig. 8), the figure shows that the old axis is more intelligible than the new one even though the value is not high, implying that its spatial structure is more legible for pedestrians or vehicles moving around. Yet a bit surprisingly, as far as synergy is concerned, the new axis demonstrates a higher synergy value, implying that it has better local and global relationship, and subsequently people are easy to infer the global structure from the local immediate spatial properties. This may be explained by previous finding that the background structure is relatively simple and lacking in the new axis areas, resulting in insignificant differences revealed between local and global structures.

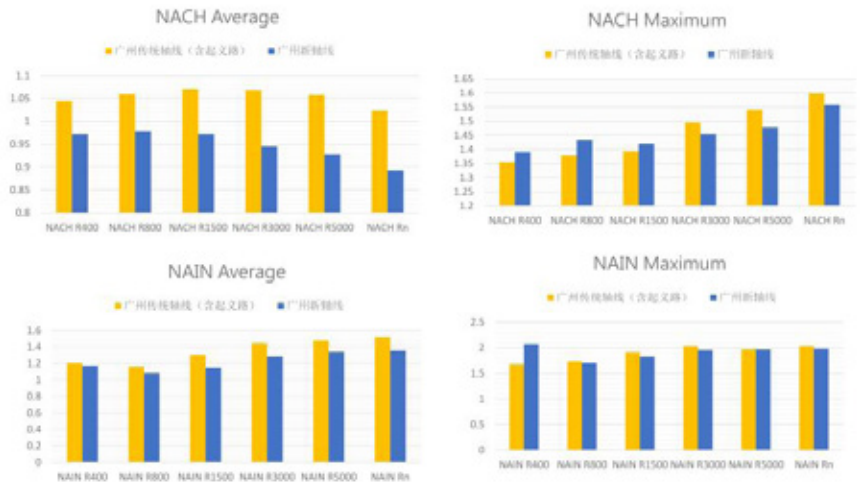

Figure 7 - NAIN and NACH of two axes

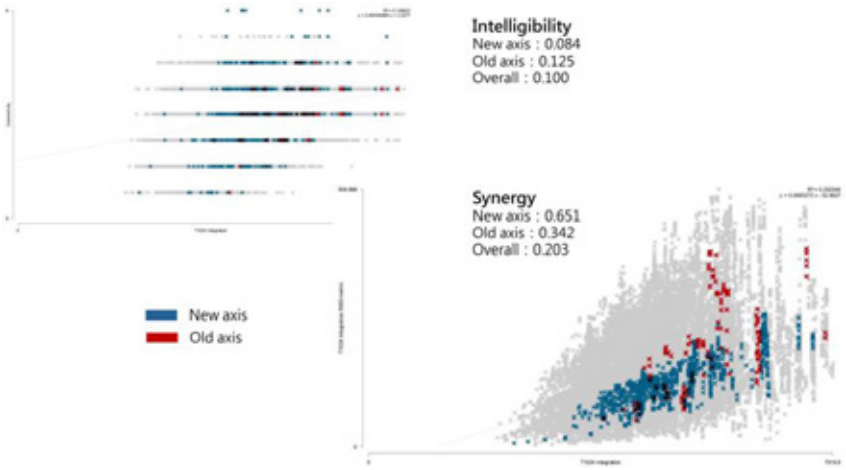

Figure 8 - Intelligibility and synergy of two axes

4.4 ANGULAR STEP DEPTH ANALYSIS

Structurally, the axis is part of the urban spatial system, and it should have an inherent connection with the other parts of the city; therefore, the analysis should not be constrained to the axis itself. To investigate their embedded level within the whole urban layout, this paper also investigates their angular depth map of 3 steps (named as pan-axis area in this paper).

As to the old pan-axis, the figure 9 shows that three step depth distributes evenly, with good connections to the surrounding areas. Also, its configuration shows a good continuity because there is no abrupt change to be found when the step depth is decreasing. It is worth mentioning that part of the new axis is also located within the old pan-axis, proving that the old axis has better structural ductility, theoretically being able to function as an authentic centre of the city.

By contrast, the depth of the new pan-axis extends well to its east edge, while to the west, the lines of two steps are mainly concentrated on the east side of Guangzhou Avenue, implying that Guangzhou Avenue has become a barrier, limiting the extension of the new pan-axis to its west.

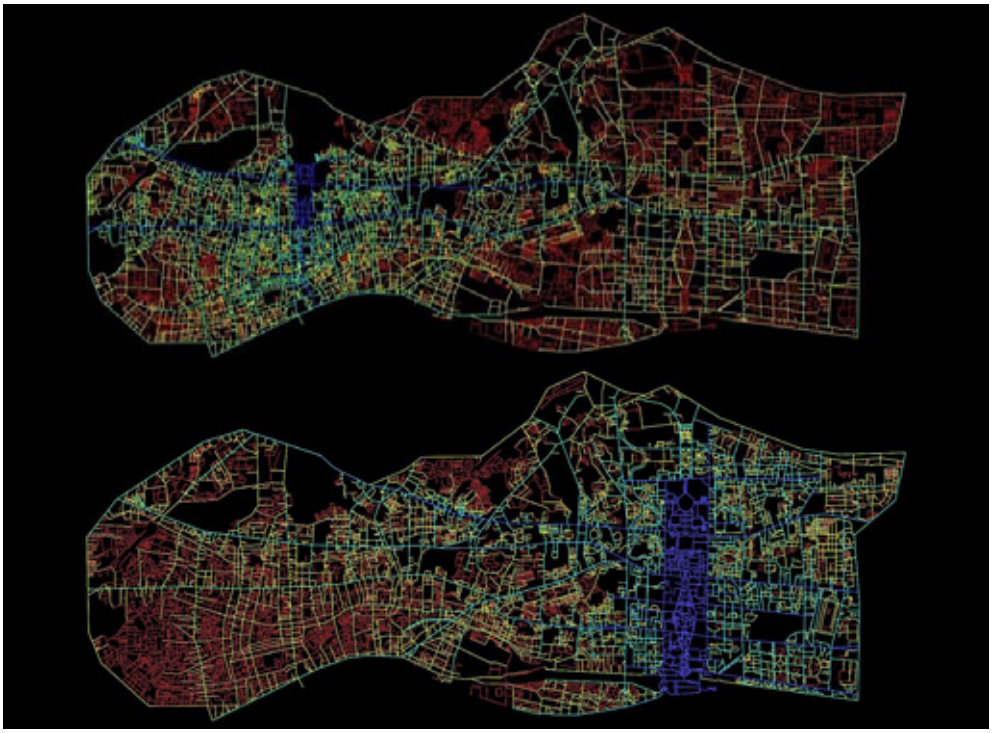

Figure 9 - Three angular step depth maps of the old axis (above) and the new axis

5. CONCLUSION

- The geometrical scale of the traditional axis is relatively small; however, it demonstrates a better structural performance from the configurational points of view. In particular, at both local and global levels, its accessibility and potential to accumulate to- and through-movements are stronger, reflecting its capability to gather social activities. Therefore, it is more likely to function as a morphological and functional centre in the overall layout of the city.
- In comparison with the new axis, the traditional axis has demonstrated better ductility together with good connections with the rest of the city in all directions. By contrast, the new axis displays better to- and through- movement potential mainly at the global level, indicating that its street network is planned more to support vehicular movement. Also, the analysis indicates that the background structure, which is more related to pedestrian movement, is lacking inside the new axis area.
- Since the old axis has considerable structural advantages, the issue of its preservation and revitalization should be carefully considered in the future spatial redevelopment. By contrast, the foreground network structure of the new axis has functioned intensively, but the lacking of background structure and poor connection with the west of the city should be improved so that it can function as the authentic centre of the whole city.

ACKNOWLEDGE

This paper was financially supported by The National Natural Science Foundation of China (No.51138004), State Key Laboratory of Subtropical Building Science Research, South China University of Technology (No. 2016ZB17) and "Guangzhou Ceremony" and Guangzhou History and Culture Research Grants (No. 2015GZY25).

REFERENCES

Duan, Jinyu. On the Growth Pattern of Beijing Axis Line—A Re ection on the Future Spatial Pattern of Beijing. Planners, 2003:10

Hillier, Bill. Space is the Machine, A Con gurational Theory of Architecture, Cambridge University Press, 1996.

Hillier, B. and J. Hanson. The Social Logic of Space, Cambridge University Press, Cambridge, 1984.

Huang, Heming and Ye Qiang. Changes on Relationship of Axis System and Evolvement of High-rise Building Spatial Modality. The Architect, 2008:05.

Li, Luke. A Study on the History of the Central Axis in Beijing. City Planning Review, 2003:04.

Tang, Zilai, Zhang Hui, Wang Shifu. New Urban Axis in Guangzhou: Concept and Design Principle. Urban Planning Review, 2000:03.

Wang, Jiangguo. The Research on Traditional Spatial Axis. Architectural Journal, 2003:5.

Yang, Yaogan. Study on Axis of Dayan Ancient town in Lijiang. Shanxi Architecture, 2007:30.

Zhao, H. and Cao Ronglin. Conservation on the Central Axis of Ancient Capital Based on Its Elements. Huazhong Architecture, 2007:04.

Zheng, Weiding and Li Jingsheng. The Research about the Evolution of Chinese Ancient Cities' Symmetric Axes. The Architect, 2008:04.