THE CHINESE CITY SUZHOU IN SEVEN HUNDRED YEARS

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN THE CHANGING FUNCTIONAL PATTERN AND ITS SPATIAL STRUCTURE IN THE URBAN TRANSFORMATION PROCESS

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ABSTRACT

What is the relation between the changing functional pattern of a city and its spatial structure? And how might an understanding of this relation for a particular city improve our ability to plan its future? In this paper we ask this question of the Chinese city of Suzhou by analysing the changing spatial structure over 700 years against a background of what is known from urban historians of its morphological and functional changes, especially the growth and shift of its various centres. Over and above its main aims, this study raises four key theoretical issues: the difference between the changing functional pattern of the city in an incremental growth in the pre-1949 time and in a massive growth after 1949; the co-existence of a canal system alongside the road system and its meaning to the city's spatial structure; the stability of the physical positions of historical urban elements against the shift of their syntactic context; and the special character of 'interrupted' as opposed to the more common 'deformed' grids. This study also explores the ability of space syntax to work in a social and cultural context in which it has rarely been applied before. By the various spatial analyses carried out in this study, it proposed that it is very important to conduct the axial modelling in a flexible way according to the specific social context. E.g. the vehicle models in the pre-1949 period are proved more powerful than the all-route model in terms of capturing the business centre; the Iida Syntaxa Model is suggested to be a better modelling to reflex the more complex spatial structure of the contemporary city.

Key words: Suzhou, Space syntax, urban, spatial structure, function

CONTENT

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CHAPTER 1: INTRODUCTION

The main object of this study is to investigate the relation between the changing functional pattern of a city and its spatial structure by a case study of Suzhou[1], a city in the southeast of China in the Yangtze River Delta *(Fig. 1.1)*. The city is chosen for two reasons. Firstly, it is a city with a well-recorded urban history over 700 hundred years. The conceptual structure of the city changed from a mono structure in the mid imperial era via a dual structure in the late imperial era to the triplex structure in contemporary *(Fig. 1.3)*. Studies by urban historians have provided the trace of functional and morphological changes of the city and implied that there was an interactive effect between two of them. Based on these findings, this study tried to provide a more evidence-based analysis on the socio-spatial relationship by the space syntax methodology, which has a strong capability to reveal the spatial dimension of a city. The second reason is that this case study provided a chance to gain a deeper understanding on one of Chinese cities, which is still a significant gap of knowledge[2] in space syntax field.

The distinct social/spatial condition of Suzhou raised four key theoretical issues over and above its main aims. The first one is the difference between the changing functional pattern of the city in an incremental growth in the pre-1949 time and in a massive growth after 1949. This issue is derived from a strange fact suggested by Chen in his study on the evolution of business centers of Suzhou (Chen, 2003). He sorted the shift of business centers of Suzhou from 13th century onwards into three generations.

[1] Suzhou, also named as Gusu, Soochow, and Pingjiang in the History.
[2] The existing space syntax study on Chinese cities is relatively few. In the author's view, the only published paper is ' A Celestial Battlefield – the Forbidden City and Beijng in Late Imperial China'. Zhu Jianfei, 1994 AA Files No. 28

Surprisingly, the emergence of the new generations of centers all happened in the pre-1949 period, when the city form was relatively stable. On the contrary, the contemporary city with an area four times as big as the city in the Republic of China period (1911-1949) still holds the dual-center's form, which has existed for a long time . Therefore, the questions this paper explored are, 'is there any underlying reason for this comparison?'; 'could we make this fact as a start, try to find out the difference between the incremental urban growth in the pre-1949 period and the massive growth after 1949?'.

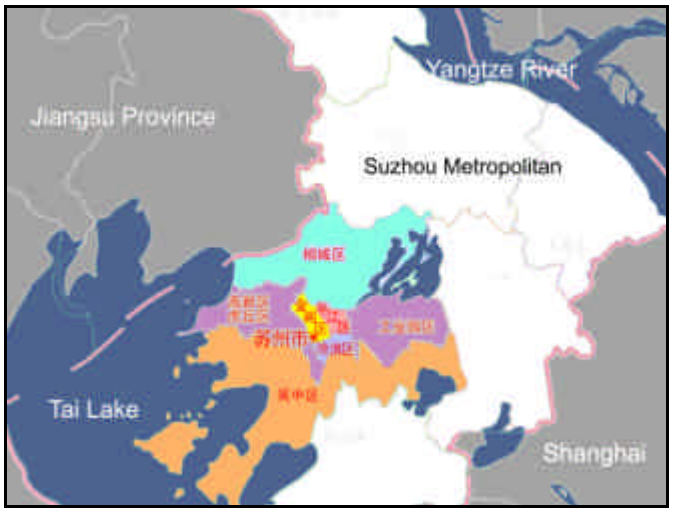


Figure 1.1: Position map of Suzhou in 2000 (Left). Adapted from documents provided by Suzhou Planning Bureau.
Figure 1.2: The Grant Canal and the moat of Suzhou before 1949 (Right). Adapted from Suzhou Shizi, the 'whole picture of Tai Lake'.

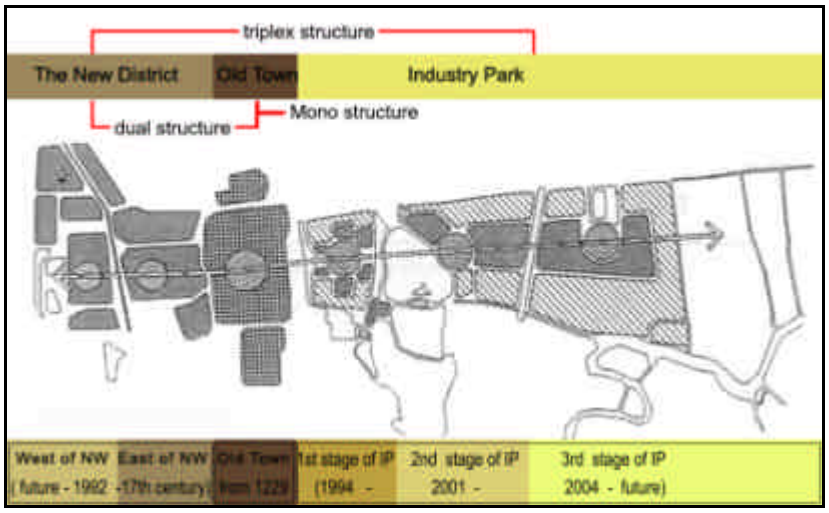


Figure 1.3: The diagram of the shift of conceptual spatial structure. Source: adapted from documents of Suzhou Planning Bureau

The second issue will be discussed in this paper is the co-existence of the canal system alongside the road system and its meaning to the urban spatial structure. The city also known as the Venice of Orient[3], developed a strong network of street and canal paralleled to each other at least from the 13th century (Xu, 2000). The canal network inside the city wall is well connected to the city moat, which was a part of the Grand Canal of China *(see Figure 1.2. The blue area is water, the dark blue line is the route of the Grand Canal in the imperial era; the doted red line is the changed route of it after 1958).* It is widely agreed that the thriving of Suzhou after Tang Dynasty was largely benefited from the Grand Canal, as it was the 'highway' of China in the imperial era, which connected the northern political center with the southern economic affluent area[4]. Moreover, Chen argued that the shift of the business center from central area to the edge in the Ming and Qing Dynasty was also mainly due to the attraction of the Grand Canal. However, besides these qualitative analysis, could we show the effect of the canal system to the functional pattern of the city with measurable evidence? Could we figure out the exact difference between the water system and the road system? These questions would be answered by syntactic analysis carried out in the latter chapters.

The third issue focused on the relation between the relatively stable local urban fabrics in the old town and the ever-changing overall spatial structure. There are many heritage points in the old town area which locate there for a very long period and have some unique features, including temples, scenery points, and private gardens. Some of these urban elements even still embed in an unchanged local grid. However, the stability of physical position of these urban elements does not guarantee an unchanged syntactic spatial property. From Karimi's study on Iranian cities (1999), we have known that there is a possibility that the major spatial rules (spatial spirit) of the historical buildings might lose in the inconsiderate transformation of urban grid under radical processes of modernization. Thus, how about the historical urban elements of Suzhou? What is the effect of the changed/unchanged spatial properties on their functional performance?

[3] In the paper 'a millennium of Chinese urban history: form, time, and space concepts in Soochow' (Mote, 1973), the term 'the Venice of china' is used. Xu proposed that such an analogy is certainly helpful to those westerners who are not familiar with Suzhou for their obtain a rough idea about what the city was like. Yet Suzhou has a much more longer history and a bigger population than Venice. (Xu, 2000 p. 282)

[4] Suzhou Shizi (1995), Xu (2000) , Chen (2001)

This last issue is about the special character of 'interrupted' as opposed to the more common 'deformed' grids[5]. From an inspection on the contemporary map *(Fig. 1.4)*, it can be found that except for a small area at the northwest of the old town (plot 'A') that has an angular grid, the rest of the city is dominated by the interrupted grid. However, there are different interrupted grids co-existing: the small-scaled one in the old town and the great-scaled outside the moat, which was the post-1949 development. The density of the urban road network varied quite a lot from the old part to new one. This difference is reinforced by the 'walled communities' that dominated the post-1949 development, no matter whether it is the gated state-owned company or gated residential community. Randomly take two plots from the old town and the New District with the same size of five hundred by five hundred meters *(see figure 1.5, 1.6, their position is the plot 'B' & 'C' in figure 1.4).* It can be seen that public spaces (the streets, colored by black) in these two plots are distinctive different. There are just two main roads with the latter, although there are many paths in the walled communities(the gray color space) which are the semi-private spaces. Although Hillier suggested that the grid in a same city always tends to have a consistent spatial logic (1996, p. 239), it seems that Suzhou with a long history was consisted of grids with different spatial logics that were generated in different time periods. So, in the investigation of the nature of the interrupted grid, there are some sub-questions needed to be answered. Would the interrupted grids with different scale in the old and new part of the city have any effect on the functional pattern? Would the methodology of axial analysis might be challenged by the city with an unusual coexistence of different grids?

[5] ' Hillier 1996, Space is the Machine' p. 364. *'The difference between a 'deformed' and 'interrupted' grid is that the controlled irregularity of the former comes about essentially through geometric deformation of the line structure, in the manner of European cities, while that of the latter comes about by placing buildings and other facilities to 'interrupt' some lines rather than others, in the manner of Graeco-Roman or American grids. Both usually achieve the result of a well-defined pattern of integration in the axial map of the city.'*

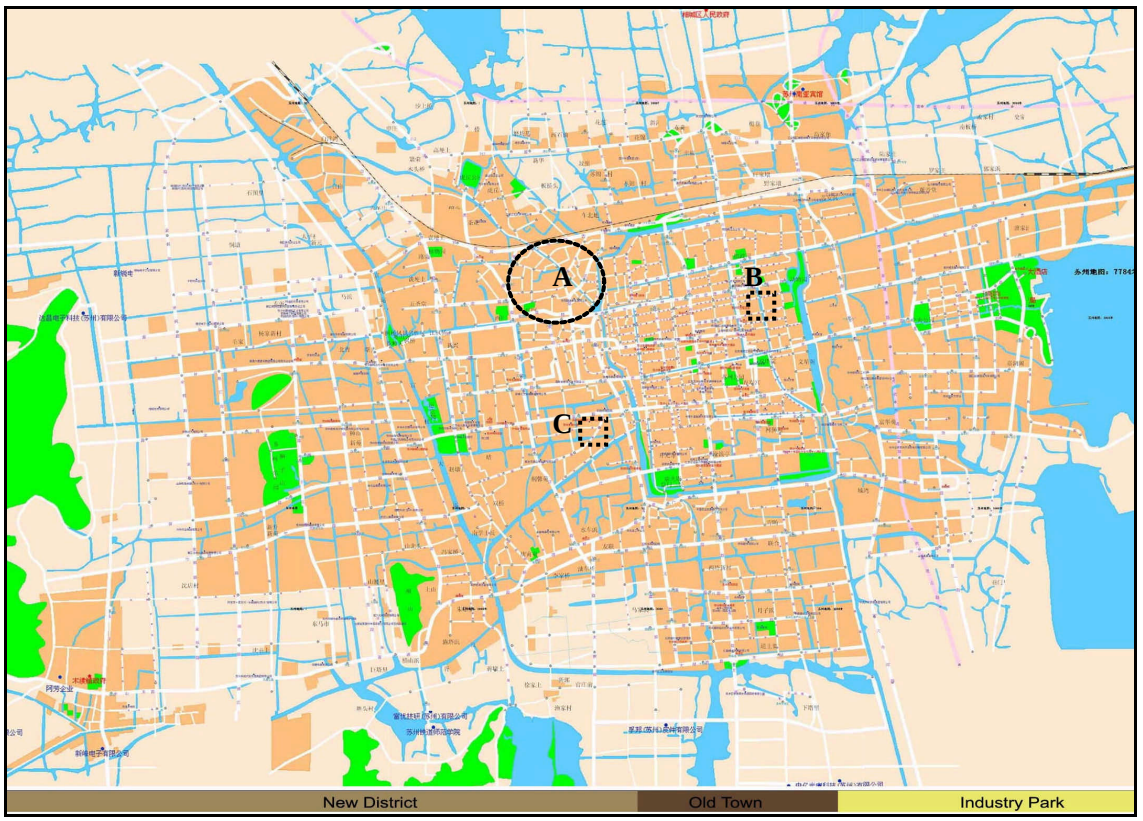


Figure 1.4: The map of Suzhou in 2004 with index. Source: www.shenlong.com.cn

Figure 1.5: The morphology in the Old Town (Left)

Blue color represents the canal. Most of the long plots are the traditional courtyards housings.

Figure 1.6: The morphology in the New District (Right)

Gray color represents the semi-private road inside the Walled community. The narrow slots are typical residential buildings built after 1949 with 6 floors. Source: adapted from land survey map offered by Suzhou Planning Bureau.

The study is consisted of five parts. The current first part outlined the research questions and the layout of the paper. Chapter two is the theoretical framework. Firstly it reviewed the relevant space syntax researches in the field of growth and evolution of urban centers, proposing that the theory and methodology has a strong capability of investigating the problem of form-function relationship. Following, it puts the study in the academic background of 'Chinese city' research, and made a summary for the work of Chen, in which the growth and shift of business centers from the 13th century in this city was studied with its morphological changes. It then pointed out that this study was a complementing work of Chen's research – attempting to articulate the effect of spatial structure to functional patterns by space syntax theory and method.

Chapter Three is a description of the research methods. In order to conduct a feasible study on a dynamic process, the study picked out five particular points in time span from the 13th century onwards. Each period was first put into a historical-social context by the data collected from written records, pictorial evidences and interviews. After that, the spatial structure was analyzed by constructing varied spatial models that are appropriate to the social context. Following, the location of business centers, political centers and important historical buildings will be superimposed on the spatial models to inspect a detailed picture of the form-function relation.

Chapter Four and Chapter Five are the main body of the research, which focus on the urban transformation in the pre-1949 period and post-1949 period, respectively. Each chapter contains the general description of the social context, the syntactic analysis of the spatial structure, the analysis of particular urban elements, and findings. In Chapter Four, it explored the dynamic structural change of Suzhou; confirmed Chen's proposal that the change from water transport to road transport did play a crucial role in the process of new center's formation. Moreover, it proposed that two spatial properties, the global accessibility and local grid intensification, are also key reasons for the success of the new centers. In Chapter Five, it proposed that as the intervention of government in the post-1949 period was imposed in every social activity in different degrees, the

subject is not at all an outcome of a natural urban growth, thus the study of form-function relation should be carried out very carefully. There are two primary findings for it. First one is the realization of the general spatial law in the modernization process of the city; second is the potential of the Iida Syntaxa Model[6] in analyzing a complex urban system.

Chapter 6 is the discussion and conclusion chapter. It reviewed the research questions made in the beginning of this paper then tried to give them answers relating with the theoretical context. A more generic conclusion was made in the end.

[6] It is a new syntactic model designed by Iida which based on a segmental angular analysis (Hillier, 2004)

CHAPTER 2: LITERATURE REVIEW

2.1 Space syntax theory – the general question of form-function relationship and the variant and invariant features of cities

Before asking the question 'what is the relation between the changing functional pattern of a city and its spatial structure', there is a methodological problem to be solved, that is how we can articulate the exact spatial structure of the city? Space syntax was developed with the purpose of investigating the socio-spatial relationship and solving the methodological limitation on analysing space. The axial map, which represents the street network as longest and fewest straight lines so that the whole network is covered, is the most powerful tool it developed for analysing the urban environment. After the syntactic calculation of relative depth (see Hillier & Hanson, 1984), each line in the axial map can be assigned a quantified value that reflects its configuration feature in the spatial system, and these values can be brought back to the axial map a get a graphical representations. With this tool, the question of whether there is significant correlation between the spatial properties and the social feature can be easily detected by rigorous statistical analysis. The research conducted within space syntax field in recent years has proved that there is a strong effect of the space organisation in settlements on the movement patterns, which then influences land use choices, and centre / sub-centre formations (Hillier et al 1987 &1993, Hillier, 1996, 1999).

Hillier argued that there are generic spatial laws, which mediate the social construction of urban space, and influence the functional pattern of a city. The 'dual' theory of urban space suggests that residential areas tend to be more affected by social reproduction and

have larger blocks and a less integrated structure (so more conservative), while centres will be more generative, and have smaller blocks and more integrated/intelligible structures (Hillier, 2001). In 'Centrality as a Process' (1999), he proposed that there are well-defined spatial factors for the urban live centres in the functional meaning, which play a critical role in the formation and location of centres, then while developing and sustaining their vitality. The spatial factors include two kinds of properties, the high global integration value and the low intensified local grids. He proposed that the generic laws of space works cross-culturally that was evidenced by the powerful invariants feature of space that is found in different regions of the world. (Hillier, 2001) This phenomenon is explained by the argument set in 'The Knowledge That Shapes the City' (2003), that there is a deeper, more generic human city underlying the various kinds of social city, which leads all human settlements to be in a narrow band of possible spatial configuration. With this theory, it can hypothesize that some of the urban theories derived mainly from western cities might also work in the orient city of Suzhou.

However, besides the invariants feature of space, the second filter[7] of urban form puts cities into different types. Hillier argued that for the sake of functionality and intelligibility, there are two kinds of structured grid – the 'interrupted grid' and the 'deformed grid'. As 'the commonest kind of grid is not interrupted but deformed' (1996, p. 354), the existing case studies of space syntax on city form are more about the deformed grid cities. The answer of Hillier toward the criticism of space syntax is also based on the explanation of the nature of the deformed grids (Hillier, 1997). However, it should note that the spatial law manifested by the deformed grid city might not apply to an interrupted grid city. The study by Major (1997) on the modern American cities, which are also examples of interrupted grid, shows that there are both similarity and difference between American urban grids to the European grids. On the one hand, the American grids are also a kind of structured and differentiated grids as the grids of European cities, but on the other hand they have different spatial logic in the city

[7] Hillier proposed that between the field of all possible spatial form and architectural actuality, there are three filters. 'Generic function' is the first, the second filter is the cultural and specific functional factors construct interfaces through which buildings become typed, the third filter is the idiosyncrasies of individual buildings and individual designs. 1996, Space is the Machine'

expansion process. Then, how about the spatial logic of Chinese cities? As suggested in the introduction, the grid of Suzhou is now a mixture of different-scaled grids, what is the spatial logic for this particular city?

2.2 Research works on Chinese cities and Chen's study on the city Suzhou

First of all, here it needs a clarification of the relation between this research and other existing research dealing with the subject of Chinese cities. There have been numerous studies focusing on the imperial capitals of China and especially exploring the symbolic meaning of the urban forms. That is an important perspective to study Chinese cities, as the form of the ancient Chinese cities was profoundly influenced by the 'cosmo-magical element', as Wheatley called it ('The pivot of the four quarters', 1972). However, not from this perspective, this study puts attention on the pragmatic aspect, and the relationship of spatial structure with the routine operation of Suzhou. The city was originated from a capital city in the Wu Dynasty (222 - 80 B.C.), so its form remains the features of the symbolic plan for a capital. However, in the studied time span, the city is mainly kept as a local city and famous as a trading/industry town in a certain period. This gives reasons for this research to investigate the urban form from pragmatic point of view instead of the symbolic meaning. E.g. the roads will no longer be stressed on their semantic meaning, such as 'axiality', but be regarded as a network where different degrees of movements are distributed.

Another point should be made clear is that the time span for this study was from the medieval urban revolution, which changed the urban system from the 'Lifang' style to a free system of street. The 'Lifang' organization in the ancient Chinese cities, was characterized by its walled-ward system which accommodated the regular citizens and the designated enclosed marketplace. However, from the Southern Song Dynasty, Suzhou had replace the 'Lifang' system by a street system, 'in which trade and commerce could be conducted anywhere within the city and its outlying suburbs.' (Xu, 2000, p. 128) This ensures that the different time periods this study compared are with a similar social rule of spatial organization, that is the most accessible place would be

most possibly chose as the business area (Hillier, 1999).

Among the varied research studies, which took Suzhou as the subject, a recent study by a Chinese scholar Chen is the most relevant one to this research (Chen, 2003). He investigated the evolution process of the central retail district of Suzhou in history, and outlined the growth and shift of the business centers from the 13th century to the early 21st century into three generations *(Figure 2.1)*. The first generation of business center was in the geometric center of the city in Southern Song Dynasty, when the urban area was mainly confined within in the city wall. The business center was attached to the northwest of the inner palace as the residence of the prefecture officer, and it decayed along with the abandon of the palace in the 14th century. The second generation of business center in the Ming and Qing Dynasty was in the new developed urban area outside the city wall, the Chang Gate Area. Chen argued that the latter area thriving due to the advantage of its waterborne traffic, the prior position on the Grand Canal of China. The three main commercial streets at that time were all alongside the watercourse, two just on the route of the Grand Canal and one was from Chang Gate to Tiger Hill, the famous historical scenery place in the north-west. As the former business center was abandoned with the former political center (the palace) discarded, the local commercial firms shifted to this place. The third generation of business center was in the formation of dual centers, starting from the Republic of China period until contemporary time. Chen proposed that besides the specific social factor of Taiping Rebellion in 1860's, which destroyed the second generation of center at that time, the shift of main transportation means from waterborne boat to overland vehicle was the main reason of the formation of the third generation centers *(Figure 2.2, 2.3)*. After the railway passed through the North of Suzhou in 1900's, modern roads was constructed to connect the inner city with the railway station. As Guanqian Street was adjacent to the most important Temple, Xuanmiao Temple, and the Stone Area was also near the old Chang Gate Area, so these two places were naturally chosen as the new centers, further their role was reinforced by the passing-by modern roads later. Chen also points out a strange phenomenon that, although Suzhou had generated the dual-center form with a built-area of only 20 square kilometers in the Republic of China period, but till 2001 it

still hold two business centers with a built-area of 80 square kilometers. The plan of 1986 encouraged developing a third 'business center' in the New District, which was mainly a residential district, but did not come into being. The conclusion Chen made was that there was a dynamic feedback process between the evolution of the business centers and the growth of the city grid; the location of business center was relatively stable comparing to the social changes; the specific factors in the history, the shift of transportation tool was the main factors that influenced the growth of the business centers.

Chen's study was the one with abundant facts and thoughtful analysis, however, it suffered from the lack of a scientifically tool to articulate the relation between the shift of business center and the change of urban grid. But parts of Chen's works was chosen as the academic background of this research, from which the research questions emerged: 'what is the exact difference between a spatial structure reliant on the waterborne transportation and the road transportation?', 'why the existent business centers did not change with the rapid urban expansion after 1949?', 'what is the exact spatial structure change after the urban expansion?'.

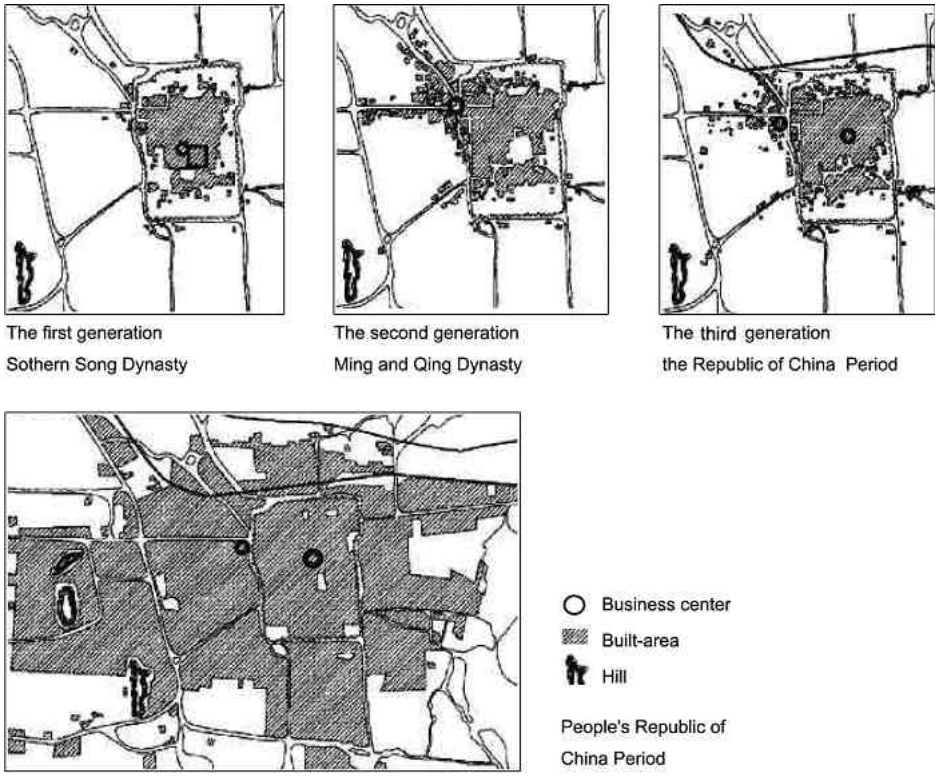


Figure 2.1: The three generations of business centers. Source: Chen Yong, 2003

Figure 2.2: The waterborne transport. (deliver goods by boats). Source: Chen Yong, 2001

Figure 2.*3*: The overland transport (deliver goods by carriage and cars). Source: Chen Yong *2001*

CHAPTER 3: METHODOLOGY AND DATA SOURCE

As discussed in the former chapter, it is very important with a scientific tool to analyze the urban form and articulate the significance of space structure to the changing functional pattern. Space syntax is a theory and a tool which has the capacity to make the spatial characteristics of settlements measurable and comparable, which proved to be a reliable platform for this research, therefore, was chosen as the main method of this project. Although syntactic analysis is capable of producing a wide range of variables, this study intended to use the ones that can exhibit the most important syntactic characteristics of the urban grid, that is to say the global integration value (Rn) and the local integration value (R3). These two values can capture the non-local properties of space in different degree, which are defined by the relation of an element to all the others (Rn) or others in 3 steps (R3) in the system. The more accurate definitions can be found in 'Social Logic of Space' (Hillier & Hanson, 1984).

To carry out a feasible analysis on the continuing history, the study picked five particular points in time span from the 13th century onwards. The criteria of which period should be picked is according to the availability of the historical map, the works of Chen's on the evolution of the business centers, and big changes of spatial form. The first period was 1229 in the Southern Song Dynasty, the mid-imperial era; the second was 1745 in the Qing Dynasty, the late Imperial era; the third was 1938 in the period of Republic of China; the fourth was the year of 1986 in the P. R. C. before the economic booming in Suzhou; and the last one was 2004, the current year. As the developments before 1949 and after 1949 were different in terms of size, scale and momentum, this study would divide them into two stages. This method allowed the first

key theoretical issue, the difference between the incremental growth before 1949 and the massive growth after 1949, could be answered by a comparison approach.

In each selected period of the pre-1949 stage, a general description of historical background, social context, and morphological features is firstly presented by studying the written records and pictorial evidence. As in the long history, there were many specific historical factors, such as the governmental intervention or changing lifestyle that might have an effect on the functional pattern of the city. In order to understand the influence of these factors as the consequence of spatial structure, a specific examination of urban history was a very important step before making any analysis. Following, axial mapping was conducted with the historical town maps in order to convert the cartographic information to spatial models, which can be analyzed and compared with each other. The location of business centers, political centers and other important historical buildings was superimposed on the analyzed axial graphs. Visual inspection of them was made to gain an understanding of the form-function relationship. As there were many spatial models at this stage (the road and canal spatial model, the modern vehicle model), these models were compared by the degree of coincidence between the integration core and the position of business centers. The most coincident one would be regarded as the dominating space structure. In such a way, the second key issue, the importance of the canal system to the city in different periods, could be qualitative.

In the post 1949 period, the general description was based on written records, public news, planning data, Chen's study, the observation, and interviews (with the local people, planning officers and researchers[8]) conducted by the author in July 2004. The aim of conducting such a wide range of data collection was attempting to give a real feeling for the current complex social-spatial relation. If it didn't tell the same story as it should be, the analysis would be re-examined and then the methodology got improved in some way. Only the road system was analyzed in the late stage because the water

[8] The interviews to Dr. Chen Yong, the associated professor in Tongji University and Dr. Tan Ying the Vice Mayor of Suzhou, are both taken on July 2004, Shanghai. The interviews to local residents are taken on four days in July 2004 in Suzhou, the interviewee including taxi driver, restaurant owner, old people and ordinary staffs meet in the street randomly, as well as planning students in the Suzhou Scientific College.

system was no longer as an important mean of transportation. However, the paper was brought into Iida Syntaxa Model when it found some feature of the grid could not be shown by the orthodox syntactic analysis. The superimposing of the location of business center, political center and other important historical buildings on the axial graphs, was still operated. To answer the third issue pointed in the introduction, the physical stability of urban historical elements against the shifts of their syntactic positions, it picked six oldest elements as samples to tracing their change of syntactic position in the five periods.

The source of pre-modern maps was chosen from 'the Atlas of Ancient Suzhou', the recent reprinted old maps. The map in 1986 was obtained from the land use map of 1985, and adjusted by the tourist maps of 1988 and 1992. The map in 2004 was obtained from the digital map of Suzhou from the Internet, and adjusted by the tourist map of 2004. As the scope of the city in 2001 was enlarged to encompass some neighboring towns, the boundary of the axial map 2004 is not according to the official definition, but referenced to intuitively geographical boundaries (such as freeways, motorways, major roads, and geographical features) and it has got the agreement of Tan, the former director of Suzhou Planning Bureau.

It should be noted that the modern maps are in a relatively lower resolution than the old maps (in the observation, it was found that many back lanes in the old town area were lost in the map). This limitation means that the graph size of the axial map in different period do not represent the actually amount of the public spaces, so the syntactic value of each graph is not comparable. However, as the axial graph is actually a graphical representation, the analysis can rely on the distribution pattern of integration values of each axial graph. This feature allowed this research could still be carried on with a limited data source.

CHAPTER 4: INCREMENTAL GROWTH IN THE PRE-1949 PERIOD

In this chapter, three historical points before the 1949 are analyzed together in order to get a whole picture of the changing functional pattern and spatial structure in the pre-1949 stage. They are the year of 1229 in Southern Song Dynasty, the year of 1745 in Qing Dynasty and the year 1938 in the Republic of China period, respectively. This stage is regarded as the process of incremental growth compared to the rapid urban expansion of post-1949 stage. As noted in Chapter Two, Chen proposed there were three generations of business centers appearing in this stage. He also pointed out that the shift of business centers and the change of morphology was a dynamic feed back process. The task of this chapter is to answer, 'what is the exact relation of the changing functional pattern and the spatial structure?', 'can we pin down this process more clearly with the help of space syntax analysis?'

The first section of this chapter gives a general account for the urban history, including three types of information: the historical background and special events, the land use pattern, and morphological features. To make the historical maps easy to read, after each map, the counterpart axial map with landmarks and urban elements marked on them is provided, either. The second section conducts the integrated analysis of both the road and canal systems, which is proposed as the all-route model and pre-urban vehicle model. The positions of the integration core of these models are compared with the real positions of the business centers. As there are four doubts emerging after these orthodox syntactic analysis in the third part, alternative spatial models were proposed in response to them and got surprising results. The fourth section superimposes the location of political center and other important historical buildings on the main axial graphs to get a

comprehensive understanding of the functional pattern in the spatial structure. A conclusion is made in the end.

4.1 General description

In this stage, the construction of Suzhou was mainly restricted within the city wall, only a small part was expanded to the west of the walled city in the late imperial era[9]. The investigation begins from the year 1229, when the oldest town map 'Pingjiang Map'[10] was made. As discussed in Chapter One, it was the time when the medieval urban revolution had already taken place, and the ward system had completely replaced by the system of streets and alleys[11]. The city in Southern Song Dynasty was an important place for its trading, silk industry as well as the important military position. Suzhou was the interchange center of transportation in South China for its location in the midst of the Grand Canal. On the 1229 town map *Figure 4.1*, it can be found that except two small expansion areas outside the Chang gate and Pan Gate, the overall form of the city was a slightly irregular rectangle confined in the city wall and moats. As the city was just completed reconstruction after the war in 1130, which almost turned the city into debris, the planed urban form was very orthogonal and even symmetrical. A well-developed network of street and canal paralleled with each other and crisscrossed the city. The total length of the canals with the city walls is estimated by Yu at about 82 kilometers, which amounts to 78 percent of the total length of the city streets (Xu, 2000, p. 129). The city had five gates, all of them catering to both road and water traffic, which again demonstrates the existence of the dual system of land and waterborne transportation.[12] The geometric center of the city was a building complex enclosed by another wall, the prefecture officer's residence. As the emperor would use the palace as his temporary dwelling, it was designed in such a big scale to match his honor. The business center was the Happy Bridge Market, just attached in the northwest corner of the palace block (Chen, 2003). Table 4.1 lists the names of important sites[13] and their initials. Their positions can be found on the axial map *(Figure 4.2)*.

[9] The area of the walled city is about 14.2 square kilometers, and the built-area of the city in 1949 was only 20 square kilometers.

[10] The map is in a scale near 1:2000, it recorded the street, canal, bridges and important buildings in detail (there are 314 bridges, 111 temples and nunneries, 93 official buildings). It was engraved on a stele in the second year of Shaoding's reign (1229) of South Song Dynasty. (preface of 'the Atlas of Ancient Suzhou')

[11] On the 1229 map, the remains of the residential wards system were still marked, but they were only the 'honorific gateways' which help the local people tell the position.

[12] Apart from the benefit of waterborne transport, the canal was also used for firefighting, convenient daily use, beautification of the landscapes, and preventing floods. (Xu, 2000, p. 129)

[13] It should note that not all the important sites are listed here. As on of the research question is to trace the syntactic change of historical urban elements, the important sites which disappeared in contemporary is not the subject of this study.

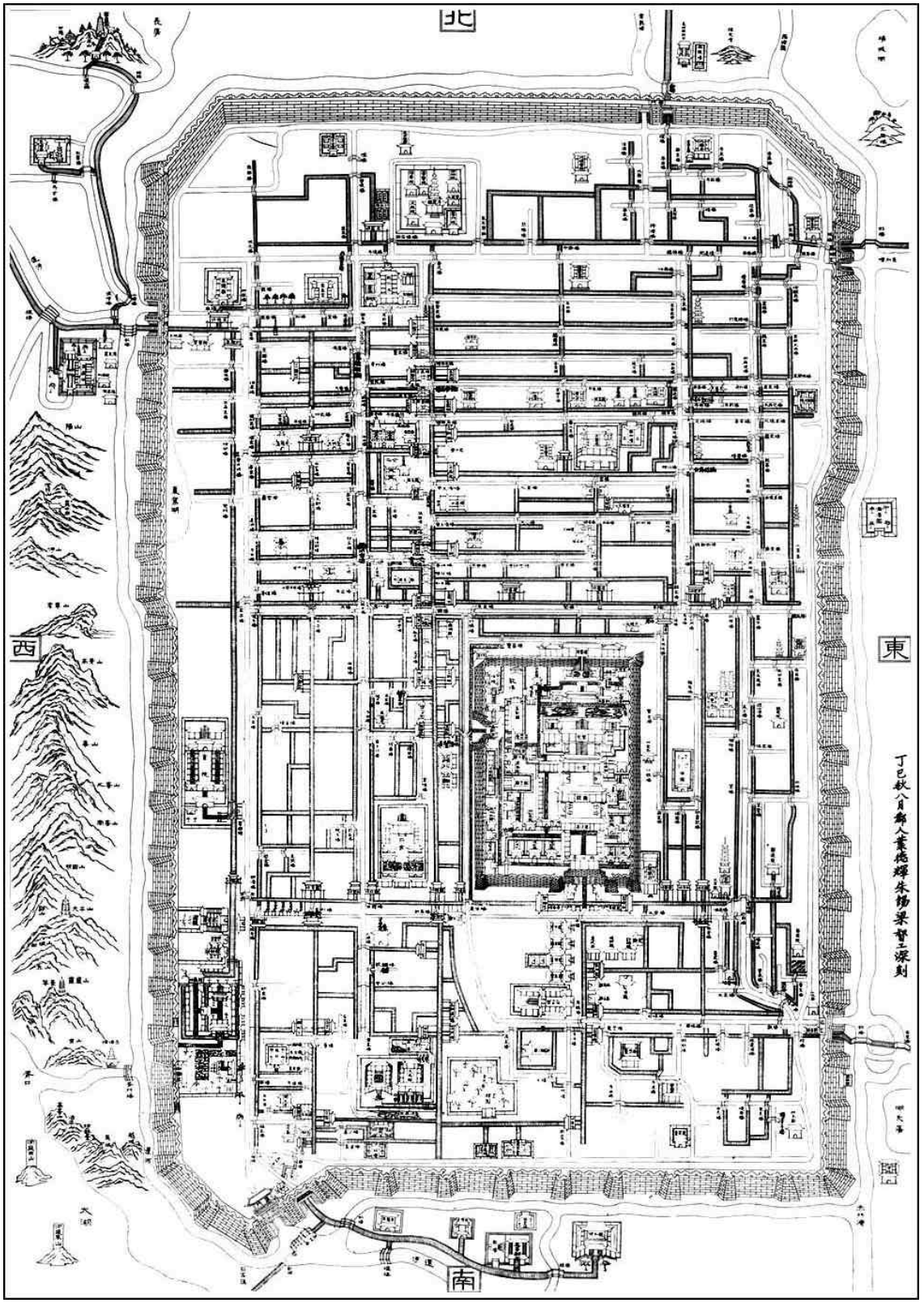


Figure 4.1: Pingjiang Map, 1229. Source: the Atlas of Ancient Suzhou

Table 4.1: Urban elements in 1229

B Business center	O Office	G Gate	T, H, B, G
HB Happy Bridge market	AC Administration Center	GC Chang Gate	CT Confucius Temple
	CC Changzhou county Center	GF Feng Gate	NT Northern Temple
	WC Wu county Center	GQ Qi Gate	XT Xuanmiao Temple
	DO Prefectual Education	GL Lou Gate	TH Tiger Hill
	DO Department Office	GP Pan Gate	MB Maple Bridge
			CG Changlang Garden

Figure 4.2: 1229 axial map and land use

The next period investigated is the Qing Dynasty based on the 'Gusu City Map' in 1745. In the Ming and Qing dynasties, Suzhou had reached significant heights of prosperity, as it gradually became the center of the silk industry of the whole country and one of the four most important trading centres of China. There was a new suburb spillover of the walled city in the northwest, which proposed by Chen as the second generation of business center, and suggested by Xu that may be regarded as more 'urban' than most areas enclosed by the city wall (Xu, p. 7). However, regretfully, the west suburb was not drawn on the map *(Figure 4-3)*, even two later maps in made in 1881 and 1890s did not depict any construction outside the city wall. Here, in order to understand such a strange contradiction between the map and real situation, it needs to introduce Xu's proposal. He argued that in the imperial china, the concept of 'City Wall' is so important for its symbolic meaning that the official record would regard the area outside the city wall as countryside, no matter how affluent it was. There is a '*remarkable stability of the city form defined by the largely unaltered position of the city walls, and a process of steady urban growth in space in the last centuries of the imperial era'* (Xu, P. 6) The understanding of Chang Gate area is achieved from the civic documents and an important scroll, 'Shengshi Zisheng Tu' made in the year of 1759, which depicted a bird view from the southern Pan Gate, up to Ghang Gate, ended at the Tiger Hill in the northwest *(Figure 4.5 shows a section of it)*. These documents show that the west suburb was composed by three streets/watercourses all started from the Chang Gate *(Figure 4.5)*. Two of them, the Up-tang Street (to the direction of Marble Bridge) and the Nanhao Street (from Chang Gate to the Xu Gate), which were parts of the Grand Canal, were developed into commercial streets with abundant wholesale markets and retail firms. Another street, the Shan-tang Road to the Tiger Hill, was the up-market commercial street, which gathered numerous theaters, restaurants, teahouse and other entertainment firms. From the 1745 map, it can be found that the grids of Suzhou, after 500 years, morphologically became much more organic than before, with many more back lanes appearing inside the super-blocks. The former prefecture residence in the geometric center of the city, used by Zhang in the end of Yuan Dynasty who claimed himself as emperor, was burned down after his failure. The place was forbidden for any re-construction by the central government and was in a state of dereliction in this period.

In order to build the vacant urban center, the Xuanmiao Temple was enlarged by the local authority. The courtyard of the temple gradually became the most important public place where the 'Temple Market' was held.

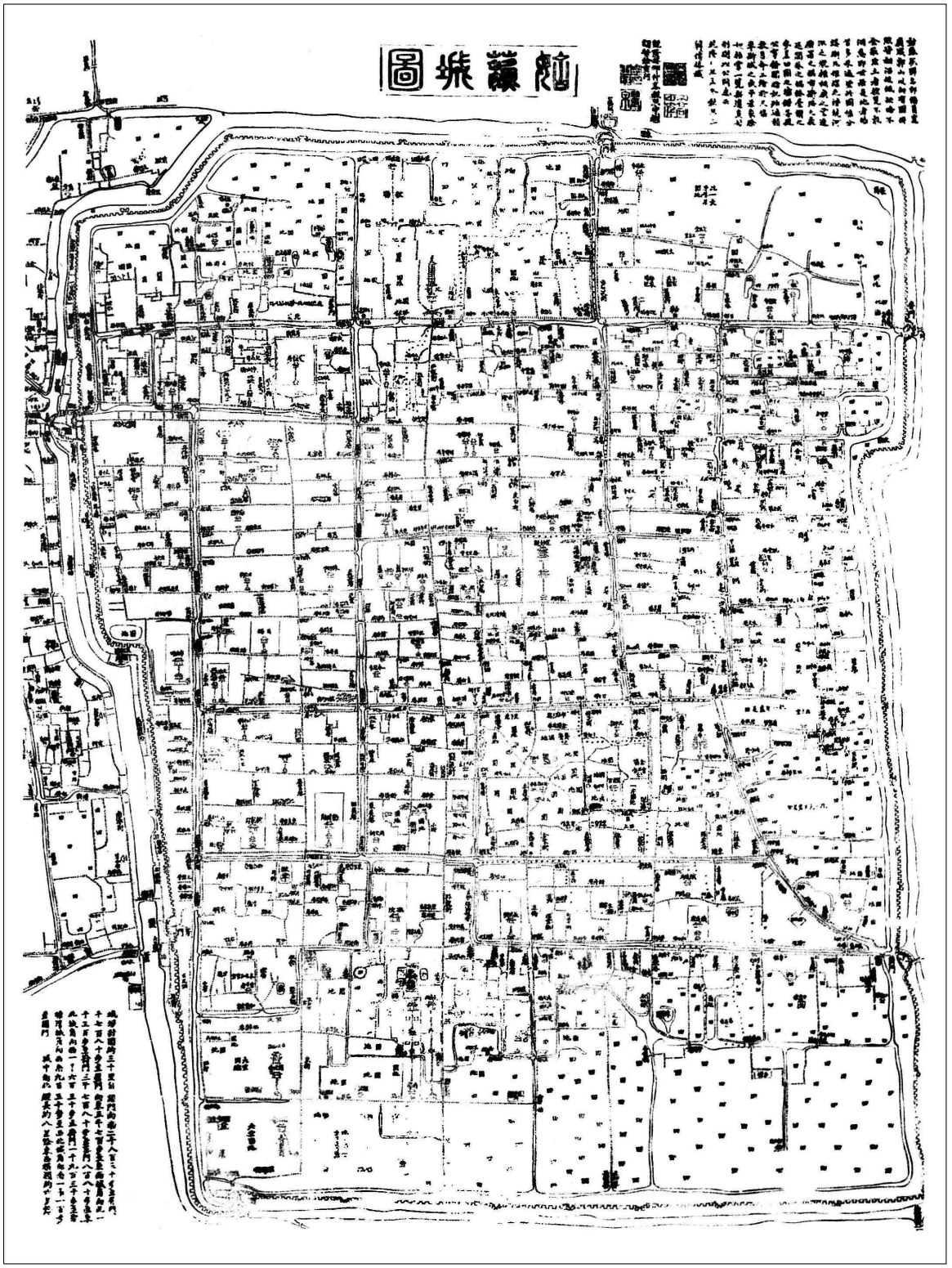


Figure 4.3: Gusu City Map, 1745. Source: the Atlas of Ancient Suzhou

Table 4.2: Urban elements in 1745

B Bussiness center	O Office	G Gate	T, H, B, G
SB Shantang Street	AC Administation Center	GC Chang Gate	CT Confucius Temple
UB Up Tang Street	CC Changzhou county Center	GF Feng Gate	DT Dual pagoda
NB Nanhao Street	WC Wu county Center	GQ Qi Gate	GT City God temple
	YC Yuanhe County Center	GL Lou Gate	NT Northern Temple
	SO State Textile Bureau	GP Pan Gate	XT Xuanmiao Temple
	DO Prefectual Education	GX Xu Gate	TH Tiger Hill
	DO Department Office		MB Maple Bridge
	DO Provincal Administation		CG Changlang Garden
	DO Changzhou County Education		SG Shizilin garden
	DO Wu county Education		ZG Zuozheng garden

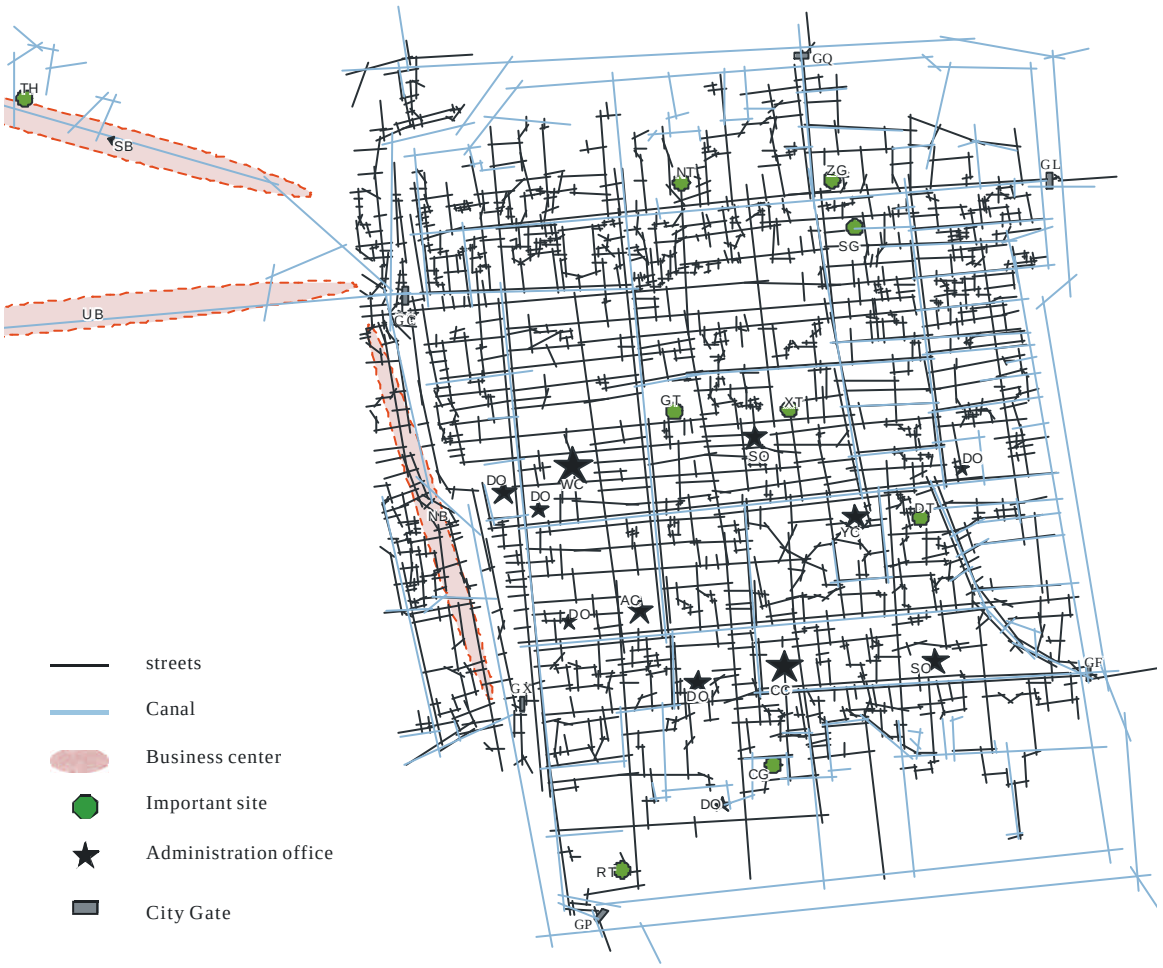


Figure 4.4: 1745 axial map and land use

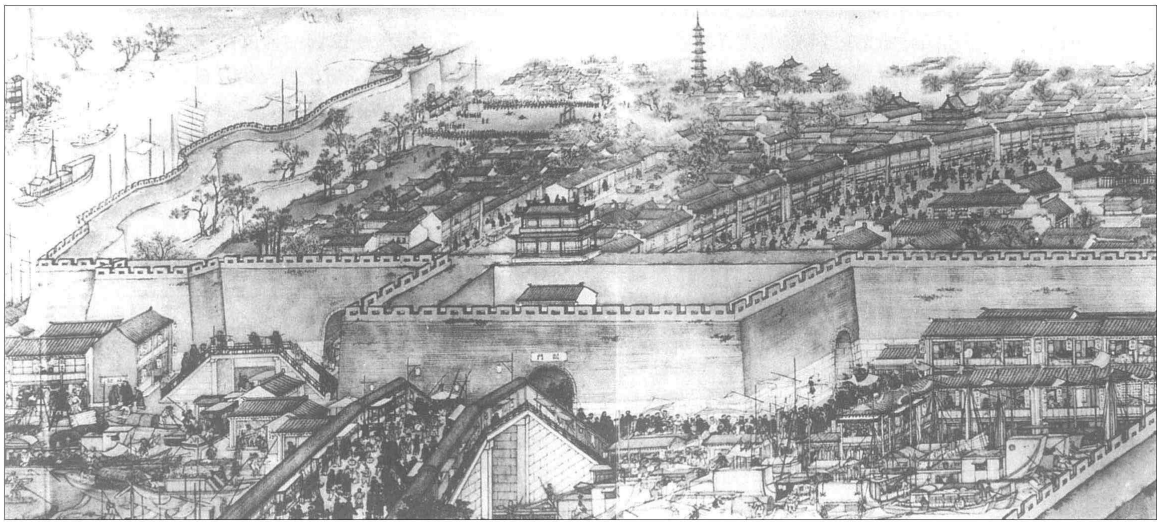


Figure 4.5: a section from the scroll 'Shengshi Zisheng Tu', 1759.

This section depicts the scenes around the Chang Gate - There were plenty boats waiting to enter the walled city; crowds on the bridge in and out the city; the pagoda in the far end is the Northern Temple Pagoda which still exists today. The scroll suggested that there were both road and water transport in the city in that period.

The third term was the period of Republic of China according to the 1938 map *(Figure 4.8)*. The prominent place of Suzhou as the regional trading center was gradually replaced by Shanghai in this period. Suzhou gradually got the reputation as a major tourist destination for stunning private gardens and historical sites. As noted in Chapter Two, the construction of railway and modern broadway made the traditional transportation tools gradually shifted from boats to overland vehicles. There was a half ring road around the city wall, which finished in the late Qing Dynasty, and two circular routes in the inner city which finished in the 1930's[14], and all designed for the road transport *(Figure 4.6)*. On the contrary, the old streets in the inner city were less than 3 meters in width, not fit for automobile[15] at all *(Figure 4.8)*. Although the old 'Chang Gate Area' was burned into ruins in the warfare in 1860, it recovered after the construction of new roads which connected it with the railway station. The commercial streets also shifted a bit to these broad ways. According to Suzhou Shizhi *(1995)*, a survey in 1912 showed that the Stone area (including the Up-tang Street, Big

[14] It was the results of the major urban renew program of the Republic of China, the 'Suzhou Gongwu Jihua' started in 1927. (Suzhou Shizi p. xx ,1995)

[15] The moat of the city was 50 to 70 meters in width (Chen, 2001).

Thoroughfare and Horizontal Thoroughfare) had about 320 firms including hotels, restaurants, banks, theaters, bookshops and other services. However, in 1935 there was another fire in the war against Japanese took place in this area, which largely restrained its natural growth. On the other hand, Guanqian Street in the front of the Xuanmiao Temple was gradually turned into another business center to fill the gap, when the Stone area was run down. In the late Qing Dynasty, the Guanqian area had 60 firms which were classified into 20 different professions. But in 1927 it had 120 firms classified into 40 different professions *(Suzhou Shizi, 1995)*. In 1930 there was a further development that turned it from the linear shopping street to a convexes form. In the southern block of the Guanqian Street, there were four large theaters opened. The Guanqian area (including the Palace lane, Eunuch lane, Youth road, Zhaomozheng lane) became a business complex with mixed land use (shop, banking, catering, and leisure functions). Both the 'Stone Road Area' and the 'Guanqian Area' were proposed by Chen as the third generation of business center *(Figure 4.9)*.

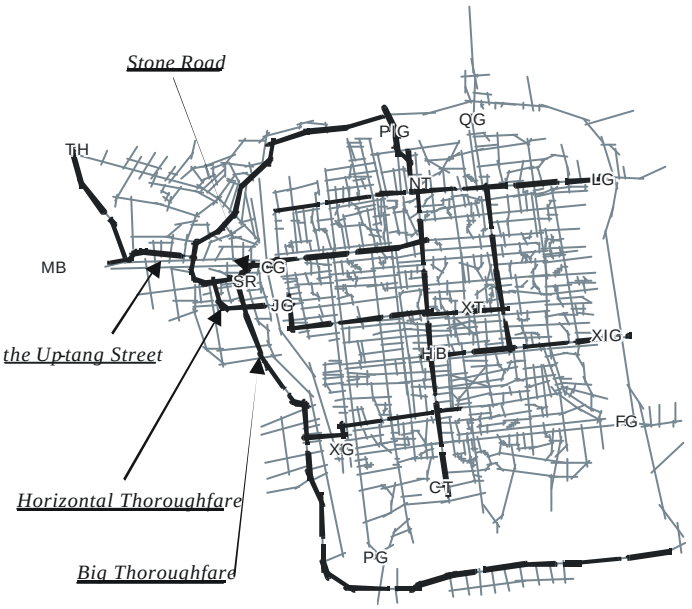


Figure 4.6: The vehicle route in 1938. Source: adapted from Suzhou City Map, 1938.
Figure 4.7: the narrow street for pedestrian in the early 20th century. Source: photo of Guanqian Street before widening, Chen, 2001

Figure 4.8: Suzhou City Map, 1938. Source: the Atlas of Ancient Suzhou

Table 4.3: Urban elements in 1938

B	Business center	O	Office	Gate		T, H, B, G			
GB	Guanqian St. Area	AC	Administration Center	GC	Chang Gate	CT	Confucius Temple	KG	Ke garden
SB	Stone Ro. Area	DO	Prefectual Education	GF	Feng Gate	DT	Dual pagoda	LG	Little Chang villa
		DO	Asylum	GQ	Qi Gate	GT	City God temple	PG	Public garden
		DO	Bridewell	GPI	Ping Gate	NT	Northern Temple	QG	Qingnianhui Garden
		DO	Court	GJ	Jin Gate	XT	Xuanmiao Temple	RG	Remain garden
		DO	Financial	GL	Lou Gate	TH	Tiger Hill	SG	Shizilin garden
		DO	Police	GN	New Xu Gate	MB	Maple Bridge	UG	Sui garden
				GP	Pan Gate	AG	arboretum garden	WG	Wang garden
				GX	Xu Gate	BG	Ban garden	XG	XI garden
				GXI	Xiang Gate	CG	Changlang Garden	YG	Yi garden
						JG	Jin garden	ZG	Zuozheng garden

Figure 4.9: 1938 axial map and land use

4.2 Syntactic analysis of the spatial structure

From the general description, we have learned that there have been some historical reasons for the shift of the business centers. However, from spatial point of view, this paper investigates, apart from these specific reasons such as the warfare and government decision, the underlying spatial power that influenced the emergence of business centers. From previous studies in space syntax field (Konstantinos 1994, Perdikogianni 2003, Karimi 1997), we have known the location of center is always tightly related with the syntactic core of the spatial structure. From Chen's study, it is clear that the shift of center was greatly influenced by the shift of transportation from water to road. Given on his findings, the questions in this section are: 'do the structures of the water system and road system of the city have relation with the location of the centers?', 'what is the difference between the structure of these two systems?', 'is it possible that this difference has some thing to do with the shift of the center?'.

The syntactic analysis is based on the axial maps achieved from the historical maps. Figure 4.10 shows both the road and water axial maps of the city on 1229, 1745 and 1938 before the analysis. It should be noted that the road system of 1745 was not a complete one due to some historical reasons mentioned above, and the 1229 map has some degree of distortion. However, as the syntactic analysis is mainly a topological analysis, this distortion will not affect the result.

Figure 4.11 shows three axial graphs of 1229, the road graphs in the measurements of global and local integration, the water axial graph only in the global integration measurement as it is really a small system. In the road network axial graphs of 1229, there is no big difference between Rn and R3. The most integrated lines almost constitute a super grid across the city proper. The intersection of two most integrated lines is just the location of the center, the Happy Bridge. In the water system axial graph of the same year, the most integrated lines constitute a partial super grid, slightly lying to the northwest part of the city. The structures of the road and water system showed in the analysis are overlapped and coincident with the market place in the reality.

Figure 4.12 shows three axial graphs of 1745, Rn and R3 of road network and Rn of the water network. The analysis shows that the Chang Area outside the walled city is quite isolated in the whole system. Is it due to the fact that the graph was drawn according to a less completed map? From a careful inspection, it can be found that there were only two connections between the Chang Gate area and the inner urban area, and the connections were crooked routes through the urban gates. The spatial link between the Chang Gate Area and the inner city was really very weak. In the analysis of water system integration[16], the integration core remained in the northwest of the city. The syntactic value of the main watercourse linking the inner wall area to the Chang Gate Area is improved, the color of the axial line changes from yellow in 1229 graph to orange in this graph. As we know that the Chang Gate Area was the business center of that time, it seems that there was a mismatch between the spatial structure showed in the axial maps and the real function pattern. Does that mean the relation between the functional pattern and spatial structure was very weak in this period? We will go back to this puzzle in the next section.

Figure 4.13 shows three axial graphs of 1938, Rn and R3 of road system and Rn of the water system. The axial graphs were based on a completed map including the west part outside the city wall. The integration core patterns in three axial graphs are similar, look like a deformed wheel slightly leading to the west part of the city. The business centers are not on the high integrated lines. Given the Rn road axial graph, for example, the syntactic value of Guanqian Street is a bit higher than the average (shows in yellow color) and the one of Stone road is a bit lower than average (shows in light blue color). However, both of them are in a very short metric distance to the most integrated lines, the People's Road and the West-middle-market Road. In this period, there were three connections between the walled city and the west part - Chang Gate, Jin Gate and Xu Gate. In the global measurement analysis, the value of the west part is still relatively lower (lines show in green and blue colors). In the local measurement analysis, some

[16] The canal outside the Chang area is mapped in this model according to the map of 1938, as the written documents shows that the watercourse do not had much change.

streets get a high value: four lines in the Chang Gate area show the yellow color. Is that suggested the Chang Gate Area has a strong local structure despite of its lower global integration value? In the water system, the tendency of the integration core towards the northwest part is kept. The main watercourse linking the inner wall area to the Chang Gate Area is now the integrator of the canal system. The graphs show that the integration core of the road system and water one overlapped again, but the location of business centers are not picked directly. What does that mean to the form-function relation?

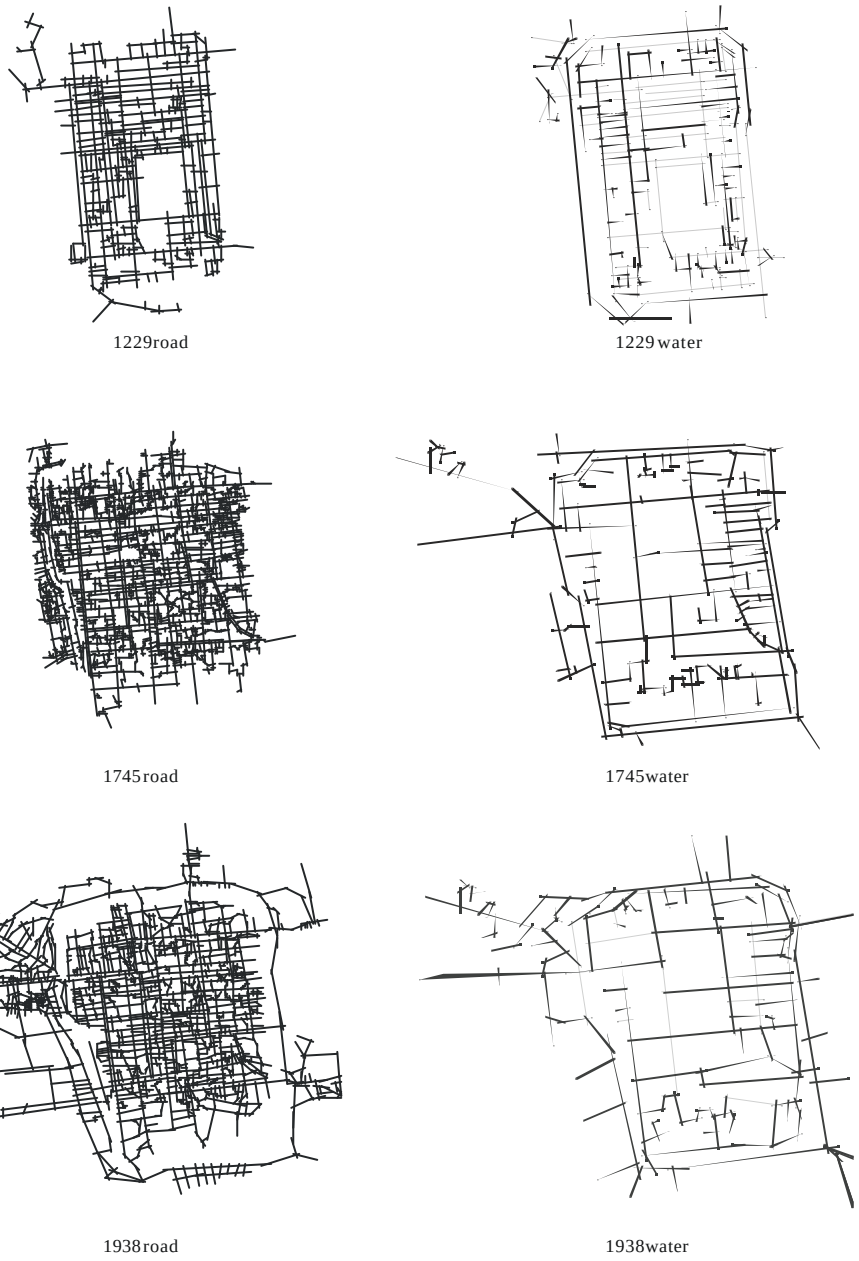


Figure 4.10: Axial maps of both the road and canal systems in 1229, 1745 and 1938

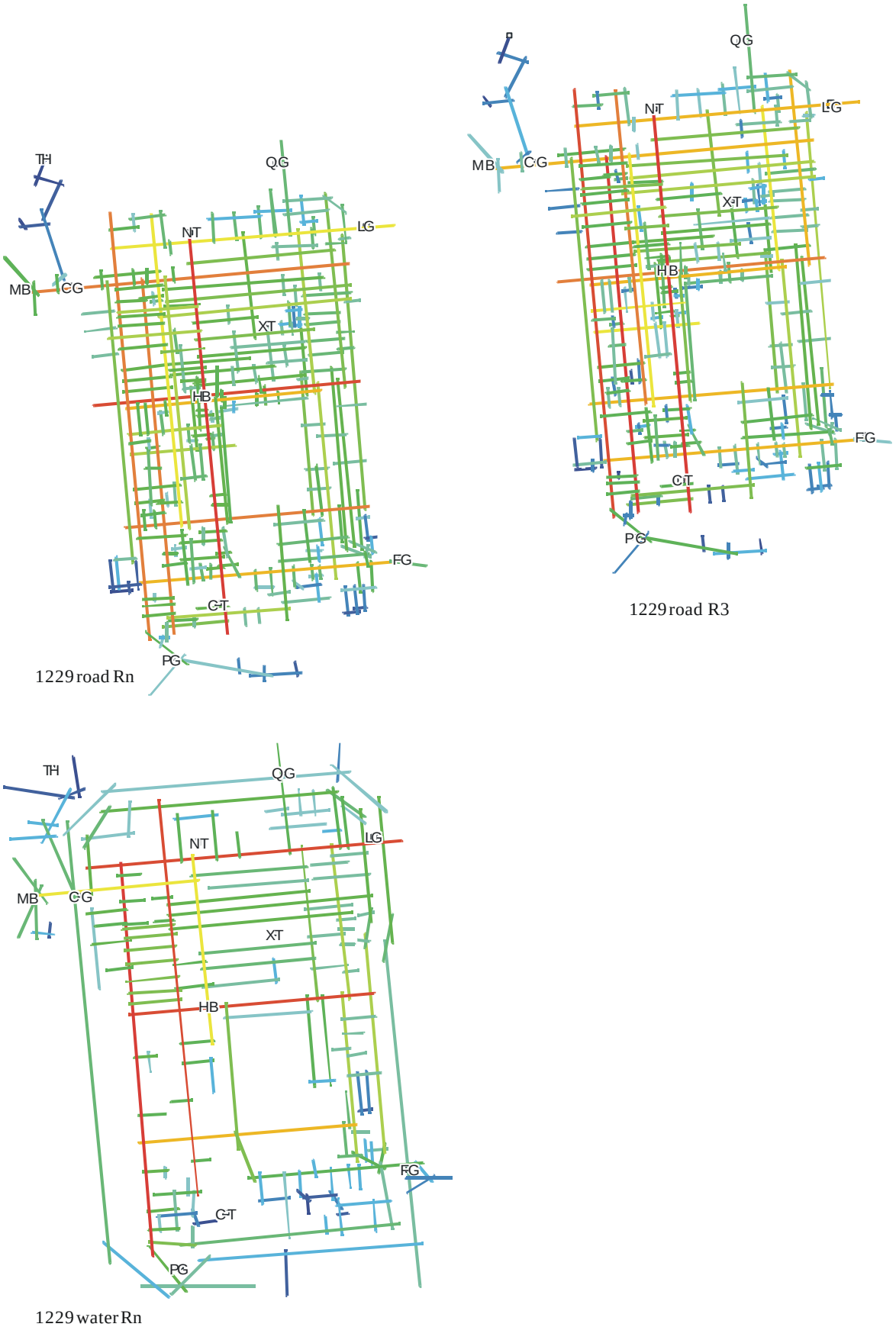


Figure 4.11: axial graphs of 1229 (Left)

Figure 4.12: axial graphs of 1745 (Right)

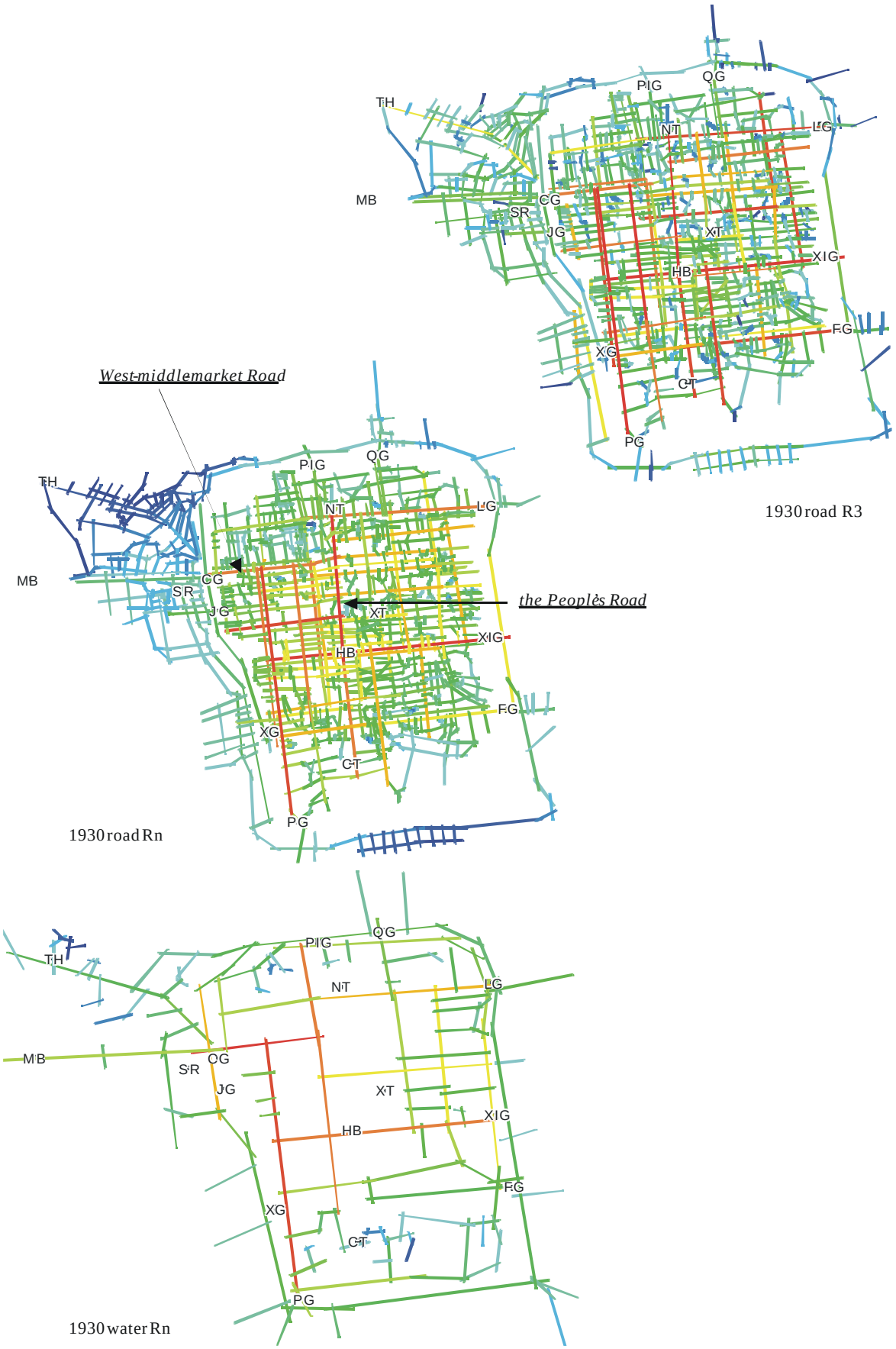


Figure 4.13: axial graphs of 1938

4.3 Re-examine the spatial structure with the help of alternative spatial models

The orthodox syntactic analysis provides us a measurable model of spatial structure. However, considering the social/spatial condition discussed in the general description, there are four doubts need further scrutiny. Firstly, the priority of Grand Canal is not showed in the water system analysis. In the reality, the west and south moats should be the most integrated watercourses, as they were on the main waterborne route, which the regional trading of the whole city was based on. The second is that the axial mapping of 1938 does not show the new construction of modern road at that time, which was actually the main spatial change in the early 19th century and had a significant effect on the shift of centers according to Chen. The third doubt is about the spatial property of Chang Gate area. From the analysis, it seems that the business streets do not have any spatial significance. Is that the truth, or might there be some aspects omitted by the model? The last question is about the local spatial property. Hillier has proposed that there is limitation of syntactic analysis on capturing the local spatial property which is very important to the emergence of center (1999, p.109). So, how should this study respond to this limitation?

These four doubts led to conduct four kinds of alternative spatial models as the complement of the orthodox syntactic analysis. The first type is trying to emphasize the importance of the Grand Canal by adding axial parcels[17] in the water system of 1745 and 1939 (figure 4.14a). How much should be added can let the west and south moat of the city, the part of the Grant Canal, be the most important space in the model? Figure 4.14b and figure 4.14c show the result: in both of the models, the watercourses starting from Chang Gate, are spatially significant in the bigger context of the Grand Canal.

The second alternative model is to map the modern thoroughfares of 1938 as a closed system of road vehicle. In figure 4.15, it shows that the integration core picked out by the global integration analysis is very well correlated with the distribution of business center in 1930's. The Stone area and the Guanqian Area were the dual business center

[17] Such kind of model has been used by Hillier in 'The hidden geometry of deformed grids', 1997

and shows in red and yellow color, the Daoqian Street connected them was also a busy street shows in the orange color.

1745 water system in the context (Figure 4.14b) 1938 water system in the context (Figure 4.14c)

Figure 4.14: water system in the regional context

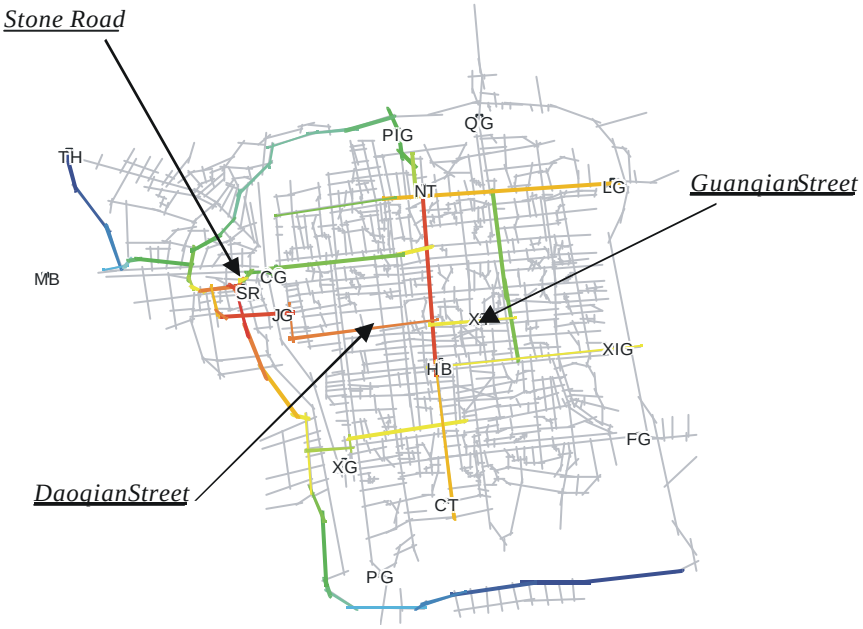


Figure 4.15: the vehicle model in 1938

In responding to the third doubt, the Chang Gate area needs to be analyzed by its own. As the area is not depicted in 1745's map, the map of 1938 is used. Figure 4.16a shows the road system itself; figure 4.16b shows the combined system of road and water in the same color range of figure 4.16b; figure 4.16c shows the combined system of road and water in its own color range. Three of them suggest that firstly there was a strong local structure in Chang Gate area; secondly, the combined system is much more integrated than the single route system. The three most important commercial roads in the 18th century are picked as highly integrated lines in these axial models. If we assume the morphology of this area in 18th century was similar as the one in the early 20th century, a conjecture can now be proposed for the puzzle why the Chang Gate Area don't be picked by the orthodox axial graphs. As the area was functioned as an independent structure, although this part was less integrated comparing to be inner walled area, the integrator of this small system still has the potential to be a local center. Again, convenient with the waterborne transport which connected this area with other cities in the route of the Grand Canal, the potential center then came into reality.

To explore the last doubt, the metric local property, four blocks of similar areas are picked from the 1930's axial map to make a comparative study *(Figure 4.17a)*. Each of them is surrounded by highly integrated lines. So, all of them fulfilled the global spatial property of a center. However, if studying the density and accessibility of the grid in each area, visual inspection of figure 4.17 shows the Area '1' has the most intensified grid, more circular route and smaller block size compared to the others. This can be proved by a simple Depthmap analysis[18]. In *Figure 4.17b*, it shows the measurement of 'Metric Mean Shortest-Path Distance' (The color range is set in a reversed way, red means shorter overall distance and blue means longer distance). *Figure 4.17c* shows the mean 'Metric Mean Shortest-Path Distance' of each system, the values are presented in Table 4.4. It is clearly that Area '1' got the shortest overall distance among the four sample areas. In the light of the results, we can suggest that, since Guanqian Area got the most intensified local grid, this area distinguished itself from other areas which also had a high global integration and became the business place in reality.

[18] This analysis was proposed by Professor Bill Hillier and carried out with his help in October, 2004.

Figure 4.16: two alternative modeling for the Chang Gate area by its own

Figure 4.17a

Figure 4.17b

Figure 4.17c

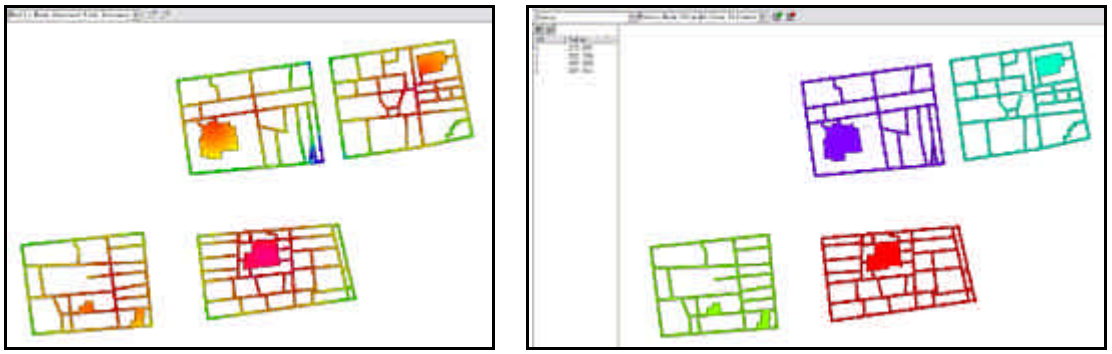


Figure 4.17: The comparison of four areas by their local property

Table 4.4: The data of the four areas from Depthmap analysis

Index	Area (m^2)	Perimeter (m)	Metric Node Count	Metric Mean Shortest-Path Distance
1	253005	2098	1491	**330.7403**
2	241446	1981	1023	368.6731
3	288030	2168	1417	410.2899
4	277538	2110	1300	372.8846

4.4 Urban elements in space structure

In the former section, the alternative models suggested that the spatial structure of Suzhou might be more dynamic than what is depicted by the orthodox syntactic analysis. It seems that the road system model, canal model and overland vehicle model might have different degree of rationality on functional pattern. In this section, it superimposed the main government office buildings, public sites and private gardens[19] on these varied axial graphs, in order to gain a more comprehensive picture of the form-function relationship.

The name of the urban elements had been listed in table 4.1-3. The results of superimposing are depicted in figure 4.18 to figure 4.20. Visual inspection of these graphs shows some overall patterns. Firstly, although different models shows different integration pattern, there is a general tendency that government offices are always near the higher integrated lines. Secondly, the main public sites and private gardens are near the higher integrated lines in some models (especially in the alternative ones), but isolated in the others (especially in the orthodox ones). Take the syntactic value of Tiger Hill (TH), Marble bridge (MB), and Remain garden (RG) in the models of 1938 for example (three of them are all in the west of the walled city). In the road system, they lie on isolated lines (show the blue color); in the water system model, the lines improve their syntactic values to middle level (green color); in the model of regional context of water system, the lines become the most integrated line of the whole system. Thirdly, it seems that the temples and government buildings have different spatial logic to the private gardens. they tend to locate at the end of an axial (such as the NT, XT, GT, AC, WC, YC, and CC), but private gardens tend to parallel with the axial. If we recall Hillier's argument about the fundamental difference between the urban forms of 'cities of social reproduction' and 'cities of social production' (Hillier, 1996, Chapter Six), this finding just illustrated the theory: the two social functions required different urban form through which the axis is handled, one use axis as symbol and another as instrument.

[19] The private gardens were opened to public in the main festivals, so they were functionally important to the city.

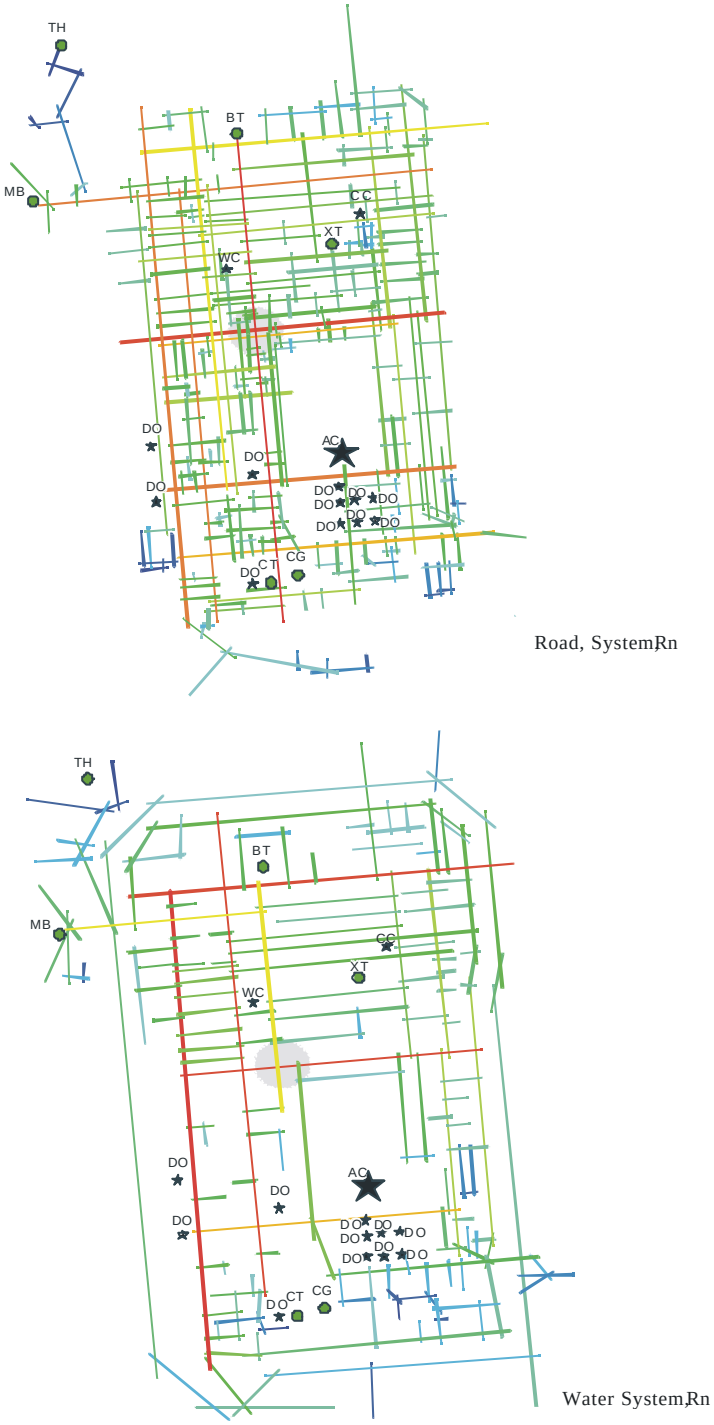
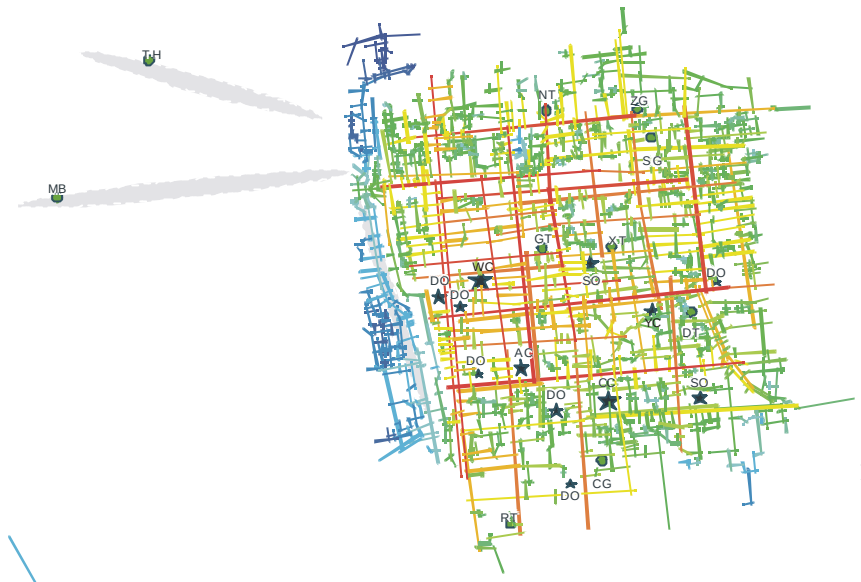
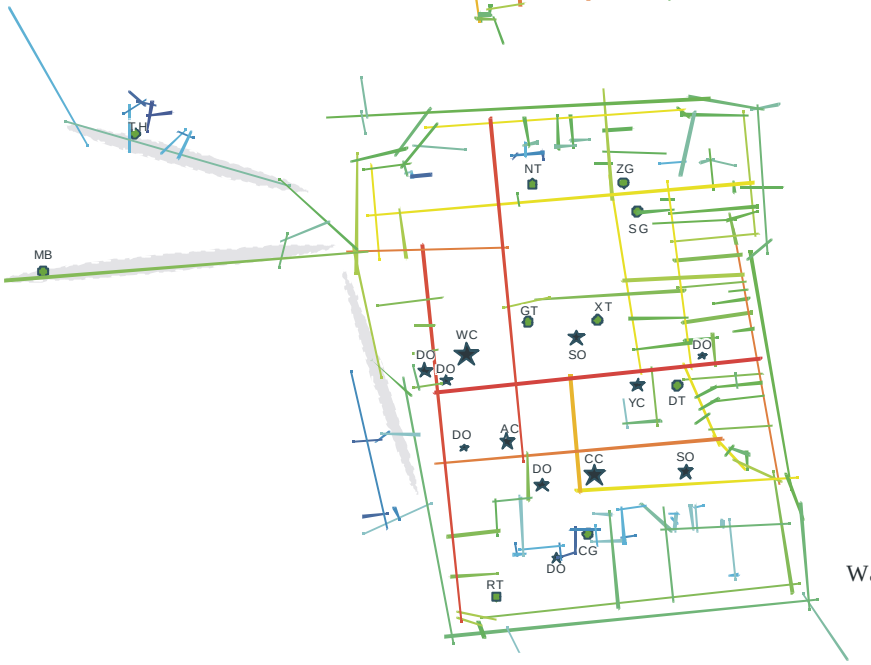


Figure 4.18: Urban Elements in 1229's spatial structure



Road System,Rn



Water System, Rn

Water System in a regional context, Rn

Figure 4.19: Urban Elements in 1745's spatial structure

Figure 4.20: Urban Elements in 1938's spatial structure

4.5 Findings

In this section, we review this chapter and summarize the conjectures and implications into six points.

1. In the description section, it proposed that the city has a canal system alongside the road system, the spatial structure of the city might have another alternative counterpart rather than the orthodox road structures.

2. In the syntactic part, the analysis showed the spatial structure of the road and water systems had a general coincidence of spatial structure; there was a strong relationship between the most integrated part of the urban grid and the location of the business center in 1229; however, the change of integration core was very subtle afterwards and not corresponded well with the change of business centers.

3. Four doubts suggested there might be some spatial properties omitted by the orthodox syntactic analysis. The alternative spatial models were carried out in respond to the doubtful points. It proposed that the spatial structure of Suzhou might be more dynamic than what is shown on the orthodox syntactic analysis. The change of social condition motivated different levels of spatial structures: the water system in regional context was thought as a powerful spatial structure when the city functioned as an interregional trading city; then the road vehicle system became the powerful structure while the overland transport replacing the waterborne transport.

4. Beside the global spatial property, the emergence of business center required the local spatial property. The local grid intensification of Guanqian Area, with more global integration, made it selected as the new center rather than other areas.

5. In the section of urban elements examination, it can be found that different functions have different degrees of sensitivity to each spatial system. To make a rough assertion, the business function is much more related to the canal system(in

the regional context); the government offices are much more effected by the orthodox road structure.

6. The spatial logics of the temples/government buildings and the private gardens are different, one use axis as symbol and another takes it as instrument.

CHAPTER 5: MASSIVE URBAN GROWTH AFTER 1949

This chapter studies the stage after 1949 with a massive urban expansion. Two points, 1986 and 2004, were picked to analyze. Although the complex transformation of this period itself deserves an independent thesis, this research would focus on the difference of the form-function relationship between this period and the pre-1949. The first section gives a general description for the historical background: the policy changes, special events, the business activity pattern and morphological features. Two difficulties of analysis were proposed. The second section conducts both the orthodox syntactic analysis and Iida Syntaxa Model, which is based on a segmental angular analysis (Hillier, 2004). As the canal lost its importance in terms of transportation shift, this modeling would not be conducted. The third part examines the urban elements and gives a synthesis of their syntactic changes from 13th century, by which the third issue discussed in the introduction part is attempted to get an answer. The last part reviews this chapter and summarized the findings.

5.1 General description

Generally speaking, the urban growth after 1949 is a massive development compared with the growth in the pre-1949 period. The total built-area of the city increased to 111.2 square kilometer in 2001, nearly six times as big as the city in 1949[20] (Figure 5.1, 5.2). The canal system in this period lost its importance for two reasons. The first is the change route of the Grand Canal in 1950's. It moved five kilometers to the west *(see the*

[20] These are no accurate data for the built area of 2004, as the city changed its jurisdiction area in 2001, so included the area of neighboring towns which has few relation to the center city this paper studied. But the rough area of 2004 is about 130 square kilometers.

doted red line in Figure 1.2), the city moat near Change Gate is not any more the freight route by water. The second and more important reason is the shift of the transportation means – the overland vehicles were much popular than the waterborne vehicles, This lead to the gradually losing position of the watercourse and arising of overland transportation. In addition, the water in canals was heavily polluted without strong regulation and control, consequently the filling of the canal began to be carried out. The length of the canal inside the city moat was reduced heavily *(Table 5.1) (figure 5.3)*.

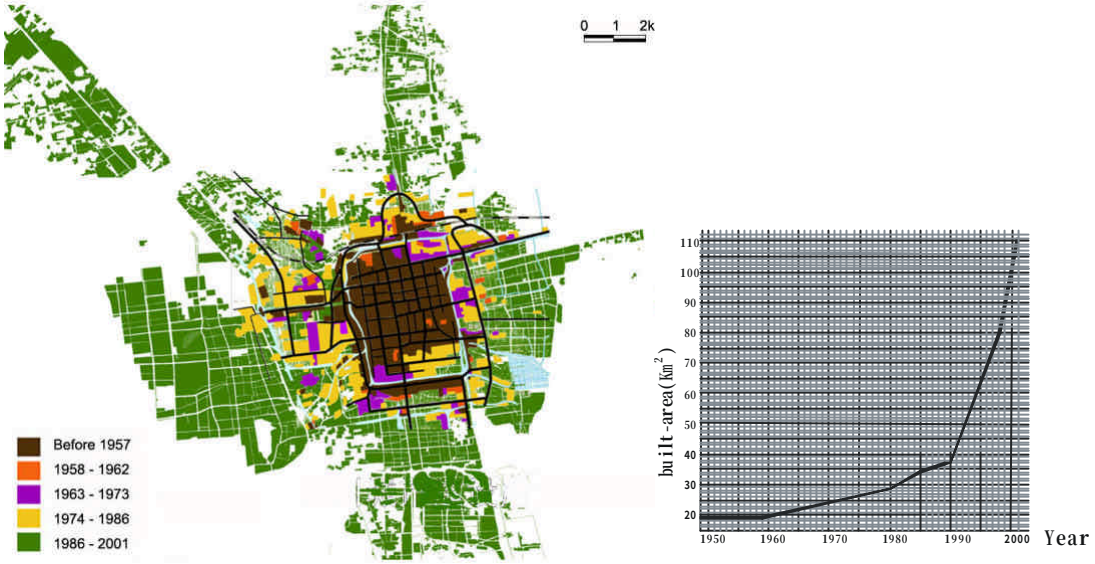


Figure 5.1: The expansion process of Suzhou (Left). Source: Suzhou Planning Bureau Documents
Figure 5.2: Chart of urban expansion from 1949 (Right). Source: adapted from Chen's PHD study

Year	Number of Bridge	Watercourse Length (km)
1229	305	84 - 89
1745	/	57
1930	/	49
2000	163	**35.28**

Table 5.1: The change of the canal system inside the city moat
Figure 5.3: The negligence of the canal. Source: PHD thesis of Chen, 2001

The development in this stage was not homogeneous but distinctly different in terms of governmental policies, function orientation and expansion speed. It can be subdivided into three stages: 1949-1977, 1978-1991, and 1992-2004. Before 1978, the urban

growth was limited. Restricted by communism ideology of "working first, living later", industry priority became the most important urban land-use policy (*Figure 5.3, 5.4* shows the expansion of the industry land from 1957 to 1973). In contrast, the business activity was decreased quite a lot. There were no private business activities allowed, so the small business places were forced to close and transformed to the residential or industrial functions[21]. The location of business center did not changed in this period because the Stone Road Area and Guanqian Street Area were assigned to be the main commercial centers by the government. Under an abnormal political control, the influence of spatial structure to functional pattern of the city was damaged and very weak. Therefore, this period would not be analyzed in this paper.

Figure 5.4: The distribution of industry land in 1957. Source: PHD thesis of Chen, 2001
Figure 5.5: The distribution of industry land in 1973. Source: PHD thesis of Chen, 2001

The second period is between 1978 to 1991. After the ending of the Culture Evolution[22], the economy of Suzhou was generally recovered, and private business activities began to be activated in this stage but still in a confined scope. The city expansion was in a considerable speed. Figure 5.6 shows in 1985, the east part of the New District (the suburb district at that time) was nearly taking shape. Since Suzhou was a major sightseeing attraction for both domestic and foreign tourists[23]. So, it is not a surprise that retail located around these scenic points. At the same time, the Southern Gate Area

[21] Shan-tang Road is a good example. In the 1950's, it had 574 commercial firms within 84 different professions, however, after the forbiddance of private business activity, except for three street segments near the scenic points, most of the business firms transformed into residential use (Suzhou Shizi, p. 728).
[22] The Cuture Revolution was ten years painful experience. There was no economic development in that stage.
[23] A survey record the number of tourist in the national day of 1983 showed that there were 156,751 visitors among 17 sceneries of Suzhou. Tiger Hill got in top number of 21,156 people. (Suzhou Chengjian Dashiji)

raised as a sub-center where the wholesale markets located. In order to solve the problem that the residents in the New District must go to the old town for shopping, the Plan of 1986 proposed to develop a new 'business center' in the west of the old town. However, it didn't come into being eventually. Tan, the former director of Suzhou Planning Bureau, suggested that this failure was mainly due to the fact that the original planned site for business was taken by the municipal administration office, which occupied the whole block[24].The form-function relationship of this period will be analyzed based on the map 1986 (Figure 5.6, 5.7; table 5.2).

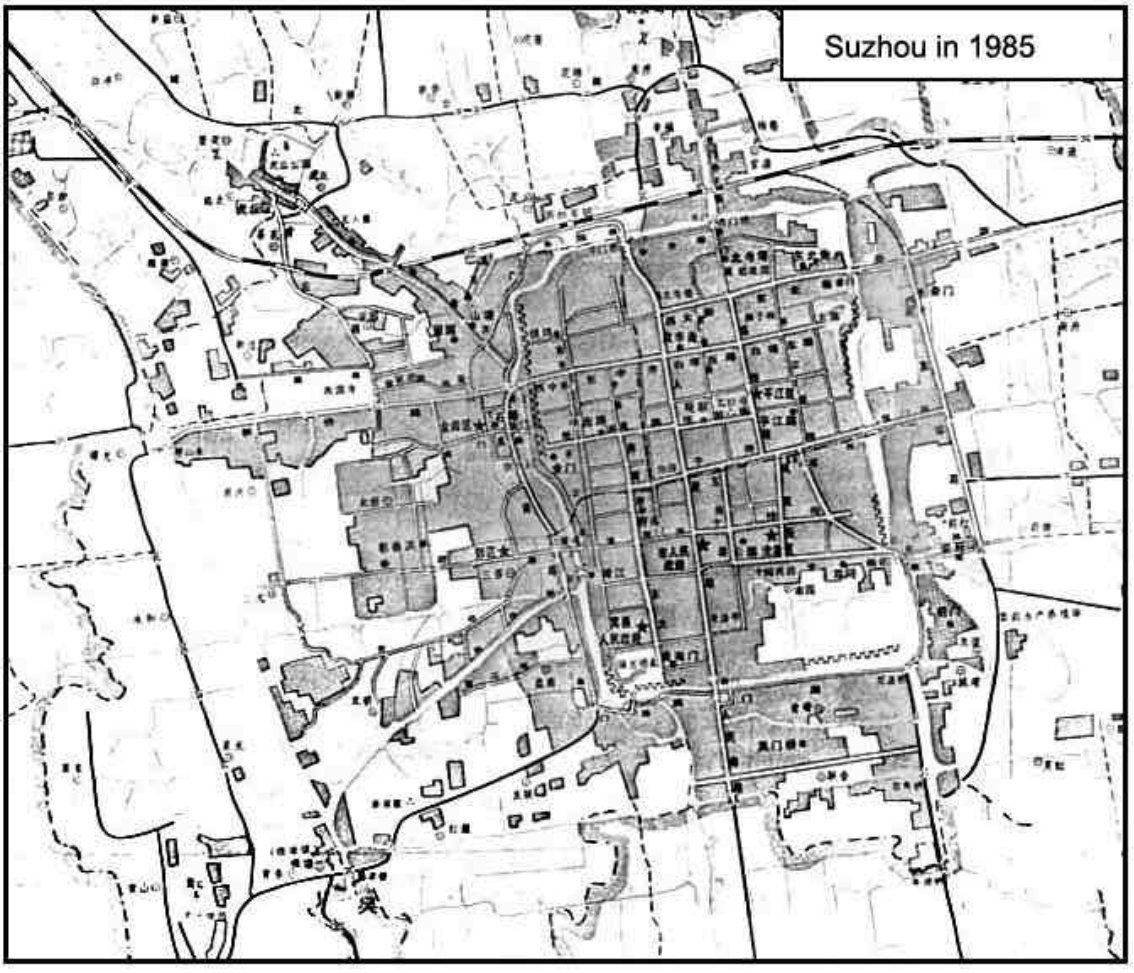


Figure 5.6: The Map of Suzhou in 1985. Source: Tourist map in 1985

[24] This was gain from the interview with Tan taken in July 2004, Shanghai, by the author.

Table 5.2: Urban elements in 1986

B	Bussiness center	O	Office		T, H, B,		G
GB	Guanqian St. Area	AC	Administation Center	CT	Confucius Temple	CG	Changlang Garden
SB	Stone Road Area	CC	Changlang District Center	DT	Dual Pagoda	OG	Ou Garden
		PC	Pingjiang District Center	NT	Northern Temple	PG	Public garden
		JC	Jinchang District Center	RT	Ruiguang Pagoda	RG	Remain garden
		WC	Wu County Center	XT	Xuanmiao Temple	SG	Shizilin garden
		SC	Suburb District Center	TH	Tiger Hill	WG	Wangsi Garden
				MB	Maple Bridge	XG	XI garden
				Zoo	Zoo	YG	Yi garden
						ZG	Zuozheng garden

Figure 5.7: 1986 axial map and land use

The third period is from 1992 onward, when the planed economy was replaced by the market economy[25]. The city got an enormous economic achievements[26] in this period.

[25] The year when Xiaoping Deng, the 'main architect of China', made a symbolic tour in south China. After that, the

There were two economic development zones founded in 1990s, the National High Technical Development Zones in the west of New District (in the west of the new route of the Grand Canal) and the Industry Park[27] in the east of the old town. Attempting to attract foreign investments, the new urban area was constructed in a great speed[28] (Figure 5.7). Suzhou was beginning to shape the triplex urban form: the old town with two wings in each side. The success of its export-oriented economy made Suzhou again become an economically important city in China[29]. According to Chen's study, the main business areas are still the Guanqian and Stone area. However, as he pointed out, the dual centers are far less than the real requirement for the large area of Suzhou. Thus, is there any new commercial development after Chen's research carried on in 2001? The observation and data collection of the author show that there are three types of sub-centers evolved in the recent three years. The first type is the Neighborhood Center in the Industry Park due to a planning control that, within walking distance of every 500 meters, there should be a building complex containing commercial facilities. The second type is the large scaled supermarket where the local people purchase their daily consumable. There are three in the New District and one in the Industry Park. The last type is the specialized commercial street. Shiquan Street is famous for antique; Pishi lane is famous for flower; and a segment of Shan-tang Street to Tiger Hill is famous for wedding dress. There are also catering oriented streets providing foreign recipes. One is the Business Street in the New District, which emerged three years ago from just one Japanese restaurant. Another is the Suhui Road in the Industry Park, a new development in this year. The thousands of foreign staff in the foreign-invested companies are the main customers of these two catering street *(Figure 5.8*). As discussed in the introduction chapter, the historical development led three types of grid coexist in the contemporary Suzhou. They are the small scaled interrupted grid in the old town, the small scaled deformed grid in the Chang gate area and the large scaled interrupted grid in the New District and the Industry Park. Although the width of the streets in the new

central government generally adopted the Market Economy as the basis of national economic policies.

[26] The annual increasing rate of the citizen income of Suzhou from 1981 to 2000 is 17.24%. The annual increasing rate of GDP from 1992 to 1997 is 25.8%. Source: Jiangsu Province Statistic, 2002

[27] A collaboration project between China and Singapore, also named as China-Singapore Suzhou Industrial Park.

[28] The Industrial Park began to construct in 1994, with the first stage of 8 kilometers built-area completed in 2000.

[29] The recent report of the competence of Chinese cities gave Suzhou the 5th rank among 200 cities. The report was conducted by the Ni Pengfei research group in Shanghai. The other four cities are Shanghai, Beijing, Shenzhen, and Guangzhou.

urban area is large, the density of the street network is very low[30]. Most of the developments in this stage are gated communities, no matter it is residential district, office, school, hotel or factory, which made more than a half of the street frontage is un-active *(Figure 5.11)*. The form-function relationship of this period would be analyzed based on the map 2004 *(Figure 1.4, 5.10; table 5.3)*.

Figure 5.8: Industry Park before and after construction in ten years. Source: Suzhou Planning Bureau document

Figure 5.9: Distribution of three new types of business sub-centers and the two main centers

[30] *'The super block system with very low proportions of land given over to roads – just 9% in Shanghai and rarely more than 20% in any city (World Bank, 1996) – led to most traffic, including buses, being forced onto a limited road system'* (John Zacharias, 2002). The proportions of land given to road in 1982 of Suzhou was 3.35%(Chen, 2001).

Table 5.3: Urban elements in 2004

B	Bussiness center	O	Office	T, H, B,		G	
GB	Guanqian St. Area	AC	Administation Center	CT	Confucius Temple	CG	Changlang Garden
SB	Stone Road Area	HC	Tiger Hill District Center	DT	Dual Pagoda	OG	Ou Garden
		PC	Pingjiang District Center	NT	Northern Temple	PG	Public garden
		JC	Jinchang District Center	RT	Ruiguang Pagoda	RG	Remain garden
		IC	Industry Park District Center	XT	Xuanmiao Temple	SG	Shizilin garden
		WC	Wuzhong District Center	TH	Tiger Hill	WG	Wangsi Garden
		CC	Changlang District Center	MB	Maple Bridge	XG	XI garden
				Zoo	Zoo	YG	Yi garden
						ZG	Zuozheng garden

Figure 5.10: 2004 axial map and land use

Figure 5.11 Gated communities and the un-active frontage of streets in New District

5.2 Syntactic analysis of the spatial structure

Before carrying out the syntactic analysis, there are two difficulties that should be noted. Firstly, the description part shows that the urban growth after 1949 has been always under the control of the state and local government, to some degree. Every major spatial change was due to the interventions from government; and every major social change was a mixture of natural evolution and governmental interventions[31]. The studied subject is not an outcome of a natural urban growth, therefore the speculation of the independent effect of spatial structure to functional pattern is especially difficult. Secondly, the co-existent of different kind of grids in the same city is an unusual spatial condition. Due to the different density of the road network, the weight of axial line (building density and population) in the old part is much less than the one in the new part of urban area. This feature raises a question on the reliability of the axial model.

The axial graphs are marked by the landmarks as the former chapter[32]. Visual inspection of the 1986's axial graph *(figure 5.12)* shows that the integration core of the city is still in the northwest part of the inner city. However, there are two high integrated lines extending to the New District, and one high integrated line (People's Road) extending to the southern area outside the city moat. As there are most direct connects made between the inner city and the west part, the former Chang Gate area becomes much more integrated.

In the syntactic analysis of 2004 *(figure 5.13)*, the global integration graph shows that the integration core is still a super grid form but extending further to the west and east. If comparing the integration core in 2004's analysis with the one in 1938, we can propose that the cover area of integration core is enlarged with the urban growth in a similar speed –now it is about four times as large as the one in 1938. The local integration graph is a bit different from the global one. There are local integrators appeared in the western, northern, and southern area, which suggests that there might be

[31] An example is the Huahai Street which emergent as a catering oriented street three years ago. It now has a comprehensive development program on it conducted by the local government, encouraging it to be a business Street (even its name was changed to 'Business Street').

[32] Although the city gates were almost disappeared, they are still used as reference of the position.

several strong sub-areas generated in the city.

1986 R3

1986 Rn

Figure 5.12: Syntactic analysis of 1986

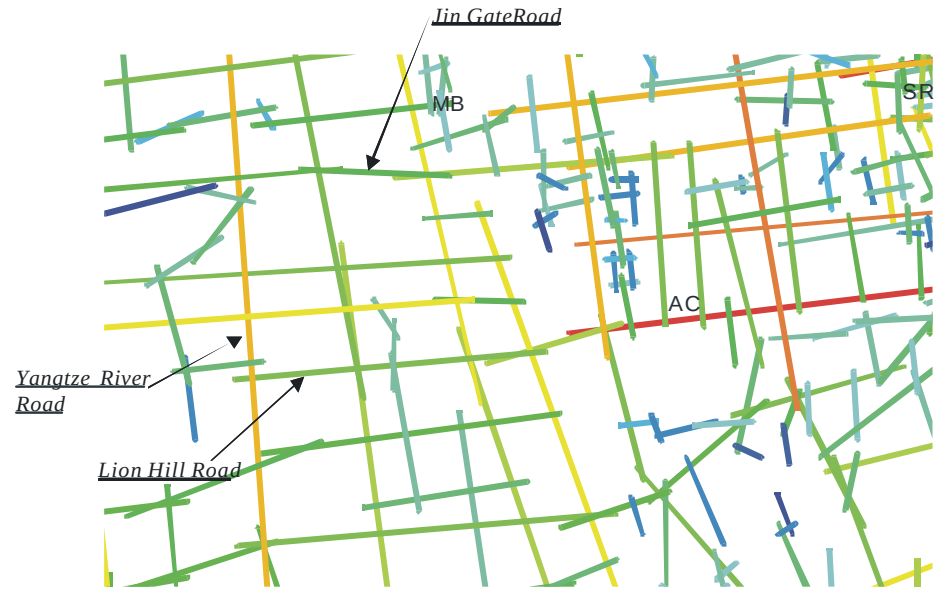
2004 R3

2004 Rn

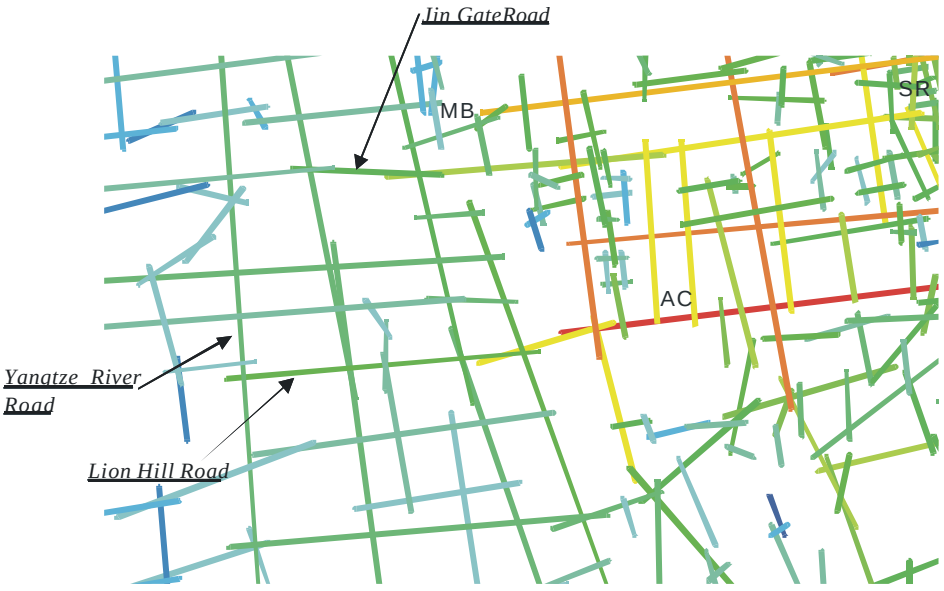
Figure 5.13: Syntactic analysis of 2004

However, a careful examination shows that there are some questions on the rationality of the axial model 2004. A part near the Maple Bridge of the axial graph is shown on figure 5.14. There are two slightly bended roads, Jin Gate Road (started from SR) and

Lion Hill Road (started from AC) passing through this area. As they are bended roads that cannot be seen through in the axial map, each of them is represented as more than three axial lines. Thereafter, the integration values of the axial lines are varied although they belong to the same road. We can notice a dramatic decrease of integration value from the east to the west: the color of Jin Gate Road is from orange, light green to dark green, the color of Lion Hill Road is from red to light green to green. However, in reality, these two roads both containing similar heavy traffic in every segment.



2004 R3



2004 Rn

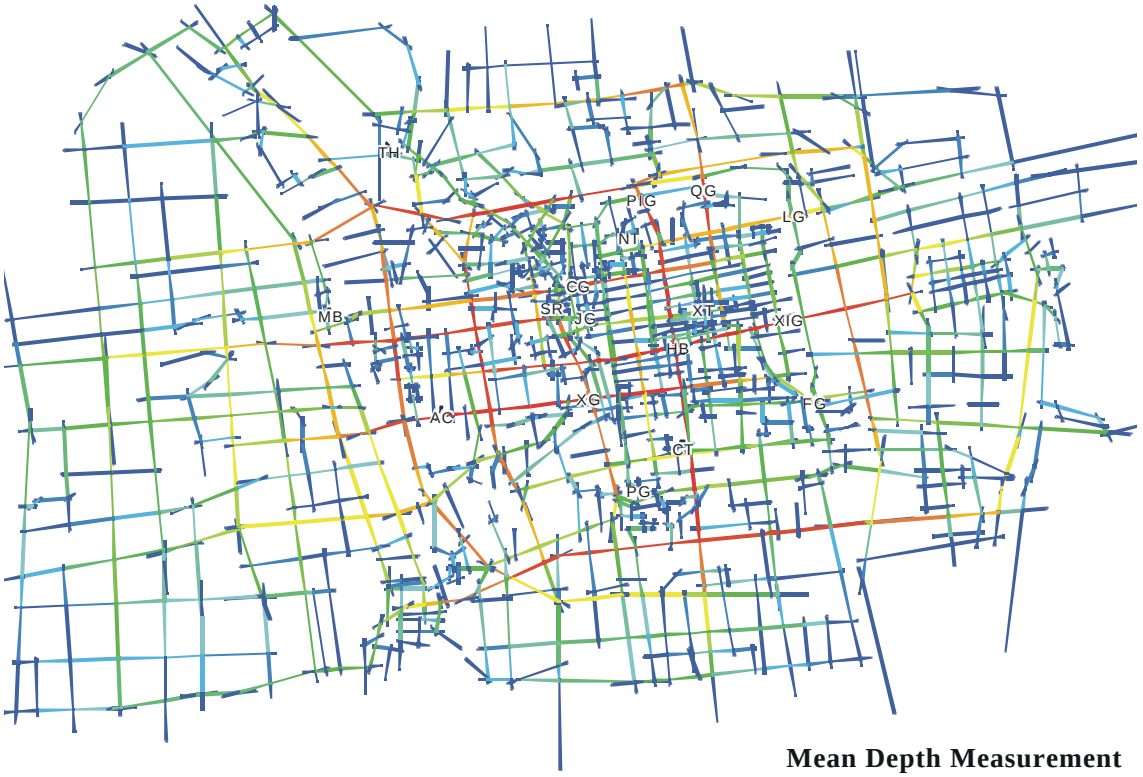
Figure 5.14: detail of the syntactic analysis 2004

Due to the nature of an interrupted grid, the interrupted grid tends to contain two types of angular change, the nearly zero degree change and the nearly ninety degrees change. As the axial map does not weight the angular change, a five degrees change will be regarded as a one topological step. In a deformed grid, Hillier has argued this is not a problem, because 'the hidden geometry of deformed grids' has already contained the variable of the angular difference. However, it would be a big question for the interrupted grid which has a different spatial logic. The nearly zero degree change in topological sense creates a step, however, in cognitive sense, it is not a step at all.

For this consideration, this study needs to apply the Iida Syntaxa Model[33], based on a segment model that makes the segment of junctions the basic element of our analysis rather than the line. This model then assigns each of the segments a value between 0 and 1 depending on the angle of connection, with 0 being assigned for a straight continuation and 1 for a right angle' (Hillier, 2004). Figure 5.15 shows the result of this model with the measurement of 'global mean depth' and 'choice 1'. A simple visual examination shows that the problem proposed previously was solved successfully.

As the different degree of angular changes is reflected by the graph, the syntactic value change of the bended roads is quite subtle now. Both of the measurements picked out the ring road and the super grid road as the most integrated lines. Other local mean depth measurements are also conducted. As the total depth is 103, the study chooses the radius 3, 10, 20, 30, 40, 50 , 60, 70, 80, and 90 as samples. The result of these varied local mean depth measurements shows that different integration cores are picked by different radios. The most true-to-life radios are presented in Figure 5.16. Radius 40 measurement picks out the main routes connected the three part of the triplex form; radius 60 stresses the significance of People's road and Ganjiang Road, from a cross in the old town; radius 90 measurement picks China-Singapore Road (the extension of the Ganjiang Road) as the dominant integrator, coincident with the planned main axes connecting the old town with the Industry park.

[33] The processing of this model was conducted by Iida, the analysis work is done by the author.



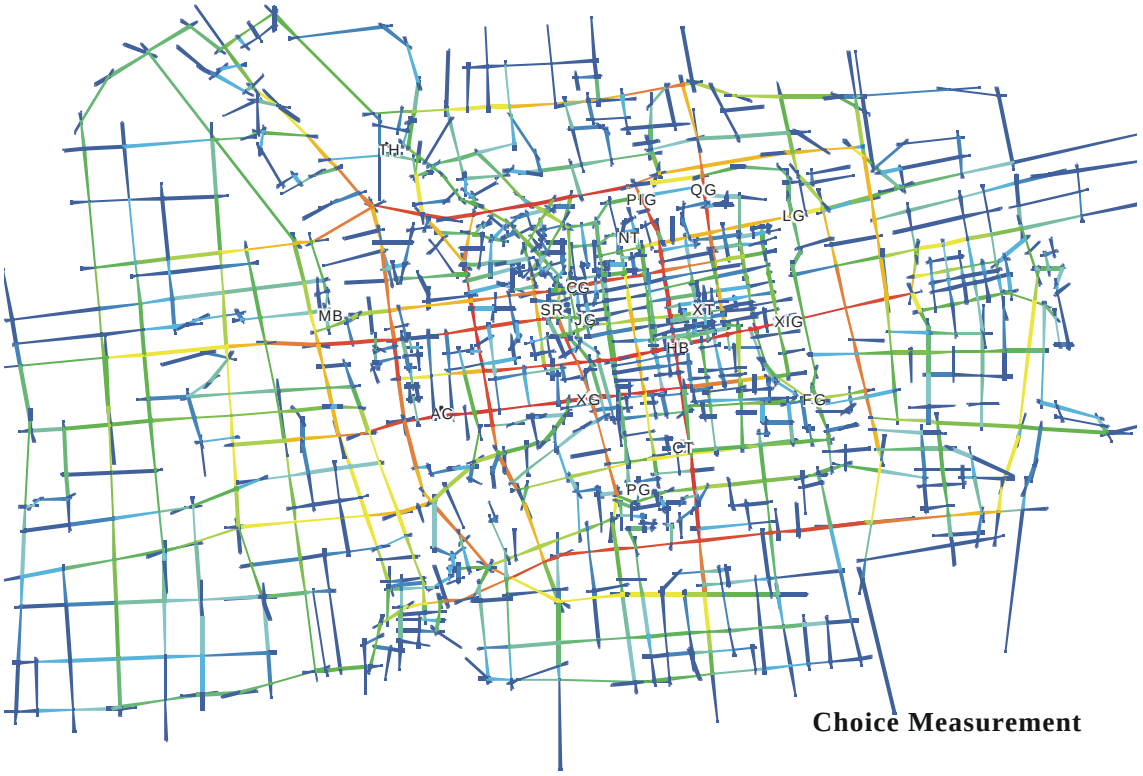


Figure 5.15: Iida Syntaxa Model analysis, ‘global mean depth’ and ‘choice’ measurements

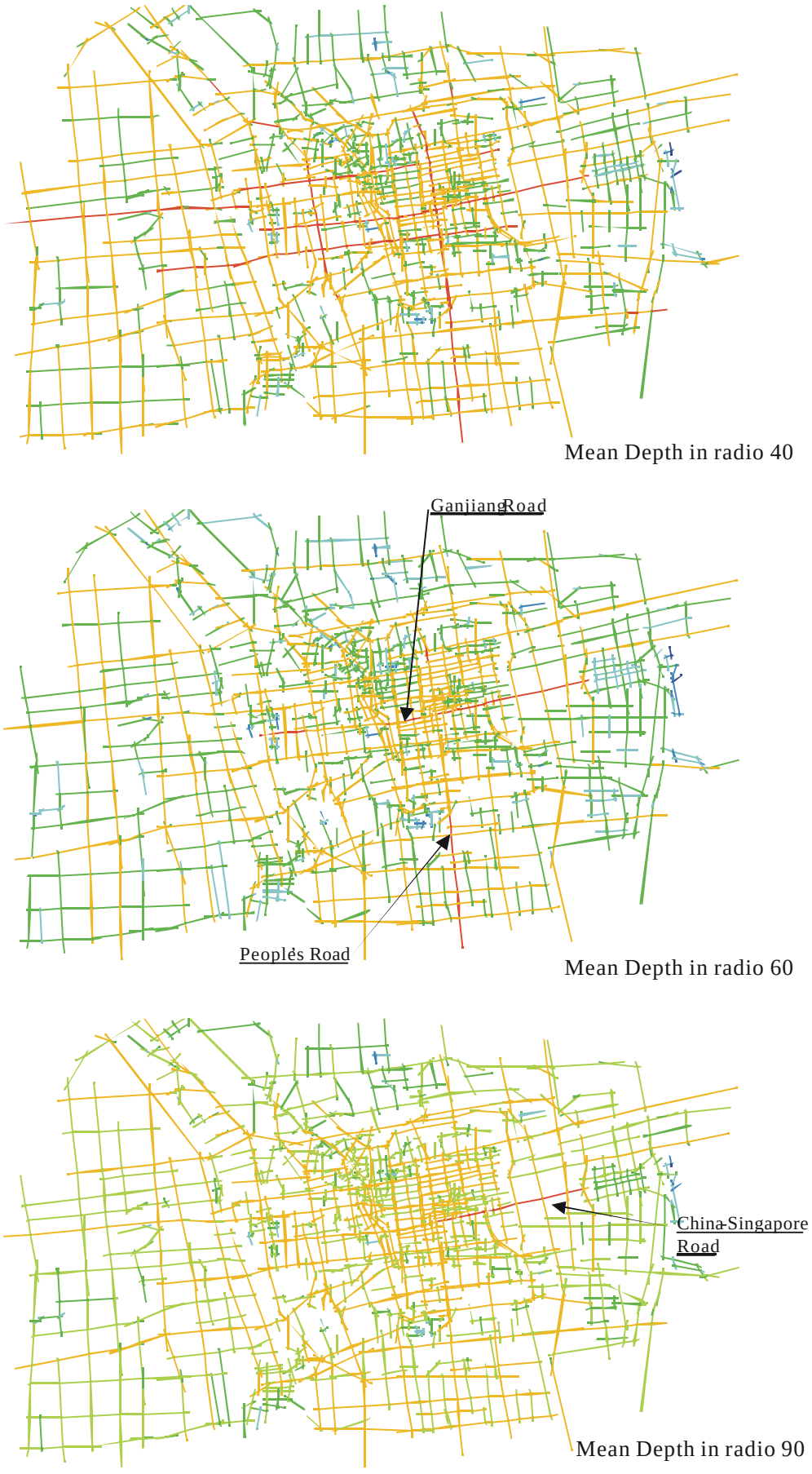


Figure 5.16: Iida Syntaxa Model analysis, 'local mean depth' measurements

5.3 Urban elements in space structure through 700 years

In this investigation, again, it chooses the most important government offices, public sites and private gardens, superimposing them on the axial graphs. The names of these elements had been listed in the table 5.2, 5.3. To make the study consistent, the global integration graph of the orthodox syntactic analysis is used *(Figure 5.18, 19).* The result shows the similar features that the government offices are still near the most integrated lines. One point is of particular interest, that the elements are no longer located at the end of axes. Taking Northern Temple for an example, it stopped a very important axis of the city People's Road in the pre-1949's period. However, after the numerous reconstruction around this place, now the road rounded the Temple to the northern part of the city as a slightly bended road.

In the introduction chapter, it proposed an issue whether the syntactic spatial property of the historical urban elements changed in the history. Here we take the oldest urban elements to make a review. The locations of these six elements are marked on the *Figure 5.19.* Table 5.4 lists the colors of the lines with these elements[34]. It is clear that Northern Temple, which was on a high integrated lines in the 13th century, still hold a significant syntactic position. The rest of all the elements get a different improvement in terms of integration value. So, the finding shows a comparable result to the Iranian case. The conjecture made here is about this is just another important nature of the interrupted grid. As the integrators of the old grid were usually the straight long lines, in the modernization process, these lines have a strong potential to be extended to the periphery area. In Suzhou, it can be found the integrators of 1229's map were all extended to the periphery. Some lines were once stopped by the city wall and moat, but the new gates were added to let the lines passing through[35], or even destroyed the wall eventually. In such a way, the spatial spirit of the old grid was kept, the old integrators are still the most integrated lines currently; so do the urban elements.

[34] The color of line in the global integration graph is used.
[35] The number of the gate was increased from six in 1745 to ten in 1930.

Figure 5.18 Urban Elements in 1986's axial model, Rn

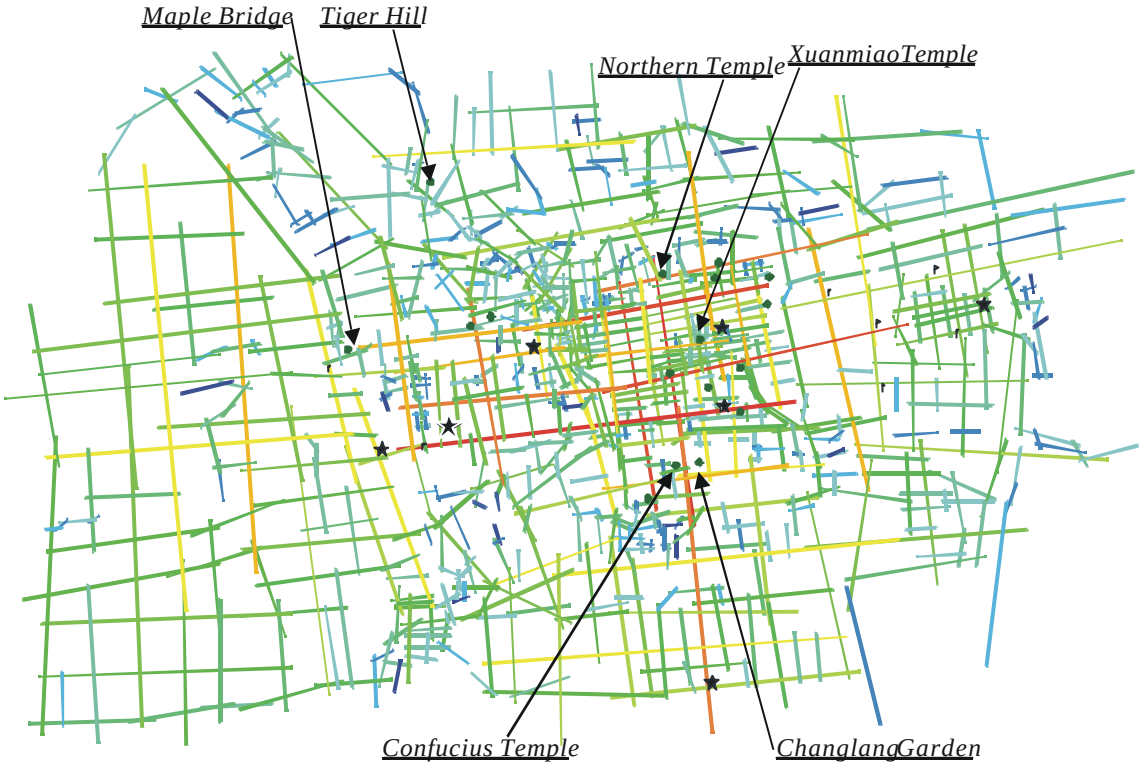


Figure 5.19 Urban Elements in 2004's axial model, Rn

Table 5.4 the syntactic value change of oldest six urban elements

	Name	1229	1745	1938	1986	2004
CT	Confucius Temple	green	yellow	green	green	green
NT	Northern Temple	red	red	red	red	red
XT	Xuanmiao Temple	green	orange	yellow	yellow	orange
TH	Tiger Hill	dark glue	/	dark glue	dark blue	green
MB	Maple Bridge	green	/	light blue	light green	orange
CG	Changlang Garden	green	green	green	light green	orange

5.4 Findings

The result and implication of this chapter can be summarized as follows:

1. The description section shows that in the post-1949 period, the government intervention had effects on every aspect of urban growth to some degree. The form-function relation is not the production of natural growth. It also suggested that the canal system is not active in this stage; the morphology of the city is now a mixture of three kind of grids.

2. The syntactic analysis section shows the change of the spatial structure, proposed that the cover area of the integration core is enlarged with the expansion of the city. It also pointed out the difficulty of orthodox axial graphs on analyzing a complex interrupted grid. The application of Iida Syntaxa Model solved the problem and showed its trait on capturing different levels of integration cores.

3. The examination of urban elements shows the phenomena that some building located at the end of axes no longer existed, and this also suggested that the instrument function of axis now exceeded its symbolic function. Generally speaking, the historical elements kept their spatial features in the long history. The conjecture is that an interrupted grid tends to keep the significance of the old integrator in the expansion process.

CHAPTER 6: DISCUSSION AND CONCLUSIONS

In this chapter, we first reviews the four key issues proposed in introduction part, discussing how the findings actually give answer to these questions. A whole picture of the form-function relation in the history is then outlined. A more generic conclusion is made in the end.

The first issue was raised by a puzzle proposed by Chen, that although the expansion of the city in pre-1949 period was much slower than the one in post-1949 period, the shifts of business centre were all happened in the former stage *(Figure 6.1)*. The explanation can be made by two parts of conjectures. Firstly, the historical centres have their internal persistent power, which required a very long time to form a new centre. Although the spatial change after 1949 is dramatic, this period might not long enough to establish of a new centre. As there has been sub-centres emerged in the periphery of the old town, it is very possible that one of them will rise as the new centre in the future. Secondly, as Hillier suggested, a successful business centre need two parts of spatial properties: the higher global integration value and the local grid intensification. As the density of the road network in the new development areas is very low, it could not fulfil the second requirement of centre. So, it is not a surprise that the old centres kept their position continually.

The second issue is about the meaning of the canal system to the functional pattern of Suzhou. The historical review showed that the canal was very important to the city in pre-1949 period, as it was a main mean of transportation. In the syntactic analysis, it

showed that the business centres in the Qing Dynasty and Republic China period cannot be captured by the road structure, but can be captured by the structure showed in the 'water system in the regional context' model. In the light of these results, we can hypothesize that the canal system provided an alternative spatial structure for the city that was different from the road system. It was the power of this structure led the centre shifted from the middle of the city to the edge.

The third issue is about the stability of the physical positions of historical urban elements against the change of their syntactic context. The finding shows that the change of syntactic values is actually not much. In the modernisation process, the integrators of the old grid were extended to the periphery area, so they kept their syntactic significance in the enlarged grid. Therefore the main urban elements, which located in the main lines also kept their syntactic trait.

The last issue is about the special character of 'interrupted' as opposed to the more common 'deformed' grids. The former issue has showed one trait of it, that in the expansion process, the old integrators of the system have great potential to be extended to the new urban part, so keep their significance. Another trait is the two types of angular changes, either be 0 degree or 90 degree. This adds a difficulty for the orthodox syntactic analysis. Iida Syntaxa Model is proposed as a possible solution for this problem.

After answering the four issues, a whole picture of the form-function relationship is trying to be outlined. Firstly, just as Chen proposed, there is an interactive relationship between the functional pattern and the spatial structure. The analysis showed that the spatial structure have had comprehensive impact on the distribution of commercial and administration functions. It also suggested that some important functions (temple, scenic point) have the power to pull the integration core to their direction. The second point is that there could be different layers of spatial structure co-existent in one period. The sensitive of different functions to these layers of structures might be different. E.g. the 1938's analysis showed that the retail function was more sensitive to the regional

canal structure, while the administration function at that time was more sensitive to the road structure. The third point is about the difference between pre-1949 period and post-1949 period. The study showed that the form-function relationship is more natural in the former period. The relationship in the latter period is strongly influenced by the government invention, the assignment of business centres made the inspection of the study quite difficult.

Reviewing this large scoped research at the end, there are two points could be proposed as the generic conclusion. Firstly, in the process of the research, the methodology was improved. Doubts emerged after the orthodox syntactic analysis brought in new spatial models according to the specific social context, which is proposed as crucial complement model for the understanding of the spatial structure. This adaptation of spatial model is coherent with the spirit of space syntax, which itself is an on-going framework of research. The second point is about the practical meaning of this study. It can be noticed that there is a contradiction between the 'metric' idea containing in the masterplan of Suzhou and the 'structured' idea suggested by this study. Figure 6.2 shows a diagram for the planned commercial centers in the Industry Park which is now under construction. The location of these pre-conceived centers is clearly decided by a metric idea. However, the proposal this study made is that the most sustainable position for business center should be explored in the configuration structure of a city. Both local and global spatial properties should be considered in a network relation among the spaces. The practical meaning of this study is just here: throw light on the independent power of spatial structure, improve our ability to plan the city to a more sustainable direction.

Figure 6.1 The change of city form and center location from 13th century

Figure 6.2 The diagram of the location decision of neighborhood centers. Source: Suzhou Planning Bureau document

APPENDIX

Appendix 1: Important event of Suzhou in the history

Source: Chinese Encyclopedia 1980, shanghai, p. 666; Suzhou Chengjian Dashiji, Suzhou Shizi Research Group, 1995; Suzhou Shizi (The historical record of Suzhou City), Suzhou Shizi Research Group, 1995

Wu 222-80 B. C.

Sui 581-618

610 A. D. The finishing construction of the Grand Canal

Tang 618-907

Northern song 960-1126

Southern song 1127-1279

1130 War, which almost turned the city into debris

1229 The carving of Pingjiang map after the completion of the city's reconstruction

Yuan 1271-1368

In the end of this Dynasty, the former prefecture residence in geometric center of the city, was used by Zhang Zhicheng, who claimed himself as an emperor. The palace was burned down with his failure.

Ming 1368-1644

The enlarge of the Xuanmiao Temple

Qing 1644-1911

1860 Taiping Rebellion against the Qing Dynasty

Shanghai replaced Suzhou as the main trading center of southern China

1908, the Nanjing- Shanghai railway passing the north of Suzhou was opened to transport.

1900's, the construction of the half ring road, which started from the railway station in the north to the custom house in the south.

Republic of China 1912-1948

1927, the proposal of Planning for Suzhou (Suzhou Gongwu Jihua Shexiang). Two circular routes for vehicle in the walled city were constructed after that proposal.

The dominated transportation tool was gradually shifted from boats to vehicles.

1937, In the war against Japanese, Stone Road Area was burned down. The west part of the inner city was also destroyed by the bombs.

People's Republic of China 1949- now

1949-1992 pre-market period, command economy

1958, the change route of the Grand Canal

1978, the end of Culture Revolution and the end of the abnormal functional pattern.

1986 the Plan for 1986-2000 was made, which suggested to built a new center in the New District

1992-2004 market economy

1992 the starting construction of the High-tech Industry park the west park of the New District

1994 the starting construction of the Industry park in the east of the old town

1999-2003 The urban renew project on the Guanqian Street Area

2003 The urban renew project on the Stone Road Area

Appendix 2: Glossary

* In most circumstance of this paper, the English translations of the Chinese terms are used in order to make the reading easier. If these are different names used for a same place in different period, only the recent name are used. In this appendix, the pinyin of these terms and alternative names are provided with the English translations.

City God temple: Chen huang miao

China- Singapore Road: Zhongxi Ru

Industry Park: Gongye Yuan Qu

Maple Bridge: Fen Qiao

New District: Qiao Qu (1980's); Xin Qu (now)

People's Road: Hulong Jie (pre-1949 name); Renmin Ru (now)

Remain Garden: Liu Yuan

Stone Road: Shi Ru

Tiger Hill: Hu Qiu

Up-tang Street: Shangtang Jie

Xuanmiao Temple: Tianqing Guan (Song Dynasty); Xuanmiao Guan

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