

Movement Technologies, Scale Structure and Metropolitan Life - an Empirical Research on the Effects of the Transportation System on the Metropolitan Process in Beijing

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1. Introduction: walls and pathways, 'setting boundaries' and 'making connections' as two strategies to regulate movement

We live in a world dominated by cities. Although not every corner has been urbanised, our way of life has been totally changed by this fast-extending and infinitely connected urban field. Metropolitan, as the origin of this word indicates, means 'mother city' in Greek. It stands out from other cities for its size and strong economical and cultural influence on the region, nation or the whole world. Instead of emphasising how a certain city or agglomeration of cities achieved this dominant position through politics, governance or economical development, this paper will try to look at how a metropolis, Beijing in this case, has come into being based on the development of modern transportation systems, which both support its functioning and give it a recognisable form.

'Cheng Shi', the Chinese word for 'city', has two characters: 'Cheng' means 'wall' and 'Shi' means 'market'.¹ The first character emphasises the role of the wall as a technical object which gives the city a distinctive 'form'; the second character reveals the functional content of city as a place for meeting and trading. This paper starts with a comparison between 'setting boundaries' and 'making connections' as two traditional approaches of regulating movement in and out of the city. The former, as an exclusive technology of claiming territories, reflects a spatial politics of segregation, while the latter, as an inclusive technology, brings different groups

together, stimulates exchange and transgresses boundaries.

Regardless of the fact that they seem to contradict each other as 'wall' versus 'path', practically these two approaches also work in alliance. For instance, in the Qin dynasty (209 B.C), emperor Qin Shi Huang re-built the Great Wall by linking the separate old walls of different kingdoms into one continuous defensive system to cope with the threat from the north. But what is normally neglected is the fact that he also built the new so-called 'Chi dao' (literally 'road for fast running horse') system which functioned as a national road network. Some of them were even made as 700km straight lines to move troops faster to the northern border. Considering the fact that the Great Wall itself was also used for transmitting signals of barbarian invasion rather than as a passive defensive structure, we can clearly see how they together functioned as one system holding the Qin Empire together as a perceivable and functional entity. Therefore, walls (together with gates) are as much movement-regulation technologies as today's trains, metros or highways.

Based on a line of thinking about the importance of movement-regulation technologies for making cities perceivable and functional objects, this paper tries to deal with two interrelated questions regarding Beijing's metropolitan form: Firstly, how have different transportation systems such as trains, buses, metros and highways influenced the formation of the metropolitan area in the last decades? Secondly,

how have changing transportation systems affected the emergence and morphology of central shopping and wholesale market places?

To address the first question, we will present the evolution or modernisation process of Beijing's movement technologies. By 'movement technology' we mean all the technical systems affecting people's movements rather than purely transportation technologies such as trains, buses or metros. This obviously includes the physical condition of the roads, such as width and paving, but it also includes non-physical organisational techniques, like the naming system that may reveal the scale hierarchies of streets. From this evolution process we can see how the old approach of using walls and gates to regulate the movement has been replaced by more complex modern transportation systems, and how certain transportation systems have contributed to the development of the historical city into a modern metropolis.

For the second question, we will present the morphology of metropolitan centralities in Beijing based on the data of shopping areas and wholesale markets in 1924, 1987 and 2006. The data will be analysed by spatial models constructed on the basis of the scales of movement networks presented in the previous part. From this study we may find how the logic of 'making connections' can affect the emergence of centralities, in place of a bounding in by walls and gates as in the past. Further, this analysis and model will be compared with the Central Place model used by Gao² to analyse the morphologies of Beijing's shopping centres.

2. Theoretical background: from Central Place as a hierarchical model to Central Flow as a network model

Central Place Theory was developed by the German geographer Walter Christaller³ based on his empirical research on the population, spacing and hierarchy of settlements in south Germany. In the

1960s, the American G. William Skinner⁴ analysed the rural market system in late 19th-century China. His results, especially the division of China into eight 'macro-regions' based on economical relationships, are considered path-making by many Chinese historians and urbanism researchers⁵. On the issue of retail geography and shopping behaviour, Berry and Garrison's research on Snohomish County⁶ provided empirical evidence for the existence of hierarchies of central functions. Among Chinese scholars, Gao, using the Central Place model, analysed the morphology of Beijing's shopping centres from the Yuan dynasty to the 1980s. [see fig.1] His work has been widely quoted in the Chinese academic world.

In the latter part of this paper we will refer to some of his work in detail. For now we will briefly outline some problems in his analysis. Firstly, his model didn't fit very well with reality, especially in 1980s, and he didn't present the actual distribution of shops in the 1980s and Minguo periods (1911-1949), using only the names of places as an indication. Secondly, his research used cultural and social demographic changes to explain why certain high level centres gave up their positions to others. This, strictly speaking, is not a problem, since the morphology of centralities is a complex phenomenon and should not be simplified to just their spatial aspects. But, it also reveals a limitation of the Central Place model, which is by its nature a static model presenting an 'equilibrium state' of the system. It does not readily capture the dynamics of change. Last but not least, Gao's way of using the Central Place model didn't reflect the development of transportation technologies, and the service range of central places remained the same in all periods.

In fact, Skinner had already emphasised the importance of transportation systems. He argued that the development of modern transportation technologies could eventually eliminate regular markets in villages, while intensifying the use of intermedi-

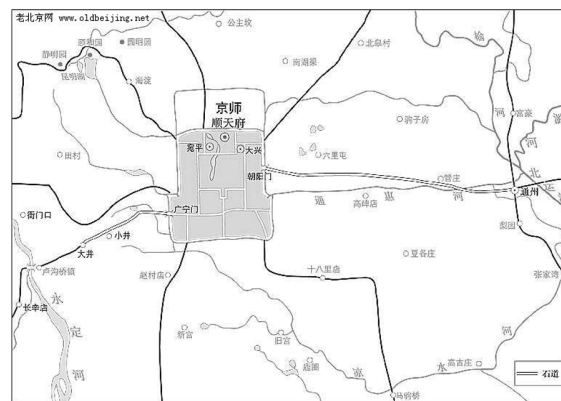
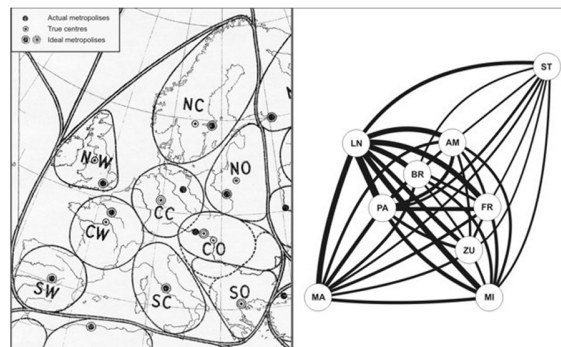
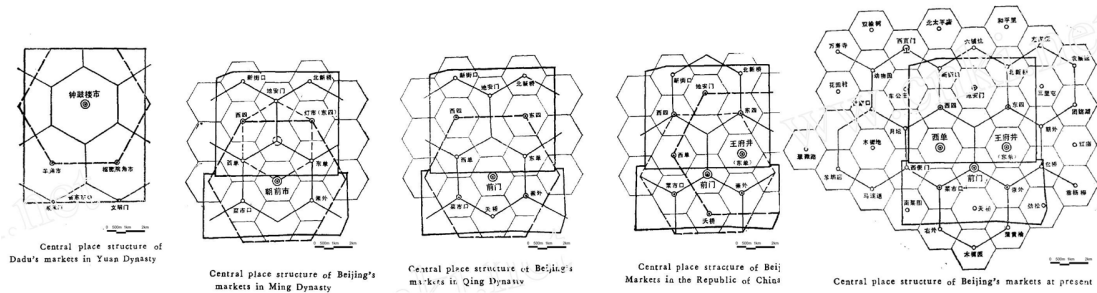


Fig. 1: Central Place model of Beijing's shopping centre in Yuan, Ming, Qing, Minguo and People's Republic of China (from left to right). Source: Gao, S., 'On the Historical Changes of Markets and their Location in Beijing', in ACTA Geographic SINICA, 44 (1989).

Fig. 2: Comparison between Central Place model (left: Subdivision codes: CC Central-Central, CO Central-East, CW Central-West, NC North-Central, NO North-East, NW North-West, SC South-Central, SO South-East, SW South-West) and Central Flow model in Europe (right: Inter-city links between nine European cities as practised by advanced producer services). Source: GaWC Research Bulletin, p. 261.

Fig. 3: Different pavements of old Beijing region (Ming/Qing Dynasty) Source: <http://www.obj.org.cn/Photo/class01/Class7/1275.shtml> (accessed 24 Feb 2009).

ate markets in larger towns or cities. Similarly, in examining how metropolitanisation processes influenced the hierarchy of central places in western Snohomish County, Berry had also emphasised the role played by freeway networks on increasing the motility of customers.⁷ As a result, the new metropolis could cause a shift of central functions between centres in different positions in the hierarchy, as well as a change in population-function relations in the region. Berry argued that numbers of central functions were the proper indicator for ranking rather than the populations of central places.

What is clear for now is that the development of the transportation network is of great importance for the distribution of central places. This paper is not based therefore on Central Place Theory, the well-defined hierarchical structure of which makes it difficult to capture the complex external relationships of cities and regions to their hinterlands. For example, Skinner still used his structure of eight macro-regions when analysing the contemporary situation. His ranking system was built up of many social-economical indicators. But looking at how modern wholesale food markets operate, we can easily see that many goods are imported from outside the system at the scale of the nation at large or worldwide. When we look at the customer range at the city scale, there is a wide variety of ways in which the area is used and the types of goods being sold.

Berry's identification of hierarchy was based on statistical data on numbers and types of central functions. Again, in his analysis he considered complimentary functions as internal relationships within the metropolitan area. Including a higher scale is normally the way the Central Place model deals with external functional relationships, but even then, as a spatial model, it turns out to be too simplistic and rough. Essentially, what Central Place theory is missing is a network understanding of urban dynamics. It is based too much on the paradigm of

'hierarchy' and very difficult to use to capture the complex external relationship of cities. As Taylor points out, the Central Place model still maintains its validity in certain situations: we can easily see that the spatial logic of Central Place theory based on travel distance is relevant for consumer behaviour in most contemporary shopping malls.⁸ But this simple internal relationship between centre and periphery, city and hinterland, is part of a process he called 'town-ness'; he proposed 'Central Flow theory' as a complementary theory to grasp the complex external relationships between cities, which he called 'city-ness'. The Central Flow model focuses on the space of 'flow' rather than 'place' itself. [fig.2]

Neal⁹ has also claimed that there is a historical move from the logic of Central Place to Central Flow. 'The spatial hierarchy had a greater influence on cities' economic structures at the beginning of the twentieth century, but was gradually replaced by the relational hierarchy, which had a greater influence at the end of the twentieth century.' Following this line of thinking, the opposition between hierarchy of central places (as presented in fig. 2 left side) and inter-connected networks (as presented in fig. 2 right side) are in perfect symmetry with the opposition between 'setting boundaries' and 'making connections' we mentioned at the beginning of this paper: the latter could be considered as a spatial representation of the former paradigm. Of course, this link means more than merely a representation: despite many interesting researches on flight traffic and business connections following the concept of Central Flow theory or the paradigm of network in general (and, like those involving Central Place theory, these researches are mostly on the regional scale), one question still remains for us: what is the role of urban space? If Central Place Theory still remains valid at the lower scale, as Neal and Taylor believe, and if the development of modern transportation networks in the last decades has made distance less relevant for long-distance trade, what is the spatial logic for the distribution of centralities

at the metropolitan scale (between regional and local) today? We believe that the development of the transportation network, the urban infrastructure, is the key to answering these questions. And in this paper we will choose the metropolitan as the scale for our analysis. At this scale we can see how the metropolis is constructed in relation to other metropolises globally and how it is regionally integrated with the local everyday life; how flows of people, material and information (in 'relational hierarchies') are substantiated, and how the hierarchies of different centres are facilitated.

3. Movement networks as construction of scales: Evolution of different transportation technologies in Beijing

In this part we start by analysing different types of movement controlling technologies, from walls and gates, street widths, pavings and names, to train, tram, bus and metro systems. After all, the term 'metropolis' itself doesn't have a clear-cut definition. If we consider only the population, even Bianliang, in the Song dynasty (960-1279 A.D), already had over a million inhabitants. In the case of Beijing, 'Dadushi', which means 'metropolis', is much younger than the term for 'city' or 'suburb'. When focusing on the development of movement controlling technologies, we can start thinking of the role played by these technical objects and the urbanism zoning concepts like 'city', 'suburb' or 'metropolis'. Without the presence of a city wall, how could we define the area of the historical city? Without the presence of 'Chidao' and the Great wall, was Qin still one unified empire? In the modern situation, how have technical objects like trains strengthened the identity of nation states? Isn't the airport constantly reminding us that we live in an age of globalisation? Obviously, those movement controlling technologies have more impact than merely on semantics; what I want to emphasise here is that they have helped us, as language also has, to organise the contingent real world into the 'scales' of neighbourhood, district, city, region and global. Of

course, Central Place theorists like Berry and Garrison focused on other attributes, like populations and functions, but these could also be considered emergent products of movement networks. At least the Central Place model itself doesn't indicate any linear causality from central functions to the spacing between these centres. The alternative approach we offer is to question how scalar concepts in urbanism are constituted by the development of transportation networks. We will therefore consider these technical systems at the scales at which they were operating, and then compare the evolution of both technologies and scale structures through 1934, 1968, 1987, and 2006. Subsequently, based on the groupings of movement technologies at different scales, we construct a movement network model to be used in the later part of the research to analyse their relations with central functions of corresponding scales.

3.1 Paving and naming, differentiation of movement networks in old Beijing on regional and city scales

The map [see fig.3] shows the road system in old Beijing (estimated in the Qing dynasty) in terms of different types of pavings: a double line stands for a stone paved road; a single black line is a tamped soil road. Two things need to be noted: first, the most important route and other routes connecting Beijing with other cities or villages have been paved differently. Tongzhou to the east is the most important transportation node for Beijing in that period. Most goods were transported firstly to Tongzhou by canal, then to Beijing by land. Before the automobile and train, our ancestors made distinctions between different transportation networks by means of the technologies available at the time. Second, most main roads inside Beijing were paved with stone. In this sense, stone paving, like city walls, helped distinguish city from rural areas; walls and paths worked together to mark social distinction. This also suggests that new technologies were implemented in the dominant spaces of the time, and then became

available for lower scales and classes.

At the city scale, Beijing's urban fabric reveals a clear hierarchical logic indicated in the names of streets (Dajie, Jie, Xiaojie/xiang, Hutong/tiao and alley) and their widths.¹⁰ In the next part we will show how this spatial logic is represented in pavings and widths and then compare these patterns.

In the map above [see fig.4] Beijing's spatial structure is represented based on the street names. 'Dajie' (big streets) mark out, for the most part, the main road structure of Beijing, connecting with gates to the outside, and gates between the inner and outer cities. Sometimes these names were changed according to their function: in some parts of the west-east oriented main road, 'Caishikou' (or vegetable market - 1 on map), 'zhushikou' (or jewellery market - 2 and 3), 'Suanshikou' (or garlic market - 4) and 'Ganlanshi' (or olive market - 5) were named according to the main goods being sold on that street. In these situations, we draw them as thick grey lines. There are some 'Dajie' located inside neighbourhoods (marked 8, 12, 10 and 9 for instance), whose importance has been 'exaggerated' because they were previously locations of important government institutions.

Based on Minguo's map made in 1934, we sorted streets by width and paving [see fig.5]. The structure of movement seems even clearer. Especially the main road network was mostly wide and well-paved. Despite the 'lip service' paid to naming and shown in the previous map, some anomalies appear when people build things up as real physical form. This one also shows some anomalies: 1, some 'Hutongs' were also well-paved and wide due to the important functions or institutions they accommodated: the embassy area (marked 3) for example; and 'Beinan he yan', an old canal (marked 6). 2, in some cases the name of a street actually reflected better how it was being used. For instance, 'Beinan xiao jie' (marked 5) is not highlighted at all on the map

showing paving, yet it actually functioned as a well-used street with quite a high number of shops and activities. In this case what it was called reflected reality better than how it was constructed.

3.2 Development of the railway in the process of modernisation, an indicator of national and regional networks

The first railway built by the Chinese was Jing-Zhang railway, connecting Beijing to the northwest in 1909. However, on the map made by the Japanese in the 1920s, this first railway was not represented, probably because it was a test line. On this map, one part of this first operational rail network connected Tongzhou in the east, and the other went to the southwest. This layout matches the directional axes indicated by stone paving very well.

After the Communist party seized power in 1949, the economy began to shift from being agriculture-based to industry-based. During that period, the northeast part of China became more and more important for its oil field and proximity to the Soviet Union, which provided technical support. From the map of the 1960s, we can clearly see how new railways were constructed to strengthen the connection to the northeast and northwest. [see fig.6] In the 1980s, the northeast connection was further strengthened by adding new lines. In addition, the railway started to form a more complex network to facilitate the needs of industries and passengers in the region. However, in 2006, we can see two tendencies: on one hand, new railways are still being constructed, such as the rapid connection to Guangzhou and Hong Kong; on the other hand, with the expansion of Beijing city and the shift of its economy to being more service-based than industry-based, the former railway on the fringe of the city which served industry now began to be substituted by light rail.

3.3 Evolution of tram and bus networks as indicators of city-movement networks

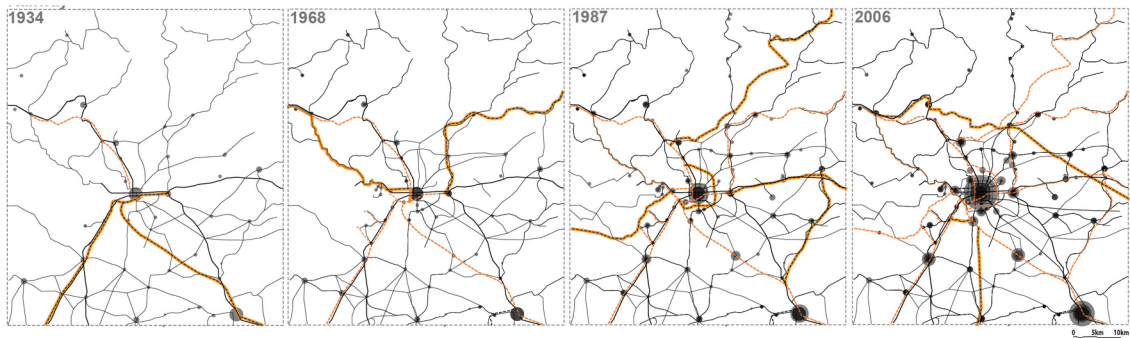
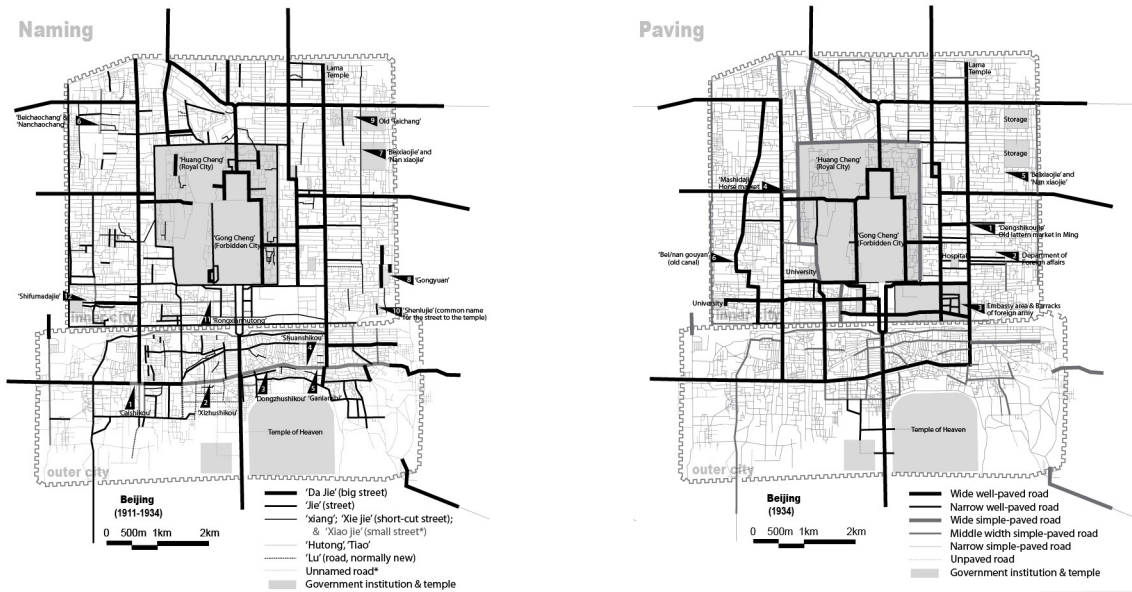


Fig. 4: Street typologies based on names in old Beijing (Qing/ Minguo): based on the map in 1911 and 1934.

Fig. 5: Street typologies based on paving and width in old Beijing (Qing/ Minguo).

Fig. 6: Development of railway from 1920s to present. Thick orange lines represent new railways added after previous periods.

The tram and bus systems form the focus of this part of the paper. These served mainly the scale of the emerging metropolitan city. The first tramline in Beijing was constructed in 1921. From the map above [see fig. 8] we can see the north part functioning as a ring to facilitate movement inside the inner city, where the upper class lived. In the outer city, it strengthened a 'cross road' structure in the middle. The history of the tram in Beijing was quite short. After the foundation of the People's Republic, the tram was removed and replaced by buses and 'Wu Gui Dian Che' (literally 'electronic bus without track')¹¹ From the 1960s, the bus system in Beijing was classified into regional, suburban and city bus systems, based on the ranges they served. However, as we can see from the map below, the distinction between the three types was quite clear in 1968, but not in 2008. With rapid urban development, the number of bus lines also kept increasing. As a result, there was more and more overlapping, especially between suburban buses and city buses.

Another means of classification could be based on the actual distance of the bus line. In the table above we divided the bus lines into seven categories. From this table and the map [see fig.8], we can see that in the last forty years the numbers of bus lines of almost all ranges have greatly increased. The role of regional bus lines has however been maintained, while city and suburban buses have become almost indistinguishable. If we consider only the length of the bus line, then a division could be drawn at the 40-50km range, and this applies for all three different years listed. Now, if we could talk about the definition of the city from the perspective of buses, after the removal of the city wall, we could say what were suburbs of Beijing in 1968 have been totally urbanised today. In this sense, the city and suburban bus systems have together replaced the role played by the city walls in history, defining limits and forming a new territory which we will later call metropolitan Beijing.

From the map above [see fig. 9] we can clearly see that most new bus lines opened between 1987 and today were located along the 3rd and 4th ring road of Beijing. Considering that buses in Beijing were the best-used form of transport at the end of the last century, this means the area around the 3rd and 4th rings has become a very centralised part of everyday life in contemporary Beijing. This point will be further demonstrated in the next part of the paper. Of course, this network expansion is also a historical process: in 1968 or 1987, a bus stop in a town or village functioned similarly to the way a regional train station does today. But with metropolitan development, the buses became more available at lower scales as connections between one neighbourhood and another.

The map above [fig.10] presents neighbourhood inter-connectivity in the bus systems in 1968, 1987 and 2008. The number inside each neighbourhood is the number of all other neighbourhoods directly connected to it by bus lines, without having to change to other lines. From this study, we can see that the average number of connections inside the 3rd ring has been increased from less than 100 to more than 300. It is also very clear that the city centre (inside the 2nd ring), which was connected well by buses in 1968 and 1987, has been left behind and is less connected than the area around the 3rd ring in 2008. In the latter part of this paper we will superimpose these maps on the distribution of shops in 1987 and 2006, and show a corresponding shifting of functions from metropolitan to lower scales.

3.4 Recent development of the metro as a further intensification and extension of the metropolitan scale

Beijing's metro system was initially planned as a defence system against the threat from the USSR in the 1950s. The first line was finished in 1969: however, it didn't fully open to the public until 1981. This system included the line underneath Chang'an street, and the north part of the former city wall. In

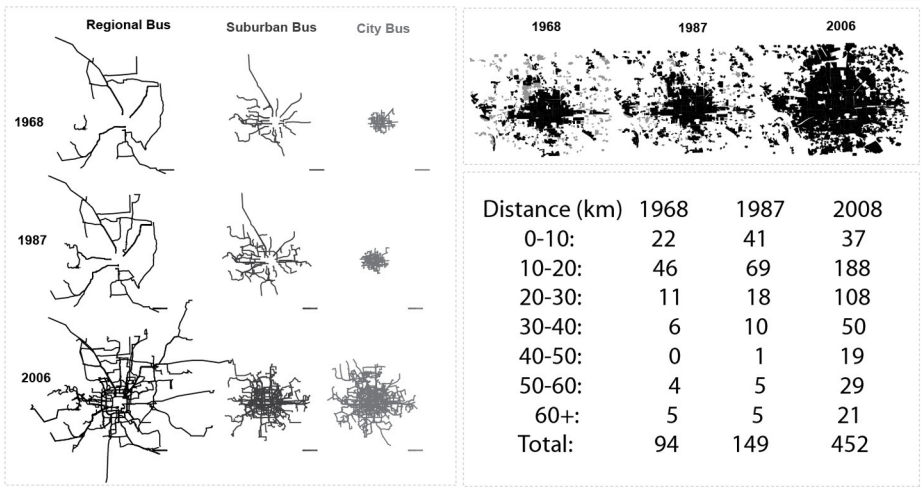
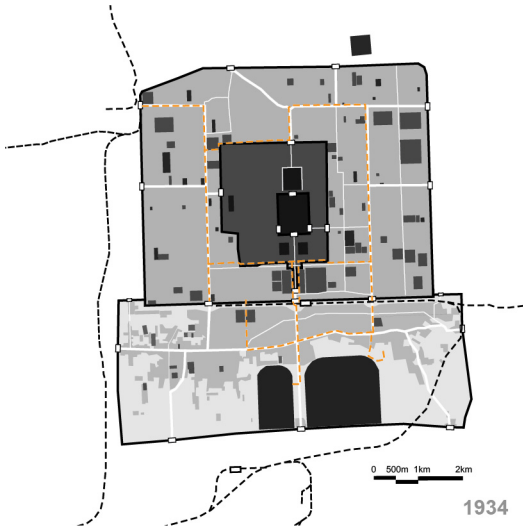


Fig.7: Tramlines (orange dash line) and railway (black dash line) in Beijing 1934.

Fig.8: Three types of buses and their service range in 1968, 1987 and 2008 (left); connected neighbourhoods by bus (top right); bus line distance distribution (below right).

the next twenty years, Beijing's metro system developed quite slowly. However, after the successful application to host the 2008 Olympic Games, this process speeded up dramatically. In 1999, line 1 extended to Sihui. In 2003, line 13 was 40.5km long and connected Beijing with many satellite towns in the north. In 2007, line 5 was 27.6km long, running through the whole city in a north-south direction. In the map below, the construction and future plans of the metro system in Beijing are shown. [see fig.11] It is still a system in development, and so far it is hard to see the influence of this system on the distribution of centralities, especially in peripheral areas. Even so, it is possible to speculate that, with the future development, the metro system in Beijing will take over the role city and suburban buses played decades ago and become the means for a further rescaling of the city.

3.5 'Scale structure' based on different technical objects

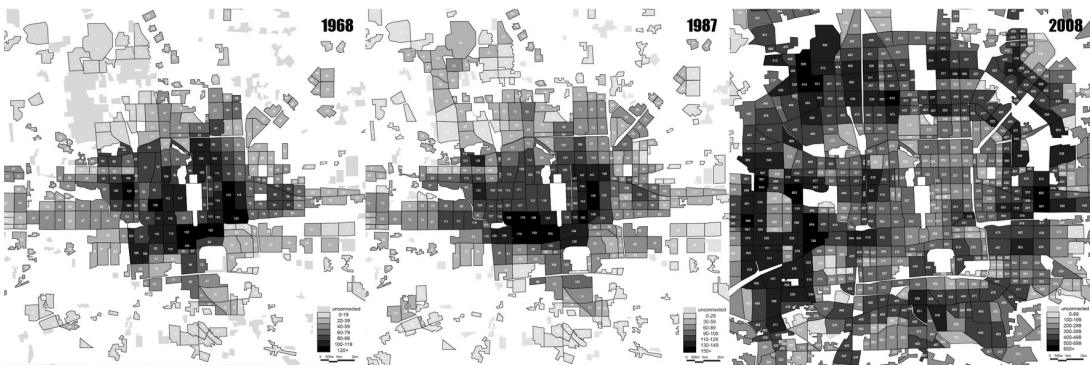
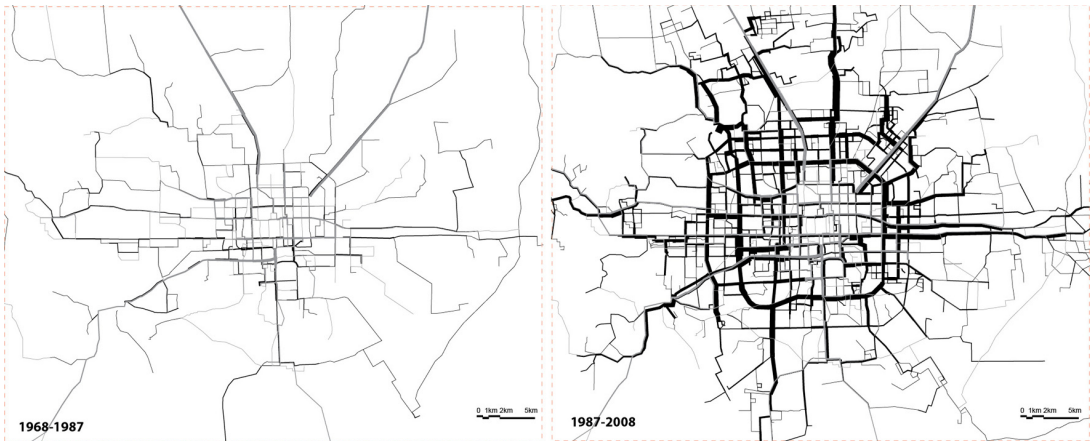
This part of the paper deals with two questions regarding the analysis of changing movement networks. One is the 'what' question: what actual transportation networks, based on what specific technologies. The other is the 'for what' question: the question of the scale structure for which technical networks were operating. After presenting how actual systems have developed, we will re-group them according to the scale of movement they support, and we will then see the morphological patterns in Beijing in terms of regional and city scales respectively. The metropolitan scale actually emerged in between these two scales and started to substitute the scale of the city through the rapidly expanding bus system in the end of the last century and the development of the metro system in this century.

The research will focus on the years 1934, 1968, 1987 and 2006 respectively. All transportation networks mentioned before will be divided into two scales: regional movement networks as connec-

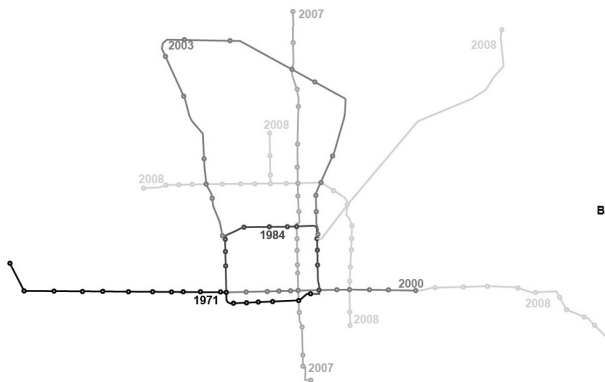
tions between cities, towns and villages; and city movement networks as connections between neighbourhoods. Under this framework, train and highway systems will be considered as elements of a regional scale, while ring roads, metros, and most buses will be considered as elements of a metropolitan city scale. It should be noted that the ring roads, as parts of the highway system, perform an important 'overlap' function between regional and metropolitan city scales. The regional bus system will be defined as having a range over 50km, based on a previous study. Based on these methods, we made the following maps of a two-scale movement network model of Beijing. [see fig. 12 and 13]

At the regional scale, we can see that between 1934 and 1987, the normal roads (also supporting the regional bus system) were still expanding towards the rural areas. At the same time the railway system was developing into a well-connected network. Between 1987 and 2006, a highway system emerged and created new direct fast links to bigger cities in and out of this region. As a result, certain nodes previously connected into the region were by-passed. For example, a new connection to Tianjing, a port city in the southeast, has made Tongzhou function less strongly as an important gateway for Beijing. In general though, new transportation networks were constructed to strengthen the privileged position of certain connections. The new spatial hierarchy built for the most part on a pattern that existed before, supported by technologies of previous periods, but systematised and strengthened that pattern into a regional structure.

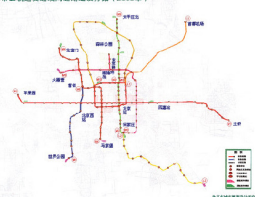
When we zoom in to the city scale it becomes rather clear that as the city expanded to become a metropolis, the city scale roads in Beijing evolved into a more regular and systematised orthogonal grid form. This could be seen as a technical solution to automobile-based movement at this scale, but it also has some side-effects. Comparing the situation today with 1934, it is clear that navigat-



Beijing Metro system current situation (2009.2)



Beijing Metro system short term plan (2008)



Beijing Metro system long term plan (2015)

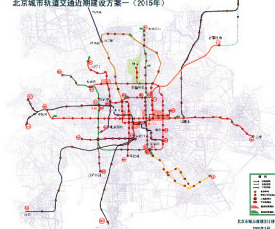


Fig. 9: Growth of bus lines: 1968-1987 (left); 1987-2008 (right); the thickness of line indicates the number of new lines opened. Grey represents the earlier period, black represents the new lines added in the later period.

Fig. 10: Inter-connectivity of neighbourhoods by direct bus lines (no change to other bus line) in 1968, 1987 and 2008. The number showed inside each block is the number of other neighbourhoods which are connected to this one by a single bus line. The darkness presents the relative connectivity in that period: the darker the higher.

Fig. 11: The development of the metro system in Beijing as a process of metropolitanisation.

ing inside the city has become much easier. There has been a reduction of labyrinthine roads in the inner city as the city grid has been systematised into something clearly different to neighbourhood roads, and today it is merely a question of going out of your neighbourhood and then stay on the city grid to your destination. Taxis and local busses are incorporated into this pattern. Therefore, although these new technologies normally regularised social-spatial patterns already there, they were constructed for contemporary purposes and transformed the environment to contemporary needs. As this study shows, in 1934 and 2006 we can see urban space organised into patterns reflecting different scales. The tools (the sets of technical devices) used to realise these scale structures are different, and this difference leads to changes of the spatial structure: starting with the removal of the city walls and gates; then the regularisation and extension of the city grids towards the suburban areas; then over time the terminals of modern transportation networks like trains stations and highway exits become the new gateways of the city. All of these processes are crucial for Beijing's metropolitanisation.

What does this analysis mean for the Central Place and Central Flow models? Firstly, the movement network model we constructed here has as its main purpose the representation of the scale attributes of movement flows. Thus we can say that it is a kind of Central Flow model at the scale of the metropolitan city, since what reveals the hierarchical structure is the flow. What about urban central places then? As we mentioned, the new transportation networks nowadays create well-defined scale structures, and this scale structure offers a framework for urban places to emerge. Our proposal is that the contemporary urban place is not dependant on its simple (distance-related) geographical relationship with other urban places, but is dependant on how it is connected in different layers of the scale structure made of movement networks. Therefore, in the next part of the paper, based on

the data of retail and market places in Beijing, we will try to investigate two things: firstly, is there a transformation in the spatial distribution of centres from historical Beijing to the present? Is this the 'historical move from the logic of Central Place to Central Flow' proposed by Neal? Secondly, what is the spatial logic for the emergence of metropolitan centres in the scale structure of the city?

4. Changing metropolitan scale centralities as a consequence of changing scale structure

4.1 Introduction

After presenting the changing scale structure, in this part we will analyse the morphology of metropolitan scale centralities using the data of retail and market places in 1924, 1987 and 2006. During the analysis, the data will also be compared with Gao's Central Place model.

'Centrality' in this paper refers to a cluster of retail, markets or entertainment. Thus, metropolitan centrality means that the majority of customers of those commercial activates should come from the whole metropolitan area. Practically, it is problematic to link the type of goods or services being offered by those shops with its scale of customers, because it is very difficult to get reliable data on actual customer distribution for all shops. Nevertheless this is a widely used method in Central Place research on retail geography. To take one example, the digital market in Beijing in the 1990s was definitely operating on the metropolitan scale, because there was only one market in 'Zhongguancun' at that time. Ten years later this type of business has become widely distributed but it is very difficult to get reliable data on actual customer distribution for particular shops. This is especially the case with historical data and we therefore have to try to make plausible estimations. In this part of the research our estimation is based mainly on the most dominant type of retail, services or wholesale market in different periods.

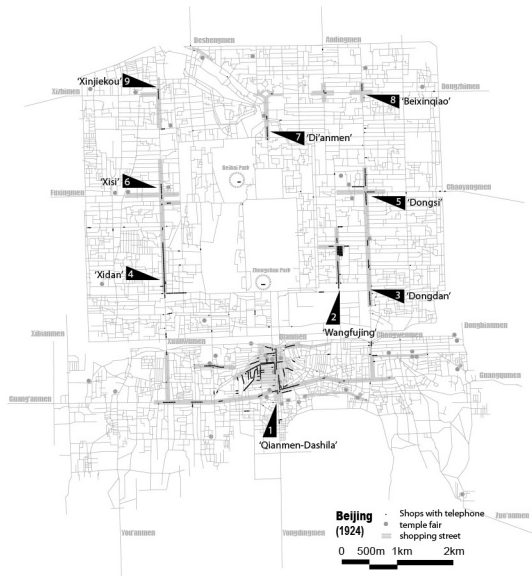


Fig. 12: The development of scale structure in Beijing from 1934 to the present on regional scale. Orange lines represent new networks based on previous maps.

Fig. 13: The development of scale structure in Beijing from 1934 to the present on city scale. Thick black lines are regional scale networks, thin black lines are city scale networks

Fig. 14: Distribution of shops in Beijing 1924.

4.2 metropolitan centralities in 1924

In his book *Zui Xin Bei Ping Zhi Nan* ('New Guild Book of Beijing'), written in 1924, Tian Yunjin listed detailed street names, social customs and all shops with a telephone in Beijing. In a way the book functioned as the yellow pages of that period. Based on this material we mapped all retail and entertainment-related functions listed. Considering the fact that in 1924 the telephone was not that widely used, this list would already tend to reveal higher-scaled commercial activities and this data could to some extent reflect metropolitan scale centralities even before we consider types of functions. To give an indication on the distribution of commercial activities without telephone, we also included shopping streets and temple fairs in light gray based on *Beijing Li Shi Di Tu Ji*.¹²

As the map shows [see fig.14], it is clear that most of the shops plotted were located along the main streets of Beijing: Xisidajie (marked 4, 6 and 9) on the west; Dongsidajie (marked 3, 5 and 8) on the east; Qianmen-Dashila area (marked 1), located on the main crossroad in the outer city to the south. Wangfujing (marked 2) was located on a relatively less important street; however, Dong An market, as the leading market in Beijing was located on the crossing of Wangfujingdajie and Donganmendajie, which was the gateway to the Forbidden City and Foreign Embassy area. When we look at the location logics of specific functions, two types could afford to be located in less visible spaces away from the main roads: one was western style restaurants, which were mostly located in parks (grey dashed circles on the map) and brothels, which were all located in the central Qianmen-Dashila area yet clearly favoured hidden spaces.

In his paper, Gao used the Central Place model to analyse the changing centrality between the Qing and Minguo periods. [see fig.15] To summarise Gao's research: in the Qing period, Beijing's highest level of central place was the Qianmen area

serving the whole city, and between the inner city (north part) reserved for Manchurian people, and the outer city (south part) reserved for Han people. The Caishikou and Chongwai areas emerged as second-level central places in the outer city, while other places like Xinjiekou, Di'anmen, Beixinqiao, Xidan, Dongdan and Tianqiao were third-level central places serving local areas. In the Minguo period, Dongdan emerged as a new first-level central place for reasons of politics, transportation and social demography. The second reason is very interesting and relevant for this paper: Gao himself claimed that changing transportation networks were a 'main reason' for the transformation of central places. The main change to the road system in that period was the connection of Xidan and Dongdan through the new Chang'an street (marked with black arrows). The geometric centre of Beijing was occupied by the Forbidden City, but the new Chang'an street broke this barrier. This meant the role of Qianmen as the obligatory point of passage for movement between the eastern and western parts of the city was reduced and centrality shifted to the north. As a result both Xidan and Dongdan were upgraded, but the actual development of Dongdan as a first-level central place was in Dong'an market in Wangfujing street to the northwest of the ideal situation in the model. What Gao also found interesting about this rescaling of central places was the projected rise of the Tianqiao and Di'anmen areas as the lower central places of Dongdan. This could, if it happened, be seen as empirical evidence of the spatial logic of the Central Place model, since the relocation of a higher-scaled central place could initiate the rescaling of the system as a whole. However, he did not give any detailed data about these changes. On the contrary, in a later part of his paper, he attributed the slow development of Di'anmen to it being an area with a higher percentage of poor people. Di'anmen apparently had not been upgraded as he had expected. In addition, there were other problems dating back to the times of development. In the first place, the Tianqiao area had already for a long

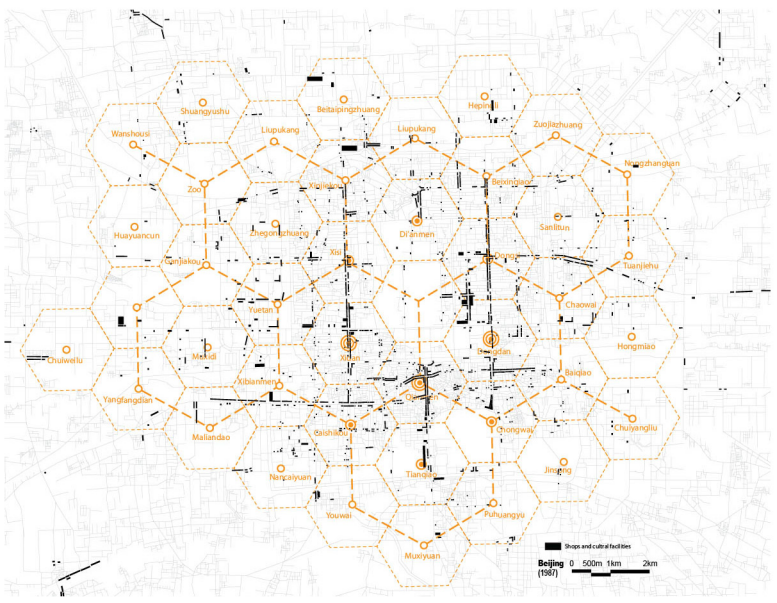
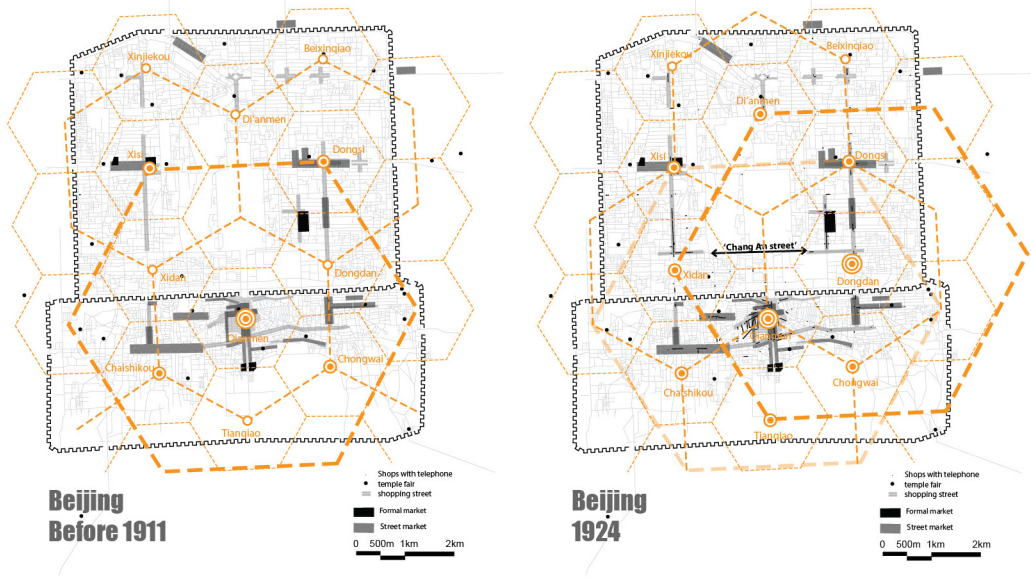


Fig. 15: Superimposing Gao's Central Place model of Beijing in Qing (left) and Minguo periods (right) on the actual distribution of shops and markets.

Fig. 16: Superimposing Gao's Central Place model of Beijing in the 1980s (Gao, 1989) on the actual distribution of retail, market places and cultural facilities.

time been a vital area not only for local people, but also for immigrants from other parts of the country, and a labour market of poor people at the city scale. Secondly, Di'anmen never achieved the same level of centrality as Longfusi, and Longfusi (Dongsi) didn't show any signs of decline due to the competition with Wangfujing at the time. In a much later period (the 1990s), the Di'anmen area was indeed upgraded, and the Longfusi area downgraded, but that was due to the construction of Ping'an street as a new through route for the inner city. Thirdly, while the upgrading of the Xidan and Dongdan areas into first-level central places indeed followed the construction of Chang'an street as a through route, this also happened much later, especially in the case of Xidan. The problem of time is important for this paper because it could also help us understand the power of infrastructure compared to other social or political factors. Indeed, urban development, especially for a capital city like Beijing, is strongly affected by politics. Once the Forbidden City and foreign embassies were located where they were, they started to attract a higher level of commercial and cultural activities, and all of these contributed to the Wangfujing area developing into a metropolitan-scale central place. But infrastructural changes such as moving the railway station from Qianmen to Dongsi, the construction of Chang'an street as a through route, the opening of metro lines, all reinforced and played an active role in this process. These interventions were strategic and were used to fulfil and stabilise the intentions of emperors and planners.

Despite all the problems with the Central Place model built by Gao, what is clear so far is that to actualise Central Place Theory, movement networks will be one of the most important factors. Now the question is: is it possible to build up an alternative model for explaining the changing centralities of Beijing based on changing movement networks related to scale? In the next part, we will try to compare the movement network analysis with the morphological

study of centralities between 1924 and 1987.

4.3 Metropolitan centralities in 1987

The data for Beijing's retail and market places in 1987 were based on an atlas named *Beijing Shi Qu Di Tu Ce*, published by China Map Press.¹³ The legend system in this map collection already indicates scalar differences: for example, a large and famous barbershop or an important public bath is represented by larger circles than less prestigious ones. Also catering has three categories: 1, 'fanzhuang' (big restaurants); 2, 'Fengweichao-cai' (stylish small restaurants); 3, 'xiaochimianshi' (snacks, noodles, fast food). Based on these categories and the detailed functions of shops, we have classified them into three levels: the first rank was intended to cover functions with customers coming from the metropolitan area and included department stores, famous or big restaurants, barbershops, clock shops, book stores, bike shops (in the 1980s, buying a bike was as big a deal as buying a car is today), opera houses, cinemas, children's or worker's clubs. The third rank included small snack and noodle shops and food shops ('fushidian'), functions which in that period were indicators of customer usage at the neighbourhood scale. All the other types of shops were considered to operate on a middle scale in between the metropolitan and local. On the following map we have superimposed the Central Place model proposed by Gao on the data for shops. [see fig.16]

As we can see, in the central part of city Gao's Central Place model of Beijing matched with the reality in a much better way than did the edges of the centre. Gao himself claimed that it was because urban development in 1987 had not yet fully actualized the model. Another thing missing in Gao's use of the model is a concern for the changes in the transportation system. Clearly, the transportation system in 1987 is different to that in 1924, but in Gao's model the service range of the centres doesn't seem to reflect that difference.

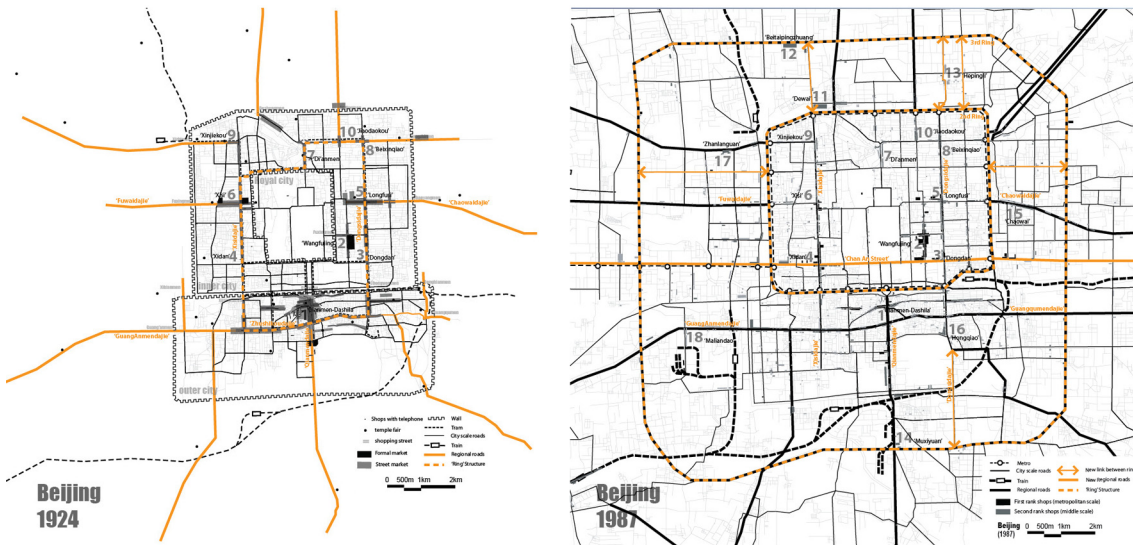


Fig. 17: Comparison of retail, market places and cultural facilities in Beijing in 1924 (left) and 1987 (right).

Fig. 18: Comparison of movement scale networks and metropolitan centralities in Beijing in 1924 (left) and 1987(right).

Comparing 1987 with the data of 1924 [see fig 17], we can see that inside the old city (inner city and outer city together) the distribution of metropolitan centralities underwent little change: the Wangfujing area grew faster and started to function as the leading shopping centre replacing Qianmen area; the retail in Xidan area started to concentrate near the new Chang'an Street, and the commercial activity expanded slightly outwards after the wall was removed, especially near where new roads were made by breaking old city walls. The case of Chang'an street is interesting. In the 1980s, it was further extended in both the eastern and western directions to Tongzhou and Shijingshan, making it into a new road of regional importance, which started to replace Chaowaidajie. This intervention was political and had to do with building a new functional and ceremonial axis. However, the power of infrastructure goes further than representation, and the upgrading of the Xidan and Dongdan/Wangfujing areas into metropolitan-scale shopping centres were side-effects of this change.

On the map above [see fig 18], we show a comparison of movement networks and metropolitan centralities in 1924 and 1987. In 1924, the shopping centres such as Longfusi (marked 5) or Xisi (marked 6) were not at the Chaoyangmen and Fuchenmen gates respectively, but rather at the crossing-points of Changyangmendajie-Fuchengmendajie and Dongsidi/Xisi. In fact, due to the barrier effect of the Forbidden City, Dongsidajie, Xisidajie, Zhushikoudajie and some other streets to the north of the Forbidden City functioned as a ring road. This was also where the tramlines were located, and they together mediated the movement coming from outside the city with that inside the city. This 'ring' (orange dash line) constituted the centre for movement inside the city, while the main streets ('Dajie', orange lines) were directly connected with gates carrying flow from the outside. We can begin to see this logic of the interfacing of outside and inside movements as generic for generating centralities.

Being connected to the outside, while holding a central position inside a certain scale in terms of flow (not in terms of geometry), is the necessary precondition for centrality to emerge. The spatial logic of this alternative model will later be tested further.

Of course, the logic of the gateway is still valid: we know that informal markets or vendors gather near the gate and that it was an important place for public propaganda. But based on the distribution of metropolitan centralities in 1924 and 1987, we can see it is rather the convergence of more than one movement scale that is important, while the gate itself is only one of many technologies used for controlling movement. Previously the gate had created a clearly defined border between inside and outside, but central places inside the city will depend also on where flows from the outside meet internal movement patterns.

In the map of 1987, we can see that the inner ring structure of 1924 has been weakened due to the extension of the Chang'an street and new connections with suburban areas. A new ring road, the 3rd ring today, has started to emerge in the suburban area.¹⁴ However, because of building lagging behind infrastructure, in 1987 this new ring had not yet become central in the city movement structure. Instead, together with the northern part of the 2nd ring (where the former inner-city wall was located), this double ring structure outside the city provided potentials for the future emergence of new metropolitan scale centralities. Some of these potentials had already been actualised where the rings met the extensions of radial streets such as Xisidajie and Dongsidajie. Examples are: Beitapingzhaung area (marked 12), Chaowai area (marked 11), Hepingli area (marked 13) etc. Other new links less well integrated¹⁵ into the old fabric (orange line with arrows on both ends) between this double ring have less effect.

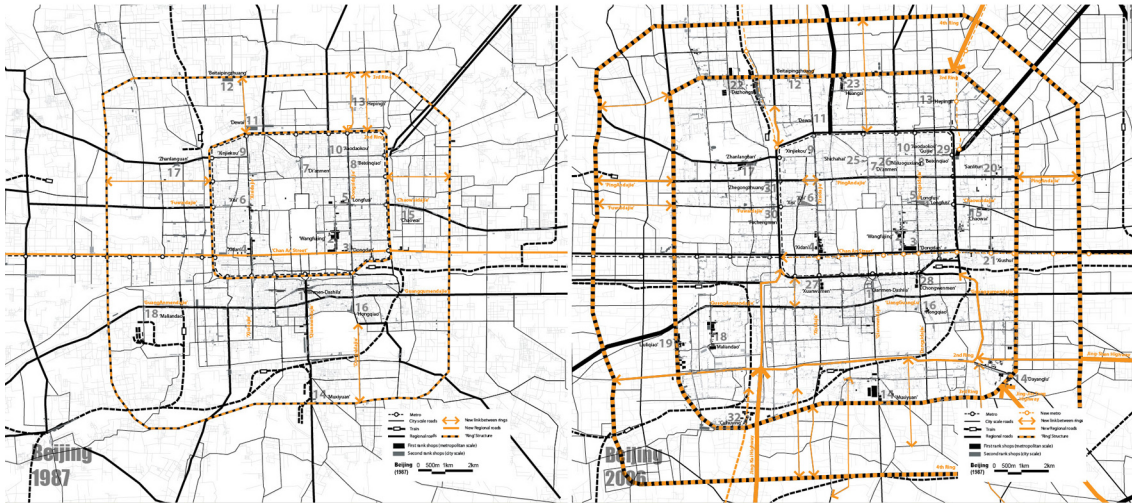


Fig. 19: Metropolitan centralities in Beijing 2006.

Fig. 20: Comparison of movement networks and metropolitan centralities in Beijing in 1987 (left) and 2006 (right), orange lines show the new links or roads upgraded from previous periods.

4.4 Metropolitan centralities in 2006

Following a similar method, all the commercial functions in 2006 have been mapped and the metropolitan scale functions have been sorted out. Within the 3rd ring, all commercial areas with specific identities have been highlighted and plotted. [see fig. 20]

Comparing this map with the situation in 1987 [see fig. 21], what is immediately apparent is the role of the 3rd ring road as a generator for new metropolitan scale centralities related to everyday life. Meanwhile many centres inside the 2nd ring road have been transformed into areas for tourism or leisure. With the rapid urban expansion in these 20 years, the 3rd, 4th and even 5th rings have started to function as mediators of internal and external movement, while the 2nd ring has become less accessible from regional highways. Some new commercial areas have emerged where the 3rd ring meets the regional highway: the Dazhongsi area (marked 22), Huangsi area (marked 23), Dayanglu area (marked 24), Muxiyuan (marked 14), Caihuiyuan (marked 32) and Liuliqiang area (marked 19) for instance. Chang'an Street's function of supporting metropolitan scale movement has been strengthened, also considering the extension of metro line 1. As a result, we see the commercial functions booming in the Wangfujing/Dongdan area (marked 2 and 3) and Xidan area (marked 4). Ping'an Street has been constructed in 1998 and formed a second straight through route in the inner city. This intervention has had two effects: on the one hand, it has revitalised some old lower-scale shopping areas such as Shichahai (marked 25), Di'anmen (marked 7), and Naluoguxiang (marked 26). In this way it has acted in a similar fashion to Chang'an Street to the south in drawing centralities through the centre. On the other hand, it has further diminished the role of Fuchengmen-Chaoyangmendajie, which was the only through route in the inner city in 1924. As a result, the Longfusi area (marked 5) and Xisi area (marked 6) have become further downgraded.

As we can see from the analysis above, movement networks with scales could offer us a model by which to reveal the spatial logics for the emergence of particular metropolitan centralities in meetings between scales, but what about actual transportation networks? We will use bus connectivity as an example to analyse this point.

As mentioned in the previous part, the bus network in the 1980s was still well used by most people in Beijing, because in that period private car ownership was very low. The connectivity by bus corresponded very well with the distribution of centralities. [see fig.21] On the left map, four main shopping areas (1, Qianmen; 2, Wangfujing; 3, Dongsigou and 4, Xidan) were connected well by bus. However, with the increase of the use of private cars, taxis, and the further development of the metro system, by 2006, the 'central area' based on bus connectivity had moved to the 3rd and 4th rings. Meanwhile, the traditional shopping areas (Wangfujing, Dongsigou, Xidan, Qianmen) have retained their vitality, supported by other transportation systems like the metro. They are also becoming more and more used by tourists and rich people. On the other hand, other shopping centres (14, Muxiyuan to the south, 19, Liuliqiao to the south west, 22, Dazhongsi to the northwest, 23, Huangsi to the north, etc.) cater to the everyday needs of inhabitants. Comparing these with the high-level shopping areas in the inner city, they are all operating at the metropolitan level, but cater to different social groups. The total movement system of a city becomes highly complex and differentiated, facilitating specialisation in both area profile and transportation mode, and the growth of a polycentric structure of more and less specialised centres. In 2006, the overall importance of the bus system may have been reduced because people have more choices, but in reality it still serves well-connected neighbourhoods in Beijing located in central places emerging where the ring roads meet the regional highway. In general, we can conclude that studying specific actual transportation networks could

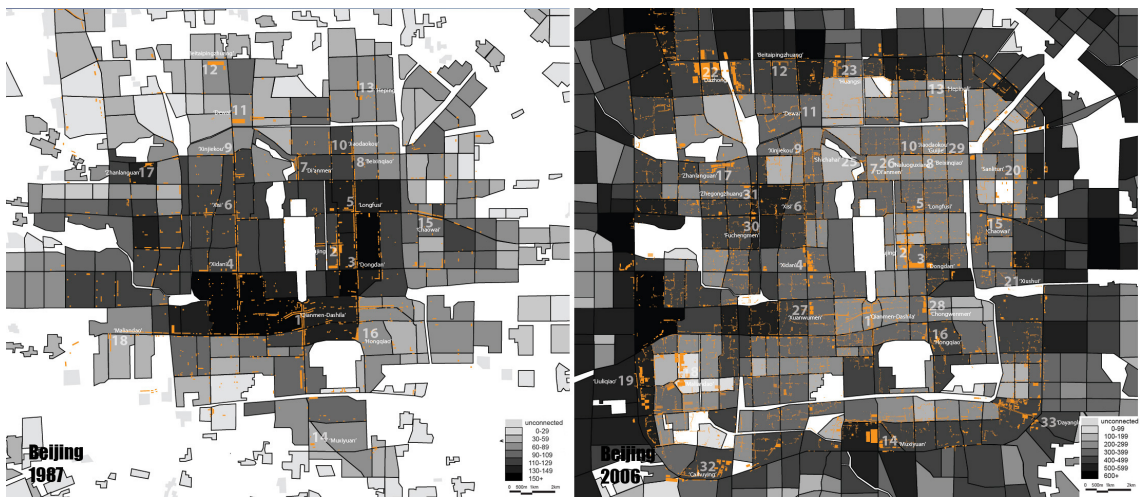


Fig. 21: Superimposition of shops on bus connectivity in 1987 and 2006 (The 2008 data of shops are unavailable, but there are few changes. The 2006 data are limited within the 3rd ring).

reveal common details about the central places they connect, such as the social/economical status of the customers and the characters and profiles of the central places.

5. Conclusions and discussion

This paper started by comparing 'setting boundaries' and 'making connections' as two strategies for regulating movement. 'Setting boundaries' refers to an understanding of space in hierarchies of enclosures and polarities of centre and hinterland, while 'making connections' treats spaces as networks with nodes that are connected together into a system. This opposition/unity duality reflects two urban models, Central Place theory and Central Flow theory. Seemingly opposed to each other, we argue that their logics together create the orders of centres and places in our cities. We argue further that these strategies are worked out today through transportation systems. The strategies and systems have been deployed together to make spatial entities like cities intelligible and functional. Therefore, our aim was to study changing movement networks and systems as a way of studying the metropolitanisation process of Beijing. Two research questions were asked: what is the role played by transportation systems in the formation of the Beijing metropolis, and; what are the spatial logics for the emergence of metropolitan scale centralities? From the empirical data on the development of transportation systems and the changing locations of retail and market places, we can draw the following conclusions:

Firstly, through the scale structure embedded in different technological systems in history (from paving and naming systems to today's highways), we can consider the scalar hierarchy in movement systems as a basic attribute of urban space, and this structure reveals a certain continuity in history. The metropolitan movement network, and even the metropolis itself, could be understood as produced by the development of multiple modern technical systems like ring roads, buses, highways and metros. These new networks together define hier-

archies of movement scales in our contemporary urban space.

Secondly, on the scale of the metropolitan city, the relationship (such as spacing and hierarchy) between centralities cannot be effectively explained by Gao's Central Place model. The movement network model based on scale structure as a Central Flow model can capture more successfully the spatial logic of metropolitan centralities. Central places are being spatially organised in relation to the movement networks they are located on, not to other central places in proximity.

Thirdly, the spatial logic of 'interface'¹⁶ between external movement and internal movement (movement across spatial hierarchies) as a general principle could explain the emergence of centralities as effects of different transportation technologies. But even in historical cities when walls and gates were the dominant movement regulating devices, this logic of interface cannot be reduced to a logic of the gateway. The logic of the gateway refers to a simple hierarchical interface between inside and outside. But the gateway also forms an obligatory point of passage for transportation networks, and the logic of interface requires scale hierarchy and flow. Centrality is deferred to the places where different flows intersect. From our empirical work, it follows that centralities were not located at the city gates in old Beijing, and neither are modern 'gateways' such as airports or train stations directly centralities. Metropolitan centralities have emerged in Beijing in the places holding central positions in a more local area on the one hand, while being connected to higher scale movement flows on the other.

There are several possible limitations to this research: firstly, Beijing is a specific case that needs to be relativised against other cases. Also, because it is a well-planned city based on ideologies and spatial principles, the strictly ordered spaces could be the result of those conventions rather than being

a product of a 'natural' space of cities. Secondly, we did not give any formalisation of 'central place' or any data on the actual distribution of flow. It may be too soon to say the spatial principle in Central Place model is not valid any more. There may be places at district or neighbourhood scales, or focusing on specific functions strongly related to daily needs (local food markets for example) where it may still hold.

Notes

1. In fact, the term 'Cheng Shi' is made up of words that can also be used separately: 'Cheng' is an old word for 'city', while 'Shi' is more widely used in modern contexts after the presence of the wall became irrelevant. This change itself also reflects an evolution process.
2. Gao, S., 'On the Historical Changes of Markets and their Location in Beijing', *ACTA Geographica SINICA*, 44 (1989), pp. 129-39.
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4. Skinner, G.W., 'Marketing and Social Structure in Rural China, Part I', *Journal of Asian Studies*, (1964/1965), pp. 24 (1) pp. 3-44; pp. 24 (2): pp. 195-228; pp. 24 (3): pp. 363-99. Skinner, G.W., 'Regional Urbanization in Nineteenth-Century China', in *The City in Late Imperial China*, ed. by Skinner G. W. (Stanford, California: Stanford University Press, 1977), pp. 211-49.
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9. Neal, Z. P., 'From Central Places to Network Bases: The Emergence of a New Urban Hierarchy, 1900-2000', *GaWC Research Bulletin*, 267, <<http://www.lboro.ac.uk/gawc/rb/rb267.html>>, [accessed 19 May 2009].
10. Deng, Y. and Mao, Q., 'Analysis on the Scale and Structure of Beijing's Urban Blocks based on Qian Long Jing Cheng Quan Tu', *City Planning Review*, 27, (2003), pp. 58-65.
11. The first 'Wu Gui Dian Che' was used in 1956; the last tram was used in 1966. So the whole replacing process actually lasted 10 years. In term of the way buses and 'Wu Gui Dian Che' function in Beijing, there is no difference. Therefore, in this paper I will treat them as one and the same and simply call them buses.
12. Hou, R., 'Distribution of Shopping Area in Qing and Minguo Period', *Beijing Historical Map Collection*, Vol.1 (Beijing: Beijing Press, 1988).
13. 'Beijing Shi Qu Di Tu Ce', (Beijing: China Map Press, 1987).
14. Officially, what we call ring road today in Beijing should have no traffic lights and functions as an urban highway, thus the 3rd ring was put in use in 1994, but in 1987 it already had its shape, although there were traffic lights on the road.
15. 'Integration' is a space syntax term. A street of high integration value means it is 'topologically' better connected in the street system as a whole.
16. Read and Bruyns in their working paper, 'The Urban Machine', have theorised the relaying point between

high-scale movement network and lower-scale movement network as interface.

Biographies

Qiang Sheng has been undertaking Ph.D. research at Spacelab, TU Delft, since 2005. His work examines the relationship between changing centralities and movement networks. He graduated from TU Delft in 2004 with a M.Sc., and his thesis was entitled 'Urban Labyrinth', it also examined a similar subject and methodology. Before he came to the Netherlands in 2002 he studied Architecture at Harbin Architecture University and also won 1st prize in the National Architectural Student Competition (2000), 3rd prize in the Tianzhuo Architecture Competition (2000), and 2nd prize in the 'Liangsicheng' Cup Competition, (2001).

Professor Linfei Han is working in Beijing Jiaotong University as the vice dean of architecture department. He has three doctor degrees in architecture, urban economy, and working as post-doctor researcher on nature geography. He is also one of the editors of "Planner", "Urban Flux", "Journal of Asian Architect and Building Engineering" in China. He has been the Chairman of Architecture Academic Committee, and guest professor of Politecnico de Milano in Italy, professor of Moscow Architectural Institute and professor of Russia Academy of Architectural Heritage.