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THE MORPHOLOGICAL EVOLUTION OF MACAU

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Abstract

The morphological evolution of Macau has been typically characterized as the extension of its city boundaries and the implementation of different urban planning traditions. However, few studies on the urban morphology of Macau employ a consistent spatial analysis to relate the morphological variation at the city level to their effects at the street level and further address its impact on the social side. In order to address this gap, this paper employs space syntax analysis to study the morphological evolution of Macau in terms of its spatial configuration as well as the relationship between the spatial characteristics and the development and role of commercial centers. It is found that the global integration core of Macau has migrated at least two times in the last 400 years, while the migration of historical commercial centers generally corresponds to the spatial migration with their changing social roles from a historical point of view. Finally, it suggests the way in which the functions of traditional commercial streets and different urban quarters today reflect on their relative function in the urban morphology of Macau.

1. INTRODUCTION

As a Special Administrative Region of the People's Republic of China and well-known for its gambling industry around the world today, the history of the city of Macau can be traced back to the 16th century, when it was gradually controlled by the Portuguese and became the first European colony in China. For over 400 years, the physical development of Macau has often been accompanied by sudden extensions of its city boundaries, resulting both from the Portuguese forcible occupation of Chinese farmlands and periodical large-scale reclamation projects[1]. Not only has the organization of city space been largely constrained by the complex geographical conditions of the Macau Peninsula, but its spatial arrangement has presented divergent and even contradictory urban planning traditions as well. All of these seem to have contributed to the distinct patchwork-like spatial pattern of Macau today.

On the other hand, when referring to historical records and previous studies, clearly indicated commercial streets or business sections seem to persist in the urban network of Macau for some particular periods. The location of such streets and sections seems, however, neither stable nor pre-planned. Moreover, although some of the historical trading spots mentioned in historical sources have survived the changes accompanying the urban growth of Macau and can still be easily detected and recognized on the city map today, their roles have largely changed. Are there underlying driving forces to promote, or impede, the development of commercial activities all through Macau's evolution process? Where do they come from and how do they perform? In this study, we address these questions from a spatial perspective, as set out by the questions listed as below:

1) How can the morphological development of Macau be described in terms of its spatial configuration?

2) Can a relationship be established between spatial characteristics and the development and role of commercial centers from a historical point of view?

3) How does a spatial perspective on the functions of traditional commercial streets and different urban quarters today reflect on their relative function in the urban morphology of Macau?

As a traditionally vigorous economic region, Macau has been actively seeking ways to sustain its economic role and position since early 20th century. One typical effort has been the continued strategic reclamation, which has greatly changed the urban fabric of Macau and is still considerably influencing its city life today. This paper aims not only to provide a descriptive study, but also to serve as an attempt to promote awareness of the consequences of ongoing reclamation projects. In the following, we present a spatial perspective on the interaction between space and function in Macau by tracing the historical commercial centers and conducting syntactic analyses of its urban morphology.

2. RESEARCH BACKGROUND

Being the former Portuguese territory and now designated as a Special Administrative Region of China (Macau SAR), Macau has attracted considerable academic interest on its urban morphology from a spatial and architectural point of view over the past two decades. These efforts are varied in their focus which ranges from the level of individual architecture, street, through to that of area and district. In addition to

[1] The reclamation projects have been going on along the inner and outer harbor of Macau for centuries. Through these consistent reclamation activities, a large amount of additional areas of land suitable for urban development have been created by landfilling along the coastline.

simply recording, as well as describing the architectural and urban forms—either through direct visual inspection or with advanced media such as GIS tools, recent studies (Tong, 2004; etc) have increasingly accounted for the built forms by resorting to their prototypes, which are believed to have emerged under certain social, economic, and cultural conditions.

However, to the best of our knowledge, only few studies on Macau's urban morphology address the aspect of spatial configuration, which also holds true for systematic studies that relate the syntactic characteristics of streets to their relative functions. The introduction of space syntax theories and related methodology in this study thus adds a new perspective both in the morphological analysis of Macau and in relating spatial and socio-economic factors.

The theories of 'natural movement'[2] (Hillier et al., 1993), 'movement economy'[3] (Hillier, 1996), and 'centrality as a process'[4] (Hillier, 1999) constitute the basic theoretical framework of space-syntax based studies. According to these theories, the spatial configuration of street layout, as an independent factor, can pose a significant systematic influence on the distribution of urban movement and further interact with the pattern of urban land use. In the light of such a theoretical model, a series of case studies have been conducted to reveal its various expressions within certain contexts, among which the most pertinent to our study include Zhang's study (2005) on the interaction between space and function in Clerkenwell from a historical perspective and Budiarto's study (2003) on the different dynamics of kampung settlements of Jakarta by investigating local structures of those settlements as well as the ways in which they are planted in the wider urban super grid.

3. METHODOLOGY

The region of Macau, in the normal sense, consists of three parts, namely the Macau Peninsula and the two islands of Taipa and Coloane. In this study, our scope is limited to the Macau Peninsula as it has undergone a much earlier and rather independent urbanization process than the other two areas.

The study is carried out through two stages:

- The first stage involves a historical review of the urban construction of the Macau Peninsula based on previous records and studies. The roles that traditional commercial centers have played in various periods are also sought through existing literature as historical clues for the following spatial analysis.

- The second stage involves a detailed spatial analysis consisting of formal descriptions and a space syntax analysis on the morphological evolution of Macau. In the space syntax part, three steps are taken to explore

[2] In 'natural movement', Hillier et al. (1993) point out that other things being equal, the spatial structure on its own will pose a systematic influence on the distribution of movement throughout its network. The configurationally more integrated streets and urban spaces are more likely to be occupied and consequently would carry more movement through themselves.

[3] In 'movement economy', Hillier (1996) points out that as some of the urban functions such as retail business often rely considerably on and take advantage of the urban movements, by shaping the movement pattern the spatial network will greatly affect the distribution of land uses to satisfy their different needs for random presence and occupation. As it happens, specific land uses like retail business would in turn drain more public social activities here. Such a 'multiplier effect' will drive the local spatial network into further subdivision, based on which an interaction model between form and space is established.

[4] In 'centrality as a process', Hillier (1999) points out that as a result of the process of 'movement economy', urban live centers are generated accordingly. Rather than being static and settled, these live centers are evolving all the time as they actively interact with changes of the spatial condition. Successful live centers are expected to satisfy two conditions, that is, not only should they locate at the more integrated spaces in regard to the whole system, but their local structures should be highly compact and easily accessible as well.

the three questions mentioned above in the section of introduction:

1) To explore the first question, four syntactic models are established based on historical maps[5] drawn/published respectively in 1834, 1889, 1952, and 2010, thus allowing a spatio-temporal analysis on the transformation of street structure with a time interval of roughly 50 years. By calculation in the DepthMap software, integration patterns of local and city-wide scales are visually compared with one another to trace the spatial centrality process[6]. Relevant measures such as average global integration and intelligibility are further represented and analyzed statistically to give a rigorous trace of the morphological changes.

2) To explore the second question, integration patterns of both global and local scales are visually compared with the distribution pattern of commercial centers in correspondent period. In this way, we detect if an interaction process exists between the form and function in Macau's evolution so that we could explore the role that space has played in shaping the historical commercial centers in the Macau Peninsula.

3) To explore the third question, scatter plots showing intelligibility and synergy of the whole street networks of the four different periods are sequentially compared. By highlighting and recording the distribution of historical vibrant spots in the scatter-grams of different eras, the functional changes of historical commercial centers are revealed from a spatial perspective. Moreover, the four selected districts of Macau today are analyzed both as embedded systems and independent systems to help understand the particular function each currently bears.

4. HISTORICAL REVIEW

4.1 A Brief Review of the Urban Construction Process

Early in the Ming Dynasty (1368-1644 AD), Macau was inhabited by a small group of Chinese people, most of whom were fishermen and farmers from Fujian and Guangdong Province. However, Macau did not develop as a major settlement until the Portuguese arrival in the 16th century. In the early 1550s the Portuguese reached Macau, and with the permission of Guangdong's mandarins, they established a city that within a short time had become a major entrepot for trade between China, Japan, India and Europe.

The Portuguese constructed their settlement with a tremendous speed during the first seventy years since they had been permitted to build permanent residences in Macau. As Yan (2004) pointed out, the 'rua direita' mode[7] had been adopted at the initial stage of their construction. In the beginning, three churches—

[5] The historical maps which were drawn or published in 1834, 1889, and 1952 and selected for this study are downloadable through the internet at the Library of Congress American Memory, and can be accessed at http://memory.loc.gov/ammem/gmdhtml/macau/part3.html. The map of 2010 is provided by the Cadastral Agency of Macau and further revised based on our field investigation which was conducted in the summer of 2010. These maps are also used by the authors as base maps for drawing Figure 2, 3, 4, and 5.

[6] Being consistent with the notion of 'centrality' raised by Hillier (1999), here the 'spatial centrality process' indicates the evolution of the spatial centers, which are picked up in the urban street network by reference to certain syntactic properties. In this paper, we choose the global integration value calculated in the axial models as the primary indicator for specifying the global spatial centers, and the local integration value at the radius of 500 meters by the angular-tulip analysis for specifying the local spatial centers. Accordingly, the centrality process on the social side is discussed later in the paper by investigating the evolution of historical commercial centers in the city of Macau.

[7] The 'rua direita' can be commonly found in Portuguese historical cities, usually serving as the oldest and main business street (Yan, 2004).

namely St. Anthony's Church, St. Lawrence's Church and St. Lazarus Church—were quickly erected at three strategic points of the Macau Peninsula, around which neighborhoods soon emerged and conglomerated. Then, the 'rua direita' began to take shape and be developed as the major spine of the embryonic urban form. No later than 1630s, they had also completed a city wall system along the boundary of their settlement, separating themselves from the Chinese settlements both in the north and in the deep south.

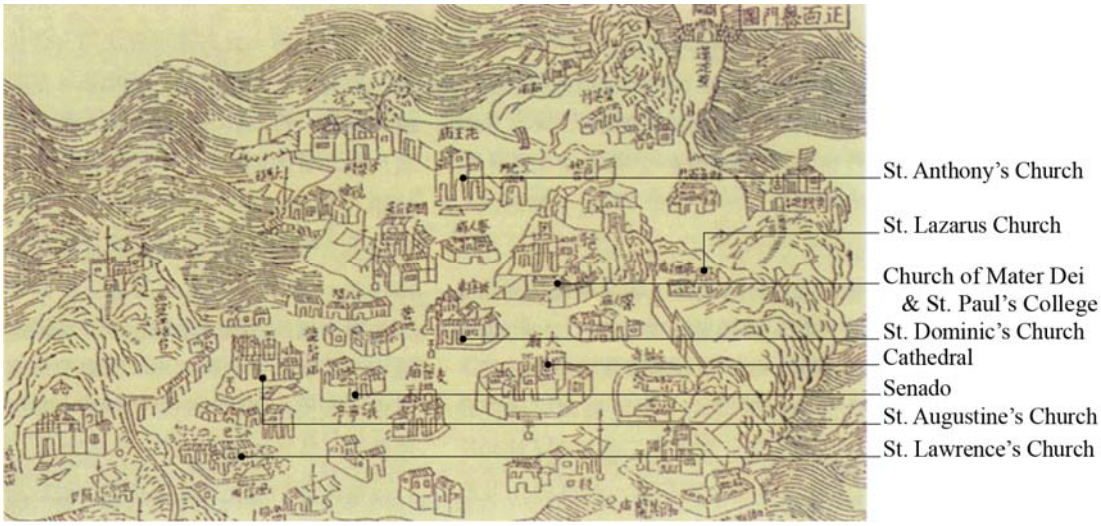

Figure 1: The city layout of Macau in the 1740s
Source: *http://www.macaudata.com/macauweb/Encyclopedia/html/44907.htm*
The map was first found in the local chronicle of Macau (also known as 澳门纪略 [*Ao Men Ji Lue*] in Chinese) which was compiled by Guangren Yin and Nulin Zhang during the mid-eighteenth century.

However, the city construction slowed down when the Dutch seized the Portuguese Malacca and cut off the shipping route from Goa to Macau in 1631. Moreover, as the rulers of Qing Dynasty strengthened their control over Macau, new constructions by the Portuguese were firmly restricted. As we can see in Figure 1 and Figure 2a, the basic spatial layout of Macau had largely unchanged until the Opium War which broke out in 1841.

Figure 2: The evolution of the urban fabric of Macau Peninsula, with major reclamation projects and historical buildings marked by the author

After the Opium War, the Portuguese set out to forcibly expand their colonial territory in Macau. They destroyed the previous city walls running from around the St. Anthony's Church to the Guia Hill and soon

took control of the northern peninsula. As shown in Figure 2b, several arteries were efficiently planned and constructed during this period. On the other hand, the Portuguese authorities in Macau conducted a series of reclamation and rehabilitation projects along the Inner Harbor in the latter half of the 19th century. These projects not only provided new available land for development, but also considerably improved the local living environment.

In the early 20th century, as the Qing Dynasty had been overthrown by Xinhai Revolution, Macau stepped into a relatively steady growth and enjoyed a quick urbanization process. As Figure 2c shows, there appeared to be a marked increase in land area due to the reclamation projects both along the Inner Harbor and the Outer Harbor. A growing number of roads were laid in the northern peninsula based on the frame set up in the previous period. In regard to the old city, the most significant project was the construction of Avenida de Almeida Ribeiro, which established a direct link between the Inner Harbor and the Outer Harbor. However, during the Second World War, Macau underwent a short regression of urban construction.

In the latter half of the 20th century, another round of massive reclamations was launched. The largest reclamation projects include Praia Grande Bay Rehabilitation Plan (PRBPG), New Outer Port Landfill Area and the new reclamation area of Areia Preta, as shown in Figure 2d. Most of these newly reclaimed lands were evenly divided into large-scale plots, upon which piles of high-rises were erected. Up until now, the reclamation projects have been continually promoted, shaping a sharp contrast to the compact urban fabric of the historical quarter.

4.2 The Evolution of Commercial Centers

Since early 17th century, the neighborhood around St. Augustine's Church had developed into a trading center. Two more trading centers had gradually emerged and developed around the St. Dominic's Church and the Gate of St. Lazarus by the Opium War (Huang et al., 1993). Due to the reclamation and rehabilitation projects conducted along the Inner Harbor since mid-nineteenth century, the global trading center began to migrate towards west, including a modern business street—Rua de Cinco de Outubro—as well as the more traditional-styled commercial streets such as Rua da Felicidade and Travessa do Auto Novo (Xuan, 2003). In early 20th century, there were four distinct commercial centers in the Macau Peninsula, which differed from each other in their functions. The Avenida de Almeida Ribeiro functioned as the largest financial center, where stood a number of stores selling high-end products; the Rua Central served as a trading street mainly for the nearby Portuguese residential community; the area surrounded by Rua do Tarrafeiro, Rua do Gamboa, Rua de Cinco de Outubro and Rua dos Mercadores performed as before as a center of business, handicraft and service industries for the local Chinese community, and so did the strip of area located between Rua da Praia do Manduco and Rua do Almirante Sergio (ibid). The pattern of commercial centers has changed again since then. Based on our field observation in the summer of 2010, we find that a major commercial center has developed around Avenida de Horta e Costa. Besides, centers of business or entertainment industry have also emerged—either through the top-down or bottom-up process—in new reclaimed areas.

Figure 3: The evolution of commercial centers in Macau

In short, the location of main commercial centers in Macau has generally undergone two shifts. Initially, the global trading center biased towards the southeast. It then migrated to the west. And now it has further moved to the north of the historical quarter of the city and the recently developed area of Horta e Costa.

5. MORPHOLOGICAL ANALYSIS

5.1 Formal Descriptions

As shown in Figure 4, the evolution of block structure has exhibited a combination of organic growth and piecemeal modern development. In the map of 1834, there appears to be a great variety of blocks both regard to their shape and size. Along the 'rua direita' lie some large churches and monasteries, while several long strips of neighborhoods are observable around the lower Inner Harbor. In the map of 1889, a subdivision of blocks can be detected in the reclamation and rehabilitation projects to the west of Rua dos Mercadores, which forms an interesting contrast to the large and irregular blocks along the 'rua direita'. As we can see in the map of 1952, rather than taking on organic forms, the blocks developed around Avenida de Horta e Costa have straight contours and demonstrate a kind of hierarchy in their sizes. In the map of 2010, the overall size of the Macau Peninsula increases considerably due to the massive reclamation projects along the Outer Harbor. The large square blocks located in these new reclaimed lands have a uniform appearance.

Similarly, the street system of the Macau Peninsula has gradually evolved to an efficient and modern looking as shown in Figure 5. In the map of 1834, the sinuous 'rua direita' clearly functions as the major spine of the whole street network, with a number of short cul-de-sacs directly linked to it. In the map of 1889, it can be seen to the west of Rua dos Mercadores and along the Inner Harbor that a marked intensification of grid has taken place and contributed to the comb-shaped form of the area.

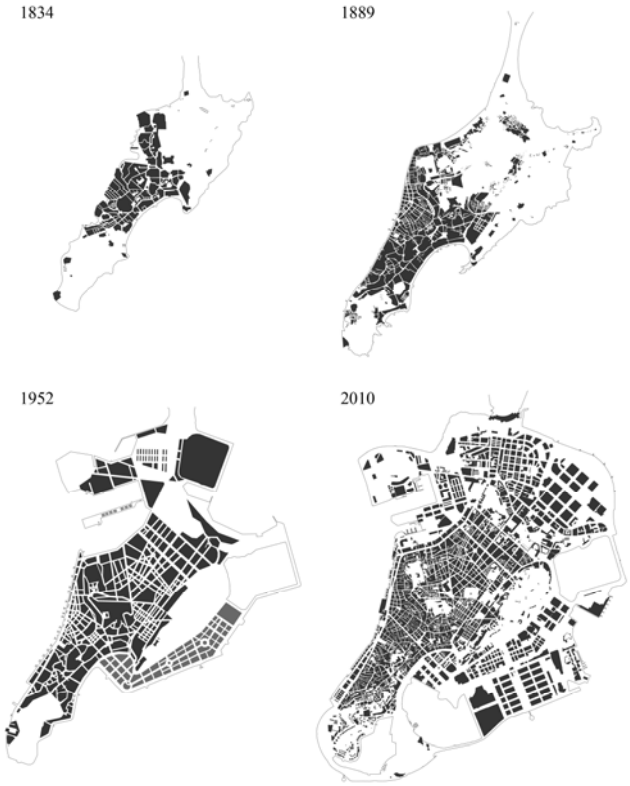

Figure 4: Block structure compariso from 1834 to 2010

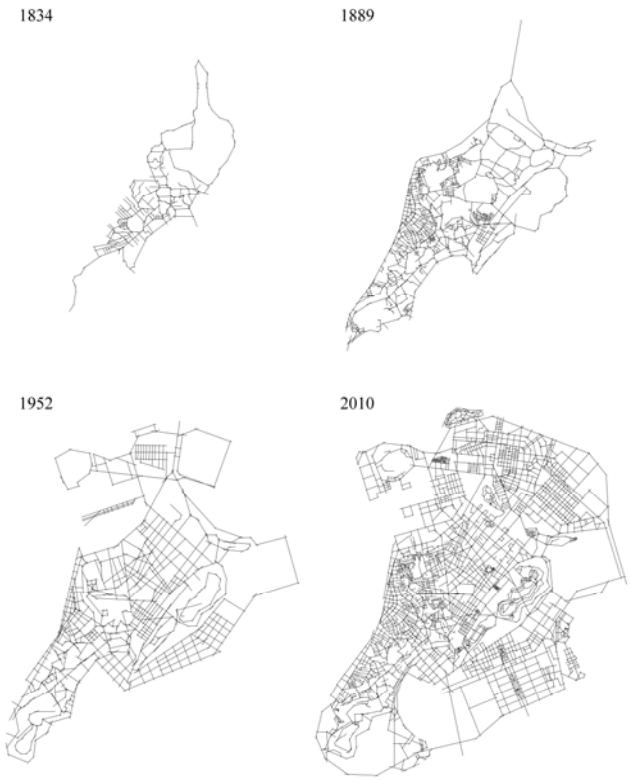

Figure 5: Axial maps showing the street structure of Macau Peninsula from 1834-2010

In the map of 1952, a series of long and straight lines can be found in the northern peninsula, demonstrating more or less a Renaissance style. While in the map of 2010, following the large-scale reclamation projects, it can be seen that patches of orthogonal grids have been introduced along the Outer Harbor.

As found through the formal descriptions, with periodic extensions of its city boundaries, the morphological changes of Macau in the block structure and the street network have frequently been characterized by attaching new pieces of different qualities onto the old. As to the historical quarter, despite the occasional small-scale redevelopment projects, its basic spatial structure has remained to a large extent. It seems that Macau has evolved into a unique collage of various urban grids.

5.2 Statistical Analysis

In order to further quantify the morphological changes of Macau, we have recorded the results of the axial analysis on the syntactic parameters as listed in Table 1.

Table 1: Syntactic parameters of the urban grid of the Macau Peninsula from 1834-2010

	1834	1889	1952	2010
Mean Global Integration (Rad-N)	0.596	0.789	1.084	0.921
Mean Local Integration (Rad-3)	1.433	1.642	1.989	1.792
Mean Connectivity	3.066	3.559	4.848	3.756
Intelligibility (connectivity/global)	0.170	0.215	0.358	0.171
Synergy (local_R-3/global)	0.429	0.470	0.727	0.601
Max Rad-N	0.845	1.194	1.669	1.541
Max Rad-3	2.693	3.406	3.917	4.001

As we can see, there is a marked rise in all kinds of integration values in the 200 years' urbanization process. Meanwhile, the mean connectivity has also grown from 3.066 in 1834 to 3.756 in 2010. All these indicate that the overall structure of Macau has turned to be shallower and the streets have become better connected. An increase also can be detected in the synergy values, suggesting an improvement on the symbiotic relation between the local and global structures. However, although there appears to be an ascending trend for the intelligibility of the street layout from 1834 to 1952[8], it remains almost the same today as that of 200 years ago.

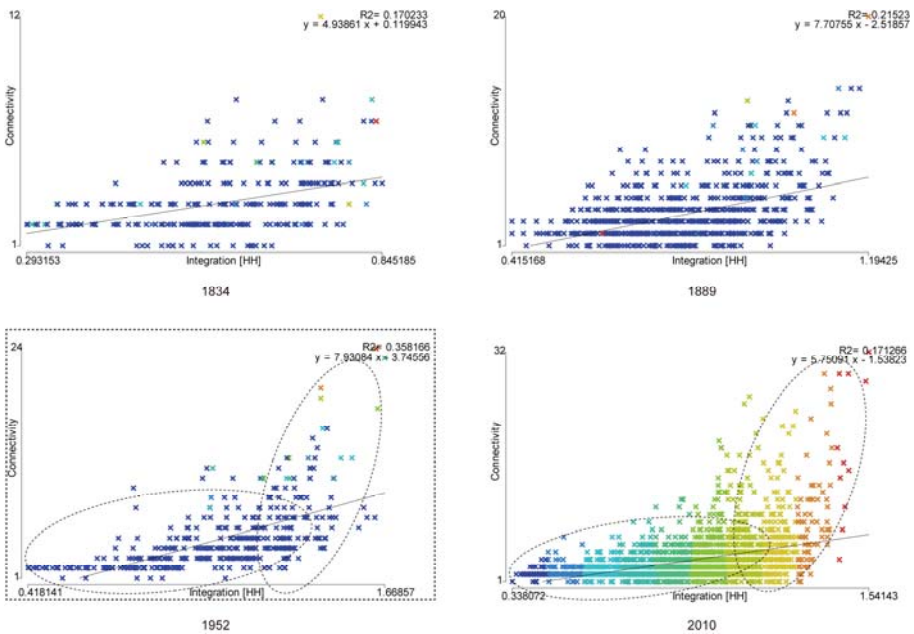

Figure 6: Scatter plots showing intelligibility of the street layout of Macau, from 1834-2010

[8] The rise of intelligibility of the spatial network of 1952 is partially due to the fact that the historical map of 1952 which we used to establish the axial model is a simplified map and a large number of cul-de-sacs and small alleys were not marked on it.

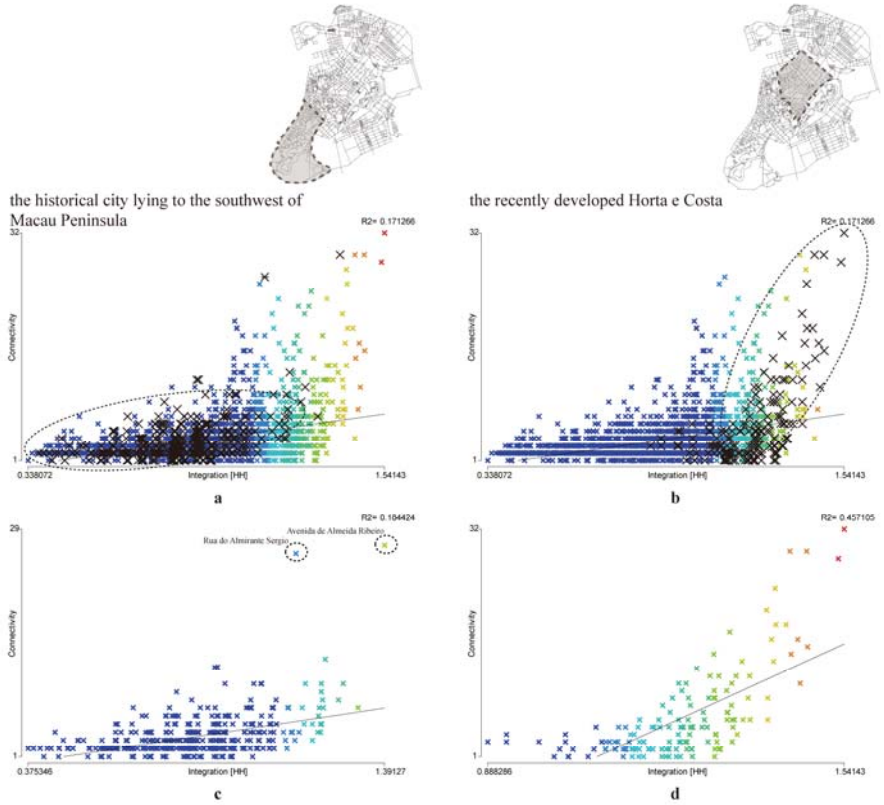

Figure 7: A comparison of the historical quarter with the area of Horta e Costa in respect to their scatter plot

If looking at the scatter plots showing the intelligibility of the street layout of Macau in different periods (Figure 6), a bifurcated pattern can be found as the city grows. As Figure 7 shows, it turns out that the alignments of the historical quarter in the southwest and those of the recently developed area of Horta de Costa respectively constitute the gentlest and the steepest part of the scatter plot. Moreover, if calculating the intelligibility values on their own, we can see a considerable value difference in that the street network of the area of Horta de Costa holds a much higher intelligibility value (0.457) than that of the historical city lying to the southwest of the Macau Peninsula (0.184).

5.3 Centrality Process

The centrality process of the Macau Peninsula is syntactically investigated at two scales. This includes both an axial analysis conducted at the global level and an angular-tulip analysis calculated at the local level—namely the radius of 500 meters in this case. Thus, we are not only able to trace the migration of strategic positions from a city-wide perspective but also can detect the local grid intensification process in a chronological manner.

As Figure 8a shows, an integration core has clearly developed in the grid of Macau in 1834. The spatial centrality strongly biases towards the southeast of the Macau Peninsula where the heart of the Portuguese settlement lies. The integration core is defined by Rua dos Mercadores in the west and the Praia Grande in

the east, reaching Rua do Campo in the north and Rua de S. Lourenco in the south—pretty much like the shape of a 'spiky potato' as Hillier (1999) describes. With regard to its local integration pattern as shown in Figure 9a, two local spots are further highlighted around the St. Dominic's Church and along the Rua Central-Rua de S. Lourenco. It is noticeable that while there are sequences of parallel alignments lying in right angle to the coastline along the Inner Harbor, they have not shaped a spatial advantage due to their relative segregation from the global integrators.

However, as shown in Figure 8b, the global integration core almost totally dissolves at its original place and migrates to the west of Rua dos Mercadores. An interesting finding is that from the integration core also extends two integrated radials—one links to the traditional Portuguese community in the southeast, and the other to the forcibly occupied northern peninsula. Around the global strategic position has also the most locally integrated structure developed as shown in Figure 9b.

A clear integration core can hardly be found in 1952's integration map. As shown in Figure 8c, the key integrators shape rather like the rims of a 'deformed wheel' pattern in the normal sense. However, obstructed by hills, the long radials linking to those rims have not converged inward at a focal point to create a strong internal hub. As to the local level, a compact and dense grid is highlighted around the area of Horta e Costa.

As Figure 8d shows, there are a much greater number of integrated lines in 2010's integration map. With large reclamation projects conducted along the Outer Harbor, the most integrated area has further biased towards the northern peninsula. A convex integration core emerges within the area of Horta e Costa—around the geometric center of present Macau Peninsula. While the global integration core is surrounded by hills, only a few long radials are developed from it to establish direct links between the central area and the peripheral parts. These radials—as well as those long alignments that lie one or two turns away from them—perform as global integrators that make the whole street structure syntactically shallower. On the other hand, besides those compact and inter-accessible structures shaped in previous periods, certain grids or streets distributed in newly developed reclaimed areas have also obtained a local spatial advantage, as shown in Figure 9d.

Figure 8: Global integration (Rad-N) analysis of Macau Peninsula from 1834-2010 (based on axial models)

Figure 9: Local integration (Rad-500m) analysis of Macau Peninsula from 1834-2010 (based on segment models)

In conclusion, the global integration core of Macau has greatly varied both in its location and size during recent 200 years. It has shifted from the southeast to the west and further to the northeast. The centrality process of Macau has been significantly influenced by its complex geographic conditions. Because of the obstruction caused by the hills, the newly developed urban areas have only weak connections to the existing ones. Thus, in contrast to those organic cities which have sustained a robust center over time by exploiting a 'deformed wheel' structure, Macau has its spatial centrality periodically displaced with inconsistent growth of urban grids. This, in fact, fully represents Hillier's argument on the 'paradox of centrality' (Hillier, 1996) in that during the process of Macau's rapid urban growth, as the possibility of forming certain edge-to-center lines are minimized by the existing natural barriers, the tension between internal and external integration inevitably leads to a shift of the integration core when an external system—the newly developed structure in the case of Macau—is attached onto the internal system—the previous existing structure.

6. CENTRALITY PROCESS ON BOTH THE SPATIAL AND SOCIAL SIDE

To do a qualitative analysis on the correlation between the live centrality and spatial centrality in Macau's evolution process, a visual comparison is conducted between the evolution map of commercial centers (Figure 3) and the integration maps (Figure 8 & Figure 9).

It is found that the centrality on both sides has similarly undergone two shifts—first towards the west and then to the northeast. Moreover, when overlapping the spatial integration maps on the evolution map of commercial centers, we find the centers picked out by spatial analysis correspond with the trading centers not perfectly, but fairly well.

On the one hand, these commercial centers demonstrate to a large extent the qualities of 'live centers' as defined by Hillier (1999) and further prove his argument (ibid) on the two conditions—both a global strategic position and a local compact and inter-accessible structure—that a successful global live center should hold. On the other hand, the periodical shift of the spatial centrality of Macau is shown to be a typical way in creating its local sub-centers. By the local adaption and intensification process, the previous global commercial center has often developed an efficient local spatial structure, which helps it sustain its influence as a local trading spot.

7. A SPATIAL PERSPECTIVE ON THE FUNCTIONAL TRANSITIONS

7.1 The Changing Roles of Historical Commercial Centers

As we have shown, the spatial structure seems to have played a role in shaping as well as sustaining the various commercial centers during Macau's evolution process. But have these historical live centers functioned equally as seen from the spatial perspective? In order to explore this question, six historical vibrant commercial streets are selected as case studies, which include Rua do Tarrafeiro, Rua Central-Rua de S. Lourenco, Rua do Campo, Rua da Praia do Manduco, Rua dos Mercadores, and Avenida de Almeida Ribeiro.

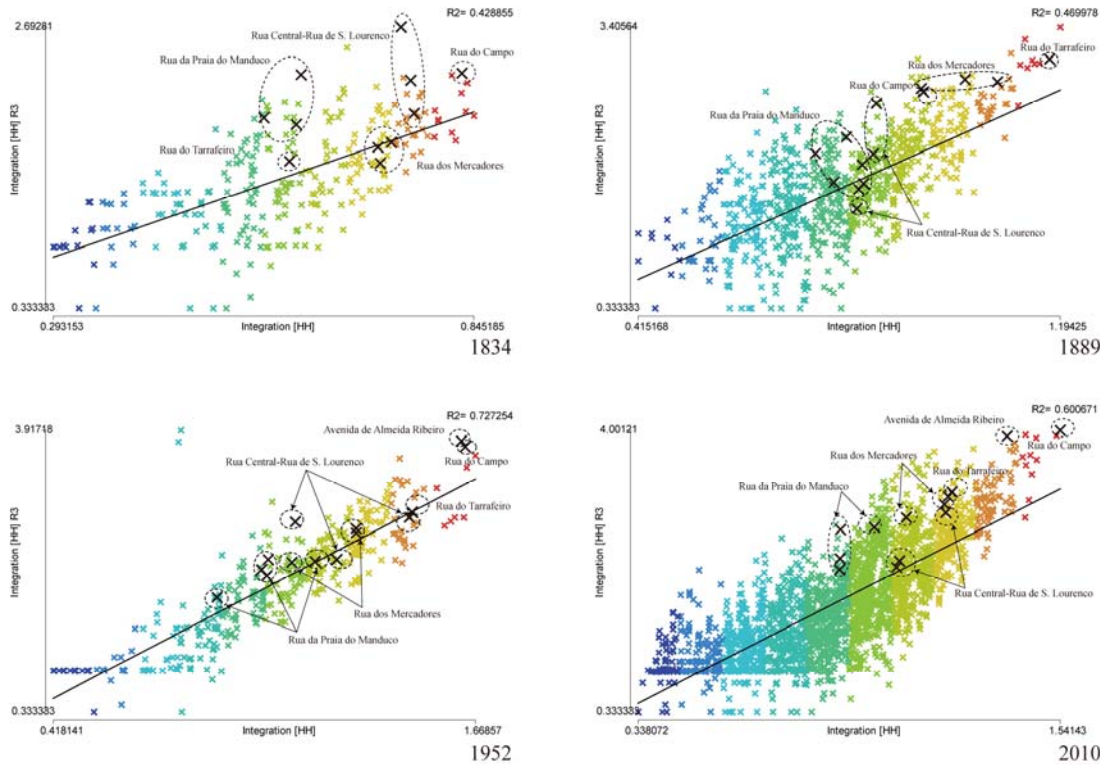

Figure 10: Scatter plots showing synergy of the street layout of Macau Peninsula, from 1834-2010

Highlighted as black dots in Figure 10, these streets lie generally above the main regression line of synergy and distribute within the top-right zone of these plots, which indicate that they are more integrated than the average level of the whole city. The interesting thing is that though scattered roughly in the same zone of the plot, they have shaped a rather linear than convex pattern, which implies that there might be a kind of hierarchy when treating these vibrant streets as a totality. By calculating and recording the average integration value each street holds both at the global and local level in historical axial models, the alterations in the functional aspect are revealed from a spatial perspective (Table 2 & Table 3).

Table 2: The local integration value (Rad-3) of historical vibrant streets

	1834	1834’	1889	1952	2010
Rua do Tarrafeiro	0.604	0.541	1.175	1.482	1.233
Rua do Campo	0.830	0.868	0.939	1.639	1.541
Rua dos Mercadores	0.737	0.917	1.078	1.316	1.222
Rua Central-Rua de S. Lourenco	0.767	1.119	0.855	1.474	1.215
Rua da Praia do Manduco	0.619	0.822	0.832	1.195	1.012
Avenida de Almeida Ribeiro				1.628	1.391

Table 3: The global integration value (Rad-N) of historical vibrant streets

	1834	1834'	1889	1952	2010
Rua do Tarrafeiro	1.569	1.467	3.053	2.872	3.192
Rua do Campo	2.306	1.949	2.808	3.708	4.001
Rua dos Mercadores	1.727	1.727	2.809	2.662	3.128
Rua Central-Rua de S. Lourenco	2.693	2.700	2.574	2.806	2.922
Rua da Praia do Manduco	2.297	2.297	2.202	2.272	2.734
Avenida de Almeida Ribeiro				3.782	3.925

7.2 Parts in the Whole: Understanding the Local and Global Dynamics in Macau Today

As mentioned above, constrained by the complex geographic conditions and constructed with disparate planning traditions, the street structure of present Macau shows a distinct patchwork-like pattern. Thus, based on the administrative division and our experience gained through field investigation, we divide the whole city into four districts, namely the Southwest District, the Central District, the Southeast District, and the North District, as shown in Figure 11. These districts are further taken as independent systems and inspected through a Rad-Rad analysis[9] to eliminate the edge effect[10]. By a comparison study of their integration patterns both as individual and embedded systems, the differentiation for the particular function each district bears is discussed from a spatial perspective.

The Southwest District lies to the south of Avenida de Almeida Ribeiro, comprising most of the historical quarter. As shown in Figure 8d, this district is only bypassed by several strong global integrators, such as Avenida de Almeida Ribeiro, Rua das Lorchas and Rua do Almirante Sergio, at its peripheral sides. The integration pattern does not change much when the district is taken as an independent system. As Figure 11 shows, there still lacks a strong integration core inside, and the internal area seems to be largely segregated from the larger urban context. As a major residential quarter in the Macau Peninsula, it effectively excludes the large-scale urban movements from its local community when seen from a syntactic point of view.

On the contrary, the street network of the Central District shows a much higher accessibility both at the global and local level. Though a complete 'deformed wheel' structure has not been fully developed due to the obstruction caused by hills, the Central District is now serving as the global live center promoted by its global strategic position and local compact structures.

The North District has been developed recently by reclamation. As shown in the global integration map of the Macau Peninsula, it only benefits from a few strong global integrators that extend from the Central District. However, when treating it as an independent system, a 'deformed wheel' pattern can be observed in its street structure. The integration hub is located around the crossing of Estrada do Arco and Istmo de Ferreira do Amaral. Several long radials stretch out from it to reach the integrated rims. Functioning pretty well as an independent spatial system, a successful commercial center—which takes advantage of the flow of immigration from Gongbei Port—has spontaneously developed along the Istmo de Ferreira do Amaral.

[9] Radius measures are used within space syntax to avoid edge effect or to observe a local phenomenon (Turner, 2007). It is a global analysis in which radius has been set at the mean depth of the whole system from the most globally integrated line (Zhang, 2005).

[10] Edge effect refers to distortions in values due to where we choose to draw the boundary of the graph (Turner, 2007).

Figure 11: Rad-Rad analysis on the four districts of Macau today

Similar to the North District, the Southeast District is a newly developed reclamation district. As Figure 11 shows, a simple 'deformed wheel' structure can also be found when it is taken as an independent system. The hub of the centrality lies right at the crossing of Alameda Dr. Carlos d' Assumpcao and Avenida da

Amizade, while the global integrators such as Avenida de Lisboa and Avenida do Dr. Rodrigo Rodrigues serve as its rims. Several large casinos, such as Lisboa and Wynn, are located in the west of the area, quite close to the global integrators. As a newly planned district whose development is significantly intervened by the cognitive planning, it seems to rely more on the key arteries which bring in the large-scale urban movement from the rest of the city to promote the main attractors in this area.

8. CONCLUSION

Based on the results obtained, several conclusions can be drawn in response to the questions set out in section 1:

1. How can the morphological development of Macau be described in terms of its spatial configuration?

Besides the growing size and the diversity of urban grids, there is a general ascending trend for the mean global/local integration value and the mean connectivity of the street structure within the urban fabric of the Macau Peninsula. The synergy values of the whole urban network, which indicate the synchronization of the local street structure and the wider unban context, also show an increasing tendency. However, the overall intelligibility, though reaching its peak in Macau's urban form around 1952, as drawn from a simplified historical map, has remained almost the same today as that of 200 years ago. There is a clear bifurcation regarding the intelligibility of the Southwest historical quarter and the recently developed Horta e Costa in that they respectively constitute the most intelligible and the most labyrinthine part of the whole city from the syntactic point of view.

The global integration core has biased first towards the southeast of the peninsula, then migrated to the west of Rua dos Mercadores and further towards the northeast, roughly located at the area of Horta e Costa today. The development and migration of the global integration core in the network of Macau Peninsula fully represents 'the paradox of centrality' as described by Hillier (1996) in that as the possibility of forming certain edge-to-center lines are minimized by existing natural barriers, the tension between the internal and external integration inevitably leads to a shift of the integration core when an external system—the newly developed structure in the case of Macau—is attached onto the internal system—the previous existing structure.

2. Can a relationship be established between spatial characteristics and the development/role of commercial centers from a historical point of view?

The frequent overlapping between the historical commercial centers and the alignments highlighted in the global/local integration maps suggests a relationship could be established between spatial characteristics and the development of commercial centers through the evolution process of the Macau Peninsula. These historical commercial centers, which have taken their shape more through bottom-up growth processes than top-down planning, demonstrate to a large extent the qualities of 'live centers' as defined by Hillier (1999) in that the global commercial centers usually have both a strategic position at the city-wide scale and a compact and inter-accessible local structure.

3. How does a spatial perspective on the functions of traditional commercial streets and different urban quarters today reflect on their relative function in the urban morphology of Macau?

The six historical commercial streets, which we selected as case studies, though holding a generally higher

integration than the average during each of the four periods, not only vary in their respective local/global integration values, but also present an evolving hierarchy as a totality. On the one hand, some of the former global commercial centers such as Rua Central and Rua de S. Lourenco, have sustained their business function for their immediate neighborhoods with the compact and inter-accessible structures that derive from the previous local grid intensification process. On the other hand, there are also spontaneous local commercial centers like Rua da Praia do Manduco which have never held a salient global spatial position but only shaped a local spatial advantage.

As an historical quarter mainly serving for the residential use today, the Southwest District is characterized by locating the key global integrators at its peripheral sides—either seen on its own or in relation with the city as a whole—so that the global flow are largely excluded. The high degree of synchronization of the integration patterns both conducted individually and with the rest of the city greatly promote the Central District's function as a global commercial center. Though the North District and the Southeast District are comparable in their local integration patterns and the ways in which they are integrated to the rest of the city, the North District has developed a mixed use pattern of commerce and residence in line with its local 'deformed wheel' structure, while the South District, due to the cognitive planning process, places its largest entertainment facilities close to the global arteries that directly linked to the rest of the city.

Finally, it is worth mentioning that this study is necessarily limited for the following reasons. First, the historical commercial centers that we find in the historical records and previous studies are likely to be subject to historical incompleteness and selective recording which may compromise our interpretation. Second, a certain degree of selection and interpretation of those historical maps that we use to establish our axial models on our part may inadvertently introduce a particular slant to our reading of Macau's spatial structure.

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