Gene-Syntax Approach to Protection and Planning of the Grand Canal Ancient Town: The Case of Dongpu Ancient Town

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Abstract. With the advancement of new urbanization and the success of the Canal heritage application, Canal ancient town as a special type of small town has received increasing attention. This paper looks at Dongpu ancient town's space protection and its organic renewal, and tentatively proposes the Gene-Syntax research approach. First, drawing on Space syntax and its computation software Depthmap, the paper employs axis method to compute the core integration of Dongpu ancient town. This helps to identify the area with the highest degree of core integration in Dongpu ancient town. Second, by reviewing the inheritance principles of the Cultural Genes of Dongpu ancient town, the paper identifies the area with the most 'goodness-of-fit' within Dongpu ancient town. The paper points out the direction of ancient town protection and renewal, and contributes to exploratory research on the cultural rejuvenation of ancient town.

Introduction

The formation and development of Chinese cities and towns has a long history. In quite a period of time, traditional small towns in China have been developing continuously with unique regional “genetic” system, showing a process of dynamic evolution [1]. As an important link in China's urban system and the intermediary between urban and rural areas, small towns are also an important force to promote China's urbanization process and regional economic growth, including newly built and developed towns after liberation, as well as historic towns that have survived the changes of times [2]. After years of baptism, some of these historic towns still maintain a good historical outlook, while some have been in decline, and the phenomenon of “empty-nest” and “hollowing out” is serious. Facing the rapid urbanization process and the trend of urban integration, it is both an opportunity and a challenge for ancient towns.

Connotation of “Gene • Syntax”

“Gene” and “Gene” of The Canal Town

The “gene” theory, derived from biological genetics, records the whole process of life from birth to death. In 1976, Richard Dawkins, a British scholar, created the word “Meme” in his book called The Selfish Gene, which is similar to Gene and means “cultural transmission unit”, that is “Cultural Gene”, to explain and describe the law of the transmission of human culture [3]. Changlin Liu believes that meme is a way of thinking and psychological structure, which has an important impact on national culture and history [4]. Recently, Jin Duan put forward the concept of “Spatial Gene”, holding the opinion that spatial gene is a unique and relatively stable spatial combination mode, which is not only the product of long-term interaction and evolution between urban space and natural environment, history and culture, but also carries unique information of different regions [5]. Scholars have given a clear definition of genes. Combined with the above theories, this paper defines the genes of the ancient town of canal as factors that have an important impact on the regional characteristics, physical space, cultural customs and other aspects of the ancient town, including the material and non-material aspects.
Space Syntax
As a research method aiming at the spatial correlation of systems, space syntax mainly discusses how social and economic factors promote the formation, continuation and development of the whole spatial system. This theory reveals the structural relationship between architecture and various spaces in the settlement, and connects it with the natural activities of human (including the modes of movement, stay and communication), reflecting the interactive relationship between human and the space ontology [6]. Similar to the theory of spatial interaction, this view holds that space, as the result of social actions and relationships, is involved in evolution on its own. As a material space for residents to live and produce, the ancient town of Canal, thanks to its rich water network, multi-level street structure and architectural form, is constantly promoting the interaction, change and development between people and space.

Overview of “Gene” of The Canal Town
As a great engineering miracle of human beings, the Grand Canal of China contains functional, technical, spiritual and aesthetic information genes. It is a historical witness and also reflects the development and evolution history of several times and regions. Canal ancient town not only acts as a material container for all political, economic and cultural activities of ancient society, but also constructs the unique “Cultural Gene” of Canal ancient town through the cultural behaviors inherited by residents of the town. This kind of gene is changeless, or changes as the transformation of material space, or develops and changes through different historical periods, or produces mutation because of the human behavior influence of environment, still maintaining the characteristics such as heredity, selection, mutation all the time.

Historical Evolution of Dongpu Ancient Town
Dongpu ancient town is located along the east Zhejiang Canal, about 1.3 kilometers away from it, 4.76 kilometers wide from east to west, and 9.94 kilometers long from south to north. The core protection area of the ancient town is 3 square kilometers, and the landscape coordination area is 9 square kilometers. It is also one of the ancient canal towns included in the provincial planning of Zhejiang Province. It is said that the ancient town had settlement as early as the end of the eastern Jin dynasty, and formed a market town in the Song dynasty. Because Dongpu is in the north of Jianhu lake, it is a water town. According to the recordation of Water Conservancy in the government of Shaoxing during the period of Emperor Qianlong, the small one in the district of hydrops can be called pu, which is near to the water. It is located in the eastern half of the original Shanyin county, hence the name is Dongpu. The water network of the ancient town is well developed, with a water area of 1 square kilometer, which well preserves the style and texture of the ancient town in the south of the Yangtze river during the Ming and Qing dynasties. Dongpu is a famous “bridge town” where 37 ancient bridges built in different periods are preserved in the market town. It is also the “hometown of famous scholars”, the hometown of Zhizhang He, a great poet of the Tang dynasty, the residence of You Lu, a patriotic poet of the southern Song dynasty, and the birthplace of Xilin Xu, a martyr of the 1911 revolution. In the old days, Dongpu ancient town was most famous for its brewing industry and bristling wine houses. It was the birthplace of Shaoxing yellow rice wine, and over 500 wine houses appeared. Ciming Li, a native of the Qing dynasty, wrote in the poem “The night of Officially Called Zhushui Village to Dongpu Village”:
“The night market is approaching Dongpu, and the red light is on as well as some new wine stores. From the barking of a dog in another village, one can tell that someone returns with a drunken mood. The poem vividly describes the lively scene of Dongpu night market. As the most distinctive intangible cultural heritage of Shaoxing, Dongpu ancient town holds a Dionysus meeting every year from the sixth to the eighth day of the seventh lunar month, which is mainly for greeting the Bodhisattva and holding the trade bazaars.
“Cultural Gene” of Dongpu Ancient Town

Similar to the action mode of biological genes, Dongpu ancient town takes brewing yellow wine as the foundation and spreading yellow wine culture as the soul. In recent years, the trend of urban integration and the successful opportunity of the grand canal’s application for the world heritage site have brought new opportunities and challenges to the ancient towns. As the pattern development of cultural tourism and yellow wine characteristic town, it endows the ancient town with new vitality. Based on the field investigation, it is found that, first of all, from the aspect of form, according to the organic renewal theory put forward by academician Liangyong Wu, and on the basis of respecting the authenticity, the classification and repair of the buildings in Jizhen Street River Area, the most core part of the ancient town, are carried out and the architectural style grade is established. Historical features are well preserved for a class of buildings, mainly for structural reinforcement and building surface corrosion treatment. 2 kinds of buildings, namely, on the basis of existing landscape, building local repair and new, and keep the Dongpu town Lou characteristics and more “room - street - river - street - room”, “room - river - room”, “room - river - under eaves space - room” waterfront space structure. In addition, the religious belief of the ancient town was continued, and the Taoist cultural public buildings of the king temple of Xingfu governor were restored and built. Secondly, in terms of format, highlight the industrial clusters of characteristic towns by making yellow wine, yellow wine culture, selling yellow wine and other sectors. Thirdly, in order to follow the cultural inheritance as the guide, the intangible cultural construction with characteristics such as blacksmith skills, pawnshop culture and religious belief of Xingfu governor temple is added to enrich the cultural form of space (see image 1).

Figure 1. Water vein diagram of Dongpu ancient town.

“Cultural Behavior” of Indigenous People in Dongpu Ancient Town

In his book communication and space, Danish scholar Yang Gail mentioned that “outdoor activities can be divided into necessity activities, spontaneous activities and social activities” [9]. The public space of the ancient town mainly includes the material space for life, production and spiritual sustenance, such as: street market along the river, living street, space under the eaves, space under the corridor, square, stage, tea house, wine workshop, temple and so on. While Taiwan scholar
Jintang Wang divided the spatial behavior into three categories, namely, the study of the artificial environment, to discuss the relevant content in the artificial environment, including the color of the building, size, shape, surrounding environment and the relationship between various urban space and human behavior and so on. The research on social behavior mainly focuses on the research on different natural environments and the research on social behavior. The research on the natural environment mainly focuses on the research on the relevant behaviors and feelings triggered by environmental stimulation in the natural environment [10]. Based on the research method of environmental behavior and the theory of Yang Gail, for the residents of the ancient town, the necessary behaviors are mainly the behaviors related to daily life and the production behaviors such as ship repairing, ship building, bridge building, wine making and sales. The spontaneous behavior is mainly embodied in the life behavior related to personal preference. The social behavior is the neighborhood contact and the interaction and so on; Cultural behaviors include opera listening, sacrifice, religious belief and folk activities, etc. [11]. Because the spatial activities of people are closely related to physical space, and some spaces have compound properties, the resulting behavioral activities are interwoven with each other. In addition to being relatively active in the public areas along the river system, the small courtyards deep in the streets also provide an important space carrier for residents’ social and spontaneous behaviors. The material space of ancient towns and the cultural behaviors of indigenous people are regarded as the “meme” group, which can be sorted and classified according to the above research to explore its inherent regularity.

In the core protection area of the ancient town, it is mainly composed of three areas: Jizhen Street River, temple bridge and new bridge. The Cultural Gene based on commercial behavior is mainly located in the residential houses on both sides of Jizhen Street River at the junction of Xijiang river. The space under the eaves and the open drainage gate are jointly used as commercial space to expand the area of business activities. The streets on both sides of the street and the river are relatively wide with numerous ports, which are directly adjacent to the water and convenient for carrying goods up and down. Based on the production behavior of memes mainly located near to the doors of Big Belly River area, residential density is relatively low, mainly distributed in a lot of factory premises, brewery and maintenance vessel (see image 1). As a production area, two-way river ports and large public docks facilitate the accumulation and transportation of goods, as well as the passage of large ships. Based on the life behavior of cultural gene, mainly in Lujia river Lou area or town street on both sides of the porch space, space for it and business practices and cultural gene overlap, and there is a competition and cooperative relations. When commercial activities are flourishing, social behaviors turn to the arcade space of residential houses in the direction of north and south, and space gives way to economic activities. When business activity is depressed, because the space under the corridor is discontinuous, there are public furniture such as beauty chair and bench for people to rest, which will also gather more people. The gene space carrying cultural behaviors is the square under Miaogqiao in the north of Jizhen Street River, which is relatively open and equipped with the king temple of Xingfu governor and winery, which is convenient for religious sacrifice and folk custom activities.

Integration Degree Analysis of Dongpu Ancient Town Based on Axis Analysis Method

With the aid of the axis analysis method, this paper analyzes the overall integration degree of Dongpu town in canal ancient town and finds out the area with the highest overall integration degree in the current situation. On the basis of digging and combing the historical evolution of Dongpu ancient town, the historical meme is fully interpreted, and the coupling between the occurrence and integration of meme is explored, so as to establish a new perspective of organic renewal of canal ancient town. Space syntax to study as an independent element space, combined with the graph theory point of view of spatial relation diagram was formed by segmentation (Justified graph), through relationship diagram to visually describe the spatial structure and morphological characteristics, and based on the calculation and computer analysis of the topology of a series of basic variables (connection value, control values, depth, integrity, the density of street network, etc.) configuration characteristics, through the study of these variables to further reveal the
space and architecture, the relationship between society and human cognitive behavior [12]. In view of the current situation of ancient towns, the space of ancient towns is firstly transformed with the help of Depthmap software (see image 2).

Figure 2. Overall integration degree of Dongpu ancient town.

The description of the organization is described as the spatial element composition relationship with linear as the basic unit. From colorific changes in temperature decide conformity spends the space with different discretion. The red line segment is located in the area with the highest integration degree, and the red-yellow-green-blue color gradually tends to the cool color, and the spatial integration degree decreases successively (see image 2). As shown in the figure, the whole ancient town is deeply influenced by Jizhen Street River and the main roads (Xilin road and Puyang road). In the figure, the area with the highest degree of red integration is the area where the Jizhen Street River connects with the peripheral roads (Xilin road and Puyang road). It can be concluded that the connection between the Jizhen Street River and the two urban arterial roads is the most accessible. In fact, as a pedestrian space, the path is also the shortest and identifiable. At the same time, it is also the most concentrated area of the main business forms and people flow in the ancient town. However, a large number of roadways in the ancient town are in a low degree of integration, which is not easy to be recognized and has strong spatial concealment. As can be seen from the figure, the areas with high integration degree in the ancient town are all along the water system space, which is highly accessible due to the connection of water network. Today, with the developed land transportation, the north ring road, west ring road and Puyang road of Dongpu ancient town have formed the most accessible transportation hub outside the town. At the same time, there are several large road networks in the town, which are connected vertically and horizontally. The whole town is orange, with clear spatial distribution and high identification. These road networks are connected with the peripheral trunk roads, greatly improving the spatial integration of the ancient town. Integration degree of the lower space, such as graphic, namely purple line location, mainly for the roadway end may courtyard patio, portal construction of the inner court, and freehand brushwork Lou, lujia Lou, saying Lou, such as gate Lou residential cluster areas. The land of these dwellings is limited. The dense and zigzag roadways are connected to each other like circuit boards, and the rich and zigzag alleys cut the land and dwellings into several small sizes, which are closely linked to each other [13]. However, these blue-purple axis Spaces are less connected to the surrounding space. It can be judged that the spatial privacy and enclosure degree of residential houses in Dongpu ancient town are relatively high. If these areas with low integration are used as sightseeing routes, the spatial recognition is not enough. The parallel mode of land and water plays a positive role in the prosperity of the ancient town. It is not difficult to understand that, although the peripheral land transportation has seriously impacted the waterway transportation of the ancient town, the water network system of Jizhen Street River keeps close contact with the outside world, which is still the core of the integration degree of the ancient town. It can be
speculated that since the development and evolution of Dongpu ancient town, although water transport has been impacted, the impact of street river is relatively small compared with the carrying function of canal. In addition, the spatial structure of streets, lanes, rivers and buildings in Dongpu ancient town has a clear hierarchy. The streets and lanes are relatively wide with good overall accessibility, which also makes the spatial integration between the two sides of streets and rivers higher.

The global depth value reflects the shortest distance between a node and other nodes. Generally speaking, the distance within 3 steps is easy to be perceived, and more than 3 steps means that more turns are needed to reach a certain space, and people who are not familiar with the space are more likely to get lost. As shown in the figure, the red line segment is the lowest global depth, and the red-yellow-green-blue decreases successively. The red line segment is described as the deepest part of the street and the end of the courtyard in the ancient town, and the street refers to the end of the zigzag alley and alley. The blue line segment represents the lower part of the overall depth, mainly including the area under the Jizhen Street river, the big belly river and the temple bridge, as well as the main streets distributed in the ancient town (see image 3).

![Figure 3. Global depth map of Dongpu ancient town.](image)

Street network density is through the line Map (Segment Map) of the Node Count R300 metric is calculated, and said, centered on a particular element in the 300 meters for the radius of circle includes many elements, reflect is the relationship between elements and surrounding elements, the red areas represent the highest value, icon (see image 4), in Dongpu town, street network density respectively river town street in areas where the highest core (between Xinqiao bridge and Dachuan bridge), as well as the ancient town of external emerging commercial block, the relationship between the two are mutually dependent and the corresponding. The surrounding area is at the core of the planning of Dongpu ancient town.
The Renewal Approach of Dongpu Ancient Town Based on the “Gene • Syntax” Protection Method

It can be seen from the “meme” of Dongpu ancient town that, for the ancient town in the old days, the “meme” generated by water veins directly led to the prosperity and decline of the ancient town. At the same time, the space where the “meme” was born in the ancient town is coupled with the street and river area with high integration and low global depth. It can be concluded that the access of water network is the carrier for the generation of “meme”, and the pedestrian system of street and lane space also provides a place for the generation of spatial behavior. Based on the coupling of gene-syntax research results, the organic renewal approach of Dongpu ancient town was proposed. First of all, on the basis of respect for ancient town space human settlements, protect bearing cultural genes space, repair the continuation of its original space form, makes every effort to keep the ancient town of historical style, texture and structure, including the original residential renovation update, secondary portal courtyard design, public building construction, river dredging, the new size and height of the building and new building facade style, architecture color, etc.; Secondly, the original spatial scale sense of the ancient town and the structural relationship between streets and streets and rivers are maintained, including the width of streets, the volume and height of buildings on both sides of streets, and the spatial rhythm of the opening and closing of streets. Thirdly, darning space is mainly for the secondary transformation of public space functions, the improvement of the landscape in the ancient town, and the addition of public environmental facilities. Compared with other belt towns, Dongpu ancient town has rich and open space, and there are many idle Spaces. Appropriate landscape improvement can help increase the spatial beauty of the ancient town. Fourth, as a brigade and characteristic town development positioning, and need adjustments carding space, refer to the calculation results of space syntax, connecting higher integration degree is low and deep the lanes of the end, the local space and improve spatial accessibility, the space for residents to live as the center to tourists, ancient town entrepreneurs use oriented. Finally, on the basis of respecting the spatial form of ancient towns and supplemented by the reasonable development of business forms, on the premise of ecological and sustainable development, the cultural inheritance of ancient towns will be promoted to the cultural Renaissance of ancient towns.
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