

# Urban Catalyst Theory and the Renewal of Old Community Road Space Under the background of Industry 4.0

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## Abstract

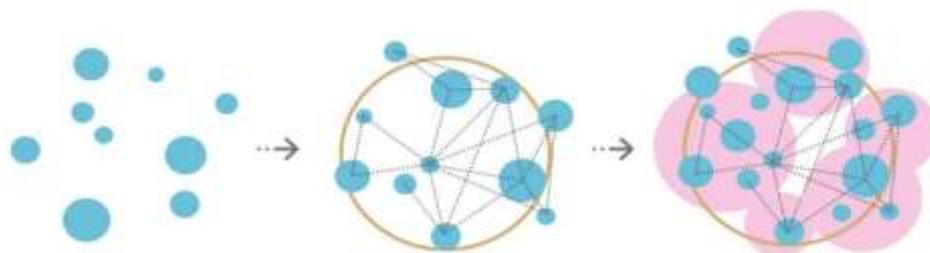
Nowadays, in the special period of post-epidemic era and industry 4.0, "community" as an important part of the city has become the focus of attention of all sectors of society. Roadways are closely related to the life of the community residents in the space composition of the old communities, which profoundly affects the daily communication and life of the residents living in the community, so the renewal and design of residential roadways in old communities has been a central issue to drive the renovation of communities and revitalize cities. In this paper, based on the theory of urban catalysts, the residential roadways of Sanyi Village in Tanhualin Community in Wuhan are studied from the aspects of the introduction of catalysts, spatial linkage, guidance and follow-up to explore how to integrate the catalysts theory to improve the quality of the community within the limited roadway space of the old communities.

**Keywords:** Urban catalysts, old communities, roadways, renewal, industry 4.0

## I. Concept and Principle of the Theory of Urban Catalysts

In the 1980s, the United States, due to the increasingly mature free market economy and the extensive use of automobiles, made a leap in economy and rapid development in urban space. Wayne Attoe and Donn Logan, American urban designers, published the book *American Urban Architecture-Catalysts in the Design of Cities*, starting from the potential of stimulating chain reaction of various urban elements in urban development, and put forward a design method that can promote the continuous and holistic development of cities-urban catalyst theory [1,2].

Urban catalyst is a way to introduce new and dynamic elements, which can promote the change of some structures in cities and change the direction and speed of urban development [3]. The catalytic reaction from the perspective of city can be understood as the planned and strategic introduction of catalytic elements in cities to change the surrounding environment caused by the shaping of catalytic elements [4]. The interaction between catalyst elements and surrounding areas can gradually promote the continuous and gradual development of subsequent urban construction as shown in Fig. 1). Urban catalyst is sometimes tangible, such as a certain element in urban physical form, and sometimes intangible, such as non-material elements related to urban development and construction [5]. According to the description in the book by Wayne Attoe and Donn Logan, the urban catalyst positively promotes the urban development through the positive catalytic effect, and can arouse the subsequent continuous development force through the continuous reaction between the activated existing elements or new elements and the existing elements [6-8]. The introduction of urban catalyst theory provides a new design model for the sound development of the whole city.



*Fig 1: Urban catalyst reaction (Source: drawn by the author)*

## **II. Concept and Status Analysis of Residential Roadways in Old Communities**

### **2.1 Roadways**

The roadway in the community is a linear public space surrounded by residential buildings, plants and roads on both sides, which is essentially an open place that can provide various residents' activities and meet people's pleasant needs. Because the roadways are usually narrow, they are mostly used for residents' daily behavior activities, and for neighborhood communication activities when necessary [9].

Scholars Huang Shuqing and Xu Leiqing (2017) defined community streets in their research as "the main place for residents to know the city and live in the city, and also the carrier of the historical memory of the block. The vitality of community streets can create the vitality of the city." Community roadway emphasizes the interaction between the flow and communication of "people" and the three-dimensional space formed by buildings on both sides, and plays an extremely important role in urban life. It is not only the main carrier of traffic, an important platform for good-neighborly exchanges in old city life, but also the basic unit for residents to know the city and urban life, which is closely related to community life. Its constituent elements can be divided into material elements, such as buildings, roads, green landscapes, public infrastructure, etc., and non-material elements, such as the historical and cultural memory of the community, which is the "soul" of the old city, recording the development history of the city and displaying the traditional culture and living habits of the old city [10-12].

### **2.2 Status analysis**

Old communities, usually built before 2000, are mostly unit-based communities where there are deep emotional ties and close neighborhood relationships that often generate rich activities in community roadways. Roadways in old communities have their own advantages in the baptism of years, such as strong life atmosphere and obvious architectural style, which record the development history of cities, witness the rise and fall of cities and show the local cultural customs [13].

At the same time, there are some common problems in roadway space, such as too single roadway space form, no diversion of people and vehicles, widespread destruction of roadway space environment and so on in the old communities. After summing up and analyzing, it is found that the key problems are mainly concentrated in the following aspects: lack of interactive roadway public space, rough design of buildings and landscapes around the roadway, imperfect street public facilities and conflicts between driving and walking in roadways, which after days and months multiplying are encroaching on the roadway spaces that old community residents frequently rely on [14,15].

## **III. Matching between Urban Catalyst Theory and Residential Roadway Design of Old Community**

In terms of design concept, the urban catalyst theory follows the internal development law of the blocks in the community, and links all local catalyst points from the local renewal design while ensuring the overall pattern and features of the block unchanged, thus gradually driving the development of the whole old community and gradually realizing sustainable design and achievements. In terms of strategy, the urban catalyst theory adopts a small-scale incremental renewal method in the process of practice, which adapts to the environmental content of the old community roadway, because only a small amount of local design updating can ensure that the natural advantages of the roadway are not destroyed and avoid many irreversible losses [16]. At the same time, this method has short cycle and strong operability, which can make the old community update and develop in a sustained and stable way without

large-scale changes. Therefore, the urban catalyst theory has similarities with the design of residential roadways in old communities, both in terms of renewal concept and protection strategy. To sum up, the multiple reaction characteristics of urban catalyst theory are consistent with the characteristics of old community roadways [17].

The category of old community design is to add some fresh and energetic elements into the original negative space in the designated active street, which is not simply implanted rigidly, but needs to be connected with the elements around the site, and can drive the changes of the elements such as the original lots after its continuous development to form an organic cycle to drive the development of the original lots and realize the renewal balance of the old community in a sense. Residents in the original area are attracted by catalytic points to gather spontaneously and come to the vicinity of elements for activities and exchanges to meet their social needs. A plurality of catalyst points are connected in series with each other and finally form an active form of replacing surfaces with points. It is thus clear that the significance of catalyst is to make the original community residents participate in social activities spontaneously, so as to improve the quality of life of residents and revitalize such old spaces [18].

#### **IV. Analysis on the Characteristics of Residential Roadway — A Case Study of Sanyi Village, Tanhualin Community, Wuhan**

##### 4.1 Object of study

In this paper, Sanyi Village, Tan hualin Community, Wuhan is selected as the main research object, a community under the jurisdiction of Liangdao Subdistrict, Wuchang District, Wuhan, located between the northern foot of Huayuan Mountain and Crab Cape in Wuchang, with an east-west direction and a total length of about 1.2 kilometers. It has 52 excellent historical buildings, with 2,716 households and 7,825 residents in its jurisdiction (as shown in Fig. 2), including 6,645 permanent residents and 852 migrants. Within 2 kilometers around the community, there are large-scale business district, hospitals, primary, secondary and primary schools and other public service facilities, making life very convenient for residents. Sanyi Village is located in the northwest corner of Tanhualin Community. Most of the buildings are multi-storey buildings built in the late 1950s. The typical one is the dormitory area of Wuhan No. 6 Cotton Textile Factory, with six three-storey double-faced dormitory buildings with the same building shape, covering an area of 6,400 square meters. Sanyi Village is crowded with more than 120 residential buildings in the area of 22,400 square meters, of which the one-storey, two-storey and three-storey buildings account for 45%, 31% and 24% respectively [19,20].

In 2013, Wuhan officially started the renewal construction of Tanhualin block, which is planned to be completed in 2018, and the relevant renewal plan was prepared in 2015. By the end of 2017, the organic renewal of Tanhualin community has achieved initial success, and produced a series of important achievements in the aspects of block material space, industrial development and historical features protection, while also revealing a series of obvious defects. For example, in the process of community renewal, the transformation of some traditional residential buildings into commercial space forced a large number of original residents to migrate, which affected the community's cultural structure. The practice of over-commercialization of residential buildings in Tanhualin community showed problems in different degrees in terms of spatial planning, economic development, social culture, and ecological civilization, which led to the bright commercial district on the outer edge of the community, the stagnant development of residential districts on the inner edge of the community, and the continuous deterioration of the living environment.



*Fig. 2 Community location (Source: drawn by the author)*

## 4.2 Analysis on current problems in roadways in Sanyi Village

### 4.2.1. Serious building damage and unauthorized construction

Due to the long history of the buildings, most of the Sanyi villager residential buildings were built 40 to 50 years ago, mainly in townhouses during the unit system period. Moreover, the houses have brick-concrete structures, dry walls and red brick walls, which are exposed to the wind and sun all the year round, causing serious damage due to untimely decoration. Collective renovation and renewal of buildings is an urgent matter. Sanyi Village is a typical open old residential area without property management, with poor living conditions and too small living area. Most residents have built huts-style toilets, kitchens or utility rooms outside the building boundary, and even built living rooms to increase living space. Such disordered low-rise podium encroaches on the public space and roadways, with many potential safety hazards for the aged sundry items. (As shown in Fig. 3)



*Fig. 3 Chaotic construction (Source: drawn by the author)*

### 4.2.2. Narrow internal roadways and lack of public space

Since the roads in the community are residential roadways, mainly designed to meet the needs of more people at the beginning of construction, the roadways are narrow, only 3-4 meters in the main stem and only 1-2 meters generally. In Sanyi Village, there are many spontaneous buildings built by residents, with uneven quality and high density. Buildings with different functions, structures and textures in different periods are mixed together, and the whole architectural style is messy and not unified, so the roads are intertwined. The main roadway is mixed with people and vehicles, which has certain potential safety hazards. Long-term parking and chaotic parking on the roadside seriously

affect the walking space and fire safety. (As shown in Fig. 4)

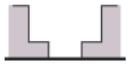
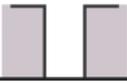
Roadway Classification	Roadway Breadth	Building Height	D/H	Roadway form
Main roadway	3.8-5.8m	9-10m	0.4-0.64	
Secondary roadway	2.2-2.8m	5-7m	0.31-0.56	
Narrow roadway	1.2-1.7m	4-10m	0.12-0.42	

Fig. 4 Street ratio (Source: drawn by the author)

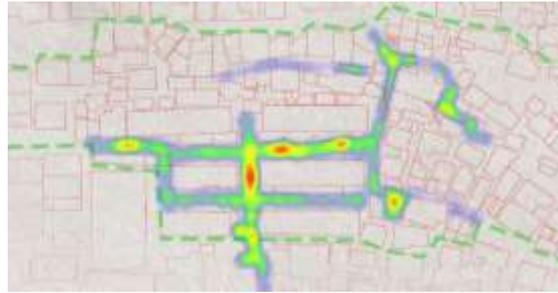
The narrow roadway in the community makes the public space of the community congenitally missing, which further aggravates the high density of space in the old communities. In addition, due to poor management and maintenance in the later stage, the original infrastructure and public facilities are old and damaged, which have far failed to attract residents to make various contacts here and to mobilize the vitality of the community.

## V. Renewal Strategy of "Urban Catalyst" in Roadway of Sanyi Village

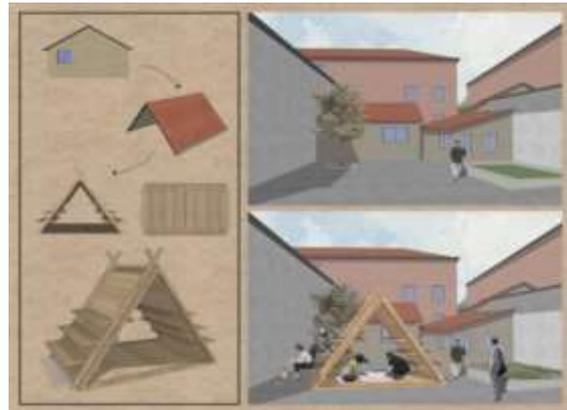
### 5. 1 Catalyst introduction: activating space

According to a survey conducted in Sanyi village, residents' daily activities are mainly walking, playing cards, chatting and children playing, but the quality of the space for public activities in the community is insufficient.

After the above analysis, the public space in Sanyi Village is characterized by scattered, narrow and mostly neglected. According to the research and analysis of the short and narrow public space in the community, it is necessary to add active settings in these "inert spaces", such as movable playing tables and chairs and detachable public furniture. Residents can plan their own public space venues, which is more conducive to the promotion of neighborhood relations. Based on the analysis of accessibility, building distribution and crowd activity density of the whole area (Fig. 5) and their comprehensive superposition, it is concluded that there are high accessibility and large crowd distribution density at the community breakfast shop and the street corner, and the first arrangement of catalyst points in several public spaces is conducive to the rapid diffusion of the subsequent catalyst effect. Because of its flexible and compact features, small-sized auxiliary movable devices can make more effective use of the narrow space between buildings and put them in an interspersed way. (Fig. 6) The addition of the variable elements enhances the curiosity of the indigenous inhabitants and the interest of the whole street, and enriches the functions of the public space by means of devices with different colors, scales and moving modes set for different age groups, so as to generate more interaction points to attract the residents, and the young people can stop to take photos when going out. At the same time, the use of larger spaces in community housing as containers to fill the space for the installation of container apartments or studios can be used as a transition room for artists' creative studios or young people when they cannot buy a house, and the low rent will attract more young people, making these container "apartments" a reuse of old space. Container-type "apartment" is designed as a detachable and buildable small space, which can be shared, rented and moved as a renewable temporary use space, thus increasing young people's sense of privacy and belonging to the city.



*Fig. 5 Crowd activity density (Source: Drawn by the author)*

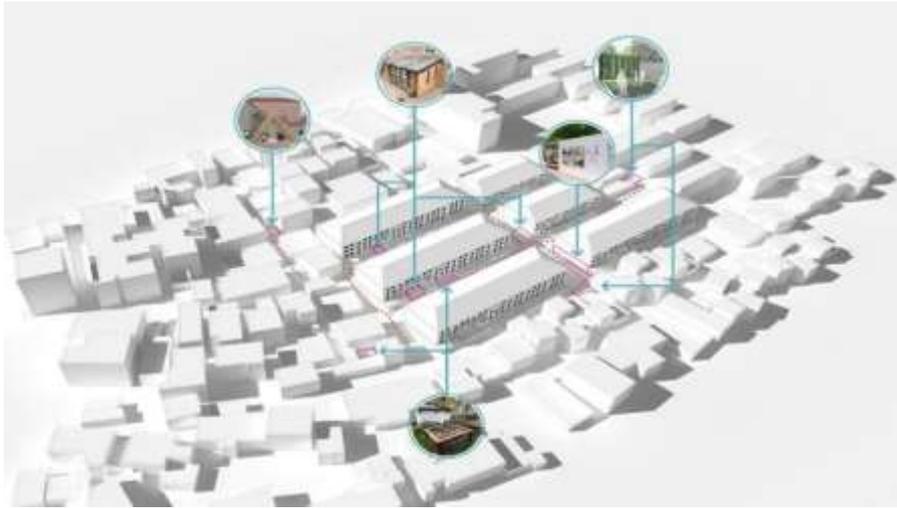


*Fig. 6 Public furniture design (Source: Drawn by the author)*

## 5.2 Spatial linkage: connected lives

According to the field investigation, residents often gather around the only small shop and breakfast shop in the roadway space of Sanyi Village to chat and play with children. Residents often bring their own desks and chairs to carry out chess and card activities here, which attracts the passing elderly to watch and promotes the possibility of further communication, so that the spaces with different functions in the roadway are overlapped, efficient and mixed. Thus, the higher the mixing degree of the functional types of buildings is, the richer the activities will be. Moreover, the improvement of activity diversity in roadway space has the potential to stimulate more interactive activities and improve the activity diversity in street space.

The linkage development mode based on the spatial dimension of urban catalyst theory can change the single function problem of the old residential community, and form a more comfortable and rich architectural interface by sorting out and eliminating the negative buildings in the community. Therefore, it is possible to update the space of squatter houses built by private use around the original dormitory building in Sanyi Village by renovating unclaimed squatter houses or dangerous houses into sunshine glass houses, mobile community bookstores, public green spaces where edible ornamental fruits and vegetables are planted, and change dilapidated cement walls into cultural landscape walls and propaganda walls. In this way, buildings with different functions are efficiently mixed to form a series connection, which can guide and adjust the mixing degree of residential roadway space, alleviate the insufficient activity space in the current roadway space and improve the vitality. (Fig. 7)



*Fig. 7 Catalyst linkage (Source: Drawn by the author)*

### 5.3 Control guidance: focus on follow-up

In addition to the above-mentioned exciting catalyst and spatial linkage, further control guidance for catalyst effect is also very important. When the catalyst system acts on the old community, it should not only solve the current practical problems but also respond to the changes of future problems. Therefore, it is necessary to rationally regulate and control the catalyst system from time to time to ensure that the catalyst effect always develops in the right direction, and build a continuous community contribution and public participation mechanism, so that the catalyst point can become the starter for the community to connect neighbors. As a result, with the continuous renewal and change of catalysts, under the influence of catalytic effect, the roadway space in the community is more perfect, the human vitality is further improved, and the future reverse growth of the old communities in a comprehensive sense is realized.

## VI. Conclusions

The residential roadway space in the old communities is the most important public space in the community, because it bears the space function of most public activities in the community, and its quality affects the needs of residents for a better life. In this paper, the renewal strategies of residential roadways in old communities are discussed from the perspective of theory of urban catalysts, pointing out the general shortcomings existing in the old communities in China. Firstly, based on the concrete analysis of the roadway space in Sanyi village of Tanhualin community in Wuhan, according to the way of "micro-design" and "urban catalyst theory", the catalyst points in micro-space are reasonably selected and arranged to construct a flexible public space in the community with the introduction of catalyst activity devices, triggering the urban catalyst effect. Then, buildings with different functions are placed in the roadway to form series connection through efficient mixing. Finally, through the follow-up guidance, a network of points and lines will be formed to realize the healthy development of the old communities in the future.

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