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A Walkable Street: Discussion on Street Design Practice in Shanghai

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Abstract: Since Shanghai Street Design Guidelines has been published in 2016, much attention has been paid to the new concept of street design in China. This paper summaries the development of street design and implementation experiences from both the overseas countries and China. The paper discusses the methodology of street design at neighborhood community level and street level respectively. The paper introduces Shanghai's experience in four aspects: street redevelopment for old communities, historical district, and new towns, and improvement of street facade sharing. The paper finally highlights a series of features for designing walkable streets that are human scale of street space, diversity of street activities, humanity of residents' trips, and green space. **DOI:** 10.13813/j.cn11-5141/u.2019.0204-en

Keywords: complete streets; walkable streets; design practice; Shanghai

0 Introduction

With the publication of the *Shanghai Street Design Guidelines* in 2016, much attention has been paid to the new concept of street design in China. Streets are no longer just spaces for road traffic, but more importantly, they have become urban places for public activities with participations of all types of population. Buildings along the street, various facilities, street landscape, and people walking on the street constitute a vibrant urban view, and streets have become an important window to showcase the characteristics and humanistic spirit of a city. Jan Gehl noted that spontaneous and entertaining outdoor activities and most social activities rely heavily on the quality of outdoor spaces. The charm of those activities would disappear when the street quality is poor and would rejuvenate when streets can provide a suitable environment [1–2].

Walkable streets discussed in this paper incorporate the street design concept of complete streets, vibrant streets, green streets, etc. Through the optimization and improvement of street spaces, functions and facilities, a walkable street is more suitable for walking and can present the unique vitality and charm of streets as well as a higher urban living quality. Hengshan Road and Huaxi Road in Shanghai are great examples of walkable streets, which are known for their suitable scale and beautiful environment.

1 Summary of the development of street design theory

1.1 The development process in overseas countries

The term of "complete streets" was first suggested in 2003 by David Goldberg, head of Smart Growth America, to promote the improvement of pedestrian and bicycle facilities and encourage people to walk, to ride bikes or to use public transit [3]. In 2005, The National Complete Streets Coalition was established and the idea of complete streets spread rapidly across the United States. By 2012, 125 communities in the United States had adopted the complete street policy [4]. The concept of "complete streets" fully considers the needs of pedestrians and non-motorized vehicles, encourages walking and public transit, and promotes more equitable right of way.

The vibrant street movement, which is developed based on the complete street movement, is more forward-thinking. It views street space as urban public spaces, improves urban environmental quality and enhances economic vitality and social cohesion in many ways [5]. The vibrant street incorporates the creation of public spaces, the preservation of cultural heritage and the participation of people in street design and construction. The design of street space pays more attention to the formation of unique characteristics to make streets more recognizable [3]. The concept of the vibrant street

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and its practical research conduct in many streets of Manhattan, New York verify and promote the correlation between urban socioeconomic development and street functions [6]. Vibrant streets focus on improving the function, facilities and walking environment of the street, enhancing the convenience and comfort of walking, thereby, increasing the proportion of walking trips on the street, boosting the attractiveness of street space, and increasing the diversity of activities, as well as the prosperity of the street economy.

The theory of "green streets" can be traced back to the landscape ecological planning idea which was proposed by Lan McHarg in 1969 [7]. "Green street" emerged in the midst of the world energy crisis and environmental crisis in the 1990s. Many countries, such as the Netherlands, implement the idea of "green streets" by promoting bicycle uses and public transportation. As this concept evolved, its scope expands gradually from the initial storm water runoff management at the street level to the improvement of the physical street environment, the beautification of community environment, the integration of regional ecological infrastructure, the organization of low-impact transportation modes such as walking and bicycles, and the integration of streets and regional public transportation [7].

The development of a series of street design theories, such as complete streets, vibrant streets and green streets, effectively promotes the transition of the understanding on streets from traditional roadway engineering to composite space for urban public activities. Streets are no longer only transportation spaces dominated by motorized vehicles but have become residential spaces that closely connect with daily life and activities.

1.2 The development process in China

Along with the penetration of overseas complete street design concepts, street design research has become popular in China. In 2013, Shenzhen issued *Guidelines for the Planning and Design of Shenzhen Walking and Bicycle Transportation Systems* to promote green transportation and to improve the walking and bicycle transportation systems and their level of service. To coordinate and standardize different street plans and designs, Beijing issued *Code for Planning and Design on Urban Road Space* (DB11/1116—2014) in 2014.

In 2016, the publication of *Shanghai Street Design Guidelines* (hereinafter referred to as the "Guidelines") marked the first major research publication of complete street design in China. The "Guidelines" raises four levels of transitions: from motorized vehicle oriented to human oriented; from engineering design to comprehensive environmental design; from road red line control to street space control; from focusing on transportation efficiency to focusing on the integrated development of streets and street blocks [8]. Along with case studies, the "Guidelines" combined texts and graphics to illustrate concepts of new street design.

The "Guidelines" were completed by a multidisciplinary team working under a dynamic structure. The team involved urban design, traffic engineering, architectural engineering, landscape greenery, transportation planning and related disciplines. Research institutes, university research centers, and relative management agencies in urban planning, transportation management, urban management, landscape management, etc. contributed to the publication of the "Guidelines". Internet surveys were also employed to promote public participation. The preparation of the "Guidelines" promoted the interactions among various urban construction and management departments and helped them reach the consensus at different management levels on the street design concepts and their future implementations.

The "Guidelines" propose four goals, namely "safety, green, vitality, and intelligence". The goal of safety includes six sub-goals: orderly traffic, pedestrians and bicycles first, ample sidewalks and crosswalks, safe street crossing, smooth riding experience and reliable facilities. The green street goal is divided into four sub-goals: resource recycling, green travel, ecological planting and green technology. The goal of vitality is divided into six sub-goals: multiple functions, comfortable activities, pleasant space, multi-layered view, distinct style and features and historical heritage. The goal of intelligence is divided into five sub-goals: facility integration, travel assistance, intelligent monitoring, convenient interaction, and environmental intelligence [9].

The publication of the "Guidelines" draws substantial attention from the industry. Many large cities started to study and compile their own street design guidelines. Shanghai Housing and Urban-Rural Construction Management Committee developed the local standards *Street Space Design Specifications* (now called "Street Design Standard", hereinafter referred to as the "Standard") in 2017, which pushed the development of street design to a new stage. Based on the "Guidelines" and relevant street design research and practical experiences in the world, the "Standard" considers the deficiencies and development orientation of the streets in Shanghai and proposes five street design goals, namely safe, energetic, green, intelligent and friendly streets [10]. The "Standard" also proposes that street design should be people-oriented, refined and systematic. It becomes the first local standard for street design in China. It integrates existing industry and construction standards, makes up for the gaps in the industry caused by the division of ownership, and strengthens connections between different systems.

The "Standard" includes the multi-disciplinary overall design and all street design components, such as cars, pedestrians, interface, greening, pavement, and facilities, providing a comprehensive basis for the implementation of refined street design. It proposes space coordination, time coordination and facility coordination. Space coordination refers to the street design scope being the U-shaped three-dimensional space formed by the open space within the street red lines, the open space for building setback, and the interface along the street. Time coordination refers to encouraging the management of the street by different time of

the day, coordinating the conflicts between pedestrians, cars and freight traffic, and providing shared streets and pedestrian-friendly streets over more time intervals. Facility coordination refers to the comprehensive utilization of greening and facility space, forming a green comprehensive facility belt, standardizing the installation of facilities such as poles and cables, trash cans and signs to avoid interference with the walking space.

The "Standard" proposes that streets and street intersections should be pedestrian and bicycle friendly. They should be safe and orderly and prioritize public transit. It also suggests moderately reducing the lane width and the turning radius of the curb to create a safe and smooth street crossing experience for pedestrians. Through theoretical analysis, traffic simulation as well as comparison of standards in the world, relevant research results, engineering case studies and expert verification, it is concluded that the values of lane width and curb turning radius in the existing standards should be reduced under certain conditions (see Table 1 and Table 2).

Table 1 Recommended value of street lane width

Design speed (km/h)		≤20	>20–40	>40–60
Lane width (m)	Lanes for small passenger vehicles only	2.85	Min: 2.85 Normal value: 3.00	Min: 3.00 Normal value: 3.25
	Lanes for large vehicles or mixed vehicles	Min: 3.00 Normal value: 3.25	Min: 3.00 Normal value: 3.50	Min: 3.25 Normal value: 3.50

Source: Reference [10].

Table 2 Recommended value of street turning radius m

Lane type	Turning radius
Motorized	10–15
Non-motorized	5–10

Source: Reference [10].

The reduction in lane width should be mainly applied to the following types of streets: streets with less traffic or less large vehicles, commercial streets and daily service streets which have many pedestrians and activities along the street and have a high demand for street crossing, landscape and leisure streets in historical and cultural areas, and renovated streets with many construction constraints. Combined with the reduction of vehicle speeds, the reduction of the width of motorized vehicle lanes returns the space to pedestrians and non-motorized vehicles.

The reduction in the turning radius of the curb should be mainly applied to the following types of streets: pedestrian-intensive commercial streets, daily service streets, and landscape and leisure streets, or streets with lanes for non-motorized vehicles, and renovated streets with many construction constraints. Smaller turning radius forces motorized vehicles to slow down before making turns, shortens the length of the crosswalk and increases the walking continuity and safety. In terms of intersection efficiency, reducing the distance for pedestrians to cross the street can increase the pedestrian flow in a signal cycle, thus improving the traffic efficiency of the intersection.

The experience of street design in Shanghai shows that from the "Guidelines" of 2016 to the "Standard" of 2019, to the "Sidewalk Design Manual" which is currently being prepared, street design research is becoming more and more detailed and systematic. This work is also an introspection of the extensive construction mode in the rapid urbanization process and an improvement of the design work under the requirements of refined management. The explorations of renovations at the street and street block level, such as the pedestrian priority, function and space optimization, facility coordination, and environmental improvement, create more livable communities and more walkable streets.

2 Shanghai case studies

This paper discusses street design cases at the neighborhood community level, including streets in old communities, historical districts and new towns, and street design cases at street level, including individual streets with different conditions. The street design at the neighborhood community level studies not only the street itself but also the entire neighborhood community.

2.1 Case study for street renovation in an old community: Caoyang New Village

A community is the epitome of the society, the social organization of the urban residents, and a collective formed in a region with certain relevance in life [11]. Streets are the most important space for social interactions in a community. Commercial and public service facilities along the street provide services for everyday necessities [12]. During the planned economy period, many new communities and residential buildings for employees were built in China. This type of community disintegrated over time. The facilities became dilapidated, and the quality of the community deteriorated [13]. Shanghai Caoyang New Village is a good example. Built in 1951, Caoyang New Village was the first community for model workers in China after 1949 [14]. Caoyang New Village was located in central Shanghai, covering an area of 2.14 km^2. There were more than 32 000 households with more than 100 000 residents, of which 38.46% were elderly population over 60 years old. The growing body of senior population was a prominent issue. Like many other old communities that have been built for a long time, Caoyang New Village faced community street problems such as poor walkability, old facilities, and lack of facilities for people with reduced mobility. In response to these problems, the street design in old communities focused on improving the functions of the streets at the community level, improving street walking space and facilities, tailoring the street design to the elderly population, and showcasing the unique community culture and historical background.

The renovation of streets first requires accurately understanding each street and determining its functions in terms of transportation, activities, culture, and landscape at the community or the regional level. The "Standard" classifies streets into five types: commercial streets, daily service streets, landscape leisure streets, through streets and integrated streets [10]. The main function of a community street needs to be further refined on the basis of these five basic street types considering the unique condition of each community. After overall consideration, the 19 streets in Caoyang New Village were divided into six types, namely community-level commercial streets, waterfront landscape streets, community-level daily service streets, through streets for pass-through traffic, through streets to connect communities and community-level integrated streets. The streets in Caoyang New Village were designed with a pleasant spatial scale, diverse activities along the street, and humanized facilities and landscapes for community residents. Different types of streets had different demands on the walking and non-motorized space, such as width, facility type and density. For example, community-level commercial streets need to ensure a certain amount of walking space to accommodate the crowd, and community-level daily service streets have a high demand on rest areas and rest facilities. In some special areas (such as the streets around a hospital), there is a high demand for parking non-motorized vehicles, and it is necessary to separate pedestrians and vehicles and organize them reasonably. Therefore, in the street renovation of Caoyang New Village, different street renovation focuses were proposed for different types of streets, and special considerations were taken based on the conditions of special areas.

The traffic volume of community streets was relatively low, and the roads in old communities were generally narrow. To solve the problem of insufficient width of sidewalks along some streets, it is necessary to reduce the width or the number of motorized vehicle lanes. For example, the Meiling South Road originally had a lane width of 3.0 m, which was reduced to 2.75 m, and 0.75 m had been added to the sidewalk on the west side, which was originally 1.5 m wide (Figure 1). At the same time, the turning radii of intersections can be reduced, and the waiting areas for pedestrians to cross streets can be added to ensure the safety and convenience of street crossing.

The age structure of the community was also an important factor to consider in the design of street space. In Caoyang New Village, the concept of "all-age-friendly" street was implemented, which fully considers the characteristics of the aged community in street paving and facility setting (Figure 2). Flat pavement and narrow seams made it easy to use wheelchairs. Pedestrian crossing lights and smart signals were installed at all street crossings. Curb ramps with flares were placed. Various rest areas or facilities were provided along the green belt with a spacing of 50 m–100 m. Accessible parking spaces and facilities were built for public facilities and buildings. Spaces that can be shared by children and the elderly were available in the green spaces and squares along the street to facilitate the elderly to look after the children. The areas that were originally full of disorderly parking were redesigned to ensure the smooth passage of life channels such as ambulances and fire engines in narrow streets.

a. Current condition

b. Plan

Figure 1 Comparison of cross section reconstruction of Meiling South Road

a. Current condition

b. Plan

Figure 2 Caoyang Xincun Block before and after renovation

Source: Reference [15].

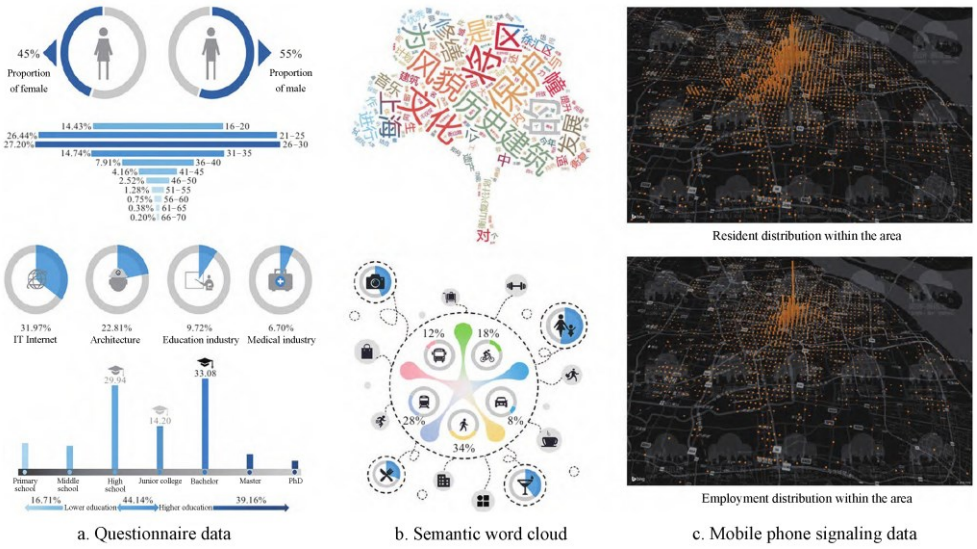

Figure 3 Utilization of multi-source data

Source: Reference [18].

2.2 Case study for street renovation in a historical and cultural district: Xuhui Hengfu Historical and Cultural District

Historical and cultural districts were the carriers of a city's cultural memory, which were assets with high historical, social, cultural and architectural values [16]. With the rapid development of urban construction and the aggregation of population, old and new buildings were mixed in historical and cultural districts and the traditional street styles gradually disappeared. Therefore, the street renovation in historical and cultural districts should focus more on protecting the existing texture of the city, protecting the original architectural culture and landscape environment. It should value the integrated renovation with buildings along the street as well as consider the connection between the street pedestrian system and the history and culture of the district.

Xuhui Hengfu Historical and Cultural District was the largest historical district in Shanghai. It had a total area of 7.66 km^2, bounded by Yan'an Road in the north, Zhaojiabang Road in the south, Huashan Road in the west and South Chongqing Road in the east. This district had a rich historical heritage, which embodied the unique characteristics of Shanghai's early modern lives and was an important carrier of Shanghai's urban culture. The renovation of Xuhui Hengfu Historical and Cultural District utilized a research technique that incorporated multiple data sources (see Figure 3) to fully study the traffic volume and the characteristics of travel demand. Through comprehensive analysis using questionnaire data, mobile phone signaling data, drone aerial data, the internet data, and transit pass data, etc., the different needs of residents and tourists were studied. Moreover, the different characteristics of different streets in the district were described, and important trip attraction points were discovered [17].

Architectures have strong cultural influences; hence, the street design should emphasize the shaping effect of architectural form on street space and ensure continuous interface, uniform style and coordination with historical features. Buildings that do not conform to the features of historical districts should be renovated. Controls should be placed on architectural exterior colors, wall materials, and roof forms, and excessive decoration should be avoided. Illegal buildings and temporary structures should be demolished to restore the original building appearances and to retain the historical charm of urban space. A bi-level slow travel network was established around important protection sites of historical architecture heritage. The first level connected the historical buildings and public spaces in Xuhui Hengfu Historical and Cultural District to improve the comfort experience of walking and non-motorized trips. The second level connected rail stations to improve the service quality (Figure 4).

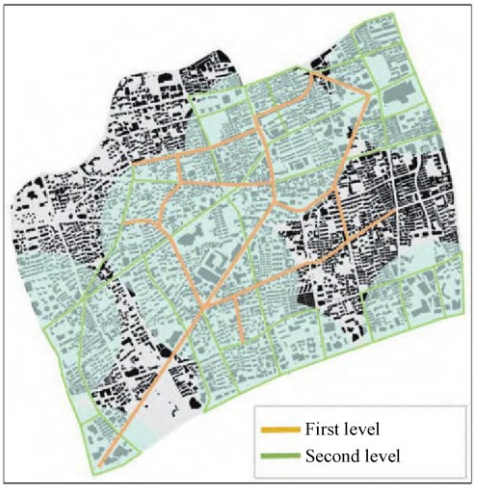

Figure 4 Bi-level pedestrian and bicycle transportation network

Source: Reference [18].

The street renovation project established touring routes, scenic viewpoints and a walking signage system of historical district culture. It is important to note that the vitality of the historical and cultural district had a strong connection with storefront businesses. Over commercialization should be avoided, but opposition to commercialization in all cases should be avoided, too. Facilities that were needed by some residents and tourists, such as convenience stores, restaurants and cultural and leisure facilities, should be provided based on the conditions of the street space and the buildings along the street. These types of business are important for the quality upgrade of the historical and cultural district.

2.3 Case Study for street renovation in a new town: Lingang New Town

As people flooded into urban regions, many new towns were built quickly to meet the needs of the new population. The process of population shifting to new towns was a gradual process, and it was difficult to achieve the job-housing balance within the new town in a short period. Large street blocks and wide streets made it easy for cars to travel but made it difficult for pedestrians. The heavy reliance on motorized travel modes quickly caused congestions in new towns [19]. At the same time, the business services of the new towns were concentrated in large-scale commercial complexes and the communities lack service facilities along the street, so residents and employees cannot get convenient daily services, which leads to the lack of vitality on many community streets.

The Shengang Community in Lingang New Town was about 70 km away from the center of Shanghai—People's Square. It was located between Pudong International Airport and Yangshan Deepwater Port. Although the neighborhood environment was good, this community was in the early stage of introducing new residents and relatively few residents have moved in. The vitality of some streets was obviously insufficient. There were important differences between the street renovations in new and old street blocks. The street design in new street blocks must start with meeting the development needs of new blocks and advocating mixed function layout and land use to foster a tolerant and dynamic community space. From the urban and regional perspective, the street design should start with integrating the new town and industries and balancing jobs and housing. At the street design level, diversified and convenient community services should be provided, and the concept of "10 min–15 min Community Service Circle" should be advocated. This circle aims to provide basic services and public activity space as well as diversified community services and customized commercial, leisure, cultural, and entertainment facilities in buildings along the street, all within 15 minutes' walk.

Through the analysis of the land use and residents' demand along the streets of Lingang New Town, it is proposed to build a motorized vehicle network with moderate separation of motorized vehicles and pedestrians and to build a pedestrian-friendly network (Figure 5). Meanwhile, a convenient and barrier-free public transportation transfer system was proposed to improve the integration and utilization of transportation stations. Service facilities such as the sports and cultural facilities in communities along the street should be open to the public. The development of smart communities should be strengthened, and the public service resources should be shared on smart platforms.

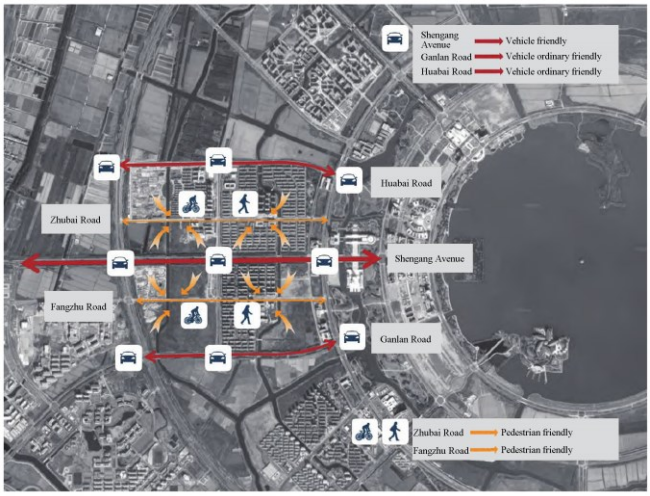

Figure 5 Pedestrian-friendly network

Source: Reference [20].

Green areas along the streets in the new town could be turned into street pocket parks and pocket plazas, attracting more people to participate in public activities, such as community fitness, leisure and entertainment activities. At the same time, it is proposed to focus on the safety of the street at night and the creation of unique scenic night views, strengthen the safety lighting and monitoring in the walking space along the street, and unify the plan and control of the lighting of show windows and public space to effectively enhance the cultural charm of the community and the vitality of the street.

2.4 Case study for street interface sharing: Huangshi Road

The concept of street space sharing in urban environments and relevant theoretical studies have been well developed in the past few years [21]. Street interface sharing was a part of street space sharing, whose core concept was to build harmony among pedestrians, strollers, children, cyclists, parked vehicles and moving cars to share the street space [22]. Street space sharing made the street a public space with mixed functions. Street interface sharing played an important role in the system of street space sharing. Its major function was to create a dynamic community atmosphere of business and residence and to achieve the sharing of multiple interfaces, including business interface, residential interface and community public interface. Shanghai Huangshi Road is a case for street reconstruction featuring the interface sharing transformation.

Huangshi Road (Longwu Road–Tianyaoqiao South Road) was located in the waterfront area of Xuhui District, Shanghai, China. The road was 24 m wide with a total length of about 470 m. It was a municipal branch road, and the interface along the street was dominated by residential uses and commercial uses on the ground level. The main existing problems on Huangshi Road included narrow sidewalks and disordered parking, which lead to hidden hazards; uninviting street interface and illegal structures and fences, which prevent the street space to be shared; and chaotic interface along the street and messy store signs, which results in poor visual aesthetic experience. The problem of street interface is the focus of this case study.

Based on the current situation of Huangshi Road, the concept of shared street was proposed, including space sharing, interface sharing and facility sharing. In the Huangshi Road project, the space in front of buildings was utilized to widen the narrow sidewalks, and the parking of motorized vehicles and non-motorized vehicles along the street were regulated to build a shared street with complete right of way.

In view of the problems that the street interface was closed, illegal structures and fences were everywhere, and the public space cannot be shared. It is proposed to open the street interface, construct public plazas at street corners, and unleash the potential of the setback areas in front of the buildings to realize the sharing of street space. For municipal branch streets like Huangshi Road, the reconstruction of street space and the sharing of street interfaces were of great significance for the creation and promotion of street vitality [23].

To reorganize the chaotic street interface and enhance visual aesthetic experience, the Huangshi Road project divided the street interface into two parts: the interface at the ground level and the interface above. For the interface at the ground level, the internal width and height of the building and the style of the store signs were controlled to create a unified and orderly street business interface, and fences were demolished to release more open spaces (Figure 6 and Figure 7).

Figure 6 Bottom store recruitment transformation along Huangshi Road

Source: Reference [24].

For the interface above the ground level, the building facades of the residential community along the street were designed to be consistent with the ground floor interface design by repainting part of the facade, adding hanging green plants, and creating unified canopy style. It is also important to restore interface uniformity by unifying the installation positions of the air conditioners' external fans and the design of drying racks (Figure 8).

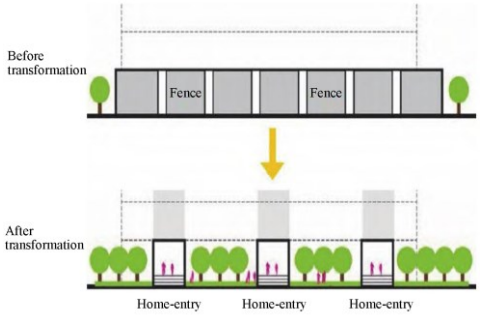

Figure 7 The boundary wall reconstruction along Huangshi Road

Source: Reference [24].

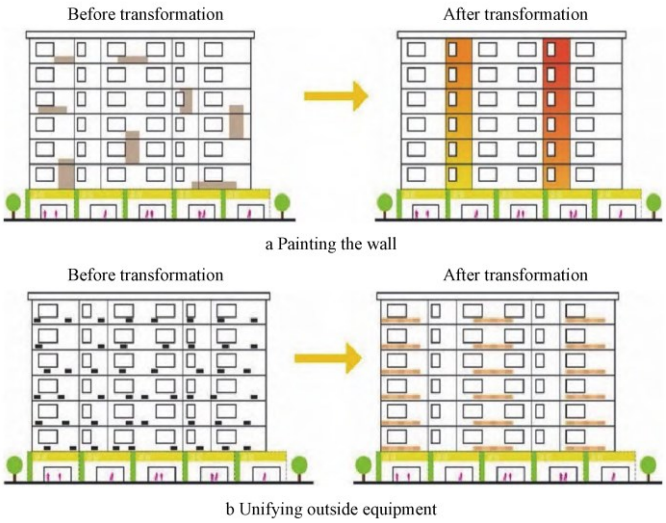

Figure 8 Reconstruction of the building facade along the Huangshi Road

Source: Reference [24].

The main feature of the Huangshi Road Street Renewal Project is to fully utilize the concept of complete street design and interface sharing to realize the unification and sharing of space, interface and facilities. This project provided an example for creating suitable walking space in existing narrow urban space.

3 Conclusion

Street design transforms streets that originally only have a single function of serving the traffic into a public space that involves the activities of more people and integrates with urban life. Streets can also meet the needs of cultural leisure, recreation, communications, fitness, education and other activities. Through the sharing of elements at the street block

level, the pedestrian area will be enriched. Along with the promotion of new technologies, the completion of more and more street design practice cases, and the publication of street design guidelines and standards, the street design concept will completely break the barriers between road engineering and architectural design. In the future, urban street space will become more people oriented, diversified and intelligent. At the same time, theoretical research will flourish as engineering practices develop.

As the application of intelligent driving technology matures, the urban spatial layout and street space design will undergo significant changes in the future. The intelligent driving system will greatly improve the efficiency of road resources, thereby reducing the road space used by motorized vehicles and releasing more space to public streets. The released street space will play an important role in the construction of smart cities. Therefore, street design research needs to keep up with the development of science and technology to promote the transformation of streets and build more livable streets.

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