

University Campus Boundary Space Analysis and Research on Green Renewal Methods

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Abstract. Against the backdrop of global climate change and environmental degradation, urban renewal is increasingly focused on promoting green and sustainable practices. The spatial renewal of university campuses has become a topic of discussion among many scholars, as it is considered an important part of the city and a reflection of urban culture and community space. The campus boundary space is an important link between the campus and the city, and it is also a key hub for cultural exchange between the campus and the city. Therefore, when discussing campus renewal, the campus boundary space is often analyzed as an independent topic. By discussing and analyzing campus boundary space, this paper proposes a renewal strategy for campus boundary space in the context of green sustainable development. In this paper, the green renewal of campus boundary space will be proposed based on five dimensions. At the same time, it combines the solution strategy of macro space problems with the detailed design of green. The green renewal strategy proposed in this paper for campus boundary space serves as the link and starting point for campus green renewal and even urban green renewal. It will provide a basic template and research direction for future green renewal efforts.

Keywords: Campus boundary space; green renewal; green and sustainable; green campus.

1. Introduction

Scholars from different countries have had a profound discussion on the boundary space. From the perspective of architectural design, as early as 1954, Dutch architect Aldo Van Eyck proposed to create "diverse and hierarchical" "intermediary space" form in the transition of indoor and outdoor space [1]. In *Life Between Buildings* written in 1971, architect Jan Gehl defined the flexible boundary as a continuous part between non-completely private and non-completely public. He emphasized the importance of external space and humanity design in cities and proposed to enrich people's life and communication through external space design [2]. Later, American architect Christopher Alexander put forward the idea in *A Pattern Language* that space will never be alive if boundaries do not exist [3]. From the perspective of urban planning, "boundary" is one of the five components of people's perception of the urban environment. In *The Image of the City*, written by American urban planning expert Kevin Lynch, he argues that boundaries may be barriers, more or less penetrating, separating one area from another, or they may be sutures, linear breaks in continuity: Such as coast, railway separation wall [4]. In addition, Chinese scholar Xing Zhong also gave a detailed definition of "edge" and "boundary" in his article "On the Fringe Space". He called the "marginal excess space" between "heterogeneous Spaces in the city" "which has a certain domain and is directly affected by edge effect" "edge space", aiming to expand the concept of "edge intermediary space" in architecture to the urban scale. Through the reasonable design of edge space, the positive edge effect in the process of spatial integration can be explored and strengthened, and the negative effect can be avoided and reduced [5].

In the study of boundary space, the boundary space of a university campus holds unique research value due to its distinct function and dual attributes. It encompasses not only the characteristics of school education and learning, but also embodies urban social communication attributes as a component. Through the research on the definition of boundary space, it is found that the boundary space of university campus not only refers to the narrow space that separates the inside and outside of the campus through obvious boundary methods such as walls and fences, but also plays the role of

dual needs of university and city. As a medium of material, information, energy and resource exchange between cities and schools, it is highly permeable and inclusive.

In the face of current challenges posed by global climate change and energy consumption, green sustainability has emerged as a central theme in contemporary architectural design and development. Green design refers to the design considerations from the perspective of safety, health, quality, convenience, comfort and resource saving. This design focuses on environmental protection and sustainable development, aiming to reduce the impact on the environment and provide more healthy and comfortable living Spaces. This paper studies the renewal method of green campus boundary space, aiming to put forward the renewal method of campus boundary space from a green perspective, combined with local cultural conditions and environmental basis, and make use of relevant energy-saving and environmental protection technology and design thinking, and meet the use demand of campus boundary space.

2. Classification of Campus Boundaries

According to the geographical location classification of universities, campus boundaries can be divided into suburban university boundaries and urban university boundaries (Fig. 1) For the suburban university, its geographical location is usually relatively remote, far away from the complex spatial form in the city. The campus is mostly designed as a closed boundary space with clear visual separation. For urban universities, the urban environment is more complex, and the requirements for the integration of campus and urban functions are higher. In developing countries where urban areas are expanding and urban forms are changing, there will be an increasing demand for urban university campus boundaries. The open and inclusive spatial form of campus boundary is the main goal of campus boundary renewal in the future.

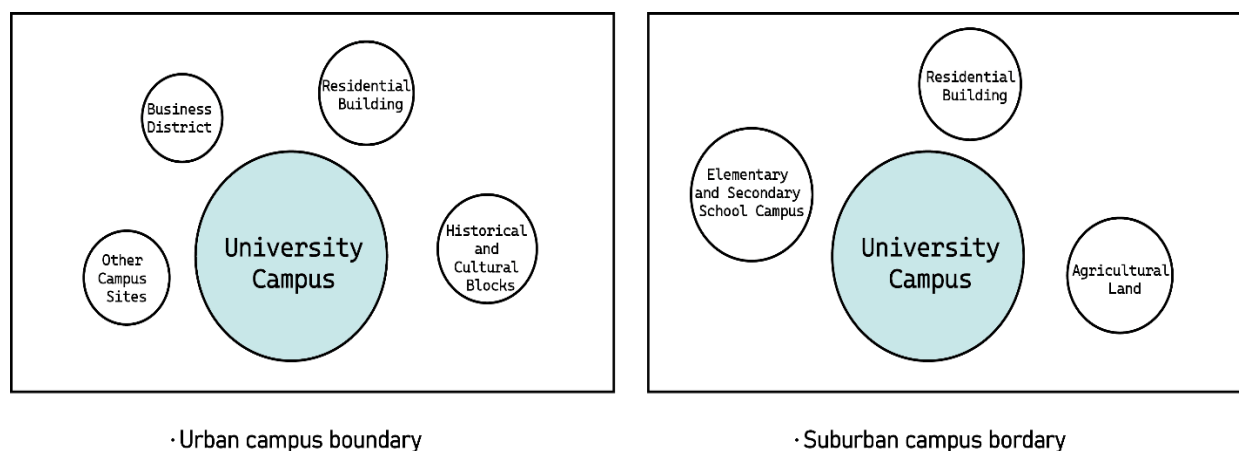


Fig 1. University campus boundaries classified by geographic location of the university.

According to the classification of campus boundary circumference and closure mode, the university campus boundary space can be divided into three types: closed, semi-open and open (Fig. 2). The enclosed campus boundary space is completely enclosed by visual walls, fences, etc. This kind of campus boundary has a strong limit on the access path, a clear sense of campus boundary, and a high degree of closed management. The semi-open campus boundary places plazas or two-way service buildings at entrances and exits to reduce restrictions on access to and from the campus. The rest of the boundary sense is more obvious, but not strong closure. The open campus boundary breaks the boundary of the campus, blurring the sense of boundary between the city and the campus transition zone, making the urban road become a part of the campus, so that students can enter and exit more freely.

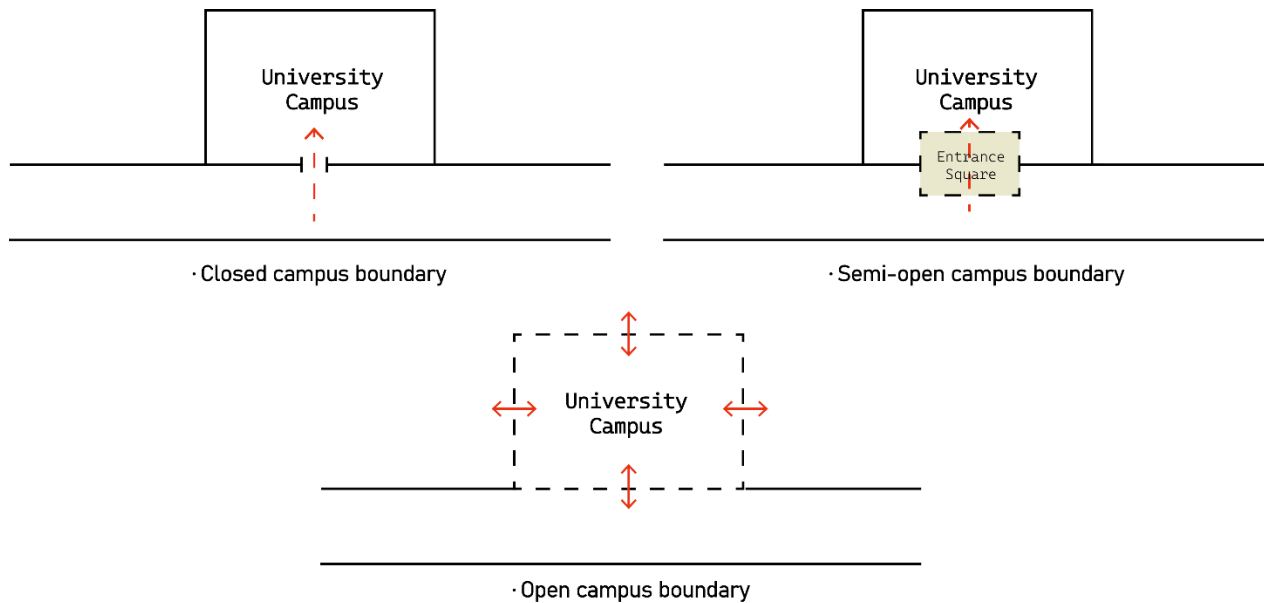


Fig 2. University campus boundaries classified according to the enclosing degree and closing mode of campus boundaries.

According to the spatial classification of campus boundary, it can be divided into straight university boundary space, corner university boundary space, multi-liner university boundary space and parallel university boundary space (Fig. 3). The straight university boundary space, which is similar to the passage and corridor, is characterized by strong continuity. It is not convenient for people to stay when it is close to the main road and the space depth is low. The corner university boundary space usually has higher flexibility in spatial design. However, the corner space is usually the area with more complex traffic flow lines, so the regional complexity is relatively high. The multi-liner university boundary space is mostly scattered space formed by the layout and planning of buildings, which mostly exists in the transition of secondary roads at the campus boundary and the junction of two adjacent campuses. And it can be combined with landscape transition to design. The parallel university boundary space is mostly the boundary space of the university campus that is crossed by the main urban roads, and it is often combined with open design.

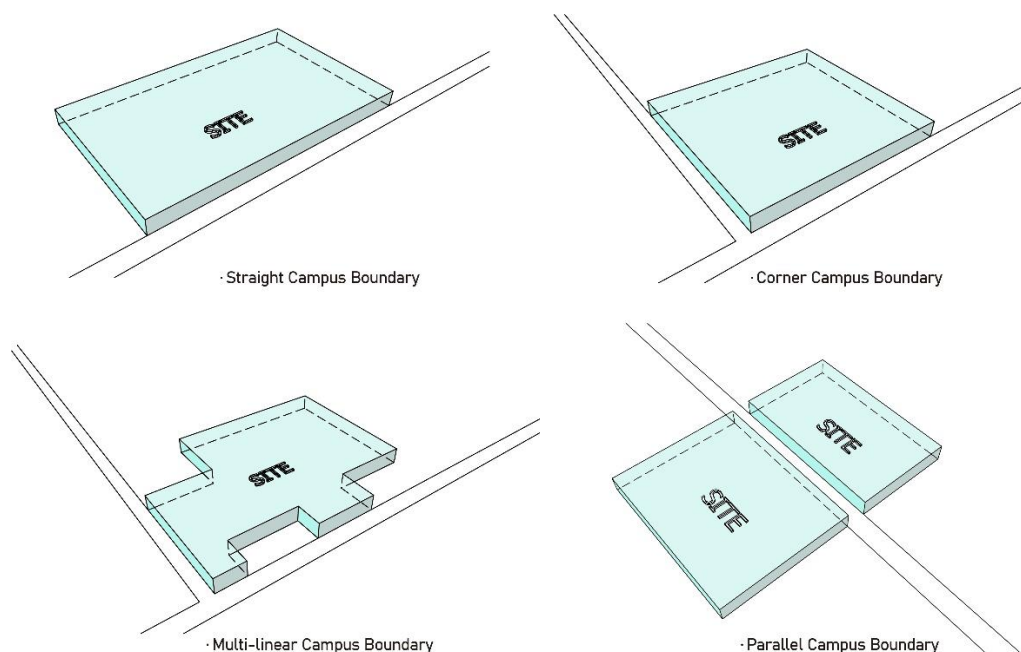


Fig 3. University campus boundaries classified according to the spatial form of campus boundaries.

3. University Campus Boundary Space Green Renewal Method

3.1. Existing Methods of Campus Boundary Space Renewal

For the optimization and updating of campus boundary space, different scholars have put forward different optimization and updating strategies based on various perspectives. In the context of special public health events, some scholars have proposed an optimization method to re-plan campus boundary space and carry out flexible university management [6]. Based on the perspective of "city-school symbiosis" or "city-school integration", some scholars proposed optimization strategies through crowd behavior analysis and relative dynamic development and change environment [7, 8]. In addition, through the investigation and summary of the border renewal of American colleges and universities, some scholars found that they have relatively mature campus boundary space renewal systems and methods from establishing school strategic goals to formulating basic planning criteria to forming specific rules and regulations and so on [9, 10]. It can be seen that there have been a lot of studies on boundary form renewal strategies, but there is still a lack of green renewal strategies. From the perspective of green, comfort and health, this paper puts forward the green renewal strategy of boundary space.

3.2. Campus Boundary Space Green Renewal Strategy

The green renewal method of campus boundary space is mainly proposed from five aspects, including pre-renewal planning and ecological design, energy and resource conservation design, environment and health design, late operation and management design and logo and publicity design.

3.2.1. Preliminary planning and ecological design

(1) Research and planning of the existing boundary space

More sufficient research can provide detailed design ideas for the subsequent update. The main research contents include but are not limited to: current situation of enclosure, safety management, sharing facilities layout, school-place connection, location and context analysis, current situation of surrounding environment, population type and behavior analysis. In addition, it is necessary to pay attention to the future urban development goals of the area, increase the possibility of boundary spatial connection between the city and the campus, and pay attention to the real-time update of the planning strategy. The strategies were adjusted according to the surrounding environment and the needs of the population.

(2) Axial design

Relevant information can be integrated to design the boundary space to form an axial connection between the city and the campus. When considering the connection between the cultural axis and the historical context of the city, it is necessary to carry out spatial design on the basis of architectural protection. For the design of vitality axis, it is necessary to consider the combination of urban sports space, and enhance the sharing and openness of campus boundaries to a certain extent while combining the design with the urban slow walking path. For the ecological axis, it can be designed through landscape construction and overlaying related functional Spaces, so as to complement the urban greening. Among them, the design of ecological axis can increase some measures of ecological compensation.

(3) Creating a good wind environment in the boundary space

The wind environment of the existing boundary space is simulated and evaluated. Since most of the boundary space is outdoor, the wind environment of the outdoor rest and activity area can be improved by adding greening during design. If the renewal design is combined with the community to design commercial or other Spaces requiring structures, attention should be paid to the disturbance of the wind environment of the area caused by the new building. It is necessary to combine the overall design of the wind environment inside and outside the school to avoid the formation of vortex area and no wind area, and rationally use the guidance of the new building to the wind direction.

3.2.2. Energy and resource conservation design

(1) Water resource intensive design

Additional rainwater collection measures, such as the use of sponge floor tiles such as grass tiles in boundary spaces and road paving, which can absorb water, and integrated with urban rainwater collection systems. In addition, it can be combined with the design of open plazas or small aquatic landscapes to achieve the reuse of rainwater. In terms of collecting and treating reclaimed water and cooling water on campus for reuse, landscape design occupies a large proportion in boundary space design. Green water can be collected in the school after treatment of school cooling water and water.

(2) Low energy consumption design

In the design of low energy consumption of boundary space, two aspects are mainly considered. First, the energy consumption of outdoor lighting facilities is mainly considered when the boundary design is softened through the landscape. Another is the need to consider building materials and construction energy consumption, especially energy consumption of small buildings and structures, in the design of increasing boundary interaction. For outdoor lighting facilities, solar photovoltaic lighting facilities, voice-controlled lamp induction lights or outdoor lamps with energy-saving design can be selected. In the selection of building materials, recyclable materials or reused building materials can be considered, and the use of BIM technology or prefabricated buildings can be combined.

3.2.3. Environment and health design

(1) Sound insulation design

As an important node in the transition between urban environment and campus environment, the boundary space can be used as an important barrier. To deal with the closed boundary space, two methods can be used: increasing the gap and depth of the boundary and enriching the vertical space. When adopting the first treatment method, it is necessary to pay attention to the sound insulation design of public learning space, which can be realized through green belts of different densities and component landscape design using sound absorbing materials, and the change design of boundary space and horizontal space should be increased. In the vertical space design, it mainly adopts the bottom overhead design to connect with the urban road. This design needs to pay attention to the sound insulation of the wall and the sound insulation of the green belt around the urban road, so as to create a good sound environment that meets the relevant functional requirements.

(2) Boundary space to reduce heat reflection design

As an important part of campus road planning, the shading design of boundary space road can alleviate the heat island effect in campus to a certain extent. In the shading design of boundary space, tall trees and green shading elements can be selected to increase the shading area. In addition, in the selection of road materials, choosing the surface color with low reflection coefficient can reduce the solar reflection coefficient of the ground. When increasing the green area, it is necessary to pay attention to the multi-layer design of the green, and to consider the regionality of the plant selection.

3.2.4. Late operation and management design

(1) Setting up relevant monitoring systems in the boundary space

For the monitoring system of surface water quality and energy consumption in boundary space, it can be combined with the overall monitoring system of the campus. The quality of surface water in the boundary space is regularly detected, and the data such as energy consumption is monitored in real time to provide a data basis for dynamic update.

(2) Intelligent management of boundary information

Campus security and boundary space management are inseparable. The use of identifiable real-time intelligent information management system can increase the possibility of campus boundary sharing to a certain extent, such as intelligent visitor system and real-time data monitoring system of boundary movement space. Invisible boundary is used instead of visual boundary to soften the boundary design and ensure the safety inside the campus.

(3) Boundary space garbage disposal system

The vast majority of campus garbage shipments pass through the boundary space. In order to deal with this garbage, special boundary channels need to be set up, and care is taken to reduce the intersection with the space used by the crowd. At the same time, attention should also be paid to masking and handling odors. In the garbage collection facilities in the boundary space, the relevant classification identification should be used.

3.2.5. Logo and publicity design

The boundary space update can incorporate relevant green guidance signs, such as boundary slow walking path signs, barrier-free boundary space signs, garbage classification signs, etc. At the same time, green advocacy activities can be carried out jointly with the boundary spaces of the campus in the surrounding community, promoting connections with other spaces and promoting a green and healthy lifestyle.

4. Conclusion

As an important part of the campus space and the connection with the city, the campus boundary space is endowed with more possibilities in its green renewal design. Reasonable green design of campus boundary space can effectively reduce the heat island effect, soften the closed campus boundary, and promote the concept of green, open and shared life, especially for the dense areas on campus. The green renewal of the boundary space runs through the whole renewal cycle of the boundary space, including the preliminary investigation and the formulation of dynamic renewal planning strategy, the specific facility setting and material selection in the middle period, and the real-time green intelligent dynamic management system in the later period. Starting from the details, it should also be paid attention to the overall macro of the whole city. The implementation of dynamic green renewal on campus boundary provides a new idea for campus boundary space, and will also become an important part of the symbiosis between urban and university.

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