Theoretical Construction and Practical Expansion of Space Design: From Traditional Dimensions to Future Scenarios

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Abstract. As a comprehensive discipline spanning art, engineering, and social sciences, spatial design has always focused on the interactive relationship between "human space environment" as its core research object. This article explores the historical evolution of spatial design, analyzes its core components and design principles, and combines diverse types of practical cases to deeply explore the current challenges and future development trends faced by contemporary spatial design. Research suggests that spatial design is shifting from simply shaping material forms to systematically constructing lifestyles, cultural identity, and ecological sustainability. The integration of digitization, intelligence, and regionalization will become the core driving force for its innovative development.

Keywords: Space Design; The Integration of Digitization, Intelligence, and Regionalization; Spatial Design Principles; Theoretical Construction and Practical Expansion of Space Design.

1. Theoretical Origins and Disciplinary Positioning of Spatial Design

1.1 Philosophical Speculation on Spatial Concepts

As the fundamental field for human survival, space has undergone a philosophical evolution from "container theory" to "relational theory". Plato defined space as the "container for the creation of all things" in his Timaeus, emphasizing its objectivity and absoluteness; Heidegger's concept of "poetic dwelling" closely links space with human existence, believing that space is a way of existence where "humans reside poetically on the earth". [1]Phenomenological philosopher Merleau Ponty further pointed out that spatial perception is a product of the interaction between the body and the environment, which provides a theoretical basis for the "experientiality" of spatial design. In contemporary society, Lefebvre's theory of "spatial production" reveals the social attributes of space, believing that space is not only a container of social relations, but also a product of social relations. This assertion deeply influences the consideration of social equity in public space design.

1.2 Interdisciplinary Nature of Spatial Design

The interdisciplinary nature of spatial design is reflected in its deep integration with multiple fields. In the field of art, spatial design has absorbed the formal language of artistic schools such as constructivism and minimalism, such as Mondrian's geometric composition, which has had an impact on modern architectural facade design; In the field of psychology, environmental psychology studies the impact of space on human emotions and behavior. [2]For example, enclosed spaces can trigger feelings of oppression, while open spaces promote positive emotions; In the field of sociology, spatial design focuses on the differences in needs of different social groups, such as the design of public restrooms from a gender perspective, which needs to consider the special needs of women for privacy and queuing space; In the field of engineering, advances in materials science provide possibilities for spatial form innovation, such as the application of high-performance composite materials that enable large-span cantilever structures to be realized. This interdisciplinary fusion makes spatial design an effective tool for solving complex social problems.

1.3 Value Dimensions of Space Design

The value system of spatial design includes three progressive levels: practical value is the fundamental level, manifested as the satisfaction of functional needs by the space, such as the basic functions of sleep and storage in residential bedrooms; The aesthetic value is reflected in the response of formal beauty to spiritual needs, such as Gaudi's Mira House in Barcelona, whose curved form breaks the stereotypes of traditional architecture and gives people a visual shock; Social value is the highest level, manifested in the positive shaping of social relationships by space, such as the design of public spaces in slum upgrading, through the establishment of community centers and children's playgrounds,Enhance residents' sense of belonging and cohesion. In post disaster reconstruction, the social value of spatial design is particularly prominent. For example, after the Kumamoto earthquake in Japan, architects quickly built temporary activity centers to help disaster victims rebuild their social networks.

2. The Composition System and Design Method of Space Design

2.1 Hierarchical structure system of space

There exists a hierarchical relationship from micro to macro in space. The human dimension space is the most basic level, such as the height of the seat and the width of the door, which should be compatible with the size of the human body. [3]The Anthropometric Data Manual developed by the American Human Engineering Research Center provides a scientific basis for this level of design; The internal space of a building is composed of multiple human scale spaces, such as offices, conference rooms, and corridors in office buildings, which need to be efficiently connected through reasonable flow design; The layout relationship of multiple buildings is involved in the space of a building complex, such as the design of a university campus building complex, which needs to consider the functional zoning and pedestrian accessibility of the teaching area, living area, and sports area; Urban space is the highest level of spatial system, including elements such as streets, squares, and parks. Jane Jacobs emphasized in "The Death and Life of American Big Cities" that the vitality of urban space lies in "diversity", which requires a mix of residential, commercial, office, and other functions.

2.2 Basic patterns of spatial organization

The spatial organization mode determines the efficiency of space utilization and the quality of experience. The linear organizational model connects various functional spaces with traffic flow as the core, such as the design of exhibition halls in museums, guiding visitors to visit in an orderly manner through linear paths; The radial organizational pattern spreads outwards from the central space as a hub, such as connecting multiple platforms in the waiting hall of a train station, which facilitates rapid evacuation of people; The clustered organizational model concentrates the layout of functionally similar spaces, such as the outpatient building of a hospital, which concentrates departments such as internal medicine, surgery, and laboratory, reducing the distance for patients to move; The grid like organizational model divides space into orthogonal grids, which has high flexibility and adaptability, such as the street grid system in Manhattan, New York, making the expansion and transformation of urban space extremely convenient. In practical design, a mixed application of multiple modes is often used, such as airport terminals often combining radial (finger gallery) and linear (departure hall) modes to meet the needs of passenger gathering and flight stops.

2.3 Innovative Methods in Contemporary Space Design

The parametric design method establishes the correlation between spatial form and environmental parameters through algorithms, achieving precision and personalization in design. The Bilbao branch of the Guggenheim Museum, designed by Frank Gehry, has each panel shape of its titanium metal skin determined through parametric calculations, which not only adapts to the complex curves of the

building, but also presents rich visual effects under different lighting conditions. The participatory design method breaks the "authoritative perspective" of designers and incorporates user opinions through workshops, interviews, and other means. In the "Community Kitchen" project in Berlin, Germany, designers and residents discussed the spatial layout together, and the final design plan included elements such as movable stoves and shared storage cabinets that meet diverse needs. [4]Narrative design methods integrate story clues into spatial design, such as the spatial sequence of the Nanjing Massacre Memorial Hall. Through dark entrances, sloping floors, and gradually rising sky, visitors are guided to experience emotional experiences from repression to hope, strengthening the transmission of historical memory.

3. Deep analysis of specific types of spatial design

3.1 Educational Space Design: From "Instilling Style" to "Interactive Style"

Traditional educational spaces are centered around the classroom, emphasizing the dominant role of teachers, while contemporary educational space design shifts towards supporting "collaborative learning" and "personalized development". Kallio Elementary School in Helsinki, Finland, has transformed traditional fixed classrooms into multiple "learning communities", each containing a discussion area, practice area, and quiet learning area, equipped with movable tables and chairs and multimedia devices, suitable for various teaching modes such as group discussions and project-based learning. The design of "maker spaces" in higher education spaces has become a new trend, such as the media laboratory at Massachusetts Institute of Technology, which encourages innovative collaboration among interdisciplinary teams through open layout, modular workstations, and shared tool libraries. The design of kindergarten space emphasizes "gamification" and "natural contact". The "Forest Kindergarten" in Tokyo, Japan, sets up most of the activity space outdoors, using natural materials such as logs, sand, and ropes to construct game facilities, promoting children's sensory development and physical exercise.

3.2 Medical Space Design: From "Treatment Machines" to "Healing Environments"

The paradigm of medical space design has shifted from "disease centered" to "patient-centered". The design of the Cleveland Clinic in the United States introduces "family oriented" elements, with family accompanying sofa beds and independent bathrooms in the wards to reduce patients' sense of unfamiliarity and anxiety; The "natural healing" design incorporates natural elements to assist in rehabilitation, such as setting up small gardens outside the intensive care unit window. Studies have shown that patients can shorten their hospital stay by 10% by watching natural landscapes every day. The "accessibility" design of medical spaces is crucial, such as the "color navigation system" adopted by Singapore Central Hospital, which uses different colors to identify the floors and routes of different departments, combined with clear illustrations, to help patients quickly find their destination. The design for special patients reflects humanistic care, such as the use of cartoon murals on the walls of the children's ward and the lowering of the height of the nurse station to the level of children's line of sight, alleviating children's fear of the medical environment.

3.3 Transportation Hub Space Design: From "Transfer Node" to "Urban Living Room"

Contemporary transportation hubs have surpassed simple transfer functions and become "urban living rooms" that integrate commerce, culture, and socializing. The Shanghai Hongqiao Transportation Hub integrates high-speed rail stations, airports, subway stations, and long-distance bus stations, connecting various modes of transportation through a commercial pedestrian street on the underground level. Passengers can complete shopping, dining, and other activities during the transfer process; The renovation of the "Yaesu Exit" at Tokyo Station includes the installation of a cultural display wall in the waiting area, showcasing historical photos and traditional crafts of Tokyo, making the transportation space a showcase of urban culture. The "emergency design" of transportation hubs is related to public safety, such as the evacuation system at Hong Kong

International Airport, which ensures rapid evacuation of people in case of emergencies through clear signage, sufficiently wide evacuation routes, and redundant design of emergency lighting. The caring design for special groups, such as the tactile guidance system for visually impaired individuals and the luggage conveyor belt for passengers carrying large luggage, enhances the inclusiveness of the transportation space.

4. Technological innovation and material innovation in spatial design

4.1 Application of Digital Technology in Space Design

BIM (Building Information Model) technology realizes the whole process collaboration of space design. From scheme design, construction drawing drawing to construction management, all professionals can work in the same model to reduce information transmission errors. In the design process of Shanghai center Building, BIM technology was used to optimize the relationship between the core tube and the external curtain wall, which solved the complex structural problems of super high-rise buildings. VR/AR technology has changed the way spatial design is presented. Designers can create virtual spaces through VR devices, allowing customers to "enter" future spatial experiences in advance; AR technology can overlay design schemes onto real spaces, such as in the renovation of old houses, by using AR glasses to view the placement effect of new furniture in the existing space. Artificial intelligence assisted design systems can generate multiple options for selection based on design requirements, such as the AI design tool developed by Autodesk. After inputting the area and layout requirements of a residential building, it can generate more than ten floor plans within minutes and provide an analysis of the advantages and disadvantages of each plan.

4.2 Innovative Application of New Building Materials

High performance composite materials have expanded the possibilities of spatial form, and carbon fiber composite materials have the characteristics of high strength and lightweight, enabling the "Crystal Palace" in Madrid, Spain to achieve a column free space with a span of 50 meters; The application of transparent aluminum materials enables building curtain walls to have both the transparency of glass and the strength of metal. For example, a certain office building in Dubai uses transparent aluminum curtain walls, which can maintain stable performance even under extreme weather conditions. Intelligent responsive materials enable the space to have adaptive capabilities, temperature controlled color changing glass can adjust transparency according to outdoor temperature, reduce sunlight in summer to reduce air conditioning load, and increase transparency in winter to utilize solar energy; The sunshade louvers made of shape memory alloy can automatically adjust the blade direction according to the sunlight angle. The application of eco-friendly materials reflects the concept of sustainable design. Mycelium materials are formed into boards by cultivating fungal mycelium, which can be used to make furniture and partitions. After being discarded, they can naturally degrade; After modification, the strength of bamboo is close to that of steel. For example, the bamboo caf é designed by Vietnamese architect Wu Zhongyi features an arched structure made of bamboo that is both environmentally friendly and has regional characteristics.

4.3 Construction of Intelligent Space System

The intelligent space system integrates sensors, the Internet of Things, and artificial intelligence to achieve autonomous perception and dynamic adjustment of space. The environmental perception system monitors spatial environmental parameters in real time through temperature and humidity sensors, CO_2 sensors, and lighting sensors. For example, the intelligent air conditioning system in an office automatically turns on the fresh air system when the indoor CO_2 concentration exceeds 1000ppm. The behavior recognition system analyzes user behavior through cameras and AI algorithms, such as the intelligent shopping guide system in shopping malls, which determines customers' points of interest based on their stay time in different areas and pushes relevant product information; The intelligent reservation system for conference rooms can predict peak demand based

on historical usage data and prepare equipment in advance. The security protection system ensures the safe use of space, such as the intelligent security system in residential buildings, which automatically alarms when abnormal situations occur through door and window sensors and human infrared sensors; The intelligent display cabinet in the museum integrates vibration sensors and glass breakage detectors to prevent exhibits from being stolen.

5. Space Design in the Context of Globalization and Regionalization

5.1 The impact of globalization on spatial design

Globalization has brought about an "international style" in spatial design, characterized by simple geometric shapes, widespread use of glass and steel structures, and a design philosophy that prioritizes functionality. This style is particularly common in building types such as multinational corporate headquarters and international airports, such as the T2 terminal of Paris Charles de Gaulle Airport, which uses a combination of steel structures and glass curtain walls to present a strong sense of modernity and international recognition. Globalization has also promoted the cross-border flow of design resources, such as many large-scale construction projects in China being designed by foreign architects, bringing advanced design concepts and technological methods. However, globalization has also raised concerns about "cultural convergence", as many landmark buildings in cities lack regional characteristics, resulting in a phenomenon of "one size fits all", such as the emergence of imitative buildings like "big underwear" and "autumn pants buildings" in various regions, reflecting the neglect of regional culture.

5.2 Practical Path of Regional Design

Regional design is not simply a collage of symbols, but a contemporary interpretation of the spiritual core of regional culture. Climate adaptive design is an important manifestation of regionalization, such as the traditional building "wind tower" in Saudi Arabia, which forms natural ventilation through the height difference of the tower body. [5] Modern architects have applied this principle to the design of an office building in Riyadh, combining solar powered ventilation systems to significantly reduce air conditioning energy consumption. The local use of materials can enhance the sense of regional belonging of space. For example, the rammed earth wall technology of the Earthen Building in Fujian Province has been used by contemporary architects for the design of home stay, which not only adapts to the local climate, but also conveys the memory of local culture; The Norwegian tradition of wooden architecture is continued in the design of the Oslo Opera House, where the wood comes from local sustainable forests, reducing transportation energy consumption and reflecting Nordic natural aesthetics. The spatial translation of regional lifestyle is a deep expression of design. For example, the traditional Naxi dwellings in Lijiang, Yunnan, known as the "Three Fangs and One Wall", have courtyard spaces that adapt to the local agricultural lifestyle of "working at sunrise and resting at sunset". A contemporary hotel design in Lijiang has transformed this spatial pattern into courtyard style guest rooms, allowing visitors to experience the wisdom of Naxi life.

The dialectical unity of globalization and regionalization

Successful spatial design often achieves a balance between globalization and regionalization. The Islamic Art Museum designed by I.M. Pei not only adopts the geometric form and structural technology of modern architecture (global characteristics), but also echoes the traditional Islamic architecture (regional characteristics) through the abstraction of the dome and the water landscape design of the courtyard. The works of Japanese architect Tadao Ando have a strong personal style (plain concrete, space of light) and are deeply rooted in Japan's "wabi sabi" aesthetics. His design for the Osaka Asuka Museum uses a simple concrete volume to communicate with the natural environment, reflecting Eastern space philosophy. This design strategy of "global language, local accent" ensures the international communication of the design while maintaining the uniqueness of regional culture. In contemporary China, the exploration of "New Chinese Style" design also reflects

this idea, such as Wang Shu's design of the Xiangshan Campus of the China Academy of Art, which combines the tile and wooden elements of Jiangnan residential buildings with modern architectural language to create a familiar and unfamiliar spatial experience.

6. Ethical Reflections and Future Prospects of Space Design

6.1 Ethical Dimensions of Space Design

The ethical issues of space design are related to social fairness and justice. Space justice requires the design to eliminate discrimination against specific groups, such as accessible design, which is not only a technical specification, but also a respect for the equal rights of people with disabilities. The United Nations Convention on the Rights of Persons with Disabilities clearly stipulates that "States Parties shall ensure that people with disabilities have equal access to public and private places on an equal basis with others. Environmental ethics require designers to take on ecological responsibility. For example, in the design of a resort in the Amazon rainforest region, elevated buildings were used to reduce ground occupation and treated wastewater was used for irrigation, achieving harmonious coexistence with nature in order to minimize damage to the ecosystem. Cultural ethics requires that the design should respect cultural diversity. For example, in the architectural design of ethnic minority areas, it is necessary to avoid imposing the Han culture on the local, and respect their traditional architectural customs and religious beliefs. For example, a hotel design in Xizang has borrowed the color system and decoration patterns of Tibetan architecture, rather than simply copying the Han architectural form.

6.2 Frontier Exploration of Future Space Design

Space design is a new challenge facing humanity, and the design of the International Space Station's residential module needs to address special needs such as sleep, work, and exercise in microgravity environments. For example, sleeping bags need to be fixed on the cabin walls to prevent floating; The design of future lunar bases also needs to consider extreme conditions such as radiation protection and life support systems. The integration of virtual space and physical space will reshape human spatial experience. Metaverse technology enables people to socialize and work in virtual space, while physical space becomes the "entrance" to virtual experience. For example, a coffee shop in South Korea has set up VR devices, allowing customers to drink coffee in real space while communicating with friends from all over the world in virtual space. The adaptive design to address climate change is becoming increasingly important, such as the "floating house" design in the Netherlands, which uses a concrete floating structure that can float with the water level when the sea level rises; The design of a typhoon resistant school in Bangladesh features a streamlined roof to reduce wind loads and a pile foundation to enhance its resistance to lodging.

7. Conclusion

The development process of spatial design is the history of human continuous optimization of the living environment. From the shelter of primitive caves to the systematic construction of contemporary smart cities, spatial design has always responded to the needs and challenges of the times. In today's rapidly iterating technology, spatial design needs to adhere to the core of humanistic care and avoid falling into the trap of technological determinism. The collision of globalization and regionalization requires designers to have both an international perspective and a deep roots in local culture; The intensification of ecological crisis has prompted spatial design to shift towards a path of sustainable development. Future space design will place greater emphasis on inclusivity, elasticity, and adaptability. Through interdisciplinary collaborative innovation, we aim to construct an ideal space that not only meets functional needs but also carries cultural memories and is more adaptable to future changes. This is not only the professional mission of designers, but also an important guarantee for achieving sustainable development in human society.

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