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Research on the Integrated Design of Guidance Signs and Plant Displays in Botanical Gardens

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Abstract

A botanical garden is a comprehensive public landscape space that integrates ecological conservation, plant education, recreational tourism, and scientific research. The signage system and plant exhibition system serve as key components for fulfilling the garden's functions and conveying its cultural values. Currently, however, signage in most domestic botanical gardens primarily provides route guidance only; plant education lacks support from modern media platforms, and signage facilities are disconnected from plant displays. With the rapid advancement of digital information technology and the growing public demand for interactive and immersive popular science experiences, the single static identification mode can no longer meet the diversified needs of visitors of all age groups. Many visitors cannot systematically obtain in-depth knowledge such as plant origin, growth habits, ecological functions, and cultural connotations merely through traditional nameplates, which greatly weakens the science popularization and educational core mission of botanical gardens. Moreover, unreasonable layout, inconsistent visual styles, and insufficient durability of signboards also cause fragmentation of the overall landscape effect, reducing the overall artistic coordination of the plant exhibition area. Against this background, the organic combination of intelligent signage terminals, QR code electronic explanations, and scene-based plant exhibition layout becomes an inevitable optimization direction. This paper thoroughly examines the practical significance and existing shortcomings of integrated design for signage and plant exhibitions, proposes corresponding implementation strategies, establishes a unified design framework, and aims to enhance both the aesthetic quality of botanical garden landscapes and the level of public services, providing reference for improvement.

Keywords

Botanical garden; guidance signage; plant display; integrated design

Today, botanical gardens serve the dual roles of disseminating ecological knowledge, providing recreational spaces, and preserving natural heritage, functioning as public science education hubs and urban ecological leisure areas. In previous planning and development approaches, guidance signage systems were designed separately from plant exhibition content across distinct zones, with unrelated design philosophies lacking dynamic information updates and context-driven presentation formats. Implementing integrated design for signage systems and plant displays can bridge the gaps between functional facilities, landscape architecture, route guidance, and science communication efforts, enhance the park's spatial environment, improve outreach effectiveness, and strengthen overall visual coherence. This paper explores implementation methods for integrated development, aiming to provide theoretical insights for the refined design of botanical garden landscapes.

1. The Importance of Integrated Design for Guidance Signs and Plant Displays in Botanical Gardens

The botanical garden is a comprehensive public landscape space integrating ecological conservation, science education, recreational tourism, and scientific research. The signage system and plant display system serve as the two core infrastructures essential for realizing the park's functions and delivering its value; their seamless integration is key to enhancing the overall service quality of the botanical garden. The signage system is not merely a navigation tool but also fulfills multiple core roles including spatial guidance, information dissemination, landscape enhancement, and order maintenance. A scientifically designed signage layout effectively optimizes visitor flow, standardizes touring behavior, prevents blind spots and congestion, while conveying information through intuitive visual means. The spatial information within the park provides convenient navigation guidance for visitors of various age groups and cognitive levels. The plant display system serves as the core feature that distinguishes botanical gardens from ordinary urban parks, fulfilling essential functions in plant education, ecological demonstration, and nature-based learning. It comprehensively and visually showcases plants' morphological characteristics, growth habits, species value, and community ecological relationships, making it a central platform for nature-based educational programs and ecological knowledge dissemination. In traditional botanical garden designs, directional signage and plant displays operate independently with distinct roles, resulting in inconsistent design standards, layout logic, and visual styles that lead to fragmented functionality and resource waste. However, an integrated approach addresses these issues effectively. The design breaks away from the traditional approach of independent planning and separate implementation for both elements, achieving comprehensive integration in form, material, and craftsmanship, information content, and spatial layout. On one hand, it incorporates plant science education information into orientation signage throughout the park, combining static plant displays with dynamic visitor experiences to make signs a regular medium for science communication; on the other hand, it creates distinctive scene atmospheres through characteristic plant landscapes, reducing the artificiality of signage and allowing it to blend naturally into the garden environment. This integrated approach effectively combines visitor services with science education functions, achieving synergy between wayfinding, natural science dissemination, and landscape design. The integration of multidimensional values not only enhances the overall coherence and aesthetic appeal of the park's space but also strengthens the botanical garden's public education role, facilitating the sustained implementation of natural science outreach initiatives (Yang, 2026).

2. Current Issues in the Signage Design and Plant Display Systems at Botanical Gardens

Currently, most botanical gardens in China face a widespread disconnect between their wayfinding signage systems and plant display layouts during planning and design phases. These two components are typically planned separately, constructed independently, and maintained separately, lacking unified design standards and holistic coordination, which has led to numerous practical issues affecting visitor experience and educational effectiveness. At the overall planning level, there is a severe lack of synergy between signage facilities and plant exhibition areas; most botanical gardens simply adopt standardized signage templates without adapting them to the specific characteristics of each plant zone, landscape features, or site culture. This results in signage styles that clash with the ecological ambiance of the exhibition spaces, while the placement of signs also lacks strategic consideration. The scientific planning exhibits issues such as uneven distribution of observation points, significant obstructions, and chaotic visitor flow guidance, failing to align with the park's touring rhythm and plant display layout. In terms of functional services, the two aspects are highly fragmented with prominent gaps in integration; most directional signs only provide basic route guidance without any educational extension content, while plant displays rely solely on simple labels indicating plant names and families, featuring simplistic, monotonous information presented in a rigid format that fails to deeply integrate visitor pathways with educational experiences. This results in visitors merely "visiting without gaining understanding," completely undermining the core values of botanical garden tours and science education. Regarding audience suitability, the current system... The design lacks meticulous consideration: signage layout is disorganized, and information presentation is monolithic, with content solely catering to the basic touring needs of general visitors rather than providing tiered, differentiated information tailored for specific audiences such as primary and secondary school study groups or scientific enthusiasts, thus failing to meet diverse educational and tourism requirements. In terms of landscape design, most botanical garden signs employ industrially mass-produced materials, exhibiting severe homogeneity in design styles—with uniform shapes, colors, and craftsmanship that lack site-specific character and natural authenticity. These rigid artificial signage elements disrupt the park's native ecological ambiance and

exhibit poor integration with the natural landscape, ultimately diminishing the overall appeal of the facility. The landscape texture also limits the realization of the botanical garden's comprehensive values, including science education, landscape enhancement, and ecological demonstration (Zhou et al., 2021).

3. Practical Strategies for the Integrated Design of Guidance Signs and Plant Displays in Botanical Gardens

3.1 Integrated Spatial Layout

The signage system should be developed in alignment with the botanical garden's overall spatial layout and the zoning plan for plant exhibition areas, establishing a tiered identification framework. Firstly, large directional signs at the main entrance and along major pathways should clearly indicate the locations of each thematic exhibition zone, highlight distinctive plants, and guide visitors to their intended display areas. Secondly, zone-specific signage should reflect the theme of each area, define spatial boundaries, and preview the plant characteristics of that zone. Thirdly, the core exhibition area employs a cluster-based signage arrangement, with interpretive signs positioned around characteristic plant communities to ensure seamless integration of guidance, viewing, and educational elements. Additionally, the design must maintain landscape harmony by considering the height of surrounding vegetation and the style of garden features. Standardize the shape, material, and color scheme of signage to avoid rigid accumulation that disrupts the natural ambiance. Install small ground signs in remote forested areas to address guidance blind spots caused by visual obstructions. Adjust sign density based on visitor flow data: increase educational tips in high-traffic zones while reducing signage in low-traffic areas. Additionally, integrate with the online digital tour system by incorporating QR code access points on physical signs and expanding botanical education content, thereby achieving seamless coordination between physical spatial layout and online intelligent guidance to further enhance the overall effectiveness of integrated signage systems (Zhang, 2020).

3.2 Integration of Visual Forms

Exclusive visual identities should be designed for each exhibition zone based on its unique botanical landscape, with considerations across three dimensions: form, color, and material. The form design directly draws inspiration from the contours of the zone's signature plants, presented in a minimalist style; distinct shapes are employed for bamboo, succulent plants, and ancient tree zones to facilitate quick visitor differentiation. Color schemes prioritize soft, low-saturation tones such as green, natural wood, and light gray, avoiding glaring bright colors that might clash with the native plant ambiance. Materials are selected to harmonize with the environment: the aquatic zone uses waterproof stone, the native plant area employs weather-resistant wood panels, while the science education space incorporates translucent, eco-friendly materials to minimize a rigid industrial appearance. For example, the National Botanical Garden's comprehensive signage system draws inspiration from natural forms such as branches and trunks, seamlessly integrating with various botanical landscapes throughout the garden and serving as a practical reference for unified visual design in domestic botanical gardens (Guan, 2020).

3.3 Integration of Information Content

The content framework of signage information should be restructured to achieve organic integration of spatial guidance information with botanical education materials, establishing a hierarchical information dissemination model. Basic directional signs should retain core navigational elements such as directions, routes, and distances, while incorporating concise educational content including introductions to key plants in the exhibition area, viewing seasons, and ecological characteristics; individual plant signs should provide additional details beyond species names, families, and scientific names, covering growth habits, species significance, and interesting facts; thematic exhibition signs should include in-depth information on ecological themes, plant community relationships, and landscape design concepts. Content development should differentiate between general visitors, educational students, and professionals. To meet the reading needs of enthusiasts, popular science content should be presented in an accessible manner with concise removal of obscure technical terms. Realistic photographs should accompany the text to reduce length and prevent information overload on display panels. Additionally, QR codes can be used to provide extended information—scanning them reveals details about plant propagation processes, conservation status, and related traditional cultural stories. Standardized font styles, icon designs, and presentation formats ensure consistent explanations across different exhibition areas, enhancing the rigor of the botanical garden's educational content (Xiang et al., 2016).

3.4 Integration of Functional Scenarios

To develop integrated design solutions with multifunctional capabilities: for public tourism scenarios, simplify information hierarchy, emphasize guidance functions and basic science education to ensure efficient and convenient visits; for natural study tours in primary and secondary schools, add interactive signage featuring engaging quizzes, plant observation prompts, and educational tips to enhance both entertainment value and educational impact; for leisure landscapes, reduce the functional emphasis on signage while enhancing its decorative appeal, making it a visual accent of the scenery; for scientific research and popularization settings, retain professional species data and ecological research materials to meet the needs of researchers and enthusiasts. For example, the National Botanical Garden (Beijing) has established a tiered guided tour system that seamlessly integrates route navigation, zoning guidance, botanical education, and nature-based learning functions, catering to diverse scenarios such as public visits, academic research, and scientific expeditions. Its integrated, versatile implementation model serves as a well-established reference for botanical garden design in China.

3.5 Integration of the Operations and Maintenance System

Integrated design encompasses not only preliminary planning and design but also requires a comprehensive long-term operation and maintenance system. A unified mechanism for updating signage and plant displays should be established to promptly adjust information and layout in response to seasonal changes in plants, landscape upgrades in exhibition areas, and updates to educational content, thereby aligning with the dynamic growth patterns of plants; signage facilities should be regularly maintained to address issues such as aging, damage, or fading, ensuring clear and complete visibility; standardized design specifications must be developed to unify the overall design logic across the park, preventing design inconsistencies when new facilities or exhibition areas are added later, thus ensuring sustained consistency between the botanical garden landscape and its functional requirements (Zhao, 2015).

By utilizing digital records to document facility commissioning dates and maintenance history, online databases ensure the preservation of maintenance data, enabling managers to identify shortcomings in maintenance practices. Concurrently, training programs on landscape signage maintenance and planning are conducted to enhance staff expertise. A dedicated maintenance team is established with clearly defined responsibilities across designated areas; regular inspections are performed, and damaged components are systematically documented. Maintenance intervals are adjusted according to seasonal conditions, with special attention given to corrosion prevention for signs during rainy seasons. Additionally, a visitor feedback mechanism is implemented to refine sign design and placement based on user suggestions, while operational evaluation criteria are further refined. The facility integrity rate and timely renewal status shall be incorporated into performance evaluations, leveraging institutional constraints to continuously consolidate the achievements of integrated development. A clear reward-and-punishment assessment mechanism shall be implemented, recognizing individuals with outstanding performance in maintenance tasks to motivate staff and enhance the precision of park operation and maintenance management.

3.6 Integration of Cultural Content

The integrated design of botanical garden signage and plant displays must deeply incorporate regional culture, botanical heritage, and ecological-humanistic elements, transcending the conventional limitations of signage that serve solely as guidance or educational tools to achieve a seamless integration of landscape presentation, cultural dissemination, and spatial orientation. During the design process, appropriate cultural elements should be selected based on the local folk traditions and historical context of the botanical garden, with regional motifs and traditional aesthetic lines incorporated into both the signage's form and decorative details, thereby transforming it into a vehicle for promoting regional culture. Simultaneously, the cultural symbolism, historical associations, and traditional applications of various plants should be thoroughly explored—highlighting bamboo's elegance, pine's resilience, and lotus's purity. Plant culture elements are integrated into signage explanations through species displays, enriching the cultural dimension of plant exhibitions. Dedicated cultural signs are designed for specialized zones such as the distinctive culture exhibition area, ancient tree exhibition area, and native plant section, linking plants' natural attributes with their cultural narratives. Furthermore, a unified cultural expression framework is established across the entire park to avoid issues like excessive accumulation of cultural elements or disorganized content, ensuring consistent cultural style throughout all zones. Through cultural enrichment, directional signage transcends its role as mere functional infrastructure; visitors can not only navigate routes and identify plants but also experience the integration of natural

ecology and human culture, thereby enhancing the botanical garden's overall artistic ambiance and cultural value while achieving cohesive design integration. The spiritual core of the concept (Yang & Jiao, 2014).

3.7 Integrated Ecological and Low-carbon Development

Based on the core mission of ecological protection in botanical gardens, we implement low-carbon and environmentally friendly design principles to achieve seamless integration between signage infrastructure development and the park's ecosystem as well as plant conservation efforts, thereby establishing a green and sustainable display and signage system. For material selection, we prioritize recyclable, biodegradable, and renewable eco-friendly materials while eliminating highly polluting or energy-intensive industrial alternatives; instead, we employ low-carbon options such as corrosion-resistant solid wood, recycled stone, and eco-friendly acrylic to minimize environmental impact during construction. Additionally, adhering to the principle of minimal intervention, signage installations are strategically located away from critical ecological areas including rare plant root protection zones and native vegetation communities, utilizing overhead or wall-mounted mounting solutions. Through installation methods such as embedded systems, land excavation and vegetation damage are minimized, preserving the park's original ecological texture to the greatest extent. The exterior design aligns with ecological circulation principles, featuring colors and shapes that harmonize perfectly with natural landscapes, avoiding exaggerated or incongruous designs to achieve seamless integration of signage with vegetation, terrain, and water features. Additionally, a low-carbon operation and maintenance model is implemented, prioritizing energy-efficient solutions like solar power supply and luminescent signage to reduce energy consumption. Outdated signs are regularly recycled and refurbished for reuse, minimizing resource waste. Furthermore, educational content on low-carbon practices and ecological conservation is incorporated into signage, leveraging these installations as vehicles to promote green awareness. Achieve comprehensive ecological integration across physical facilities, the ecological environment, and science education (Liu & Zhu, 2012).

4. Conclusion

In conclusion, promoting the integrated design of botanical garden directional signage and plant displays represents an essential approach for contemporary landscaping to achieve refined aesthetics, diversified functions, and immersive experiences. This model addresses the shortcomings of traditional planning where signage facilities were disconnected from botanical education, integrates artificial infrastructure with natural environments, leverages plant landscapes for science communication, comprehensively enhances park environmental quality, and elevates both public service standards and ecological education value. Future botanical garden development should firmly embrace this integrated design philosophy, continuously refine planning schemes, and contribute to the steady, high-quality advancement of urban landscaping and natural science education initiatives.

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