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Research on Landscape Greening System Based on the Application of Digital Landscape Technology

Hao Lei

Art and Design School, Wuhan University of Science and Technology, Wuhan, China
614021318@qq.com

Abstract: *In recent years, with the rapid development of urbanization and the continuous improvement of environmental requirements by residents of various cities in the digital era, it has prompted smart cities and smart gardens to become important nodes towards the future of the world. This paper mainly analyzes the practical application of digital landscape technology in gardening through case study and literature research methods. It finds that, in the digital era, the application of emerging technologies provides new possibilities for the planning and design of gardens, and 3S technology plays an important role in garden planning and design. This paper also describes the design process in detail. The combination of digital flow and data flow will greatly improve the efficiency of planning as well as the sustainability of the design. At the same time, we summarize the software used in the design. Landscape design development should not only focus on function and aesthetics but also on ecological protection and sustainability. The conclusion is that the use of 3S technology and related emerging technologies can make modern garden landscape pre-planning and post-construction landing more scientific and intelligent. Through digital technology, we can have a more rational vision to increase the achievability of garden planning. Through the application of technology, landscape design can better serve urban development and residents' lives.*

Keywords: *Digital landscape technology, 3S Technology, Design process, Ecological suitability evaluation*

1. Introduction

The progress of technology is the driving force behind the development of garden design, and better intelligent construction of gardens also promotes technological advancement. Gardens, as an important part of urban green space, provide people with fresh air and a beautiful environment. At the same time, with the help of progress in the times, they selectively combine current popular technologies such as artificial intelligence, GIS decision support systems, the Internet of Things, and big data to actively respond to the future development of cities. In the past, gardening has played a dominant role in the quality and level of urban greening. The direction of development at that time was simply summarized as "plant landscaping as the main focus, adhering to the ecological garden." However, research on the specific characteristics of plants and the underground environment is an urgent issue[1].

Based on the development of emerging technologies, massive data can be transmitted in an efficient, safe, and convenient way. This realizes intelligent management and detailed monitoring of plant growth in gardens. Additionally, through the Internet of Things technology and sensing equipment, real-time observation of the microclimate of green spaces and the overall soil environment is possible. This not only ensures that the scientific and intelligent garden system provides maintenance data but also solves the problem of plant growth support. It also addresses the issue of detecting the overall impact of plant growth changes on the garden environment[2]. The Internet of Things technology can also effectively reduce the cost of manual testing, achieving smarter and more efficient maintenance and management of landscaping[3]. The use of GIS decision support systems dates back to the late 20th century, mainly used in the measurement of landscape sensitivity. The application of digital technology in the design of landscaped green spaces originated from the geographic information system and computer graphics technology, gradually developing into a core design methodology in this field. Through the collection and analysis of data and information in the early stage, a database can be constructed. Designers need to carry out program construction and effect output through modeling and rendering software, which has become a necessary skill for designers and an important means of presenting program effects (see Table1).

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Table 1: Landscape Design Digitization Software

Design progress	Design Purpose	Software name	Software function
Program Design and modifications	process control	ArcGIS	Site area spatial data collection and analysis Planning information modeling
	Modeling	Autodesk Revit	Build a 3D model
		Rhino 3D	
		SketchUp	
	Programming Applications	MATLAB	Programming on demand to realize architectural design and analysis and optimization
		Grasshopper	
		AutoCAD	
Expression of results	Graphic Design	Photoshop	Basic graphic presentation and design
	Scene Rendering	Enscape	Scene animation design
		Lumion	
	Virtual Reality	ArcScene	3D visualization
		Lumion	

2. Case study and application of digital landscape technology

2.1 Z landscape green space

Z landscape green space is a small campus landscape green space. The planning of the site combines the suitability of the land and relevant knowledge of landscape design. From the perspective of landscape ecology, it considers the surface structure of Z landscape, surface biodiversity, and different sizes of spatial structures to create a sustainable and harmonious atmosphere on campus. The development of the campus green space was accompanied by a conceptual exploration and master planning process (see Figure 1). Due to the campus nature of the green space, it required consideration of the willingness of students and teachers, as well as the reasonableness of the combination of landscape and technology, to come up with a feasible strategy for the landscape planning program.

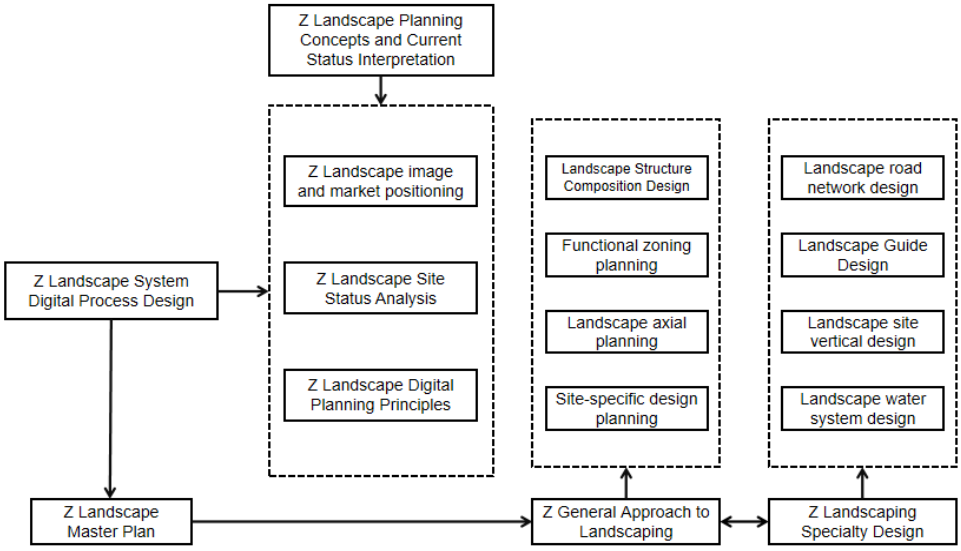

Figure 1: Master Planning Process for Z Landscape

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2.2 Z Campus green space planning pattern

Z campus green space planning uses the "patch-corridor-substrate" model to describe the landscape pattern. This involves concepts such as green spaces or campus arterials and major buildings in Z colleges, which can be regarded as different patches, and corridors can be regarded as campus arterials. The Z landscape, as a campus landscape, is not only a natural complex but also infused with cultural colors. The campus, as a typical humanistic landscape, is responsible for the development of students' overall qualities and therefore has cultural characteristics and aesthetic colors. Additionally, the Z landscape considers bird diversity and vegetation structure. Research shows that bird diversity is affected by the vertical structure, the number of group planting factors, and the horizontal structure of the garden. The improvement of biodiversity is conducive to the sustainable development of ecological dynamics. Therefore, it is necessary to consider all aspects of green space and biodiversity in the green landscape area to ensure the abundance of birds and diversity index.

With the development and widespread application of digital management technology for landscape biological information, biological information within the landscape can also realize dynamic management. By detecting the impact of biota on the landscape environment and making timely adjustments, a more efficient and intelligent campus landscaping system can be built. In the digital era, the construction of landscapes will also be healthier and follow the trend of development.

3. Digital analysis of landscape green space

3.1 Integrating Emerging Technologies to Enhance the Landscape Recreation Experience

With the increasingly mature development of 5G technology, VR (virtual reality) and AR (augmented reality) technology can be integrated into urban smart gardens. This stimulates the freshness of urban residents and enhances the fun and wisdom of the garden experience. Through such emerging intelligent interactive technology, residents can use a set of professional equipment to gain a more detailed and intuitive understanding of garden plant information and obtain a more profound gardening experience and immersive embrace of the natural environment. Additionally, through artificial intelligence services, people can get everything they want to know by communicating with the constructed artificial intelligence platform. This increases the efficiency of users in searching for information and optimizes the overall experience of visiting the garden. In short, the integration of emerging technologies into intelligent garden interactions has undoubtedly promoted the development of urban garden intelligence[4]. For basic plot area data collection, it is necessary to use 3S technology, namely remote sensing technology (RS), a geographic information system (GIS), and a global positioning system (GPS). These play an important role in the design and planning of green space in gardens. These technologies provide more scientific and modern methods for preliminary data collection and analysis, as well as processing of spatial information related to land use planning in garden green spaces[5]. Among them, GIS is mainly used to analyze, display, and store site spatial data, playing a crucial role in assessing the geographical structure. RS and GPS help planners understand the situation of the green space and provide a more macroscopic perspective to show site details, such as plant growth status and water body distribution.

3.2 Digital Flow and Design Flow

The design of green space involves many parts and aspects of combination and cannot rely on simple intuitive judgment to solve planning problems. To express the rational level of green space garden design, it is necessary to use digital platforms. The use of rigorous, rational, and orderly byte data to work is a solution and innovative new means. In the process of green space planning and design, the application of digital hardware and software not only greatly improves the efficiency of planning and design relevance but also helps realize the sustainability of green space design. Through digital simulation analysis, the microclimate of the green space can be optimized, and BIM technology can improve resource use and reduce waste. The design flow involves sustainable optimization and multi-level judgment after the digital flow. With the designer leading, supplemented by the work of the digital flow, the two together build the thinking system of garden green space design. The work logic flow is as follows:(see Figure 2)

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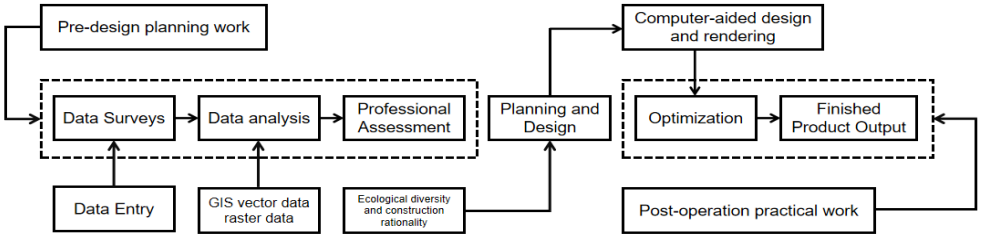

Figure 2: Parametric landscape green space design process

3.3 Programming Model Thinking

In the current 5G era, programming model thinking is the logic of most digital platforms. Programming models can be tested and adjusted to address unpredictable changes over time. The essence of digital green space planning and design is to use websites, applications, operating systems, and component computer hardware to work together for planning and design operations. By collecting and analyzing data such as climate, soil, vegetation, and foot traffic, designers can create data-based models to support design decisions. In programming, structured chains of thought can help designers solve problems in a systematic way[6]. This approach can be applied to the planning and design of landscapes and green spaces. The design program can be constructed through logical and clear steps to ensure that the design is logical and systematic. In conclusion, programming model thinking provides a new perspective and problem-solving approach to landscape green space planning and design. It emphasizes the method of parameterizing data, the accuracy of simulation, the effectiveness of collaborative work, and the possibility of innovation. Through these methods, designers can create more scientific, rational, and sustainable landscaped green spaces.

4. Ecological suitability assessment

Ecological suitability assessment is a multidisciplinary, comprehensive research process that is essential for the continued development and survival of humanity into the future. This assessment typically encompasses ecological diversity, ecological sensitivity, ecological service functions, environmental impacts, and socio-economic factors, aiming to achieve a balance between development and nature conservation. The evaluation system is primarily guided by the suitability evaluation principles proposed by McHarg.In the 20th century, urbanization progressed rapidly, leading to the encroachment of natural areas by human constructions and a swift expansion of urban land. If this trend continues, natural features such as lakes, rivers, and forests may vanish, jeopardizing the sustainable development of human habitats. Urban planners are in dire need of a more profound understanding of urban planning principles. They urgently need to identify and develop usable land within cities, as well as to protect areas that maintain ecological balance and establish ecological boundary lines (see Figure 3). Ecological suitability assessment, as a foundation for studying the ecological significance of land and its utilization, can address these related issues [7].

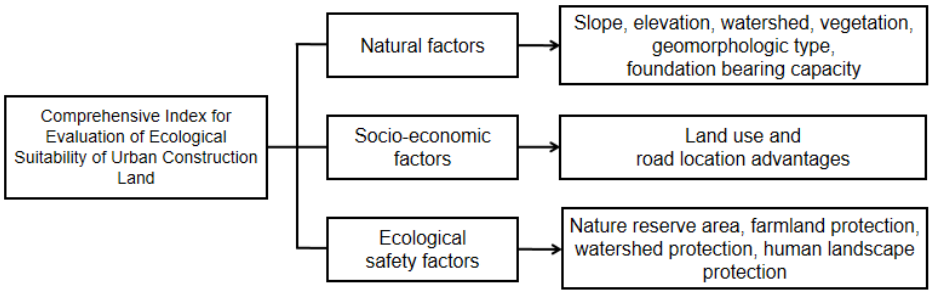

Figure 3: Evaluation of Ecological Suitability of Urban Construction Land

The development of ecological suitability evaluation has garnered increasing attention from scholars, who conduct targeted research in various areas. The practical applications of these evaluations are predominantly found in urban construction land suitability assessment, urban land ecological

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suitability evaluation, ecological suitability assessment of industrial layouts, and land development adaptability evaluation. Through ecological suitability evaluation, a more robust theoretical foundation can be provided for land use planning and the conservation of environmental resources.

5. Conclusion

The urban green space system stands as the sole vital infrastructure within cities, serving not just as a crucial space for citizens to connect with nature but also as the linchpin for maintaining urban ecological balance. Nevertheless, the accelerated pace of urbanization has led to the replacement of numerous natural green spaces with buildings, resulting in heightened vulnerability of urban ecosystems and ecological disarray. As urban green spaces represent biodiversity hotspots, with their biological populations far richer than other urban land types, prioritizing the preservation and enhancement of their biodiversity should be paramount for landscape planners[8]. Amidst the backdrop of globalized technological revolution and industrial transformation, advancements in high-tech such as big data, artificial intelligence, and 3S technology have ushered in new opportunities for the urban landscape industry. The seamless integration of digital landscape technology with modern garden construction fosters the scientific, rational, and sustainable progression of garden design[9].

Ecological suitability assessment offers pivotal theoretical support and practical guidance for urban planning and landscape design, aiding in a deeper comprehension of the ecological value and function of urban green spaces. With the dawn of the new era, urban garden environments and management endeavors confront more stringent requirements. We must harness the potential of digital construction to forge an urban garden system that better aligns with modern needs and furnishes residents with sustainable urban green spaces. Presently, urban gardening is predominantly government-driven, with relatively minimal participation from the public and professional groups, thereby constraining the innovation and diversity of garden construction to some extent. The absence of an effective mechanism for social participation hinders the primary audience of urban gardens from actively engaging in the design and planning phases. Moreover, the government often fails to engage in comprehensive communication when soliciting societal opinions, further restricting the innovativeness of garden construction.

Urban green space development in the new era spearheads ecological city construction. The progression of science and technology, coupled with the emergence of new industries, has rendered various sectors increasingly reliant on "intelligent management" and "big data services." The assistance of digital technology empowers traditional garden industry practitioners to design garden programs that are more scientific and better tailored to the demands of the present era. We must establish an open and interactive platform for social participation, enabling citizens, professionals, and non-governmental organizations to engage in landscape planning and management, thereby collectively promoting the sustainable development of urban gardens[10]. By doing so, we can ensure that the urban green space system not only caters to present needs but also adapts to future changes, emerging as a vital component of sustainable urban development.

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