Practice and Case Study on the Integration of Digital Architecture Design and Sustainable Development Concept

Zhenyao Yin[1,a], Yali Liu[1,*,b], Xing Ren[2,c]

[1]Guangzhou Institute of Science and Technology, Guangzhou, 510000, Guangdong, China

[2]Guangzhou Sewage Purification Co.Ltd., Guangzhou, 510000, Guangdong, China

[a]zhenyaoyin@163.com, [b]404528598@qq.com, [c]rxailee@126.com

Keywords: Digital architectural design; The concept of sustainable development; Practice; Case

Abstract: Digital architectural design is profoundly changing the landscape of the construction industry, achieving precise simulation and efficient management of the entire building process through advanced computer technology and design software. Designers can quickly build realistic virtual building models with the help of 3D modeling software, greatly enhancing the intuitiveness of design and customer engagement. Digital technology also accelerates the iteration and optimization of design solutions, effectively shortens project cycles, and improves design efficiency and reliability. The combination of digital architectural design and sustainable development concepts has further promoted green innovation in architectural design. By adopting renewable materials and energy-saving technologies, as well as optimizing building layout and increasing green area, digital design has achieved respect and protection of the environment. This design concept not only satisfies modern people's pursuit of a better life, but also contributes to the sustainable development of society. With the continuous progress of technology and the expansion of applications, digital architectural design will play a more important role in the field of architectural design.

1. Introduction

In today's rapidly developing construction industry, digital architectural design is leading the industry's transformation with unprecedented efficiency and precision[1]. At the same time, with the increasingly severe global environmental issues, the concept of sustainable development has become an indispensable guiding principle in the field of architecture. Therefore, integrating digital architectural design with sustainable development concepts is not only an inevitable trend in the innovative development of the construction industry, but also an important way to achieve green, low-carbon, and environmentally friendly buildings[2].

Digital architectural design can achieve precise simulation and optimization of building form, structure, function, and other aspects through the use of advanced computer technology and design software, greatly improving the scientific and rational nature of design[3]. The concept of sustainable development emphasizes reducing the negative impact of buildings on the environment and achieving harmonious coexistence between buildings and the environment through the use of energy-saving, environmentally friendly, and renewable materials and technologies throughout the entire lifecycle of buildings[4]. The aim of this study is to explore in depth the practices and cases of the integration of digital architectural design and sustainable development concepts. By analyzing the design process and implementation effects of specific projects, a feasible integration strategy and method will be summarized. This not only helps to promote technological innovation and green development in the construction industry, but also provides useful reference and guidance for other fields[5]. We believe that with the joint promotion of digital technology and sustainable development concepts, the future construction industry will present a more green, intelligent, and sustainable development trend.

  DOI: 10.25236/etmhs.2024.021

2. The application and advantages of digital architectural design in the field of architectural design

2.1. Application of digital architectural design in the field of architectural design

The application of digital architectural design in the field of architectural design is gradually becoming widespread and in-depth, and its powerful functions and unique advantages have brought unprecedented convenience and possibilities to architectural designers[6].

Digital architectural design achieves precise simulation and optimization of building form, structure, function, and other aspects through advanced computer technology and design software[7]. Designers can use 3D modeling software to create realistic virtual building models for comprehensive display and preview. This not only enables designers to better grasp design details, but also provides customers with a more intuitive and clear design display [8].

Digital architectural design can also achieve rapid iteration and optimization of design schemes [9]. Through simulation software, designers can design and compare multiple solutions for buildings, and find the optimal solution. This efficient design approach not only saves time and costs, but also improves the accuracy and reliability of the design [10].

Digital architectural design is also widely used in the creation and management of Building Information Modeling (BIM). BIM is a digital representation of building information that can integrate various information in building projects, such as structure, materials, equipment, construction, etc. Through BIM technology, designers can have a more comprehensive and in-depth understanding of various aspects of building projects, improving design coordination and consistency.

The application of digital architectural design in the field of architectural design has become increasingly widespread, and its powerful functions and unique advantages have brought great convenience and possibilities to architectural designers. In the future, with the continuous progress of technology and the expansion of applications, digital architectural design will play a more important role in the field of architectural design.

2.2. The advantages of digital architectural design in the field of architectural design

Digital architectural design has shown significant advantages in the field of architectural design, greatly improving the efficiency, quality, and innovation ability of design.

Digital architectural design can quickly generate multiple design schemes through high-precision simulation and calculation, and compare and evaluate them, greatly improving the efficiency of design. Designers can quickly adjust their design plans to meet customer needs and shorten project cycles.

Digital architectural design ensures high precision and quality in design. By utilizing advanced modeling software, designers can accurately control the size, shape, and material of buildings, reducing design errors. At the same time, digital tools can also simulate the performance of buildings in different environments, such as lighting, wind resistance, etc., to ensure the reliability and practicality of the design.

Digital architectural design promotes innovation in design. Designers can use digital tools to create unprecedented architectural forms and structures, breaking the limitations of traditional design. Digital design also encourages interdisciplinary collaboration, such as close collaboration with engineers, environmental experts, etc., to jointly create more environmentally friendly and intelligent building works. Table 1 clearly demonstrates the advantages of digital architectural design in the field of architectural design.

Table 1 Advantages of Digital Architectural Design in the Field of Architectural Design

Advantages	Concrete content	Impact on design	Other impacts
Design efficiency	High precision simulation and calculation, quickly generating multiple design solutions, and quickly adjusting to meet customer needs	Improve design efficiency and shorten project cycle	Quickly respond to market demand

Design quality	Accurately control the size, shape, and material of buildings, reduce design errors, and simulate the performance of buildings in different environments	Ensure the high precision and quality of the design, and ensure the reliability and practicality of the design	Improving Building Quality
Design innovation	Create unprecedented architectural forms and structures, break through traditional design limitations, and collaborate across disciplines (engineers, environmental experts, etc.)	Promote design innovation and expand design ideas	Creating environmentally friendly and intelligent building works

3. The embodiment of sustainable development concept in architectural design

The embodiment of sustainable development concept in architectural design deeply reflects the comprehensive consideration of environment, society, and economy. In the process of architectural design, the concept of sustainable development is fully reflected through multiple aspects.

In the selection of building materials, emphasis is placed on using renewable, recyclable, and low-energy materials to reduce excessive consumption of natural resources and environmental pollution. This choice not only reflects respect for environmental protection, but also provides a solid foundation for the long-term use of buildings.

Architects and engineers can integrate energy-saving technologies into architectural design, such as efficient and energy-saving insulation systems, natural lighting, and ventilation design, to reduce the building's dependence on energy during use, as well as to reduce energy consumption and carbon emissions. This not only helps to reduce energy consumption, but also provides users with a more comfortable and healthy living space.

Architectural design also emphasizes harmonious coexistence with the surrounding environment, by optimizing the building layout, reducing land occupation, increasing green area, etc., to enhance the integration between the building and the environment, and reduce the impact on the ecological environment. This design concept reflects respect and protection for the natural environment, as well as the beautiful vision of harmonious coexistence between architecture and nature. Table 2 clearly demonstrates the embodiment of sustainable development concepts in architectural design.

Table 2 The embodiment of sustainable development concept in architectural design

In terms of manifestation	Concrete measure	Environmental effect	Social and Economic Impact
Building materials	Renewable, recyclable, and low-energy materials	Reduce consumption of natural resources and environmental pollution	Provide a solid foundation for long-term use of buildings and reduce long-term maintenance costs
Energy saving technology	Efficient and energy-saving insulation system, natural lighting and ventilation design	Reduce energy consumption and carbon emissions	Provide comfortable and healthy living space, reduce energy costs
Environmental harmony	Optimize building layout, reduce land occupation, and increase green area	Enhance the integration between buildings and the environment, and reduce the impact on the ecological environment	Showcasing the vision of harmonious coexistence between architecture and nature, and improving the quality of community environment

4. Integration mechanism of digital architectural design and sustainable development concept

The integration mechanism of digital architectural design and sustainable development concepts reflects an innovative and forward-looking architectural development model. The core of this integration mechanism is to combine the precision and efficiency of digital technology with the

environmental and sustainable development, jointly promoting the progress of architectural design.

In the process of integration, digital technology provides strong technical support for sustainable development. Through advanced BIM technology, digital management of the entire lifecycle of buildings can be achieved, enabling more accurate assessment of their impact on the environment and optimization of building design solutions. At the same time, digital technology can also simulate the performance of buildings in different environments, providing designers with scientific decision-making basis, ensuring that buildings meet usage needs while minimizing negative impacts on the environment.

The concept of sustainable development provides important guidance for digital architectural design. In digital architectural design, it is necessary to fully consider factors such as environmental protection and energy efficiency of the building to ensure efficient resource utilization and environmental protection during use. At the same time, the concept of sustainable development also emphasizes the coordinated development of architecture, society, and economy, requiring digital architectural design to not only pursue technological innovation, but also pay attention to the sustainability of society and economy.

The integration mechanism of digital architectural design and sustainable development concepts, through a combination of technological innovation and conceptual guidance, jointly promotes the progress and development of architectural design.

5. Practice and case analysis

5.1. Case 1: Oasis smart complex

The Oasis Smart Complex is located in the core area of the city, aiming to create a green complex that integrates office, business, and leisure. Faced with increasingly serious urban environmental problems and resource shortages, this project has established green, low-carbon, and sustainable development goals from the beginning.

In this project, digital design tools have been widely applied. Through BIM technology, designers have established three-dimensional building models and accurately simulated every detail of the building. This simulation not only improves the accuracy of the design, but also makes the design process more efficient. Digital tools also assist designers in multiple scheme comparisons, ensuring the optimization of the final design solution. The concept of sustainable development runs through the design of oasis smart complexes. From building layout to material selection, and then to energy utilization, all reflect respect and protection for the environment. For example, the building has adopted large-scale green roofs and vertical greening, increasing the green area and improving the urban microclimate. At the same time, the building also fully utilizes renewable energy sources such as solar and wind energy, reducing reliance on traditional energy.

After practical operation, the Oasis Smart Complex has achieved significant results. The energy consumption of buildings is much lower than that of similar buildings, and the indoor environmental quality has also been greatly improved. This achievement has been widely recognized in the industry, setting a model for the promotion of green buildings.

5.2. Case 2: Cuilin ecological home

Cuilin Ecological Home is located in the suburbs, aiming to create a living environment that harmoniously coexists with nature. This project focuses on ecological protection and sustainable development, integrating ecological concepts into all aspects of residential design.

In the Cuilin Ecological Home, digital technology has played an important role. The designers used simulation software to comprehensively analyze the energy-saving performance of the building, ensuring that the building achieves optimal results in insulation, heat insulation, ventilation, and other aspects. In addition, digital technology also helps designers accurately monitor and manage the energy use of buildings, achieving efficient energy utilization. In terms of material selection, Cuilin Ecological Home insists on using renewable and recyclable building materials. These materials not only reduce the consumption of natural resources, but also reduce the

impact of buildings on the environment during production and use. At the same time, these materials also have good insulation and thermal performance, which helps to improve the energy-saving performance of buildings. The successful implementation of Cuilin Ecological Home not only provides residents with a comfortable and healthy living environment, but also enhances society's understanding of green buildings and sustainable development. The successful experience of this project provides useful reference and inspiration for the construction of other ecological residential projects.

6. Conclusions

The application of digital architectural design in the field of architectural design is becoming increasingly widespread and in-depth. With advanced computer technology and design software, it achieves precise simulation and optimization of building form, structure, and function, bringing unprecedented convenience and possibilities to designers. It not only improves the efficiency and accuracy of design, but also provides customers with a more intuitive and clear design presentation through rapid iteration and optimization. In addition, the integration of digital architectural design and sustainable development concepts has further promoted innovation and development in architectural design. By emphasizing the use of renewable and low-energy materials, integrating energy-saving technologies, and harmoniously coexisting with the environment, digital building design achieves respect and protection of the environment. At the same time, digital technology provides strong technical support for sustainable development, and through BIM technology, digital management of the entire lifecycle of buildings is achieved, providing designers with scientific decision-making basis. Therefore, the integration mechanism of digital architectural design and sustainable development concepts not only promotes innovation in architectural design, but also contributes an important force to achieving green, low-carbon, and sustainable urban development.

Acknowledgements

The authors acknowledge the Public Elective Course of Guangzhou Institute of Science and Technology - “Chinese Architecture History "(Grant: 2023XGXK006);The authors acknowledge the 2023 Campus level Education and Teaching Reform Project of Guangzhou Institute of Science and Technology - “Research on the Curriculum Reform of Civil Engineering Construction Technology Based on the "CDIO+PBL" Teaching Model "(Grant: 2023JG038).

References

[1] Goubran S, Cucuzzella C. Integrating the sustainable development goals in building projects[J]. Journal of sustainability research, 2019, 1(e190010): 1-43.

[2] Nguyen H D, Macchion L. A comprehensive risk assessment model based on a fuzzy synthetic evaluation approach for green building projects: the case of Vietnam[J]. Engineering, Construction and Architectural Management, 2023, 30(7): 2837-2861.

[3] Nguyen H D, Do Q N H, Macchion L. Influence of practitioners' characteristics on risk assessment in Green Building projects in emerging economies: a case of Vietnam[J]. Engineering, construction and architectural management, 2023, 30(2): 833-852.

[4] Tran Q, Huang D. Using PLS-SEM to analyze challenges hindering success of green building projects in Vietnam[J]. Journal of Economics and Development, 2022, 24(1): 47-64.

[5] Morrison N, Honegger L. The Promotion of Sustainable Development Principles Through the Design Review Process. The Case of the Cambridgeshire Quality Panel[J]. Planning Theory & Practice, 2022, 23(3): 329-348.

[6] Huo X, Yu A T W, Zezhou W, et al. Site planning and design of green residential building projects: case studies in China[J]. Engineering, Construction and Architectural Management, 2020,

27(2): 525-543.

[7] El-Shihy A A, Ezquiaga J M. Architectural design concept and guidelines for floating structures for tackling sea level rise impacts on Abu-Qir[J]. Alexandria Engineering Journal, 2019, 58(2): 507-518.

[8] Naqash M T, Alluqmani A E, Farooq Q U. A comparative analysis of design and analysis methods for steel connections: contrasting American and European perspectives[J]. Journal of Umm Al-Qura University for Engineering and Architecture, 2024, 15(1): 14-30.

[9] Lv M. HVAC Design Strategies for Municipal Waste Incineration Power Plants[J]. Journal of Architectural Research and Development, 2022, 6(2): 35-40.

[10] Simanjuntak J P, Anis S, Syamsiro M, et al. Thermal Energy Storage System from Household Wastes Combustion: System Design and Parameter Study[J]. Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, 2021, 80(2): 115-126.