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Application of Computer Aided Design Technology in Landscape Design

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Abstract: With the progress of human civilization, people's pursuit of beauty is increasing. The traditional landscape architecture design methods and layout can no longer meet the aesthetic needs of modern society. At the same time, with the increasing maturity of computer technology, the planning and design of landscape architecture is constantly intersecting with many related disciplines, which makes the integration of computer and landscape architecture planning and design more closely intertwined. This article points out the main application directions of computer-aided design (CAD) in landscape architecture and provides a construction plan of an ecological auxiliary system. CAD-based ecological environment analysis methods have been introduced in landscape planning, with meteorological simulation, wind environment simulation, light environment simulation, water environment simulation, and ecological environment simulation as research objects. In the efficiency data statistics of CAD in landscape architecture design, AutoCAD technology reduces the design cycle by 20% and improves design efficiency by 30%. Therefore, the narrow understanding of traditional landscape architecture design has been extended to computer-aided landscape architecture planning and design, which has important value for landscape architecture planning and design in China.

1. Introduction

In the design of modern landscape architecture, it is necessary to consider both the beauty of the landscape and the optimal utilization of resources within the region, as well as the impact of climate. CAD technology provides reliable information for designers in these aspects, making it easier for designers to carry out their designs. This is a further improvement on traditional landscape architecture design, while also enhancing the practicality of modern landscape architecture design.

This article first provides the exploration background of the application of CAD technology in landscape architecture design, and points out the shortcomings of modern CAD. Then the main application directions of CAD in landscape architecture design, including teaching landscape design courses and site selection for landscape architecture, are provided. Finally, further experimental exploration is conducted on the application of CAD technology in landscape architecture design.

2. Related Work

Landscape design is a discipline that studies the relationship between human living space and nature. Its connotation and extension have constantly changed with the development of history, and its scope has expanded from traditional methods of building pavilions and towers to broader fields. Li Hongyan combined the "New Agricultural Science" project with the construction of the "Landscape Architecture Design Course" to address the issue of only "instructions" and "operations" in the traditional teaching mode of "CAD drawing" practice, in order to achieve the goal of "diversified integration" in cultivating professional innovative talents [1]. Based on the essential characteristics of *Landscape CAD* and the training objectives of applied local colleges, Zhou Yang deeply analyzed the problems encountered in the teaching process of this course, in order to adapt to the cultivation of applied landscape architecture professionals in China [2]. Li Xiaomei combined CAD education in landscape architecture with professional learning and designed classroom teaching content reasonably [3]. Chen Xin believed that with the continuous innovation and development of computer technology, there were some new changes in landscape architecture design. By elaborating on the definition and functions of CAD software, the application of CAD software in the field of environmental design and its professional training mode were described [4]. Yan Pengfei proposed the concept of "ecological adaptation" design from the perspective of ecological environment protection in response to the problems in the construction of the city's landscape architecture, and applied it to the creation of the landscape architecture [5]. However, their research lacked the content of landscape architecture design and the techniques used were also limited.

Although there are many humanized methods in traditional landscape architecture design, there is a lack of consideration for physics in the design. Some landscape architecture has low stability due to uneven stress distribution and other reasons. When subjected to external forces such as natural disasters or construction, it may also be damaged to a certain extent, coupled with the neglect of local departments, resulting in many accidents [6]. Using CAD technology to detect it and providing corresponding improvement suggestions based on its mechanical characteristics can achieve the goal of improving the durability of landscape architecture buildings [7-8]. In addition, the floor plan of AudoCAD can help designers plan the entire garden. Before starting the work, designers can have a rough understanding of the overall situation of the project, and if any problems are encountered, they can quickly propose solutions.

3. Method

3.1 Main Application Directions of CAD in Landscape Architecture Design

CAD has broad application prospects in the field of landscape design. Firstly, in the teaching of landscape design courses, CAD is used as an auxiliary teaching tool. Through this approach, landscape design cases can be presented to students, enabling them to have a macro understanding of landscape architecture. The design ideas of industry experts can be interspersed in the teaching process, which can enrich the content of the course and enhance the learning interest of students. This enables students to proficiently master the computer technology required for landscape design, laying a solid industrial foundation for future work.

Proper research on site selection for landscape architecture is the primary step in landscape design practice. To make a good plan, it is necessary to have a comprehensive understanding of the site's condition, and to have a comprehensive understanding of various factors such as resource allocation, climate, environment, etc. When designing a landscape architecture, some elements need to be carefully grasped [9]. However, the designed target points may not be easily achievable, and a

single exploration cannot fully describe the full picture of the destination location. Before planning, referring to geographic information systems can make it easier and more direct to grasp the overall condition of the plot, providing a basis for the next evaluation and design. For drawing and manufacturing, drawing has always been a fundamental skill in landscape design. The original landscape design drawings are mostly manually drawn by designers, which not only consider whether the design is reasonable, but also ensure the accuracy of the information. At present, the graphic production of CAD has gradually become well-known to people. Computer drawing technology has solved the problem of inaccurate manual drawing, saving a lot of manpower and resources in the drawing process. Moreover, computer drawing can be more easily transmitted and saved, and has also been greatly improved in communication and other aspects.

Due to the development of computer graphics technology, computer application software has performed well in other aspects of landscape design. Usually, CAD is used to draw sketches, which are reviewed and then inputted into modeling software such as 3D models, making the planar design three-dimensional and reflecting materials and colors into the model. Lighting, scene simulation can all be completed through professional software.

3.2 Ecological Auxiliary System

With the continuous improvement of technology and environmental assessment systems, CAD-based ecological environment analysis methods have been introduced into landscape planning. This article focuses on several simulation environments, including meteorological simulation, wind environment simulation, light environment simulation, water environment simulation, and ecological environment simulation. Various simulation environments include rigorous data analysis and refined reference indices. For example, using database software, it is possible to simulate the surface temperature of building materials under daytime lighting conditions, and predict the temperature inside the building to select the optimal building materials.

Sustainable development is a development model widely recognized by countries around the world today. In landscape design, environmental ecology is an increasingly important topic [10-11]. By integrating environmental factors into the design process, it provides decision-making basis for design to minimize its impact on the environment. With the proposal of the concept of sustainable development in ecology, many universities have established majors in ecological sustainable development, providing strong support for the formulation of building energy conservation policies, the development of building energy conservation technologies, and the construction of major projects.

In terms of indoor wind environment simulation, probabilistic fluid dynamics models are used to numerically simulate the indoor wind environment and obtain the variation patterns of indoor wind speed and pressure parameters. Probabilistic fluid dynamics models are also used to numerically simulate the external wind environment of a building, and the distribution of wind speed and pressure on the surface of the building is obtained, providing a theoretical basis for the design of the building. In terms of water environment simulation, using computational fluid dynamics software to simulate rivers can obtain the variation patterns of river flow velocity and water depth. Fluid dynamics software is used to simulate the pollution and diffusion status of the environment, in order to achieve effective control of the environment. By using fluid dynamics technology, it is possible to simulate water features in landscape architecture, such as the distance at which flowing water falls [12]. Through the simulation system of light and thermal environment, the variation patterns of temperature and light can be obtained, providing reference for the planting and maintenance of plants in landscape architecture [13]. In the context of rapid urban development, the buildings in the city have also had a certain impact on the surrounding environment. On this basis, designers can

make more reasonable layouts for landscape architecture site selection based on the obtained urban environmental data, reducing the impact on the internal environment of the city.

The formula for calculating landscape architecture angles is:

$$\tan(\theta) = \text{opposite} / \text{adjacent} \tag{1}$$

In Formula (1), θ is the angle; opposite is the length of adjacent edges; adjacent is the length of the slanted edge. This formula can help designers determine the angle between two lines.

The formula for calculating arc length is:

$$s = \theta * r \tag{2}$$

In Formula (2), s is the arc length. This formula is used to calculate the length of an arc with a given center angle and radius, which can help designers make accurate calculations when planning the curve part in landscape architecture.

The formula for calculating area is:

$$A = \pi * r^2 \tag{3}$$

In Formula (3), A is the area; r is the radius. This formula is used to calculate the area of a circle and can help designers determine the size of circular areas in landscape architecture.

The formula for calculating volume is:

$$V = \pi * r^2 * h \tag{4}$$

In Formula (4), V is volume; h is height. This formula is used to calculate the volume of a cylinder and can help designers make precise calculations when planning water bodies or earthworks in landscape architecture.

3.3 Geographic Information Systems and Landscape Planning and Design

Geographic information system (GIS) is a comprehensive digital system that not only has the functions of data query and processing, but also includes remote sensing technology, allowing designers to obtain comprehensive environmental information at the landscape architecture construction site [14]. On this basis, designers can choose suitable landscape architecture plants according to their needs. By building a stable ecosystem, landscape architecture can enhance the ability to resist external disturbances and self-repair, thereby enriching the ecosystem. At the same time, remote sensing technology can also provide designers with parameters such as surface temperature, making the landscape architecture environment more in line with the local environment. The combination of remote sensing and ground measurement enhances the scientificity of the survey and the reliability and comparability of the results, facilitating the statistics and analysis of landscape data [15-16].

4. Results and Discussion

4.1 Cost and Benefits

The cost and benefits of CAD technology in landscape architecture design are shown in Table 1. The cost of technology import is 500,000 yuan, and the benefit is 2 million yuan. The cost of training is 200,000 yuan, and the benefit is 1 million yuan.

Table 1: Cost and benefits of CAD technology in landscape architecture design

Project	Cost (10000 yuan)	Benefit (10000 yuan)
Technology import	50	200
Training expenses	20	100
Software procurement costs	100	500
Total	170	800

4.2 Scoring of the Degree of Impact

The evaluation of the impact of CAD technology on landscape architecture design is shown in Table 2. The impact scoring of AutoCAD is 4.9 points, and the impact scoring of SketchUp is 4.7 points.

Table 2: Scoring of the impact of CAD technology on landscape architecture design

Technical name	Impact rating (out of 5)
AutoCAD	4.9
SketchUp	4.7
Adobe Photoshop	4.6
SolidWorks	4.2
Revit	4.1
SketchBook Pro	4.3

4.3 Efficiency Data Statistics

The efficiency data statistics of CAD in landscape architecture design are shown in Figure 1. The design cycle reduction ratio of AutoCAD technology is 20%, and the design efficiency improvement ratio is 30%. The SketchUp technology reduces the design cycle by 15% and improves design efficiency by 25%.

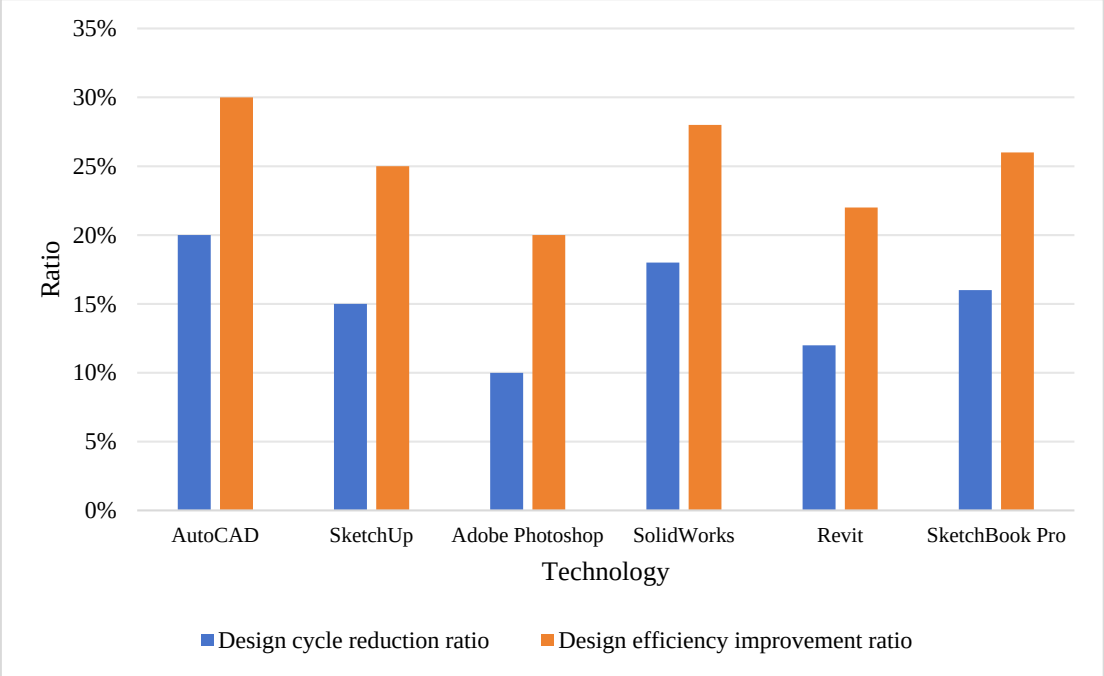

Figure 1: Efficiency data statistics of CAD in landscape architecture design

4.4 Precision, Accuracy, and Average Error

The proportion of improvement in precision and accuracy, as well as the reduction in average error, are shown in Figure 2. The average error of AutoCAD decreases by 1.5mm, while the average error of SketchUp decreases by 2.0mm.

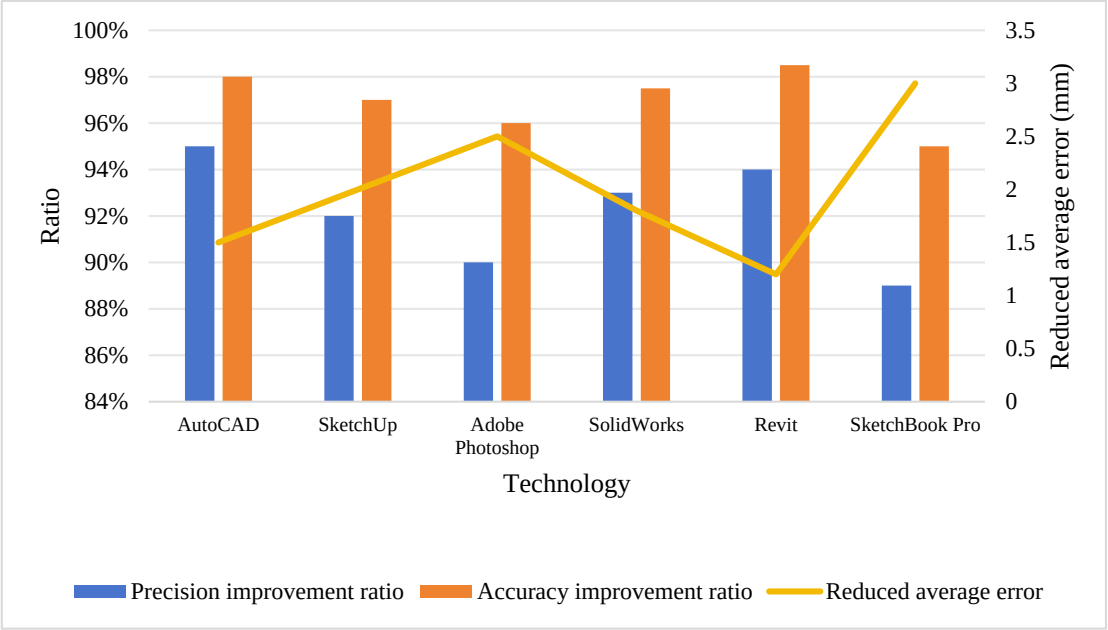

Figure 2: Precision and accuracy improvement ratio and average error reduction

4.5 Rating of Visual Effects and User Satisfaction

The visual effect rating and user satisfaction are shown in Figure 3. The visual effect score of AutoCAD is 8.5, and the user satisfaction is 95%. The visual effect score of SketchUp is 9.0, and user satisfaction is 98%.

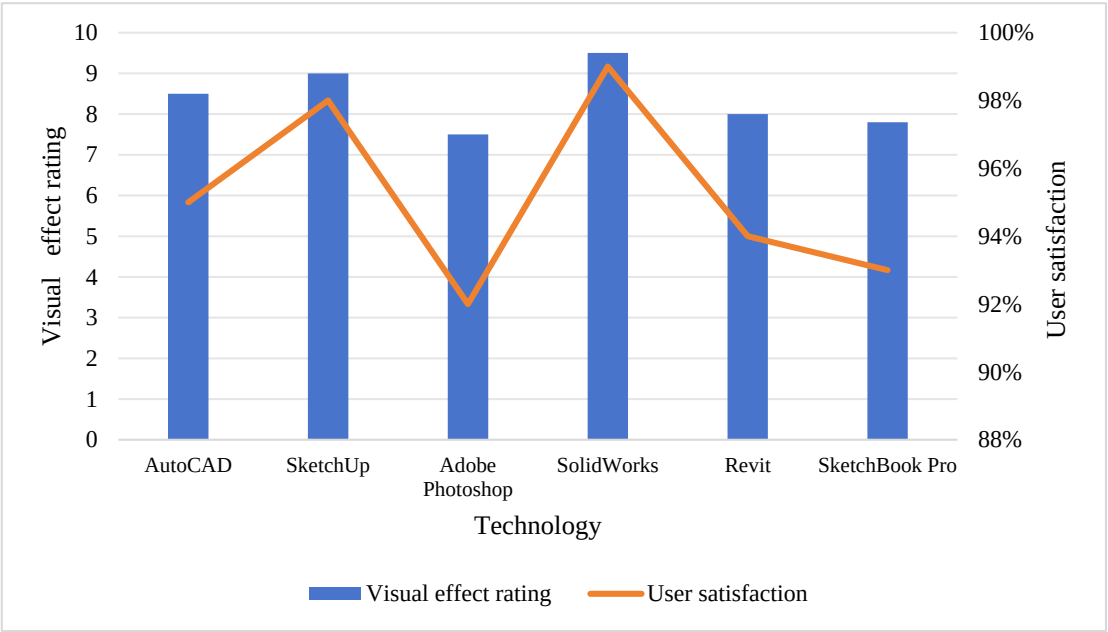

Figure 3: Rating of visual effects and user satisfaction

5. Conclusion

Landscape architecture is a process in which people combine nature with their living space. The combination of modern landscape architecture design and CAD not only creates a new discipline, but also organically combines tradition and modernity. This enhances the applicability and service of landscape design, not only bringing people leisure fun, but also making a certain contribution to modern urban construction. In the future, some computer software can be combined to further plan the landscape architecture, and it can also provide useful assistance for the planting and maintenance of plants in landscape architecture.

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