A REVIEW OF DIGITAL AND HAND-DRAWN RENDERING TECHNIQUES IN LANDSCAPE DESIGN: COMPARATIVE ANALYSIS OF EFFICIENCY, USABILITY, AND CREATIVE EXPRESSION

O ANALIZĂ A TEHNICILOR DE REDARE DIGITALĂ ŞI MANUALĂ ÎN PROIECTAREA PEISAGISTICĂ: ANALIZA COMPARATIVĂ A EFICIENȚEI, UTILIZABILITĂȚII ȘI EXPRESIEI CREATIVE

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Abstract.
This review examines the efficiency and user preferences of digital rendering software, Lumion® and Twinmotion®, in landscape design while considering traditional hand-drawn rendering. Rendering is crucial in visualizing landscape designs and transforming conceptual models into realistic representations. Lumion®, developed by Act-3D®, integrates seamlessly with CAD software and offers an extensive asset library, making it practical for large-scale projects. Twinmotion®, owned by Epic Games®, leverages gaming technology for real-time rendering and immersive experiences, including virtual reality. In contrast, though less efficient, hand-drawn rendering remains valued for its artistic expression and personal touch. This review highlights the strengths and limitations of each method in landscape design, focusing on user satisfaction and project efficiency.
Key words: rendering, visualization, efficiency, landscape design

Rezumat.
Această analiză examinează eficiența și preferințele utilizatorilor de software de randare digitală, Lumion® și Twinmotion®, în proiectarea peisagistică, luând în considerare, de asemenea, randarea tradițională desenată manual. In vizualizarea proiectelor peisagistice, randarea reprezinta un proces de bază prin care modelele conceptuale sunt transformate în reprezentări realiste. Lumion®, dezvoltat de Act-3D®, se integrează perfect cu software-ul CAD și oferă o bibliotecă extinsă de active, ceea ce îl face eficient pentru proiectele la scară largă. Twinmotion®, deținut de Epic Games®, valorifică tehnologia jocurilor pentru randare în timp real și experiențe captivante, inclusiv realitatea virtuală. În schimb, randarea desenată manual, deși mai puțin eficientă, rămâne apreciată pentru expresia sa artistică și pentru emoția pe care o transmite. Această analiză evidențiază punctele forte și limitele fiecărei metode în proiectarea peisagistică, concentrându-se pe satisfacția utilizatorului și pe eficiența proiectului.
Cuvinte cheie: randare, vizualizare, eficiență, proiectare peisagistică

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INTRODUCTION

Rendering is at the heart of landscape design. It is the process that allows designers to turn ideas into visual realities. Over the past decade, digital rendering tools have transformed the industry, making it easier and faster to create photorealistic images. However, hand-drawn renderings remain relevant because they allow designers to express themselves artistically in ways that digital tools sometimes cannot [Zhang & Wu, 2024].

The need for this research arises from the rapid development of digital rendering technologies, which are increasingly transforming the way landscape design is approached. Digital tools like Lumion® and Twinmotion® have become popular for their ability to produce highly detailed, realistic visualizations in a fraction of the time it would take to create hand-drawn designs. However, despite the efficiency of these digital tools, there remains a significant demand for artistic expression and personal creativity in landscape design, qualities often attributed to traditional hand-drawn techniques.

As landscape architecture continues to evolve, there is a gap in understanding the full impact of these two methods - digital versus hand-drawn - on the overall design process. Specifically, it is necessary to investigate how these tools affect efficiency and productivity, the creative process, and how designers express their visions.

This study explores and compares the effectiveness of digital rendering tools, such as Lumion® and Twinmotion®, with traditional hand-drawn rendering methods in landscape design. The study seeks to provide insights into the strengths and weaknesses of each approach, focusing on how they influence efficiency, usability, and creative expression.

MATERIAL AND METHOD

This review compares digital and hand-drawn rendering techniques in landscape design, focusing on two widely used software programs, Lumion® and Twinmotion®, and traditional hand-drawn methods.

Materials

The study utilizes the software Lumion® and Twinmotion®, both of which are widely used in landscape design due to their integration with CAD tools such as SketchUp®, AutoCAD®, and ArchiCAD®. Additionally, traditional hand-drawn rendering tools, such as pencils and markers, are considered for their role in the conceptual and detailed stages of landscape design.

Methods

The methods used in this review include a comparative analysis of the real-time rendering capabilities of Lumion® and Twinmotion®, focusing on performance metrics such as rendering speed, visual realism, and integration with CAD tools.

A literature review was conducted to gather existing research and case studies, exploring the technical capabilities of digital rendering tools and the creative advantages of traditional hand-drawn methods. Combining these approaches provides a comprehensive understanding of each rendering method's strengths and limitations in landscape design.

RESULTS AND DISCUSSIONS

Digital rendering: advantages and applications

The efficiency and accuracy offered by digital rendering tools, especially when integrated with CAD software, are significant. These tools enable the quick generation of 3D models, which improves the accuracy of designs and reduces the time needed for revisions [Yin & Yuan, 2024; Zang & Wu, 2024; Istrate *et al.*, 2023]. Rapidly adjusting and refining designs is a crucial advantage in large-scale landscape projects. Moreover, digital tools offer enhanced visualization through extensive libraries of pre-designed elements and realistic textures, which help communicate ideas more effectively to clients and stakeholders [Lallawmzuali & Pal, 2023].

A notable feature of digital tools like Lumion® and Twinmotion® is their integration with emerging technologies. Machine learning in CAD, for instance, optimizes the modeling process, ensuring that landscape designs align with functional requirements while maintaining aesthetic qualities. This technology integration enhances the technical side of landscape design and increases productivity by streamlining tasks that traditionally take much longer to complete manually [Lallawmzuali & Pal, 2023; Hangan *et al.*, 2023].

Hand-drawn rendering: artistic value and cultural significance

Despite the widespread use of digital rendering, hand-drawn techniques remain highly valued for their artistic qualities. Methods such as traditional Chinese ink painting can capture unique aesthetic characteristics that digital tools often struggle to replicate. This creative expression is significant in conveying emotional and cultural elements within a design [Li *et al.*, 2023].

Additionally, hand-drawn renderings carry significant cultural heritage. Many traditional design practices, passed down through generations, rely on manual techniques to convey a landscape's natural beauty and cultural context. These methods resonate with specific audiences, often preserving a personal touch that is sometimes lost in digital renderings. Given their cultural and artistic value, hand-drawn techniques continue to play a role in the early stages of landscape design, even as digital methods dominate the technical aspects of large-scale projects [Li *et al.*, 2023; Cojocariu *et al.*, 2023].

The role of rendering in landscape design

In landscape architecture, rendering is crucial for visualizing a project's spatial, aesthetic, and functional qualities. Whether using digital or hand-drawn methods, the aim is to create a realistic representation of the landscape concept. This visualization incorporates natural elements like terrain, vegetation, water, and lighting. These visualizations help designers communicate their ideas more effectively, ensuring clients, stakeholders, and construction teams understand the design vision [Ackerman *et al*., 2023; Coconu, 2008; Coconu *et al*., 2006].

Rendering also plays an essential role in improving communication between designers and clients and enables iterative design processes where feedback can be easily incorporated. Through this feedback loop, designs are refined and adapted to

meet specific needs and expectations, making rendering an essential step in ensuring that the final project aligns with the client's vision [Tarakci *et al.*, 2019].

Advanced visualization techniques

Recent advancements in digital rendering have further enhanced the design process. For example, GAN-based rendering (Generative Adversarial Networks) has been introduced to transform simple sketches into vibrant, color-rich designs, improving detail retention and speeding up the design process [Chen *et al*., 2024; Petrasova *et al.*, 2021]. This innovation is instrumental in urban landscape design, where time constraints often demand quick yet detailed visualizations.

Augmented reality (AR) also plays a growing role in landscape design. AR systems that utilize real-time ray tracing can reflect virtual models in physical environments, greatly enhancing communication between designers and clients by allowing them to experience the design within the real-world context. These technologies improve the accuracy of client feedback and provide immersive experiences that help bridge the gap between concept and reality [Chen *et al*., 2022; Shan & Sun, 2021].

Cultural and historical context in rendering

Another important consideration in landscape design is how cultural and historical contexts are represented. For example, non-photorealistic rendering (NPR) can effectively convey historical changes in landscapes. By utilizing more stylized, abstract renderings, designers can highlight the evolution of cultural heritage sites in ways that photorealistic images might not. This approach offers a more nuanced understanding of how landscapes have changed, making it particularly valuable in historical preservation projects [Ackerman *et al.,* 2023].

However, while these advanced techniques offer significant benefits, they also raise questions about the interpretation and accuracy of visualized landscapes. Especially in historical contexts, where some elements may rely on speculative or incomplete data, there is a risk that these renderings might inadvertently distort the viewer's perception of authenticity [Ackerman *et al.,* 2023].

Comparative analysis of digital rendering tools

In landscape design, two of the most popular digital rendering programs are Lumion® and Twinmotion®. Both are widely used for their ability to produce real-time rendering, allowing designers to visualize changes instantly and adjust their designs accordingly (Table 1).

Table 1

Comparison of Lumion® and Twinmotion® features

Feature	Lumion®	Twinmotion®
Integration with CAD tools	Excellent	Good
Real-time rendering	High performance	High performance
Asset library size	Extensive	Moderate
Virtual reality (VR) support	Limited	Excellent
Large-scale project support	Strong	Moderate

Lumion® is especially valuable for large-scale projects, where the integration with CAD programs like SketchUp® and AutoCAD® enables the efficient importation of complex models. Lumion® excels in creating detailed natural environments with a vast library of plants, trees, and water features, allowing landscape architects to build comprehensive visualizations quickly. However, some users report performance issues when working with larger models, especially when rendering higher resolutions [Ramdhaniati & Mulyanti, 2021; Yao, 2014].

Twinmotion®, which Epic Games® owns, distinguishes itself through its immersive and interactive features. It leverages Unreal Engine technology to create interactive walk-throughs, allowing clients to experience the design from within. While it may not have as extensive an asset library as Lumion®, Twinmotion® compensates with its focus on animations and virtual reality. This makes it particularly useful in projects where client presentations and interactivity are prioritized over detailed environmental simulations [Bordus, 2024; Lallawmzuali & Pal, 2023; Yao, 2014].

The relevance of hand-drawn rendering in modern practice

Despite the increasing dominance of digital tools, hand-drawn renderings are valued for their personal and expressive qualities. These drawings often serve as an essential step in the conceptual phase of a project, where ideas are still fluid and evolving. Sketching by hand encourages a deeper understanding of composition, proportion, and spatial relationships, resulting in images that evoke a more robust emotional response than many digital renderings [Luo *et al*., 2019].

In practice, many designers begin with hand-drawn sketches to develop the overall framework of their landscape designs before moving on to digital tools for more detailed and realistic visualizations (Figure 1). However, the main limitation of hand-drawn renderings is their time-consuming nature, especially when multiple revisions are necessary or when working with highly detailed projects [Corner, 1992].

Fig. 1. Workflow: from hand-drawn sketch to computer rendering

Artistic expression in landscape design

Hand-drawn sketches convey technical information and express the moods, atmospheres, and compositions envisioned by the designer. For example, Petra Blaisse's work [2022] highlights how collages and experimental drawing techniques

can offer a more intuitive and artistic approach to landscape design. Similarly, integrating artistic techniques, such as calligraphy or map art, enhances landscape architecture's educational and representational value [Eplényi & Oláh, 2011].

In contrast, NPR techniques in digital tools, like pen-and-ink illustrations, allow designers to simultaneously represent various aspects of a landscape. These stylized representations communicate complex environmental data in real-time, especially in interactive visualizations [Coconu *et al.,* 2006].

Combining traditional and digital techniques

A balanced approach to rendering in landscape design often involves combining traditional and digital techniques. Designers can begin with hand-drawn sketches to develop initial ideas and explore the creative aspects of their designs. Once the concept is finalized, digital tools like Lumion® or Twinmotion® can add realism, detail, and interactive elements, making the design more accessible to clients and stakeholders [Li *et al*., 2023].

This hybrid workflow allows designers to leverage the best qualities of both methods: the artistic freedom and personal touch of hand-drawn renderings combined with the efficiency and realism of digital tools [Kim *et al*., 2023].

CONCLUSIONS

Both digital and hand-drawn rendering methods have unique strengths and play essential roles in landscape design. Lumion® and Twinmotion® are powerful tools for creating realistic and immersive visualizations efficiently, with Lumion® excelling in detailed environmental features, while Twinmotion® offers a more interactive, client-focused presentation. Although digital methods are more efficient, hand-drawn rendering retains its value for artistic expression and the ability to communicate design ideas personally and evocatively.

The choice between digital and hand-drawn techniques depends on the project's specific needs, with hybrid approaches offering a balanced solution by combining the efficiency of digital tools with the creativity and flexibility of hand-drawn methods. Hand-drawn techniques remain valuable during the early conceptual phases, where artistic freedom is crucial in developing ideas.

This review represents the initial phase of a broader study. Based on the presented findings, a questionnaire will be developed to gather practical insights from landscape designers, assessing their preferences and experiences with digital and hand-drawn rendering methods. This subsequent step will provide empirical data to support the theoretical analysis further and contribute to a more comprehensive understanding of the best practices in landscape design rendering.

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