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The model as a medium for expressing the third dimension in the work of a landscape architect

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Patryk Czerwiński
https://orcid.org/0000-0001-8699-0727
patryk.czerwinski@pbs.edu.pl
Laboratory of Horticulture and Landscape Architecture, Departments of Biotechnology,
Bydgoszcz University of Science and Technology

Justyna Kadlec
justyna.kadlec@pbs.edu.pl
Department of Microbiology and Plant Ecology,
Bydgoszcz University of Science and Technology

Abstract: The model is one of the tools employed in the work of a landscape architect, enabling a three-dimensional representation of design assumptions. This article analyzes the role of the model as a means of expressing the third dimension, considering its application in design processes, educational contexts, and communication. Based on the conducted studies, it has been demonstrated that transforming flat 2D plans into a 3D spatial representation of a section of an urban residential area facilitates the intuitive understanding of the design by both professionals and laypersons. Particularly valuable is the ability to explore the model haptically, which intensifies the audience's emotional engagement and enhances their spatial perception. The process of constructing the model requires landscape architects to perform a detailed analysis of the site and to make deliberate design decisions, representing an active form of learning and iterative refinement of solutions. In the context of landscape architecture education, the model enables the visualization and critical evaluation of spatial scenarios, surpassing traditional drawings and digital 3D models in terms of the capacity for physically testing design concepts. Despite its significant advantages, such as affordability and relatively low production costs, constructing a model presents challenges. These include the time-consuming nature of the process, difficulties in accurately representing scaled details, and logistical limitations. Furthermore, the static nature of the model precludes dynamic modifications to the design, and photographic documentation of models does not match the aesthetic quality of digital 3D visualizations. The research findings confirm that the model serves as an effective communication platform between the designer and stakeholders, facilitating an understanding of the spatial context and the integration of artistic vision, scientific analysis, and design practice. The conclusions emphasize the value of models as tools that support multidimensional spatial thinking, making them an indispensable element in the landscape architect's toolkit.

Keywords: model, three-dimensional visualization, landscape architecture, spatial perception, design process, design communication

1. Introduction

Shaping space and planning the landscape are fields that merge aesthetics with functionality in designing the environment. Although plans and technical drawings provide detailed information about urban layouts, they do not always capture the full intent of the designer. It is only when they are supplemented with functional diagrams and cross-sections

that the spatial assumptions can be better understood. With the development of technology, creators have gained the ability to enhance their projects with computer visualizations and animations; however, the traditional model remains an indispensable tool. It enables a three-dimensional presentation of concepts, offering both designers and audiences a better understanding of spatial relationships and potential solutions (Lorens & Martyniuk-Pęczek, 2014, p. 45–46). In the field of landscape architecture, the designer must possess a range of skills that include the practical application of knowledge about natural, cultural, and social determinants, as well as the ability to solve engineering problems using natural science knowledge. Design support is crucial; however, during public consultations and communications with representatives of other industries, a model can be particularly helpful in better illustrating projects, including green areas (Wolski, 2007, p. 30; Gulczyńska, 2022, p. 172). Both digital and analog presentation forms have their unique advantages. Models offer tangible interaction and a realistic representation of details, which facilitates a better understanding of space, while digital visualizations provide specialized graphic effects and flexibility in modifications. The choice between them depends on the project goals and the preferences of the audience (Barełkowska, 2011, p. 188–189; Janusz, 2016, p. 38–41). This paper aims to highlight the importance of the model as a means of expressing the third dimension in the work of a landscape architect, emphasizing its role in the creative and communicative processes.

2. Literature review

The development of cities over the centuries reflects progress as well as changing needs and the aesthetics of societies. From the simple models and orthogonal urban plan schematics used in ancient cultures to the precise, large-scale urban compositions (Paszkowski, 2015, pp. 20–21). Initially, models were employed by ancient civilizations, such as the Inca, for precise planning in challenging topographic conditions. They evolved over the centuries alongside advances in techniques and materials (Słodczyk, 2012, p. 195). In the 19th century, construction sets, cardboard templates, and educational models enhanced the significance of models, laying the groundwork for the more advanced methods used in 20th-century design. The advent of technologies such as photography and offset printing in the 1920s enabled the presentation of models in publications and exhibitions, contributing to their popularization. Modernist architects, such as Walter Gropius and Mies van der Rohe, regarded them not only as visualization tools but also as means for spatial experimentation. In the latter half of the 20th century, models began to assume an increasingly important role in public consultations and as elements of resident participation in the design of public spaces. Simulation techniques, such as endoscopy, allowed for realistic, scaled representations of space, facilitating the analysis of proportions, visibility, and the integration of landscape elements. The history of models also encompasses their transformation from a practical tool to an object of art. The exhibition Idea as Model (1976) demonstrated that models can function as standalone works of art, underscoring their significance not only in architecture but also in visual culture. Contemporary developments have further evolved this practice. Digital models and 3D printing have opened new possibilities in design, blurring the boundaries between the model and the actual object. These changes highlight the enduring importance of models as design, educational, and artistic tools that continue to evolve in response to societal needs (Elser, 2014). Modern technologies such as artificial intelligence (AI), machine learning (ML), and natural language processing (NLP) are increasingly playing a key role in landscape design practice, assisting architects in data analysis and the creation of complex design models (Fernberg & Chamberlain, 2023).

The role of the model in the design process extends far beyond visualization. It becomes a platform for collaboration and communication between designers and local communities. Its visual form makes it possible to present complex design concepts in a more comprehensible way, thereby facilitating dialogue between designers and the public. Workshops that utilize models enable participants to better understand the complexity of the designed spaces and to propose their own solutions, contributing to the development of more responsive designs. This approach not only generates a rich array of ideas but also increases social acceptance of the project and fosters a sense of belonging to the space (Raszeja et al., 2020, p. 178). In spatial analysis, models allow for a detailed examination of proportions, visibility, and the integration of landscape elements. By involving communities in activities such as participatory design workshops or public consultations, it becomes possible to create spaces that genuinely meet users' needs (Iwuanyanwu et al., 2024, p. 1954). As these authors emphasize, an inclusive approach to design leads to more appropriate and sustainable solutions that account for social equality and the accessibility of space for diverse social groups. The appropriate presentation of the project is crucial because, despite the growing awareness of the role of green spaces in urban areas, the contemporary approach of decision-makers is still dominated by an economic perspective, limited to a cost-benefit balance (Szczepanowska, 2012, p. 45).

Figure 1. Design concept of an urban housing estate. *Source: Own elaboration*

3. Methods

3.1. Description of the Model-Making Process

The selection of materials for constructing the model depends on its intended purpose, scale, and the required level of detail. In the process of representing the design concept for a section of an urban housing estate, the base materials used were cardboard, paper, and acrylic glass, which are characterized by ease of handling and wide availability. These materials allowed for precise modelling of simple spatial elements and building details. The primary modelling

medium was desiccated plant material, used both in its natural form and after undergoing a dyeing process, which enabled an accurate depiction of the area's natural character. Various types of aggregates were also employed to supplement the composition and convey the textures of the terrain in close association with the vegetation. Additionally, ready-made modelling products made of plastics were incorporated to enrich the space with finer details. The processing of these materials required the use of scissors and modelling scalpels, while hot glue and spray adhesive were utilized for joining elements with plywood. The maintenance of the proportions of individual components was ensured by employing precise measuring tools, such as an extended ruler, a protractor, and a scale. The model was constructed at a scale of 1:100, a typical scale used in projects involving smaller objects or sections of the landscape, thereby allowing for an accurate reproduction of spatial details.

The process of depicting the building layout, transportation system, and both composed and natural vegetation on the model was based on a detailed design concept for the development of a section of an urban housing estate (Fig. 1). The work commenced with the transportation system, which was represented by thin layers of cardboard in various shades to symbolize roads, sidewalks, and plazas, thereby facilitating a clear depiction of the hierarchy of communication spaces. Subsequently, attention was directed to the buildings. The building layout was rendered through the precise arrangement of building masses made from cardboard, paper, and acrylic glass, taking into account proportions, dimensions, and the spatial relationships between the structures. The composed vegetation, including group arrangements, solitaires, and selected lawns, was crafted from desiccated plant materials often subjected to dyeing, which enabled a realistic reproduction of their shape, structure, and coloration. Natural vegetation was executed in a similar manner, with particular emphasis on the absence of a discernible compositional arrangement. The entire project was integrated into a harmonious composition of four urban quarters, considering the interrelationships among the constituent elements and their impact on the functionality and aesthetics of the housing estate.

3.2. Analysis of Model Photographs

The photographic documentation of the housing estate model was carried out using a variety of photographic techniques, enabling a comprehensive spatial and visual analysis of the project. Vertical, top-down shots, simulating an aerial view, allowed for the presentation of the entire spatial layout and composition of the analyzed area. This technique proved particularly useful in illustrating the spatial relationships between individual architectural and landscape elements. Photographs taken at horizon level enabled the observation of proportions and height differences among the architectural and natural elements, revealing their impact on the perception of space. Macro photography focused on the details of a selected quarter of the estate, allowing for a precise analysis of spatial configurations and the modelling materials employed. Additionally, landscape photographs in macro scale, captured using variable settings of perspective and depth of field, simulated a realistic landscape by showcasing the sense of depth through skillful framing with foreground objects. The entire photographic documentation was executed in natural lighting, which, due to its softness, minimized contrasts and shadows, thereby ensuring even illumination and a realistic representation of the model.

4. Results

4.1. The Model as a Tool for Presenting Three-Dimensional Views

The applied model-building technique allowed for a complete representation of the design concept assumptions (Fig. 2). Transforming the 2D plan layout into a three-dimensional spatial representation promotes intuitive understanding among a broad audience, including individuals outside the architectural field. The perception of space was further enhanced by the possibility of haptic exploration of the model, which significantly intensifies the viewers' emotional engagement. However, achieving this effect was associated with several challenges, primarily due to the time-consuming nature of the modelling process. The choice of a static model, lacking movable elements, limited the flexibility of the authors, preventing later corrections or modifications. In most cases, each step of the model-building process became final. A particular challenge was faithfully reproducing the details at scale, which required a precise approach and adjustments to the constraints related to transportation and storage. In the case of larger models, these aspects can become significant logistical issues.

Figure 2. Vertical aerial photograph of the spatial model and macro photographs of selected parts of the housing estate. *Source: Own elaboration*

Despite significant efforts to capture the content presented by the physical model through photography, the resulting visual quality is difficult to compare with that of real-time 3D digital presentations generated through rendering in advanced graphic software (Fig. 3). Photographs of an urban housing model may be perceived as less impressive and may fail to produce the intended visual impact, often referred to as the "wow effect." However, it is worth considering whether achieving such an effect should always be the primary objective. A clear advantage of photographic documentation is its relatively low cost, stemming from both the limited consumption of resources in the modeling process and the absence of the need for investment in high-performance computer hardware and expensive software

licenses. Another potential limitation of digital presentation methods is the lack of sufficient proficiency in using modern design tools, which poses a significant challenge given the rapid evolution of functions and technologies in software supporting digital project visualization.

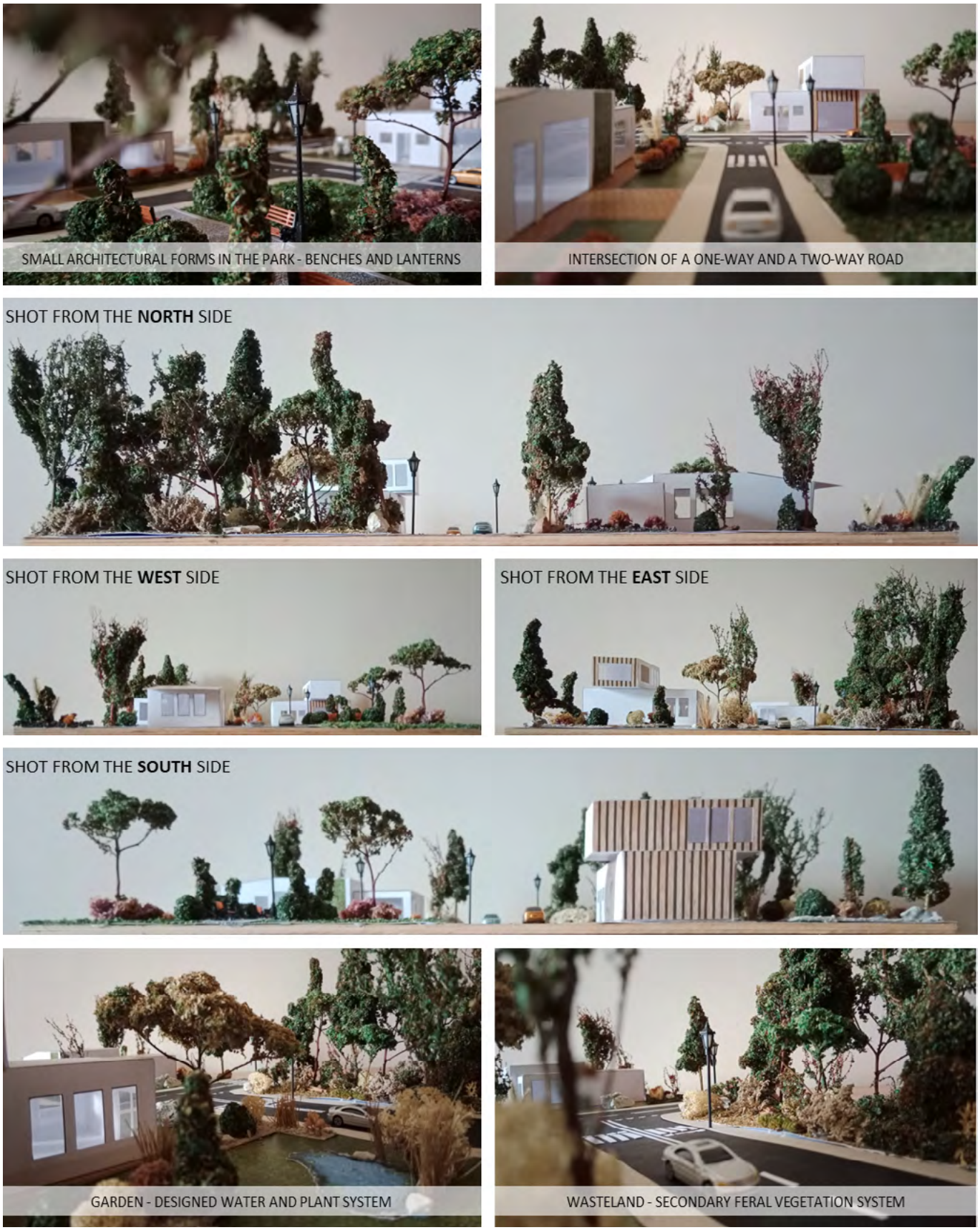

Figure 3. Shots taken on the horizon line and landscape shots on a macro scale. *Source: Own elaboration*

4.2. Didactic Value of the Model

The process of constructing the model required its creators to conduct a detailed site analysis and to make conscious design decisions while considering key aspects such as scale, proportions, and geometry in the context of potential spatial perception by viewers. This process constituted an active form of learning, engaging designers in an iterative cycle of designing, testing, and refining proposed solutions. Research has shown that, in educational practice, physical models play a crucial role in visualizing and testing spatial scenarios, enabling a critical assessment of the physical consequences of design decisions. This is a value that neither traditional drawings nor computer-generated 3D models can fully provide.

The urban housing model, serving as both an artistic and scientific medium, functioned as a communication platform between the designer and the observer. The three-dimensional representation of space proved to be more intuitive and accessible than flat plans or digital visualizations, as confirmed by the observations of the authors acting as curators during the ARCHITEKTURA KRAJOBRAZU exhibition held in 2024 at the Jan and Jędrzej Śniadecki Bydgoszcz University of Science and Technology (Fig. 4). Exhibition participants, while admiring the presented model, demonstrated that this tool not only supports the development of multidimensional spatial thinking, fundamental in landscape design, but also acts as a catalyst for dialogue, facilitating the audience's understanding of the spatial context and user needs.

Figure 4. Exposition of the model at the "ARCHITEKTURA KRAJOBRAZU" exhibition. *Source: Own elaboration*

As a result, the model became an element integrating artistic vision with practical design. According to the authors, it is one of the most valuable tools in the work of a landscape architect, enhancing communication among all stakeholders in the design process and improving the quality of final spatial solutions.

5. Discussion

The use of physical models plays a crucial role in the design process by enabling the creation of immersive environments that allow users to physically engage with the designed spaces. Research indicates that the closer a model is to a true-to-life scale, the better it supports co-creation and inspires users to generate innovative solutions. The potential of models in engaging stakeholders and adapting to their needs is confirmed by a study on the development of mobility stations in Nancy, northeastern France. Researchers emphasize the need for further studies on the role of models in various design contexts, particularly in the development of smart cities (Dupont et al., 2015). It is important to recognize that the cultural landscape is the result of the interrelationship between the natural environment and human activity. By adapting spaces to their needs, people modify their surroundings; however, at the same time, the characteristics of the landscape determine the scope of possible actions, influence the standard of living, and affect well-being and spatial perception (Juchacz et al., 2023, p. 117).

In Polish design practice, landscape architecture models are typically created on special request from investors. Such projects primarily involve public spaces, commissioned by local government authorities to facilitate public consultations, as well as promotional purposes in real estate developments. Contemporary approaches to modelling also incorporate new technologies such as 3D modelling and spatial printing, enhancing both their functionality and precision. Publications indicate that such innovations enable architects to present their visions more effectively and engage communities in decision-making processes (Żołnierczuk, 2016, p. 127). Community involvement in urban design plays a key role in shaping spaces that align with users' needs. The effectiveness of this engagement requires the application of diverse tools and methods that foster meaningful interaction and collaboration among stakeholders. One such tool highlighted by researchers is three-dimensional (3D) models, which play a significant role in visual communication. Through 3D models, abstract design concepts become more tangible and comprehensible, allowing participants to express more informed and thoughtful opinions. These tools not only enhance the efficiency of public consultations but also contribute to building consensus in design decision-making (Ha et al., 2024, p. 1958). It is worth noting that models displayed in storefronts or public spaces attract a significantly larger audience than traditional exhibitions in galleries or museums. Due to their physical form and location, models engage a broader public, inspiring discussions about architecture and urban planning (Urbanik, 2011, p. 51; Głaz, 2022, p. 51). The authors of this study reached similar conclusions during the LANDSCAPE ARCHITECTURE exhibition held in 2024 at the Jan and Jędrzej Śniadecki Bydgoszcz University of Science and Technology.

The growing popularity of graphic technologies and spatial visualization has led to an increasing use of specialized computer software in design-related education. Proficiency in working with two-dimensional (2D) and three-dimensional (3D) software, such as AutoCAD, Rhino, or SketchUp, enhances students' ability to visually represent and present their design ideas. However, it also comes with certain limitations. As noted by Ha et al. (2024), models displayed on a computer screen often fail to accurately convey scale and textures, making it more difficult to assess designs and identify their weaknesses. A valuable solution in the design process that allows for a more realistic representation of the environment is the use of VR technology, which integrates traditional model-making approaches with digital design environments. Similar to physical models, virtual reality (VR) proves beneficial in both education and design practice, enabling the effective application of theoretical knowledge in simulated conditions. This, in turn, supports more informed design decisions. There is no doubt that in the world of digital technologies, the physical model still holds its place and effectively competes with modern design tools (Swarabowicz, 2004, p. 86).

6. Conclusions

As a tool for expressing the third dimension, the physical model plays a multifaceted role in landscape architecture, combining presentation, educational, and communicative functions. The conducted research confirmed that constructing three-dimensional models enables an accurate representation of design concepts, offering an intuitive spatial perception for both professionals and non-specialists. A key advantage of physical models is the possibility of haptic exploration, which enhances the emotional engagement of viewers and supports the understanding of complex spatial arrangements.

However, the model-making process requires a significant investment of time, precision, and manual skills, which may limit its applicability in resource-constrained design environments. The static nature of a physical model restricts flexibility in making later modifications, while achieving high-detail accuracy poses substantial logistical challenges, particularly for large-scale models. Additionally, although photographic documentation of models is cost-effective, its visual impact is inferior to advanced digital presentations generated in real-time. Nevertheless, in the context of design practice, the technological accessibility and intuitive nature of physical models help balance these limitations.

The educational value of physical models has been clearly confirmed as a tool for developing critical spatial thinking and design skills. Their creation engages designers in iterative processes while also serving as a catalyst for dialogue between the creator and the audience, an essential factor in understanding spatial context and user needs. The three-dimensional representation proved to be more accessible and intuitive than traditional drawings or digital visualizations, as demonstrated by practical observations during the ARCHITEKTURA KRAJOBRAZU exhibition in 2024.

However, the authors recognize an urgent need for further research on physical models in the context of the rapid development of artificial intelligence (AI) technologies. AI tools, such as generative algorithms and machine learning systems, offer new possibilities for integrating traditional physical models with digital visualization techniques. Particularly promising is the application of AI for generating realistic visualizations based on photographs or physical models.

This hybrid approach could significantly enhance the communicative potential of physical models by combining their haptic accessibility with the dynamic visual effects characteristic of digital 3D models.

Moreover, the use of AI tools in spatial data analysis could support the automatic identification of key landscape composition elements and simulate interactions between designed structures and their environment. Such integration opens up new avenues for innovation in terms of efficiency, precision, and accessibility of design tools. Future research should focus on how AI can support design processes—not as a replacement for traditional modelling techniques but as an enhancement to them. A crucial question remains whether a symbiotic relationship can be established between the physical form of models and digital methods of generating and presenting design solutions.

In summary, physical models remain an irreplaceable tool in supporting both the design and educational processes in landscape architecture. At the same time, advancements in AI technologies present opportunities for expanding the capabilities of this tool, necessitating systematic research on new ways to integrate traditional and digital techniques within the field.

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Makieta jako środek wyrazu trzeciego wymiaru w pracy architekta krajobrazu

Streszczenie: Makieta jest jednym z narzędzi stosowanych w pracy architekta krajobrazu, umożliwiającym trójwymiarowe odwzorowanie założeń projektowych. Niniejszy artykuł analizuje rolę makiety jako środka wyrazu trzeciego wymiaru, uwzględniając jej zastosowanie w procesach projektowych, dydaktycznych oraz komunikacyjnych. Na podstawie przeprowadzonych badań wykazano, że transformacja płaskich planów 2D w przestrzenną reprezentację 3D fragmentu osiedla miejskiego sprzyja intuicyjnemu odbiorowi projektu zarówno przez specjalistów, jak i osoby spoza branży. Szczególną wartość stanowi możliwość eksploracji haptycznej makiety, która intensyfikuje emocjonalne zaangażowanie odbiorców i wzmacnia ich percepcję przestrzeni. Proces budowy makiety wymaga od architektów krajobrazu szczegółowej analizy miejsca oraz świadomego podejmowania decyzji projektowych, co stanowi aktywną formę nauki i iteracyjnego doskonalenia rozwiązań. W dydaktyce architektury krajobrazu makieta umożliwia wizualizację i krytyczną ocenę scenariuszy przestrzennych, przewyższając tradycyjne rysunki i cyfrowe modele 3D pod względem możliwości fizycznego testowania koncepcji. Pomimo istotnych zalet, takich jak przystępność i nie najwyższy koszt produkcji, budowa makiety wiąże się z wyzwaniami. Są to przede wszystkim czasochłonność procesu, trudności w odwzorowaniu detali w skali oraz ograniczenia logistyczne. Co więcej, statyczna forma makiety uniemożliwia dynamiczne modyfikacje projektu, a dokumentacja fotograficzna makiet nie dorównuje estetyce cyfrowych wizualizacji 3D. Wyniki badań potwierdzają, że makieta działa jako skuteczna platforma komunikacyjna między projektantem a interesariuszami, ułatwiając zrozumienie kontekstu przestrzennego i integrację wizji artystycznej, analizy naukowej oraz praktyki projektowej. Wnioski podkreślają wartość makiet jako narzędzia wspierającego wielowymiarowe myślenie przestrzenne, co czyni je niezastąpionym elementem warsztatu architekta krajobrazu.

Słowa kluczowe: makieta, trójwymiarowa wizualizacja, architektura krajobrazu, percepcja przestrzeni, proces projektowy, komunikacja projektowa