# The Impact of Digital Technology on Interior Design: Aesthetics Applications of Virtual Reality and Augmented Reality

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Abstract: This article discusses the impact of digital technology, especially Virtual Reality (VR) and Augmented Reality (AR), on interior design aesthetics. The industry of design has been transformed by VR and AR in the sense that clients can now be immersed in the walkthroughs, visualization, and experimentation of new designs in real time. These tools improve collaboration, cut down the time needed to make decisions, and even allow designers to be more creative. The paper highlights that VR allows such simulation in which clients can interact in an environment and make use of the spatial layouts and materials without having them actually built. Similarly, AR aids in the making of decisions and selections as it combines the facets of concept and reality and overlays digital elements into physical spaces. These advanced technologies make it possible to fuse cultural and personal aesthetics, creating ideal designs that are both meaningful and practical. The possible challenges, such as accessibility and cost, among others, appear not to be a hindrance to the greatest potential that VR and AR have in terms of interior design. Finally, this article also emphasizes the role of these digital tools in transforming the future of interior design where space, technology, and imagination allow one to create extraordinary spaces.
Keywords: Digital Technology in Interior Design, Virtual Reality, VR, Augmented Reality, AR

## 1. INTRODUCTION

Digital technology has evolved significantly over the years and this has affected how people in the creative industries approach their propositions. Of all the industries, interior design occupies one of the most major places since aesthetics is crucial in the field for creating useful and emotionally meaningful environments. Standard techniques of representing designs have progressively evolved and advanced technologies, such as Virtual Reality (VR) and Augmented Reality (AR), are becoming the new norm. The two emerging technologies, VR and AR, have brought drastic changes

in interior designing by allowing designers to visualize and improve the client's involvement, and develop creative approaches to aesthetics. These technologies enable the designers not only to 'draw' designs on paper as blueprints but also to make the spaces actually dynamic and interactive, which helps in taking the conceptual spaces to new heights of creativity and precision. The consequence of this shift is broad, affecting both design construction and the associated experience. This article explores the integration of digital technology in interior design, i.e., VR and AR, how they can be used, the part they play in shaping the aesthetics, and the difficulties inherent in implementing them. Studying these focuses on how these new technologies are changing the role of interior design in the future, matching innovation with the aesthetics of a place.

### 1.1 Evolution of Interior Design and Digital Technology

Interior design tools and technologies have come a long way over the years. This began with simple methods, like pencil sketches and drawing, but now has evolved to computer-aided design (CAD) software, 3D modeling software, and virtual reality (VR) and augmented reality (AR) tools. CAD is a popular technology that creates building models based on physical parameters. These models can be changed by changing the parameters that are needed. Before CAD software, interior designers made their plans with hand sketches, marker drafting, and manual drafting (Izani et al., 2022). In the 1980s, CAD software emerged, and by the 1990s, interior designers were using 2D and 3D modeling along with technical drawings and other spatial simulations (ARUMUGAVEL, 2018). There are numerous advancements that have shaped the digital and software tools for visualization within the realm of interior design. For instance, 3D visualization helps interior designers in presenting photorealistic 3D images and animation to clients during the early stages of design discussion (Rajab, Chaudhry, & Cherian, 2019). Manufacturers and suppliers of materials in the interior design area have further developed online shops to offer 3D visualization of their products, which will be useful to designers when choosing the material for their projects (Rajab, Chaudhry, & Cherian, 2019). Furthermore, constructive tools enable non-experts to edit data and images, therefore enabling designers to inspire further study of design principles and overcome obstacles to visualization creation (Méndez, 2018). The shift from 2D drafting and drawing to 3D modeling in interior design, as well as the use of immersive technologies, are being driven by advancements in CAD and VR technologies. Another key breakthrough has been the use of 3D computer modeling that extends design options

into a new dimension where designers can do parametric modeling, analysis, and visualization of their final design. Virtual reality technology helps designers decide the layout, colors, material, and lighting before the physical installation, saving them both time and money while also allowing a higher level of creativity during the design process. Combining virtual reality technology with 3D computer software has transformed the interior design sector and increased output and innovation, hence raising consumer satisfaction. Moreover, studies have found that the shift from 2D to 3D has also affected the early phases of the design process, with the development of new interaction techniques for the creation and manipulation of 3D shapes directly rather than merely relying on 2D sketching (Fleisch et al., 2004).

### 1.2 Virtual Reality in Interior Design

Virtual Reality (VR) is a high-tech application that utilizes 3D animation to simulate real-life scenarios and has a wide application in the field of interior design (Han, 2022). VR technology offers real-time experience of the design in a simulated 3D environment for the designers and users during the design process (Wang, 2023). It supports al-time rendering, and dynamic layout adjustment, as well as the integration of virtual and real space, enhancing design efficiency, users' satisfaction, and overall creativity (Wang, 2023). Research shows that over 50% of participants discovered VR technology to be highly beneficial for interior design, while more than 80% of the participants had some knowledge about its application in the entertainment industry but not as much about interior design (Han, 2022). Another study shows a large number of participants claiming VR to feel like a real-life experience and would prefer buying a house if offered a prior VR tour of the place (Ozacar et al., 2017).

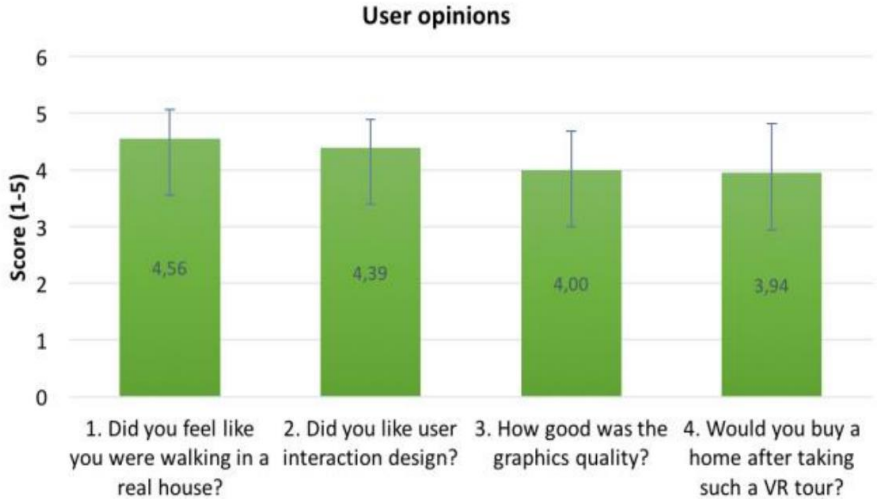



**Figure 1:** Users' Score Regarding VR Real-Estate Interaction (Ozacar et al., 2017)

## 2. APPLICATIONS IN INTERIOR DESIGN

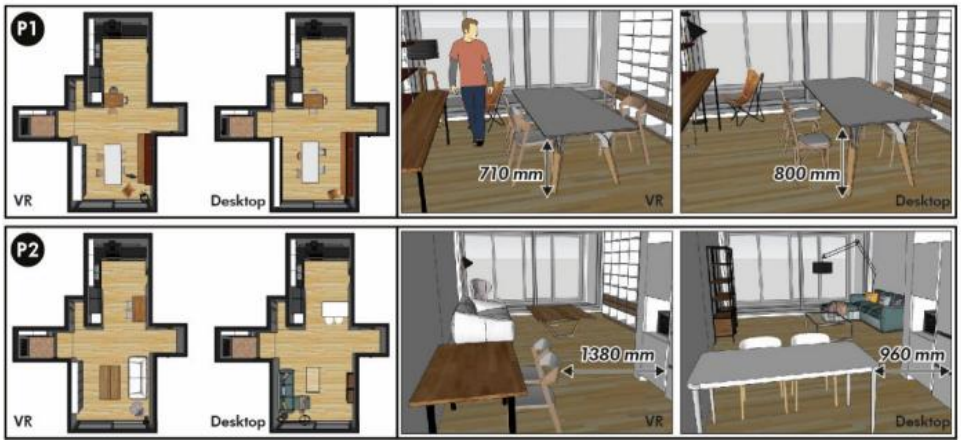
Virtual Reality (VR) has positively impacted interior design by enabling more immersive and interactive experiences, making the overall design process more focused on the client. Some of its most promising uses are immersive walkthroughs and testing spatial layouts and materials.

### 2.1 Immersive Walkthroughs for Clients

Virtual Reality lets designers create life-like, 3D virtual environments through which clients can walk and move around as if they are actually within the space. Through this application, clients can explore the proposed design before the physical layout is built, offering an understanding of the design, furniture, and even the ambiance. Traditional approaches to visualizing a design include 2D drawings or a static 3D model, whereas VR walkthroughs provide the client with several aspects of the design at once, allowing them to move through the rooms and spaces and engage with the elements within it. This immersive experience aids the clients in visualizing the final result, helping in improved decision-making and reducing the number of revisions needed.

### 2.2 Experimentation with Spatial Layouts and Materials

VR can also conceptualize spatial arrangements and material choices in a real-time environment. Designers can test mock-ups of different furniture placements, walls, and lighting structures to make sure the space is used optimally. Furthermore, with VR, it is possible to present how the materials would feel and look like, i.e., aspects that are not easy to express through traditional renders. This ability to see and change details on the spot underlines the way that creativity can be immediately improved to meet the client's preferences and expectations.



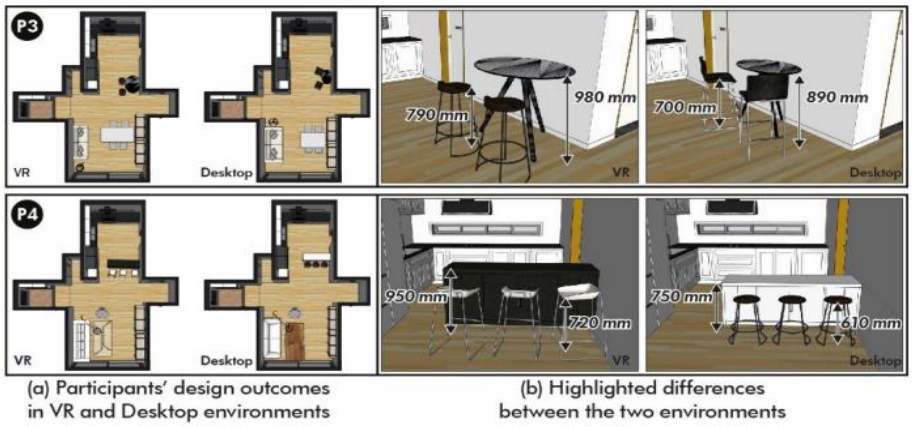



**Figure 2:** Design Outcome from the Experiment Participants (Kim & Hyun, 2022)

2.3 Impact on design process efficiency and client engagement.

The application of Virtual Reality (VR) has a great influence on increasing the efficiency of the design process, especially when it comes to client interaction. According to studies by Lei and Juan, Chi, & Chen, the use of VR in interior design can (Juan, Chi, & Chen, 2021; Lei, 2024):

- Make the design process more realistic, which will improve its communication efficiency and speed of making decisions.
- Allow users to experience the design in real time within the virtual environment, offering an immersive and interactive experience.
- Support users to make changes within the layout in a real-time manner using gesture recognition, therefore allowing the users to be more involved in the design process.
- Allow users to see how the design will look in real life by combining virtual furniture and design elements with the real space. This will make communication between the designers and the clients more accurate and visual.

Moreover, Krinizki et al., established that by using VR, clients may have deeper interaction with the interior designers, particularly where spaces and objects are intricate and unfamiliar to the clients since the technology increases confidence among non-specialists regarding spatial measurements (Krinizki et al., 2021).

## 3. AUGMENTED REALITY IN INTERIOR DESIGN

Augmented Reality (AR) is a technology that allows a user to map a real environment and place virtual items within it, thereby designing an overlap of cognitive and perceptive channels between the real and the simulated

elements (Amor, 2013). Hence, AR enables the users to delineate relevant spaces and place virtual objects such as furniture and ornaments, among others, thus making it a great reality interior design tool that is linked to the real environment (Amor, 2013). A significant number of studies have demonstrated that the application of augmented reality technology has numerous benefits in the context of interior designing. For instance, it provides an intuitive approach in that the end-users can view and interact with 3D virtual objects and furniture (Phan & Choo, 2010). It also enables users to change the attributes of virtual furniture, thanks to occlusion interactions in a Tangible Augmented Reality experience (Phan & Choo, 2010).

It can be noted that Augmented Reality is changing the interior design sphere in a revolutionary way as it offers potential clients the knowledge of how a certain item of decor or a piece of furniture will look in their space. For instance, the IKEA Place app allows the user to virtually place IKEA products into a home environment and see if the items match the layouts and general appearance of the space. Likewise, Houzz AR provides the feature of 'View in My Room' that helps people explore how they might place furniture, lights, and décor items in their room. Both these apps offer accurate scaling and life-like projection to help in improved decision-making. Other tools include Wayfair AR and Planner 5D AR, which increase the comfort and imagination of a user while deciding on a customized interior design.

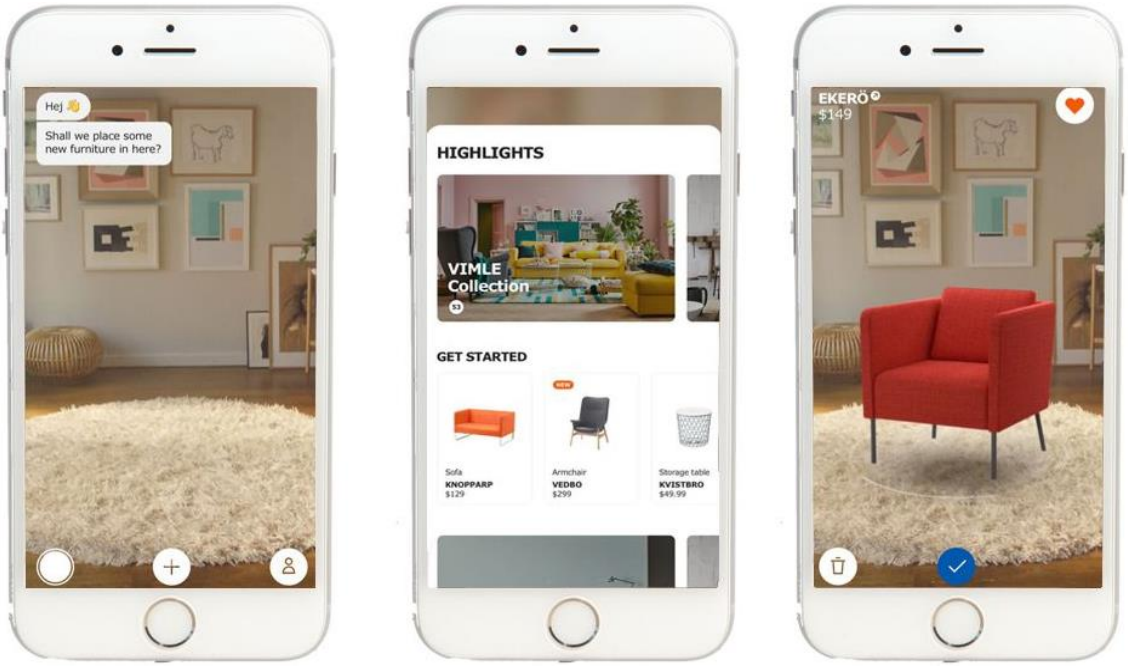



**Figure 3:** IKEA Space App

## 4. APPLICATIONS IN INTERIOR DESIGN

The usage of Augmented Reality has made a significant impact within the field of interior design since designers and clients can now visualize furniture and other elements in real settings. Two noteworthy uses of the technology are real-time first visualization of furniture and décor in real spaces and improving on-site decision-making.

### 4.1 Real-Time Visualization of Furniture and Décor

Through the use of smartphones and AR glasses, users are able to place furniture and décor items as if they present are in real life. Services such as IKEA Place and Houzz AR let app users know how some product of interest is likely to look in the real space as a way of driving the purchase intention. This technology is useful to determine the size and style of objects in proportion to that of the rooms so that clients do not have issues with size, color, or style differences. Moreover, it grants designers the ability to present several designs at once instead of physical models, thereby reducing the time and costs required to design the specific object.

### 4.2 Enhancing On-Site Decision-Making

AR apps also support decision-making at the site level by giving real-time visual feedback when designing and installing structures. Interior designers can use AR to position digital models of furniture, fixtures, and other architectural items within a real room to experiment with their alignment. For instance, in a renovation project, AR tools allow for confirmation with current building plans of how a proposed element, such as a partition wall or lighting design, will fit. These make real-time operations extremely useful as they eliminate any chances of errors and unnecessary reworking, thus increasing productivity.

### 4.3 Influence on Consumer Experience and Design Customization.

AR has an increasingly considerable impact on consumer experience and design personalization in terms of interior design. Studies by Zhang et al., Vieira, Rafael, & Agnihotri; and Turner et al., show that incorporating AR in interior design has enhanced client experience in the following ways (Turner & Welch, 2019; Vieira, Rafael, & Agnihotri, 2022; Zhang et al., 2023);

1. The application of AR in interior design will enhance the perceived elegance and space experience and facilitate consumers' interaction with

the products.

2. Adding AR to interior design can make the process seem more fun, useful, informative, and aesthetically pleasing, which can lead to higher satisfaction and willingness to purchase.

3. Using AR in interior design can lead to more personalized and customized designs. This is because users can be more involved in the design process, giving them more control over the experience and satisfaction with it.

Additionally, as research highlights, the level of immersion and presence that Augmented reality brings to the client can also influence the levels of satisfaction with the co-design efforts. Some other aspects that can promote perceived value through the AR co-design experience include flow, information-seeking, novelty, enjoyment, and personalization (tom Dieck et al., 2023).

### 4.4 Aesthetic Transformations through VR and AR

Design visualization, particularly in the AR and VR spaces, is now regarded as a crucial aspect of the interior design process. The infusion of these technologies has facilitated visual communication between the clients and the designers. The clients themselves can understand the intention of a designer and include the final designs in their living spaces (Lee et al., 2023). AR helps designers in recreating real interiors and positioning virtual furniture and other design elements in a particular space; therefore, the work provides essentials of 'what you see is what you get' kind of interaction with the clients (Amor, 2013). With VR, the user gets a fully immersive first-person experience of the space from a 360-degree virtual headset, with tracking ability for the user's movement (Lee et al., 2023). Utilizing both AR and VR features, the "Augmented Virtual Reality (AVR)" concept can offer users the highest level of realism and immersion, adapting to location and environmental factors like lighting and material to make the design process easier and include them in the decision-making process (Lee et al., 2023). Using AR and VR technologies, interior designers have a golden chance to design not only traditional but unique and avant-garde design models as well. With these tools, designers can test out risky ideas in terms of location and material, as well as look into other possibilities, like new plans, cutting-edge materials, or changing lighting, without being limited by any physical barriers. Virtual reality (VR) lets designers create immersive virtual environments where they can test and improve new designs. For example, designers can use VR to imagine future

interiors with organic, flowing patterns or places that can be used for different things with parts that can be changed. Clients can then virtually walk through these designs and see and feel the space for themselves. AR, on the other hand, assists interior designers by overlaying unique virtual design elements over the actual real-world environments to let the designers and clients see how exactly will they look and feel in the real space.

In the field of interior design, innovation is fostered by expanding the bounds of traditional designing, encouraging creativity, and allowing the risk-free investigation of bold alternatives. These technologies also help designers in developing transformative simulations for the integration of cultural and personal aesthetics in interiors. These tools enable the creation of patterns, colors, as well as architectures from various cultures and their integration based on clients' choices and preferences. For instance, with VR, it is possible to show how such aspects as Moroccan tiles, Japanese minimalism, or Indian textiles may be implemented in the design. Clients can hence get to experience how the combinations may look in real life and how such cultural aesthetics may serve to improve the vision. This can then be personalized by AR by superimposing the said cultural transformation overlays into real spaces to demonstrate how the elements fit into the space. For instance, a client can visualize a modern living room with traditional motifs added to the furniture and ornaments, or simply as wall art. Designing settings with culturally affirming and personal importance is made possible by these adaptive simulations, which place an emphasis on celebrating both individual and cultural preferences.

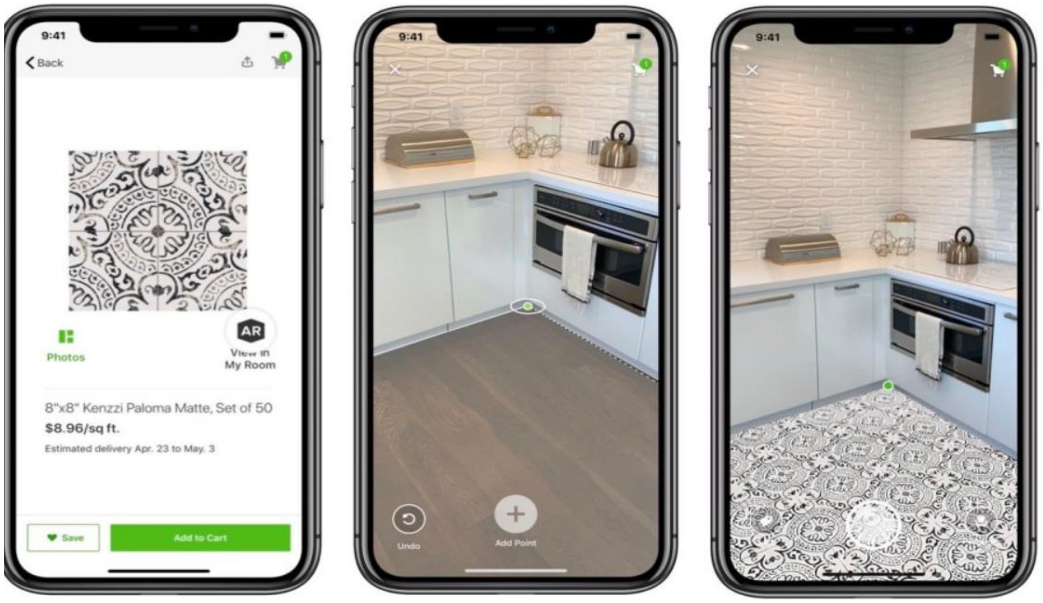



**Figure 4:** AR feature of the Houzz App

## 5. CHALLENGES AND LIMITATIONS

While many positive aspects of these two technologies are already visible, some issues and restrictions associated with the implementation of augmented and virtual reality tools concerning interior design also exist. Cost and availability issues with AR and VR equipment are among the biggest challenges facing the implementation of these technologies. Most designers do not have the ability or the means to acquire devices such as VR headsets and content systems, making them impractical in the field of interior designing. Thus, the use of these tools has been hampered in developing nations as well as in areas with low resources (ManiMekalai et al., 2024). Furthermore, there are certain criteria that the existing AR/VR authoring programs fail to satisfy. More significantly, they were not intended to be as user-friendly as anticipated for designers and clients (Nebeling & Speicher, 2018). Newer interfaces and affordable VR headset technology, as well as inclusive participatory content creation techniques, may help address these problems (ManiMekalai et al., 2024). Another main issue is that, if interior designers lack expertise with more advanced technology tools, they might struggle to apply these technologies correctly. Extensive coding is needed to operate AR and VR tools, as they are not user-friendly for designers or clients who do not have adequate tech skills (Nebeling & Speicher, 2018). All of this makes AR and VR prototyping difficult to use and implement. Designers and clients also can't use these technologies because of the rapid hardware changes, as well as AR/VR teams being made up of people from different fields, and the lack of any clear standards or best practices for the application (Krauß et al., 2021). To get around these problems, researchers are planning to make simpler tools and methods for clients and designers who don't know much about tech, like ones that can be used with gestures and make quick prototypes (Ho, 2017).

## 6. CONCLUSION

There is no doubt that Virtual Reality (VR) and Augmented Reality (AR) have made interior design better, in terms of both space and function. The technology has allowed designers to visualize, plan, and model one-of-a-kind experiences that are pleasing to the eyes and mind, both in terms of creativity and innovation. There's no denying that there are constraints, be it the cost or accessibility of the technologies, but VR and AR have

significant potential for revolutionizing the industry for the better. As digital technology keeps on growing and advancing, its application in interior space design will grow as well, opening windows for enhanced creativity and accuracy. This, however, demands caution as this development should ensure that technological devices complement the creativity aspect and do not become the core focus. If VR and AR are used responsibly, the industry has a bright future with its application as it will bring together aesthetics, practicality, and emotions, hinting to a time when design will truly resonate with the problems and desires of its users.

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