WE[AR] – Dynamic Interaction in Public Spaces Using AR/MR

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Abstract: The integration of Mixed Reality (MR) in public spaces offers transformative opportunities for designers and visitors, particularly in enhancing engagement and interaction. This pilot project investigates the creation of a dynamic, interactive platform accessible to the public, in collaboration with technology specialists. The study illustrates how virtual environments can be strategically utilized and provides a framework for landscape architects to create their own tools tailored for specific projects.

Keywords: Augmented Reality, mixed reality, public art installation

1 Introduction

Public art installations can present metaphors, stories, analogies, and visual imagery that evoke deep emotional reactions and cultivate individual experiences. These projects have the potential to convey messages succinctly, adapt information to local contexts, and introduce diverse methods of understanding through kinaesthetic and sensory engagements (BONNEMAISON & EISENBACH 2009). This pilot study explores the idea of dynamic interactions in public spaces through the implementation of an interactive augmented reality public art installation. Dynamic interaction, at its core, refers to the ever-evolving engagement between users and digital interfaces, driven by real-time user inputs and system responses (DIX 2009). WE[AR] was one of the winners of a public art installation competition in 2023 and is the first-ever virtual installation in this annual competition.

Within the context of the "WE[AR]" project, dynamic interaction transcends mere interactivity by creating an ecosystem wherein user engagement directly shapes the visual and thematic representation of the installation. This symbiotic relationship is emblematic of modern digital interface paradigms where systems are not static but instead fluidly adapt based on user behavior and feedback (BENYON 2013). Such interactions are not just confined to the user-system duality but expand to facilitate dialogues between individual users, forging communal experiences and shared narratives (HORNECKER & BUUR 2006). By harnessing the potentials of augmented reality in "WE[AR]", the project accentuates the centrality of users, positioning them as co-creators and emphasizing the importance of collective participation in shaping digital landscapes and discourses.

1.1 Why AR/MR and not VR

In order to ascertain the optimal immersive environment, it was imperative to acquire a comprehensive understanding of the definitions and characteristics of immersive environments (Fig. 1).

Augmented Reality (AR): AR combines real and virtual elements, overlaying virtual images onto real environments, allowing users to see the real world enhanced with computer-generated information (KERR & LAWSON 2020). This technology creates interactive 3D experiences anchored in the physical environment and uses sensing devices for realistic virtual representations (MARTENS & BROWN 2005).

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Virtual Reality (VR): VR creates a computer-generated environment that simulates physical reality, offering sensory experiences through hardware like head-mounted displays. It is especially useful in architecture for surpassing traditional representation limitations, enhancing imagination and addressing complex challenges (PORTMAN et al. 2015).

Mixed Reality (MR): MR is a technology that seamlessly integrates the physical and digital worlds, creating environments where real and virtual elements coexist and interact dynamically (ZHAO et al. 2022) MR allows users to see, interact with, and manipulate both physical and digital objects in a shared space, offering a more immersive experience than traditional augmented reality (AR). Its applications are diverse, ranging from enhancing training and education to transforming design and manufacturing processes. The technology has been evolving rapidly, with recent developments focusing on improving interactivity and user immersion (KRESS & CUMMINGS 2021).

Extended Reality (XR): XR encompasses VR, AR, and MR, merging real and virtual worlds to enhance user interaction and experience (GOWNDER et al. 2016). It is facilitated through devices like HMDs and applies to multiple fields, improving spatial learning and potentially reducing cognitive load. XR's scope includes architecture, medicine, entertainment, and more (DARWISH et al. 2023).

MR at its core is the interactive version of AR. The decision to employ Interactive Augmented Reality or MR instead of Virtual Reality for the “WE[AR]” project was rooted in the intrinsic benefits AR offers in terms of blending digital elements with the real-world environment. AR allows for greater social interactivity, permitting multiple users to simultaneously engage with the digital content while still being aware of and interacting with one another, thereby fostering a collective experience (BILLINGHURST & KATO, 2002). Hence, the utilization of Interactive AR or MR was a strategic choice to enhance contextual relevance and foster collective engagement in public spaces.

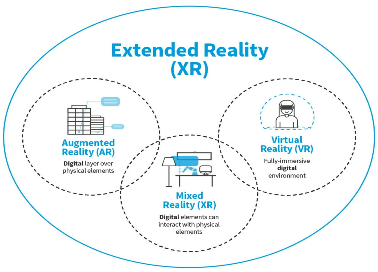

Fig. 1:
Representation of current XR technologies according to the spectrum of immersion (Tremosa 2017)

In recent years, augmented reality (AR) in public spaces has gained significant traction, illustrated by projects such as “Rain Room” by Random International (THE MUSEUM OF MODERN ART n. d.) and “Terracotta Warrior” AR experience (YETZER STUDIO 2024). These initiatives highlight AR's potential in enhancing public interaction and engagement. However, a common challenge faced by these projects, similar to “WE[AR],” is balancing immersive experience with technological constraints. The workflow for “WE[AR]” followed a structured approach: concept development, design and simulation in Unity, user experience testing, and finally, implementation. This workflow mirrors that of the “BMW Museum App” which also utilized Unity, for AR content creation and experienced similar stages of development. Unity is a versatile game development platform used for creating video games, simulations, and other interactive 3D and 2D content across multiple platforms.

2 Research Objectives

This research explored the capabilities and implications of dynamic public art installations, especially their role as an innovative platform for promoting conversation and interaction within the wider community.

3 Method

This study aimed to develop a systematic approach for the design of tools specifically tailored for public space design and landscape architecture. The project was an interdisciplinary collaboration, involving a team of landscape designers and technology specialists.

3.1 Concept

The installation's form, responding to the theme of 'Radiance: the quality or state of being radiant', represents an artistic interpretation aimed at fostering community engagement in public spaces. This project, accessible globally via a QR code, introduced an innovative method for public interaction and sought to showcase the power of unity in tackling social challenges.

3.2 Design Process

3.2.1 Form-Making

An algorithm was developed and employed in a Grasshopper plugin to translate the concept to a form. The choice to incorporate a parametric design approach in "WE[AR]" stemmed from the desire to infuse flexibility, adaptability, and a level of unpredictability that reflects the dynamism of human interactions and the challenges of the societal challenges it addresses. For instance, as visitors interacted with the installation, the intensity, colour, and patterns of the "Radiance" theme could evolve, representing the collective mood and sentiments of the audience. Designing in an immersive environment can diminish the limitations of construction and manifests visual transformations in real time. Such designs offer a continuous feedback loop between the users and the installation, ensuring that the art is not just representative but also reactive (MENGES & AHLQUIST 2011).

3.2.2 Scenario Development in Interactive Augmented Reality (Mixed Reality)

The augmentation of reality in the "WE[AR]" project was not merely about superimposing digital visuals onto a physical world, but about creating an interactive intertwining of real-world context and curated digital content. The design process commenced in Unity, a leading platform for creating interactive, real-time content. Multiple interactive scenarios were generated, each portraying different user interactions and experiences with the virtual installation. This iterative approach allowed for diverse simulations, ensuring the most engaging and fluid user experience was selected by the design team and developers.

3.2.3 User Experience Simulation

In this phase, the team explored how users would navigate, engage with, and perceive the virtual installation. This phase offered insights, allowing the team to refine scenarios, debug errors, and enhance usability.

3.2.4 Embracing Dynamic Interactivity& Design Adaptability

Static public art, once constructed, offers limited scope for change. In contrast, the virtual domain of "WE[AR]" provided leeway for swift design iterations, making it adaptable and more receptive to user feedback and interaction nuances. This dynamic nature was pivotal, as it meant that the installation could morph and adapt in real-time based on user interactions.

3.3 App Development

Specialized AR goggles or hardware can be expensive and are not always readily available to the average person. In contrast, developing an app is more cost-effective, ensuring that the project remains inclusive and is not limited by the economic constraints of potential users. Since the project was intended to be widely used and accessible to the public, the team developed an application available on both the Apple Store and Google Play. After thorough testing, the app was launched, making it accessible worldwide (Fig. 2). Post-launch, the team continuously monitored user feedback and analytics, introducing regular updates to further refine the experience and address any emerging issues.

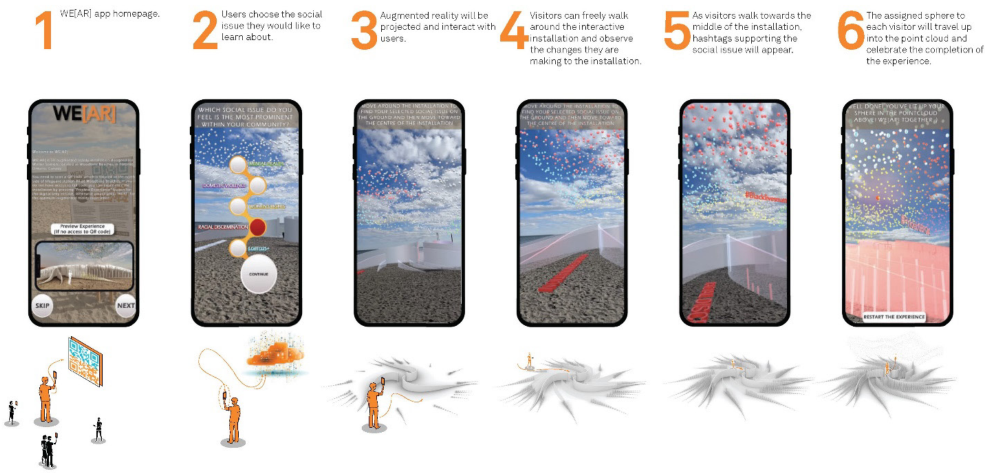

Fig. 2: The app guides users through an interactive experience on their smartphone. Initially, users scan a QR code installed at the site and select a social issue relevant to their community. This choice activates and animates elements of the installation. As users follow a designated path, the installation's form dynamically responds to their location, altering its appearance and colours accordingly.

3.4 Exhibition

As visitors experience the augmented reality installation on their personal tablet devices at the competition site, the developed API Gateway collects feedback based on user input and transforms the data back to the app, updating the cloud above the installation and its curvilinear form (Fig. 3). The immersive nature of WE[AR] sparks curiosity and fosters a sense of wonder, encouraging individuals to delve deeper into the interconnected themes of unity and solidarity.

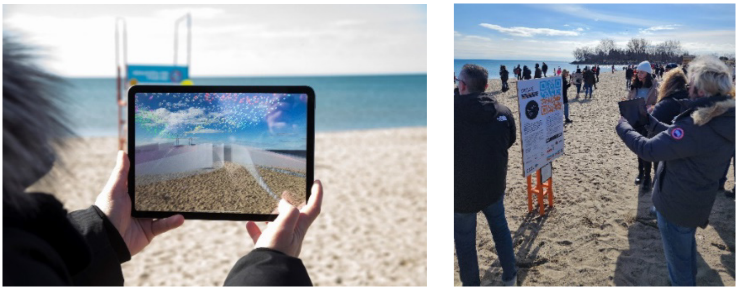

Fig. 3: Visitors scanning the QR code and sending API to the cloud server to activate the MR experience

3.5 Work Flow/Data Management

A robust backend was required to handle the influx of data, especially with multiple users engaging simultaneously. Cloud services were employed to ensure data consistency, quick load times, and real-time updates, enhancing the overall user experience (Fig. 4).

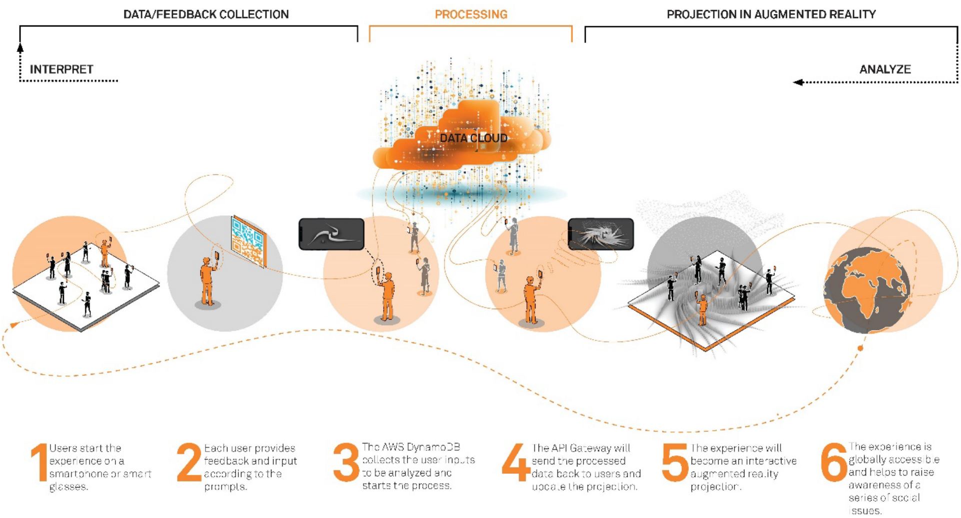

Fig. 4: This illustration depicts the data management process in WE[AR], highlighting how user feedback is collected and processed

4 Performance

This digital medium provided an advantage, enabling access to metrics and insights into user behaviour that are typically unattainable through conventional analysis methods. The app's capability to capture real-time user interactions allowed for a performance evaluation, offering a level of understanding of user engagement prior to construction (Fig. 5, Fig. 6 and Fig. 7).

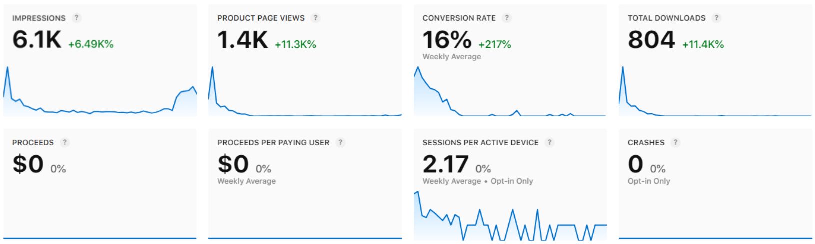

Fig. 5: App Store analytics show app download, open, and view counts, total devices with sessions, and usage frequency within a selected period

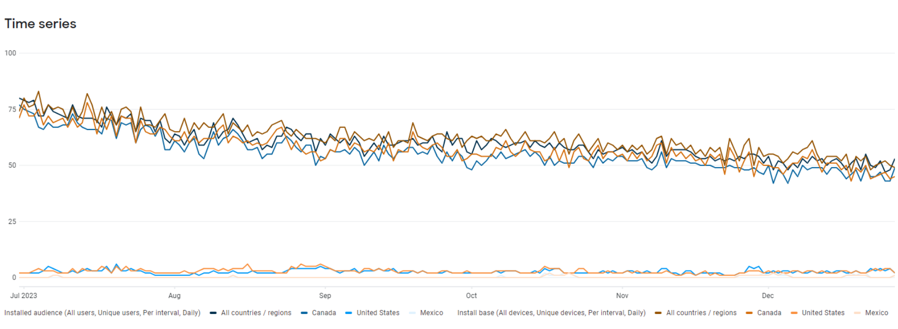

Fig. 6: The installation base analysis from Google Console illustrates the frequency of use across various locations

The 'WE[AR]' project offers more than just download and time metrics. This process enables the team to extract a circulation heat map to understand how individuals interact with the installation (Fig. 8). This method is akin to the studies conducted on the 'ArtLens' app at the Cleveland Museum of Art (PROCTOR 2016), which assessed user engagement and interaction patterns. Hammad et al. (2021) emphasize the importance of user experience evaluations in AR applications, suggesting that such analyses can lead to improvements and user-centric design.

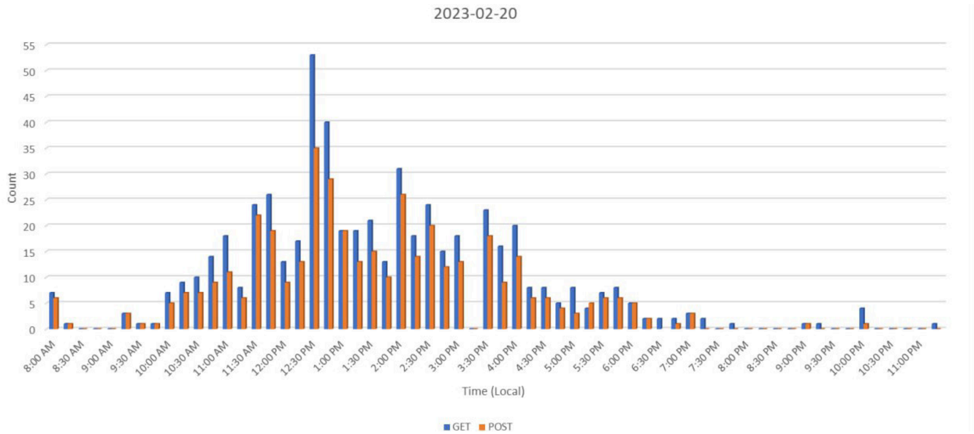

Fig. 7: Data from the AWS server, which illustrates daily API calls in smaller time increments. GET requests retrieve information from the server, while POST requests submit data to the server, to update resources, or providing feedback.

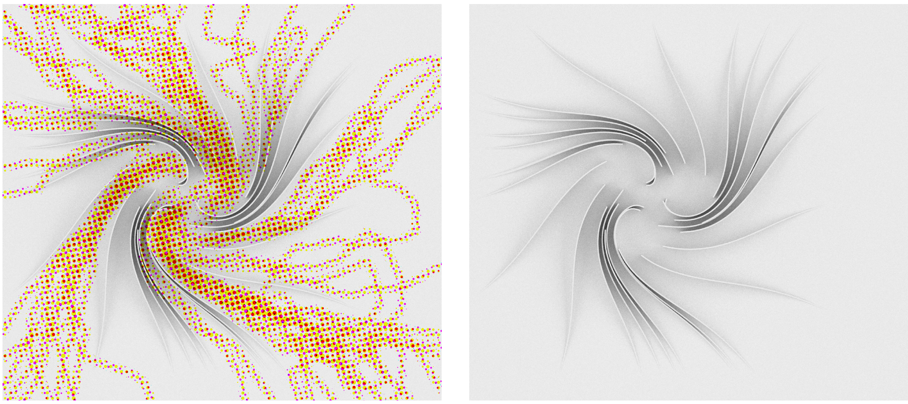

Fig. 8: Plan view of the installation illustrating the circulation heat map over an 8-hour period. The visualization captures the movement patterns and density of traffic offering insights into areas of high engagement and interaction.

5 Limitations

While this project achieved success in promoting interactive public art through augmented reality, it was not without its limitations. Here are some of the key constraints and challenges faced:

Accessibility and Technological Constraints: Despite the app's availability on major platforms, not every individual possesses a smartphone or tablet with the necessary specifications to run augmented reality applications smoothly. This limitation potentially restricted some individuals from fully experiencing the installation.

Digital Literacy: Engaging with AR requires a certain degree of digital literacy. People unfamiliar with AR technology or who are less tech-savvy might find it challenging to navigate the installation or may not fully engage with it.

Internet Connectivity: The real-time interaction and dynamic nature of the installation required stable internet connectivity. In areas with poor or unstable internet access, users might have experienced glitches, reduced quality, or interruptions.

Environmental Conditions: While AR is adaptable, external factors like lighting conditions, weather changes, or physical obstructions in real-world locations could sometimes affect the clarity and quality of the augmented overlay.

Positional Accuracy: One of the main technical challenges for "WE[AR]" was ensuring positional accuracy. In AR, maintaining the correct alignment of virtual objects in the real world is crucial for immersion. This issue of "model jumping" or misalignment is not uncommon in AR projects (BILLINGHURST & KATO 2002). For instance, in the "Museum of London's Street museum" app, users occasionally experienced inaccuracies in overlaying historical images on current city landscapes. To mitigate these issues, "WE[AR]" utilized advanced tracking and calibration techniques, similar to those employed in the "ARKit" by Apple ((APPLE INC., n. d.), to enhance the accuracy of virtual object placement.

6 Conclusion

With the advent of digital media and array technology in interactive product promotions, there's a fresh perspective on nature, technology, urban aesthetics, and cultural views. Advances in technology have cultivated new thought patterns among the public, leading to emerging markets and evolving needs in urban development and landscape architecture. Beyond the discussed aspects of user engagement and public behaviour, this process also presents potential applications in landscape architecture as follows:

Client Engagement and Visualization: MR enables landscape architects to showcase interactive 3D models of their designs within the actual environment. Clients can view and interact with these models in real-time, providing immediate feedback that can be integrated into the design process. This technology also supports multiple users engaging with the model simultaneously. For example, engaging community members in the planning stages of urban development projects through AR can help in visualizing proposed changes, allowing for real-time feedback and suggestions. This collective input can lead to designs that better reflect community needs and preferences.

Public Participation and Feedback Collection: Interactive Augmented Reality (AR) or Mixed Reality (MR) installations in public spaces can serve as effective tools for community engagement. These technologies facilitate participatory design by inviting public interaction with proposed landscape designs and collecting feedback. This approach enables landscape architects to ensure that their projects align with community needs and preferences, fostering a sense of ownership and involvement among community members. Moreover, the integration of participatory design principles enhances the relevance and sustainability of these projects, as they are grounded in the actual desires and insights of the community (SPEICHER et al. 2019). In projects aiming to preserve or restore cultural heritage sites, MR can enable the community to visualize restorations, contribute historical information, share personal stories related to the site and potenyially contribute to the formation of the design.

Simulation of Environmental Impact: Using Mixed Reality (MR), landscape architects can simulate the long-term environmental impacts of their designs, such as vegetation growth, water management, and erosion control. This approach can lead to more sustainable and ecologically responsible design choices. Furthermore, landscape architects can employ this technology for in-depth site analysis. By overlaying digital information, such as soil conditions, sunlight patterns, and historical land use, directly onto the physical site and simulating various options, they can gain valuable insights for informed planning. This can be applied in environmental conservation projects to simulate environmental changes such as the impact of deforestation or benefits of reforestation.

As Taigel et al. (2014) highlights, augmented reality (AR) applications, while intriguing to experienced smartphone users due to their novelty, face certain practical challenges and a preference for traditional methods like paper leaflets among some people. It suggests that as smartphones and related technologies (GPS, mobile data) become more common, these issues and preferences might shift. However, the study also points out that not everyone is comfortable with technology that distracts from their physical environment.

While augmented reality via smartphones holds potential for landscape planning and design, it may not serve as a one-size-fits-all solution (TAIGEL et al. 2014). To fully leverage this technology, its integration into broader decision-making processes is crucial. This aligns with the ongoing exploration in landscape visualization, indicating a need for further research on the effective application of these technological tools in landscape architecture.

WE[AR] project might introduce a process that encourages landscape architects to create a tool or medium and become a tool maker to offer innovative design approaches and perhaps new analytical methods. This requires collaboration with IT experts. It might be an era where landscape architects need to collaborate more with IT professionals, just as they do with other engineering consultants in practice.

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