

Designing Virtual Reality Environments for Sociality

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Abstract

This research investigates how virtual reality (VR) environments can be designed to support sociality. It is guided by two core questions: what sociality means in VR, and how VR experiences can be designed and evaluated to meaningfully support social interaction.

The dissertation examines how interactions in VR are shaped by relationships, shared goals, and role asymmetries through three application domains. The first explores social experiences among remote audiences through a virtual opera lobby designed to support connection and reflection. The second examines collaborative work by introducing a VR meeting environment into XR production workflows, enabling alignment between producers and clients within a shared immersive space. The third extends this work toward decision-making and coordination under high-pressure conditions, focusing on collaborative and adversarial interactions. Methodologically, the research adopts a mixed-method approach combining qualitative and quantitative analyses, aiming to synthesize insights across cases to inform the design of social VR environments.

CCS Concepts

• **Human-centered computing** → **Virtual reality**; **Collaborative interaction**; **User studies**.

Keywords

Social Virtual Reality, Immersive Environments

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1 Introduction

My research investigates how virtual reality (VR) environments can be designed to support sociality. It is guided by two core questions: what sociality means in VR and how it can be explored across different domains; and how VR experiences can be designed and evaluated to meaningfully support social interaction.

When studying sociality, I focus on how interactions between people are shaped by their relationships, mutual goals, and hierarchical structures within shared virtual environments. I explore this through three application contexts: social experiences among audiences, collaborative and creative environments for professionals, and decision-making and coordination in high-stakes situations. My dissertation aims to connect all three applications through a coherent conceptual narrative around designing VR environments for sociality.

This extended abstract presents a summary of the first two application studies, which form the empirical foundation of my dissertation. The first investigates social connection among remote audiences through the design of a virtual opera lobby, examining how VR environments can foster togetherness and reflection after shared opera-watching experiences. The second examines collaboration and alignment in XR production workflows by introducing a VR meeting environment for communication between producers and clients, where VR functions as both the medium of collaboration and the object of discussion.

As a future direction, I outline the third application scenario, which extends this work toward collaborative and adversarial interactions under more challenging conditions, such as high-pressure environments where decision-making is critical. Beyond individual applications, the broader goal of the dissertation is to synthesize insights across studies to articulate more general design and evaluation guidelines for social VR environments.

2 Application 1: Social Connection in VR - A Virtual Opera Lobby for Remote Audiences

The first application examines how virtual reality (VR) environments can be designed to support social connection among remote audiences. This study originated from a collaboration with the Irish National Opera during the COVID-19 period, when traditional forms of opera production - such as large orchestras or choruses - were no longer feasible. During this time, the Irish National Opera created *20 Shots of Opera*¹, a series of short digital opera works designed for remote viewing.

In physical theaters, the lobby plays an important social role as a shared space where audiences naturally gather before and after a performance to reflect and converse [2]. When opera is experienced remotely, this social layer disappears. To address this gap, I designed a virtual opera lobby where remote audiences could engage with each other, even while watching digital performances individually from different locations [3, 4].



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¹ 20 Shots of Opera: <https://www.irishnationalopera.ie/20-shots-of-opera/about>

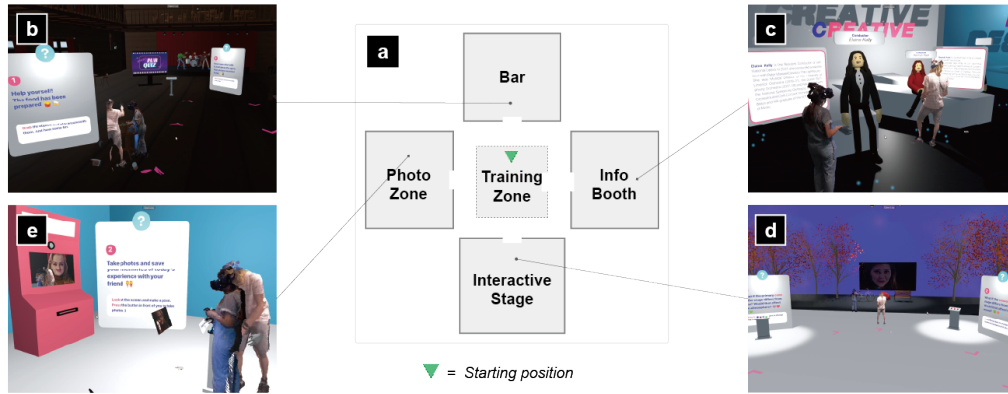


Figure 1: (a) A floor plan of the initial VR lobby, including (b) a Bar (c) an Info Booth (d) an Interactive Stage, and (e) a Photo Zone.

The design of the VR lobby was informed by literature on ongoing motivations, which identifies social, intellectual, spiritual, and emotional engagement as key drivers of audience experience [6]. Based on these motivations, I initially designed four distinct rooms in the virtual lobby, each intended to evoke one form of engagement (Figure 1). Following an iterative design process and an initial controlled experiment, the lobby was refined into two final spaces, reflecting the insight that engagement in the lobby emerges as a collective and cumulative experience rather than as isolated room-based interactions.

To understand how sociality manifests in such environments, I conducted a controlled study comparing experiences between individual participants and pairs who entered the lobby together. I adopted a mixed-method approach combining questionnaires, semi-structured interviews, and spatial interaction data collected from user navigation and interaction logs. This approach allowed me to examine not only subjective experience but also how participants actually moved through and spent time within the virtual space.

The results revealed an important contrast between quantitative and behavioral findings. Questionnaire responses did not show statistically significant differences between individual and paired participants across factors such as *Engagement*, *Immersion and Presence*, *Connection to the Performance*, and *Realism* (Figure 2). However, navigation behavior told a different story: paired participants spent more time interacting in the lobby and remained predominantly within personal and social distance zones (approximately 0.45–3.6 meters) (Figure 3) [1]. Qualitative interviews further highlighted shared reflection, conversation, and the experience of being together as key perceived values of the social VR lobby.

This application serves as a foundational case for understanding sociality in VR. It demonstrates how sociality can emerge through spatial configuration, interaction design, and co-presence, and highlights the importance of mixed-method approaches in capturing social experience. Insights from this study shaped my broader conceptual framing of designing VR environments for sociality.

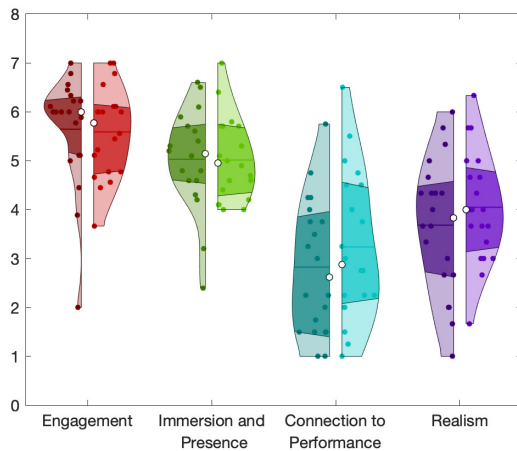


Figure 2: Violin plot of the results from the quantitative analysis.

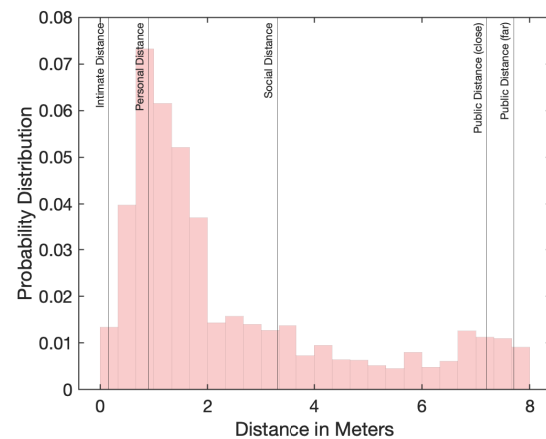


Figure 3: Histogram of the probability distribution of the pairwise (Euclidean) distance between paired participants. The proxemic zones [1] are labeled on the x-axis.

3 Application 2: Professional Collaboration in VR - A Social XR Meeting Space for XR Production

While the first application examined social connection among audiences without explicit goals or clear hierarchies, the second application focuses on collaboration in a work setting, where participants share a common goal but differ in roles and expertise. This application investigates how social VR can intervene in professional collaboration and support communication between stakeholders in XR production.

To understand how XR production operates in industry, I conducted on-site focus groups with XR professionals at three production companies across Europe (France, Lithuania, and Denmark). Through this process, I identified and consolidated the XR production workflow into four stages: pre-production, production, post-production, and post-release (Figure 4) [5].

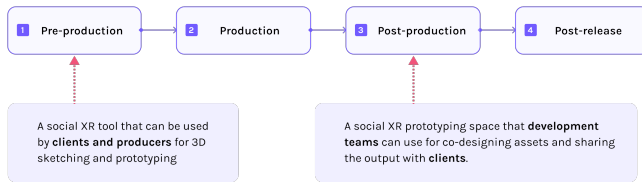


Figure 4: A production workflow diagram with suggested Social XR solutions.

These focus groups revealed a recurring communication challenge rooted in the nature of XR outputs. While XR experiences are inherently three-dimensional and immersive, discussions around them are largely mediated through two-dimensional materials. This mismatch motivated the use of VR not only as a delivery medium but also as a communication tool: by discussing ideas within the same immersive medium as the intended product, stakeholders can better align their understanding and expectations.

Specifically, this application focuses on the pre-production stage, where producers and clients engage most actively in shaping ideas, yet often operate with different roles and levels of XR expertise. This asymmetry frequently leads to misalignment in vision, which can result in costly redesigns later in the process.

As an initial study, I conducted an in-the-wild study with XR producers and museum curators, who met in a Social VR meeting space to discuss a potential collaboration project. This study revealed the advantages of Social VR over traditional meeting tools, particularly its affordances as a pre-production meeting environment.

Building on these qualitative insights, I designed a VR meeting room for early-stage pre-production meetings between producers and clients (Figure 5 illustrates the concept). A controlled experimental study has been designed to examine how this VR meeting environment supports collaboration between professionals with different roles and levels of expertise. Specifically, the study compares the alignment of project vision before and after the meeting, using this change as an indicator of meeting success.

Through the two applications explored above, I examined how virtual reality environments can support different social contexts, characterized by varying relationships and goals. While the first



Figure 5: A conceptual social XR tool solution for clients and producers to communicate and showcase prototypes clearly during the pre-production phase.

application focused on shared reflection and connection without explicit goals, the second highlighted how social VR can support alignment and collaboration in professional settings where goals are shared but expertise and authority differ.

4 Application 3 (Planned): Decision-Making in Social VR under High-Stakes Conditions

Previous studies were conducted in relatively cooperative and low-risk environments. The first application examined sociality in an artistic context, emotional and reflective aspects of shared experience. The second shifted to an industrial work setting, focusing on collaboration, efficiency, and technical alignment between professionals with shared goals but different roles and expertise.

To further expand the scope of this work and fully explore the unique affordances of virtual reality, I aim to move toward scenarios that are costly, risky, or ethically difficult to simulate in real life. VR allows for the creation of immersive, controllable simulations at low cost, including environments that do not follow the constraints of physical reality.

The next application extends the investigation to high-stakes situations involving pressure and potential adversarial relationships. In particular, this study focuses on the psychological dimension of sociality, examining how individuals and teams make decisions under stress. This enables a systematic comparison between collaboration under shared goals and interaction under conflicting goals, revealing how decision-making processes unfold in high-pressure virtual environments.

5 Conclusion

This extended abstract presented two concrete application studies examining how virtual reality environments can be designed to support different forms of sociality: a virtual opera lobby for social connection among remote audiences, and a VR meeting space for professional collaboration in XR production workflows. Together, these studies explore social interaction in cooperative and relatively low-risk contexts, while differing in relationships, goals, and levels of expertise.

To extend this scope, I outlined a planned third application that investigates sociality in high-stakes virtual environments, where participants operate under pressure and may engage in adversarial

relationships. This next step aims to examine how decision-making dynamics differ between shared and competitive goals.

What remains unresolved is how to articulate a coherent framework of sociality in VR that connects these application studies, and how to translate accumulated empirical insights into general design and evaluation guidelines. Beyond individual cases, my broader goal is to synthesize knowledge drawn from three empirical studies, five years of VR design practice across European projects, XR course development at university, and invited talks into a more general understanding of how to design VR environments for sociality.

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