

Exploring the Interactional Affordances of a Web-Based 3D Virtual World for Design Exhibitions

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Figure 1: Visitors, designers and curators mingling and interacting with 3D sculptures and posters in the Interior Design Exhibition in Spot Virtual. Visitor names redacted for anonymity.

Abstract

We present an investigation of using the web-based 3D virtual world platform, Spot Virtual, for exhibiting design work. We built an exhibition gallery, recruited interior design graduate students, and installed their work in the gallery. This included images, videos, and

3D scanned objects. We then held an online public opening event for the exhibition. We analyzed data from interviews with student participants, survey responses from gallery visitors, and curator reflections. Our findings show that the exhibition was positively experienced by student participants and visitors, and supported dynamic engagement, both socially and around the student work. Students particularly appreciated the scale, fidelity, and amount of their work that could be exhibited, as well as the ability of visitors to join from anywhere in the world. However, both visitors and participants noted some navigational difficulties, and we describe some other interaction features that are missing or lacking. We provide recommendations for enhanced features for web-based 3D worlds that would better support visitor interaction with image, video, and 3D design artifacts.

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CCS Concepts

• **Human-centered computing** → **Collaborative and social computing systems and tools**; **Web-based interaction**; *Empirical studies in collaborative and social computing*.

Keywords

Virtual Environments, Exhibition Spaces, Sustainable Exhibitions, Interaction Design, Web-based Exhibitions

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1 Introduction

For spatial design disciplines, such as architecture, landscape design, urban planning and interior design, social virtual worlds offer new possibilities as laboratories for experimentation. Virtual worlds can be used to explore and test spatial design concepts, serve as virtual co-working hubs for design professionals, and function as educational platforms for students in architecture, design, and planning. We report on a study that focuses on the use of virtual environments for design *exhibition* purposes.

While design work has been featured online, it has typically been shown in web-based galleries as static images and videos viewed by individual users. There is a lack of research examining how 3D virtual environments can support the complexities of design exhibitions as social sites for interrogation, dialog and reflection [21]. This study explores the potential of web-based virtual galleries for exhibiting work such as images, videos, and 3D models, while enabling social interaction between creators and gallery visitors. Using the Spot Virtual platform [19], we worked with graduate Interior Design students from two design studios to curate their course projects in an immersive online gallery space (see Figure 1). A gallery reception event was held and was open to the public.

Online interior design work should allow for interactive experiences that can inform creative practitioners about how audiences experience their work and guide future design choices. Creativity-supporting spaces and interactions allow the audience to become a key participant and their interactions with the designers and each other are crucial components enabling further innovation [21]. Iacovou and Artopoulos conceptualize the exhibition as a “stage of mediated narratives”, where spatial and multimedia interventions actively foster engagement among diverse publics [5]. The authors encouraged audiences to assume critical and participatory roles, facilitating new forms of collective engagement with the built environment. Our work furthers this by investigating how to enable social, critical, reflective exhibitions in web-based 3D virtual world platforms, building on our previous work designing interactive galleries in 2D virtual worlds [11] and investigating how to manifest creativity support in virtual environments [12].

The following research questions guided our investigation:

- (1) How do design students experience presenting their work in a 3D digital environment?

- (2) How do public visitors perceive and interact with the work, designers and other visitors during the gallery opening event?
- (3) How feasible is it to build and curate a design exhibition within a web-based 3D virtual environment? What are the challenges and benefits?

To answer these questions, we ran a study in which we conducted interviews with the students (n=4) who contributed their course work to the gallery and collected anonymous survey feedback from visitors (n=12) at the gallery reception event, a form of exhibit-based research (EBR) focused on understanding interaction affordances and their impact on the creative engagement of attendees and presenters [1]. We also recorded our own reflections about the experience of designing the gallery, installing the work, and running the exhibition event. We used qualitative methods to analyze the data collected. Our results illustrate the benefits and challenges of holding design exhibitions in web-based virtual worlds. In our discussion, we highlight interaction opportunities for virtual world platforms to better support socially-mediated design exhibitions. In addition to this, we briefly present a comparison with our previous work hosting an exhibition in Gather, a 2D virtual world.

1.1 Research Team

Latulipe is a Human-Computer Interaction (HCI) Professor who led the project, and assisted with the curation and installation of the work as well as with running the event. Horn is an Interior Design graduate student who built the Spot Virtual gallery, and installed student work in the gallery, including their own work. Shields is a Professor of Interior Design who assisted installation, advertising the opening event and running the event. Pareek is an undergraduate design student who assisted with gallery construction and showcased their digital art work in the garden terraces. Wormie is an HCI graduate student who assisted with data analysis.

2 Related Work

We draw upon research in the following three areas: methodologies for exhibiting design work in architecture and interior design, virtual exhibition software platforms, and desktop virtual environments which can be appropriated for exhibition purposes.

2.1 Exhibiting Design Work

Physical exhibitions in architecture and interior design serve as pedagogical, spatial, and curatorial exercises that synthesize design thinking, material practice, and audience engagement. Well-structured exhibitions often emphasize a clear narrative, spatial rhythm, and the relationship between design processes and outcomes, foregrounding the conceptual development of the work alongside its physical and digital representation [23]. In design education, exhibitions serve as a mode of reflective practice, where students publicly discuss their intentions and explore spatial storytelling through images, simulations, and written text [18, 24]. As O'Doherty shows, the gallery itself can function as a medium that shapes the meaning of the work it presents [16].

While the physicality of exhibitions remains central to how viewers experience texture, proportion, and spatial immersion, recent research has explored the evolving role of virtual environments in curatorial practice. Digital platforms can broaden accessibility

and introduce interactive elements [20], yet they often lack the sensory and atmospheric qualities intrinsic to in-person displays [14]. These developments build on earlier forms of online exhibition, many of which began as static, solitary experiences. Understanding this historical trajectory helps contextualize the emergence of contemporary, socially engaged virtual exhibition platforms.

2.2 Virtual Exhibitions and Platforms

A notable early example of online art exhibition was SITO, founded in 1993 as the OTIS Project by Ed Stastny [15]. SITO quickly developed into one of the largest online artist collectives, offering a public archive of scanned and digital artworks. These initial art platforms were static, typically accessed in isolation, and lacking opportunities for real-time social engagement. This contrasts sharply with contemporary, socially-enabled virtual exhibition environments, which prioritize engagement, critique, and collaborative interpretation. One notable example is the ‘Apart: Posters from a Social Distance’ gallery created by Paradowski Creative and hosted on the Mozilla Hubs platform [17]. This gallery enabled users on desktops and in VR to walk up to the posters and interact with other users.

The recent affordability of VR equipment has led to a surge in the development of 3D gallery spaces, including a number of private companies that offer bespoke 3D gallery design services. For example, VR-ALL-ART and KunstMatrix are platforms that hosts galleries and allows artists, collectors, and art dealers to build online 3D galleries [9, 22]. Some of these enable web-based browsing without VR equipment, but most only provide individualized instances, with each user viewing the galleries in isolation.

Some VR platform providers, such as EmperiaVR [2], do enable multi-user gallery visit experiences, and this is where designing for social interaction is critical. An issue with collaborating with others around objects in virtual worlds is that individual visitors may not be able to tell what others are looking at [4]. When virtual platforms do not support this in some way, it impedes the ability to collaboratively engage [25].

2.3 Web-based Virtual Worlds

The proliferation of applications and worlds which require expensive VR equipment may be exacerbating a global digital divide [10], so it is worth considering how web-based virtual worlds, which do not require any specialized hardware, support a more universal audience. Current web-based virtual world platforms such as Gather (2D) [3], Spatial (3D) [6], Spot Virtual (3D) [19], and Kumspace (2D) [8] enable within-world real-time spatial video conferencing, merging virtual worlds and meeting software into one. These platforms provide spatial conferencing options without requiring specialized hardware or software installations, adding to their appropriateness for hosting exhibitions. This opens up visitor access to anyone with a web browser, enabling more equitable and sustainable access. In the 2D Gather gallery that we presented in previous work, the exhibiting artists valued the synchronous interaction with and feedback from attendees [11] however, we did not investigate the *attendees’* perspectives and experiences of the exhibition, and so that perspective was missing.

When using desktop input devices such as keyboards, mice and touchpads, navigating in 3D virtual worlds is more challenging than

navigating in 2D worlds because it requires dexterous simultaneous use of the pointing device and the WASD or arrow keys. While gamers have mastered this type of interaction, it is challenging for non-gamers. Navigating 2D worlds with desktop devices is simpler because of the fixed viewpoint, and requires much less dexterity because the user only needs to use the keyboard to move the avatar. In our previous work presenting an interactive art gallery in Gather, there were no reported navigation issues [11]. However, a 3D web-based virtual world should offer a more immersive experience than a 2D web-based virtual world, while still only requiring a computer with a web browser. Thus, there is a potential trade off between immersion and ease of use. For this reason, our study investigates how both exhibiting designers and visitors experience art/design exhibitions within a 3D web-based virtual world.

3 Design Requirements and Platform Selection

Our goal was to build an online exhibition that would meet the following requirements:

- Provide a 3D spatial gallery experience that could be navigated and explored freely, supporting a sense of immersion.
- Support the presence of multiple participants within the space, enabling real-time, social interaction and detailed collaborative engagement with the works presented.
- Ensure that the gallery supports a range of media formats, including images, video, audio tracks, and 3D artifacts.
- Ensure that participants and visitors could visit the gallery with only a computer and web browser (i.e., without the need for specialized equipment such as VR headsets).
- Enable fast and fluid environment building and installation of work, without requiring extensive 3D modeling experience or scripting knowledge (given that many gallery curators do not have those specialized skills).

3.1 Web-based Social Virtual World Platforms

Given the above requirements, a web-based virtual world platform that enables social interaction was desired. While some 2D web-based virtual worlds can support interaction with 3D objects (such as Gather), the interaction is through a launched window-in-window and only supports 3D objects hosted on other platforms, rather than through movement in the world, thus breaking the sense of walking ‘around’ an object. Placing 3D objects in 3D virtual worlds allows avatars to move closer and farther away, move around the objects, and also see how others are interacting with the object and what angle they are viewing it from. This was the type of interaction we wanted. This meant that we needed to choose a web-based 3D virtual world. We considered Mozilla Hubs, which has been used for virtual galleries, including the COVID poster gallery “Apart: Posters from a Social Distance” [17]. However, we found that interaction modalities on the Hubs platform were limited, and that building a space for Hubs required significant modeling expertise. In addition, Mozilla’s tool had a very high learning curve, making the overall process a substantial barrier to most curators [13]. We note that Mozilla discontinued their support of Hubs (and Spoke) over the course of our study. We also considered Spatial.io, which has some support for in-world building, but required more scripting knowledge and had a more challenging build tool-chain [6]. The

Spot Virtual platform [19] offered better affordances for creating an aesthetically pleasing gallery quickly, without the need for any 3D modeling expertise. Similar to most social virtual world platforms, Spot Virtual enables people to share video and audio feeds which are proximity-based, though the norm on the platform is for people to only share audio feeds. There is a text chat that allows direct or room-based text conversations.

3.2 Building Process in Spot Virtual Platform

The building process for Spot Virtual is interesting and quite different from other 3D platforms, such as Hubs. Rather than building environments in external modeling tools such as Blender and importing them into the platform, Spot Virtual provides an in-world embedded 'build mode' that allows customization of a world on a flat grid with a surrounding skybox. The build mode can be activated by a space owner even while users are actively in the space, and has four different sub-modes: 'floorplan mode' for adding/editing walls, floors, ceilings; 'environment mode' for changing the skybox surrounding the buildable grid; 'add mode' for adding and editing decorative objects, interactive elements, lighting, and furnishings; and 'branding mode' to add logos and adjust colour schemes. While the platform intends for users to start with one of their provided space templates, it is possible to build a space from scratch by starting with a template space and deleting the walls. The platform provides many objects and furnishings that are education or office-related, but any 3D object can be imported into the world for further customization. Additionally, some built-in objects have interactive features associated with them, such as chairs that can be 'sat on', 'coffee cups' that can be picked up, and screens which can be linked to videos or used to embed web sites or other content.

4 Study Methodology

This mixed-methods study involved the following phases, which are further described in the following subsections:

- Initial Gallery Design
- Participant Recruitment
- Gallery Install
- Gallery Event with Visitor Survey
- Follow-up Participant Interviews

This study was approved by the Ethics Review Board at the University of Manitoba.

4.1 Gallery Design

The first step in this study was to design a gallery space in Spot Virtual. We created the gallery space shown in Figure 2 by starting with a template space, and removing all existing walls, and then placing new walls to create the desired layout. When first entering the space, visitors land in the entrance foyer, which contains information about the exhibit, as shown in Figure 3. From the foyer, visitors move to the first main gallery, containing 3D scans of physical centerpieces created by students, along with posters that showcase the design intention and process, as shown in Figure 1.

The Spot Virtual gallery consists of both interior and exterior spaces, along with social lounge areas. The interior space is divided into three main galleries joined by a central corridor. Navigational aids were placed throughout the space to help people know where

to go, as shown in Figure 4. One of the central galleries displayed the design briefs that the students' work responded to, Figure 5.

Most of the galleries featuring the work of individual students were in the top-most gallery section. These galleries included both images and looping videos, with the audio tracks of those videos audible throughout each individual gallery space. The galleries also had bench seating and plants, as shown in Figure 1. Exhibited images could be viewed by the avatar in first person view, though they could be visually obstructed by other avatars in the space. Visitors could click on most images in the gallery to view them in full screen mode (as seen in Figure 7) and download them.

4.2 Participant Recruitment

Students who were enrolled in the Master's of Interior Design program and who were taking the first or second semester Studio Design course at the University of Manitoba were invited to participate via email circulated by the course instructors. Students in the courses were informed that this would be a voluntary activity that did not count towards their grade, but would provide an opportunity to have their design work featured in an innovative format, with the potential for exposure to a broader audience. The potential recruitment pool was 13 students, and we had 5 students choose to participate.

4.3 Gallery Install

We met online with the student participants to show them the gallery space. They then uploaded their work to a shared drive. Four of the five students were in both Design Studio courses and had two galleries showcasing their work, one for each course.

Images and videos were relatively straightforward to embed in Spot Virtual, though significant time was spent tinkering with spatial arrangement and scale. Images were given plain black frames using a graphics editor and then uploaded. Videos were embedded in the rooms with appropriate spatial audio settings and set to loop continuously while visitors were in the gallery space.

As part of the first design studio course, each student produced a physical sculptural object, fabricated using both traditional tools in the woodshop and digital equipment in the fabrication laboratory. The physical works were carefully 3D scanned using high-resolution photogrammetry and LiDAR-based methods. The resulting meshes were cleaned, optimized for performance, and then imported into Spot Virtual and placed on virtual pedestals. To ensure objects appeared properly placed within the virtual gallery, the 3D models were adjusted so their coordinate systems aligned with the platform's pedestal geometry, preventing visual misalignment. This process was critical for accurate visual representation and for preserving the material and spatial intent of the work.

After placing work in the gallery, each design student participant was invited in to the gallery to preview how their work was presented and request any adjustments.

4.4 Gallery Event with Visitor Survey

We held a gallery opening event in the Spot Virtual gallery, open to the general public. The two-hour event provided a unique opportunity for attendees, including students, colleagues, and design professionals, to engage with the student work in real-time. Visitors



Figure 2: Birdseye view of the exhibition gallery. The entrance is at the bottom, and the 3-D model gallery is immediately above. The individual galleries are in the middle and top. Lounge spaces are at the sides and the bricked areas are terraces.



Figure 3: Gallery entrance foyer with information about the exhibition being viewed by a visitor.



Figure 4: Navigation aids placed throughout the space helped visitors to know where they were and where they could go.

could navigate the multi-room 3D space, view embedded images and 3D models, watch video walkthroughs, and interact with the designers and other attendees. The invitation was shared with people in the Faculty of Architecture, as well as with others on campus. Design student participants were also encouraged to share the invitation with friends and family.

An online, anonymous visitor survey was created and links to the survey were placed throughout the gallery space. During the event, participants and visitors gathered in the sculpture gallery for opening remarks, and visitors were asked to consider filling out the survey to provide feedback on the web-based gallery experience.

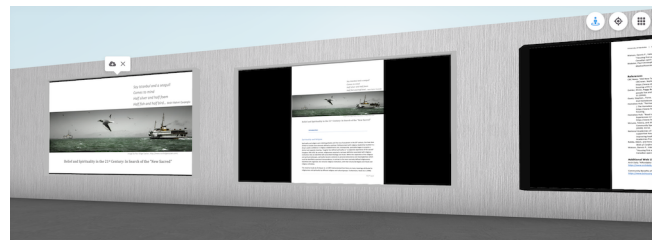


Figure 5: Design briefs were displayed in one of the galleries, to help contextualize the work of the student exhibition.



Figure 6: One of the individual student work galleries, with visitors. Design work attribution: Sara Hosseini.



Figure 7: When an image is clicked on by a visitor in the gallery it goes into near fullscreen mode, allowing the visitor to look at the image in detail. The user can click again to zoom in further and drag around the image to view it in detail. Design work attribution: Danae McKennitt.

4.5 Participant Follow-up Interviews

The design students who participated by contributing their work to the gallery were invited to participate in a 30 minute follow-up interview to share their thoughts and perceptions about presenting their work in this platform. Student participants received \$20 in compensation for attending this interview. The interviews were conducted within the virtual gallery space, allowing for direct reference to the work displayed and to the gallery environment.

4.6 Analysis

Our three data sources are the interviews with the design student participants, survey responses from visitors, and our own curator reflections (from authors Latulipe, Horn, and Shields) on the process of building the gallery, installing the work and running the exhibition. We used content analysis to summarize participant interviews and survey responses [7]. Author Wormie created spreadsheets for participants and for visitors, with questions detailed in columns and each participant or visitor response represented by separate rows. Colour-coding was used to highlight responses as positive,

negative, mixed or neutral. Wormie summarized majority opinions and also highlighted outliers at the bottom of each column to further refine the analysis. The colour-coding, summarization and highlighting of outliers was verified by Latulipe. Latulipe and Shields collaboratively grouped these results into cohesive themes. Curator reflections were written separately by Latulipe, Horn and Shields, and then grouped into coherent themes through iterative discussion between authors. This aligns with the method of exhibit-based research in which the curators are co-designers and their design and installation decisions are objects of research [1].

5 Results

5.1 Participant and Visitor Experiences

In this section, we combine results from a detailed content analysis of both design student interviews and gallery visitor survey responses to answer RQ1 and RQ2. The four students who were not part of the design team participated in interviews. The gallery opening event was attended by approximately 30 people and twelve visitors to the gallery completed the visitor survey. Of these twelve visitors, one third had design backgrounds, one third had tech backgrounds and one third had a mix of both backgrounds.

Design students' overall reaction to the experience of contributing work and participating in the exhibition was strongly positive, and all reported that they would participate in a virtual gallery exhibit again if given the opportunity (RQ1). The participants (4 female, 1 male) had varying expectations for what the virtual gallery would be like prior to participating, with P2 noting that it turned out to be exactly as they expected it to be, while P4 was very surprised and was expecting something quite different:

I thought it would be something like a slideshow or something that would be on a board and people would go in at their own times. But it was super exciting. I found it really interesting that it was actually like a virtual reality kind of, kind of like a simulation where you could create your own character and walk around as if you're actually in a gallery in a 3D space.

Similarly, feedback from visitors about their experience attending the online exhibition in Spot Virtual was overwhelmingly positive (RQ2). For example, V8, who reported having spent a significant amount of time in various virtual worlds, noted:

I would consider the Virtual Exhibition an improvement over most social virtual worlds I've experienced. It had pleasant features such as music and models, and the art was interesting.

5.1.1 Design Work Presentation. The design students were generally very positive about how their work was presented in the gallery. They were especially enthusiastic about how the 3D models of the centerpieces worked in the gallery. They were impressed with the quality of the 3D scans, but also the experience of walking around these objects in the virtual world while seeing them in high resolution, as shown in Figure 10. For example, P4 described the suitability of the Spot Virtual Gallery for exhibiting their centerpiece:

I feel it is much more understandable in a 3D space than, say, a 2D picture, because you're not really able



Figure 8: One student augmented their gallery space using post-it notes. Design work attribution: Sara Hosseini.

to gather the information just from looking at a picture.

Similarly, P2, in discussing the centerpiece elements, noted enthusiastically:

I feel like the detail is insane!

Visitors to the gallery also enthusiastically discussed the ability to engage with the 3D scanned objects. V2 noted:

I liked the experience of walking around the centre-pieces and being able to explore at my own pace.

Multiple participants reported really liking how large the work looked in the space, especially the scale of the work in relation to the size of the avatars (see Figure 6). For example, P2 was surprised by the size of each image in the gallery, and commented:

Like they're almost like full-sized walls in comparison to us...Because like the images appear so large, it feels like you're *in* the place

Visitors such as V5 enjoyed being able to both click to expand images and to see them in first-person view:

I enjoyed being able to read signs within first person view. I often never clicked on things to view them in expanded mode, and simply read them as part of the virtual world.

Similarly, V10 noted that they liked that they could watch and hear the videos while in the space, without having to click to view the video in a separate frame or tab.

The virtual exhibition also enabled the inclusion of *more* work for each student than would be in a physical gallery. P1 noted:

And the main thing I like about it [Spot Virtual] is that in person, in the Vision Space, we have a shortage of [space for] displaying things. But here, people can have the four walls to themselves to display their work. So I think in that sense, it's a very good initiative to present all of our works. ...I got really excited because when I saw my name in here and it's a whole room, I didn't expect that. And I think it's brilliant.

Similarly P2 commented on how the large set of work displayed for each student provides a more holistic view:

...it kind of gives you a sense of like how cohesive the work is.

5.1.2 Social Interaction. Another aspect that participants were quite positive about was how the platform enabled social interaction. The design students interviewed liked the ability to mingle and chat with others in the space. P3 commented:

...I'm having a quality time with my friends and my teachers. And we're talking about the projects. So I was sitting in my room but I had a great conversation. And it was so nice... hanging with friends without being with them [physically] was so funny. We ate [virtual] cupcakes together. We just gathered and like, I could speak in private, I could speak in groups.

P3 also noted how satisfying it was to be in the gallery and to watch other users come into the room where their work was presented and take time to engage with the work:

I could see my friends and other people coming to my room and they were looking. And it was just, I really saw that, I really felt like they're looking at my project... when there were like a couple of people in this room, looking at different pictures, it was so satisfying.

Among gallery visitor responses, there were 15 mostly positive comments about the various ways that the platform supported interacting with others (RQ2). V7 appreciated that there was a built-in 'rock, paper, scissors' game that you could play with another person, just by presenting their avatar with one of those objects. Other visitors, such as V9, appreciated the social interaction possibilities:

The avatar interaction like fist bump, saying hello, and the expression [emoji] feature was most enjoyable.

V3 noted pleasure seeing others engaging with art and V2 was surprised by a lack of awkwardness in the social interaction in the virtual gallery:

It was surprising how natural it felt to walk up to someone and chat!

5.1.3 Access & Sustainability. The virtual nature of the platform appealed to the students as a way to share their work with people who are far away and would be unable to see their work if presented in a physical gallery space. This was a positive impact on the student experience (RQ1). For example, P1 said:

I can see the possibility that people can see my work, even if they're not in person, present in the exhibition space. So I thought that my friends and family back at home, they can also see that what we are displaying in this exhibition space. And not only the work by me, but also my classmates...

P4 was enthusiastic about the accessibility of the exhibition:

I think it's very accessible, say, to those with disabilities or mobility issues...

P4 also discussed the ability for people from far away to participate and linked this to environmental sustainability:

I would love to see it more mainstream. I feel like it would be really interesting and environmentally conscious, say, to have these virtual galleries so visitors don't have to come across, say, the country, to visit a



Figure 9: Visitors chatting and looking at work in the gallery during the event. This screenshot illustrates the scale of the work on the walls in comparison to the size of the avatars. Also visible in this screen is the left sidebar; users can teleport by clicking on room names. The sidebar shows who is in each room (visitor names blurred). Design work attribution: Tessa Horn.



Figure 10: An avatar walking around one of the centerpieces. Design work attribution: Tessa Horn.

gallery that they wanted to see or to support, say, a loved one and their work being presented.

P2 noted that the fact that the gallery can exist long term and be revisited, is beneficial for education and professional practice:

In terms of educational ways, or honestly, even potentially in professional practice, being able to put all this work up, and then ... being able to go back and look at everything exactly as it is, would be interesting.

Visitors also commented on the ease of access, with V11 noting:

The virtual world gallery ... encourages people from other parts of the world to socialize and come together. Social virtual worlds build a sense of community.

5.1.4 Navigation. The biggest challenge reported by the student participants and visitors related to navigating in the space, moderating the positive experiences reported so far in relation to RQ1 and RQ2. Similar to most 3D desktop worlds, Spot Virtual offers three navigational modes: sidebar room menu selection (teleports the user to the center of the selected room), double-clicking at the desired location in the current view (teleports the user to that spot,

while keeping the user's view direction the same), and navigation through a combination of keyboard and mouse interaction with mouse dragging changing the view direction while keyboard arrows moves the avatar with respect to the current view direction. This last navigation mode has usability issues within Spot Virtual because there are two different viewpoints: top-down view, and first-person view, and mouse clicking and dragging operates differently between these two views. This difference in interaction was a serious usability issue in Spot Virtual and led to confusion for some participants.

As an example, P1 struggled with navigation during the interview, and had trouble moving their avatar sideways along a wall, while maintaining their viewpoint so that they were looking at their images. While looking at an image in full-screen mode, they mentioned that they would like a 'next' button or the ability to use the arrow keys to see the 'next slide'. This suggests that they did not want to get out of full-screen mode, move their avatar over to the next image and then click on it to view it in full-screen mode, demonstrating that positioning their avatar in front of each work was seen as a lot of effort for some participants.

One of the visitors (V6) wanted to be able to zoom their focus in on the artwork while walking through the space:

I'd love better zooming! I wanted to see all the art closer up (I used my computer's accessibility zoom to fake this).

Some participants enjoyed the navigational affordances of Spot Virtual. For example V5 noted:

The change from first to third person was the most surprising and made the experience much more immersive than a forced perspective.

The same participant also discussed how switching between the two navigational modes could be really helpful:

If I was lost in first person I could easily switch to “top-down view” and navigate to where I needed to go. I really enjoyed the maps and directions that were available. Even though you could move to top-down view, seeing the maps in first-person improved overall realism and made it easier to navigate.

Similarly, V4 noted that each mode offered benefits:

I struggled a little with navigation as I found top down easier to use, but first-person easier to see things.

5.1.5 Suggestions. Both students and visitors offered suggestions for improving the gallery experience. P3 expressed an interest in being able to embed walk-through simulations of interior designs in the gallery:

...almost all of us work in Revit. So we can like give you the project. So like, the guests can go inside the project, and they can just walk through the building.

Similarly, V9 suggested:

I think there is an opportunity to have visitors “step into” the artwork. Having visitors navigate floor plans and view 3D blender art from a first person perspective would be very immersive and be almost like a real gallery, possibly better.

Two students expressed curiosity about what it would be like to have a gallery that pushed the boundaries of the virtual medium and was not a replication of a physical gallery, including P2:

Like, this, as it’s laid out, really reads as a gallery. Like, I feel like I’m in a virtual gallery. Which is good. I also feel like maybe, like, being able to kind of step outside the box of a typical gallery as we think it is, and explore that virtually, could be interesting...

5.2 Curators’ Perspectives

In this section we answer RQ3 by presenting the reflections of authors Latulipe, Horn, and Shields, who acted as curators: designing and installing the gallery, and organizing the exhibition event.

5.2.1 Time & Access. While there was no need for a physical setup, working in a fully editable virtual environment introduced its own set of challenges. Because all design elements in the space could be modified at any time, finalizing the design took longer than expected. Frequent tweaks were made to improve flow and presentation, and manual adjustments to each artwork’s scale and position added additional time. The process encouraged experimentation and refinement but also led to longer design periods and the risk of ongoing revisions. A benefit is that the gallery remains available indefinitely since it does not have to be dismantled to make room for a new exhibition and so it can continue to serve as an archive of the students’ work as long as the platform exists.

5.2.2 Cost. Hosting the exhibition virtually significantly reduced costs compared to a physical show. There were no expenses for printing, fabrication, transportation, or manual installation. Instead, the only fees were a flat rate for hosting the event and paying a graduate student to build the virtual gallery. The overall cost was modest compared to the material, logistical, and labour costs



Figure 11: A whiteboard in the lounge where visitors have doodled, the doodles are legible from anywhere in the room, without having to click and enlarge the whiteboard.



Figure 12: The gallery with a cityscape as the skybox, viewed from one of the gardens.

involved in traditional physical installations, demonstrating that this is feasible (RQ3).

5.2.3 Fidelity. As the curators of the space, we appreciated the ability to include high resolution images that users could click on to enlarge and examine. However, immersion was strongly enabled by the fact that users could see the images with a reasonably high fidelity just by moving their avatars through the space, *without having to click on the images and enlarge them* (as shown in Figures 6 and 9). The video walkthroughs of each project worked well in each room, and played on a loop during the event. The videos play synchronously for all avatars in the space, helping to create a shared experience. The audio for these video walkthroughs was spatially immersive in that it was loudest when closest to the video, and quieter when further away. We also were satisfied with the fidelity and textural representation of the 3D scans that could be imported.

6 Discussion

Our results provided answers to our research questions: students’ experiences of presenting their work showed mostly positive results, with some issues around navigation (RQ1); visitors also reported strongly positive experiences, using features such as chat, emojis, and voice conversations to engage in dynamic exchanges with the creators and one another, though they also reported some navigation issues (RQ2); and it was feasible to build and curate a design exhibition in Spot Virtual, with many benefits relating to time, cost, flexibility, sustainability, and accessibility (RQ3). While assessing these questions, we also noted that there are areas where

improvements can be made to enhance the experience for presenters, visitors, and curators, which we discuss in the following sections. We also provide a comparison with our prior experience presenting work in a 2D Gather world [11], and discuss limitations.

6.1 Social Interaction

Salama noted the importance of exhibitions as a forum for design students to publicly discuss their design intentions, and the synchronous nature of the Spot Virtual exhibition enabled that [18]. Similar to results of our previous work that showed exhibiting artists value synchronous interaction with visitors in a Gather virtual gallery [11], our design student participants and visitors were positive about the social interaction affordances that allowed them to both informally socialize and to discuss the design work while attending the opening event (RQ1 and RQ2).

One of our participants (P3) explicitly noted pleasure at being able to see gallery visitors looking at their design work (RQ1), however, it is likely that this can be improved. Hindmarsh noted the importance of being able to see what someone else is looking at [4] and this is enabled to some extent in Spot Virtual because each user can see where the other avatars are within the space and which design work they are facing, even from a distance. For example in the sculptural gallery, it is obvious which side of each centerpiece a visitor was looking at. However, there is no ability to follow the gaze of another user to see exactly what details of a particular work they are paying attention to. Spot Virtual does enable users to indicate something of interest by sharing their cursor, and though a cursor icon is visible at the bottom of the Spot Virtual interface, we did not observe or hear about any visitors using this feature.

6.2 Accessibility, Flexibility & Sustainability

The virtual exhibition expanded access, allowing students to share work globally and enabling participation by those facing mobility, health, geographic, or scheduling barriers, although we did not ask visitors where they were visiting from and if they faced such barriers. The ongoing availability of the gallery potentially allows visitors to revisit the gallery and reflect at their own pace. This outcome supports Salama's framing of exhibitions as reflective and pedagogical spaces [18]. By removing physical constraints, the virtual gallery extended opportunities for spatial storytelling and critical engagement beyond the brief timelines of traditional displays. Because more work was shown for each student designer, visitors were able to engage more fully with each project's conceptual and visual narrative (RQ2), enabling deeper reflection.

Multiple design student participants told us that the ability of their friends and family from other countries to join the exhibit online was a highlight (RQ1), and something they hoped would be made available to them in future design exhibitions. Unlike VR-only platforms that require specialized equipment, Spot's browser-based access lowered technical barriers. However, access to the virtual exhibition requires a computer and Internet, and so it may exclude users on the other side of the digital divide [10].

The design and installation in Spot Virtual provided significantly more flexibility in gallery sizing, scale and volume of work that could be exhibited. The ability to iterate on the design and change

the layout with no additional cost is a stark contrast to the limitations of working in a physical gallery, as we had previously noted [11]. Additionally, there was no quick turnaround to install work after a previous exhibition was removed, no deadline to vacate the space for a future exhibition, no need to uninstall and securely pack up artworks, and no risk of damage to physical materials, easing the curatorial burden (RQ3).

6.3 Interaction Challenges and Opportunities

While the participants and visitors shared positive experiences, there were some clear opportunities for improvement. The act of walking around a 3D exhibit object, such as the centerpieces, was somewhat awkward in Spot Virtual. In real life, you step around a museum sculpture radially, keeping your focus on the object. That circling maneuver is tedious in a desktop virtual world using arrow keys that move your avatar forward/back or left/right. An option to anchor yourself temporarily to an object so that left and right keys move you *around* the object radially would be a better interaction.

Multiple gallery guests mentioned that they enjoyed viewing the 2D images within the space, on the wall, rather than clicking on them to view them in 'near full screen mode' (RQ2). This type of viewing is more akin to the way you would look at a painting or photograph in a museum, and as in a physical exhibition, other visitors may be in the way, occluding the work. None of the participants or visitors mentioned this as a problem, but there is an opportunity in a virtual gallery to hide other visitors in order to view the work. One can imagine a 'reverse ghost mode' that makes other users transparent by holding down the space-bar or some other key, in order to have an unobstructed view of an image, video or sculpture. This type of interaction would fall in line with the suggestion of P2 to 'step outside the box of a typical gallery'.

The student designers could use the interactive features of the world and P3 did so, making use of post-it notes to provide more signage near their work (RQ1). However the students did not have the ability to edit the space themselves. There is an opportunity to envision a more dynamic gallery event in which students build out their own gallery rooms in response to visitor questions and comments. This would require a great deal of trust and training to avoid accidental or purposeful destruction of work, and could be best managed with room-level build permissions, something which is not currently a feature in most virtual world platforms.

Participants and visitors expressed excitement about the potential to include interactive 3D walkthroughs of the interior design projects (RQ1 and RQ2). However, full VR immersion would require headsets, posing economic and technical barriers for most gallery visitors. Future iterations could make use of exported Revit models shared via web-based 3D viewers, for accessible, headset-free navigation and exploration. However, embedding these *within* Spot Virtual would create individual instances shown in 'near full-screen mode' – we are not aware of any embeddable, multi-user, 3D walkthrough viewers that handle Revit models. This is an opportunity for improvement in web-based virtual world environments.

6.4 Web-Based Gallery Comparison

We previously described a study that involved presenting an interactive art gallery event in a 2D web-based virtual world (Gather) [11].

The design of these two events allows us to provide an experiential comparison across the two platforms. As noted in the introduction, we were interested in trade-offs of immersion and ease of use between the 2D Gather gallery and the 3D Spot Virtual gallery. The artists presenting in Gather worked with video, physical materials, and electronics, but none were video-game designers or reported significant experience with virtual worlds. None of those artists mentioned any difficulties with navigation at all. This is in contrast to the presenting students in our Spot Virtual gallery (and some of the visitors), who did note issues around navigation.

As we expected, the sense of immersion was higher in Spot Virtual, with participants noting that it felt like being in a real gallery, and enjoying the experience of walking around the 3D centerpiece objects, and reading the imagery on the walls by walking through the space. This differs significantly from the Gather gallery, which artists described as having a child-like video-game aesthetic, and where the artworks really needed to be expanded in order to be properly viewed. The 3D sculptures embedded in Gather were tiny static 2D images, which could be clicked on to load 3D models in near full-screen mode, but users could not walk around them the way the Spot Virtual visitors could walk around the centerpieces. From the curator production perspective, the two platforms were similar in terms of expense saving, increasing accessibility and improving sustainability. However, building the Spot Virtual gallery was easier than building the Gather gallery, and importing work into Spot Virtual was significantly faster. It was significantly easier to scale and move work in Spot Virtual than in Gather.

6.5 Limitations

Because the participating students volunteered to show their work in this venue, their opinions on the effectiveness may not represent all design students, and their responses during interviews may also be subject to participant bias or novelty effects. We had a small number of designers showcasing their work ($n=5$) and so larger studies could more deeply interrogate the utility of using this type of platform for exhibition and educational purposes.

7 Conclusion and Future Work

We employed an exhibit-based research methodology [1] to investigate how the web-based Spot Virtual platform can support the social exhibition of design work. The outcomes of this study demonstrate the potential for 3D web-based virtual environments to enhance the exhibition of, and visitor engagement with, interior design work. The in-world building affordances in Spot Virtual enabled the creation of a gallery that ‘reads like a real gallery’ (P2), and supports ‘encounters’ between designers and visitors. Gallery visitors and exhibitors were able to interact with each other in real time through voice and video, unlike most commercial gallery platforms that provide bespoke 3D galleries as individualized instances with no social interaction. Gallery visitors reported positive experiences interacting with each other and with the design work, especially the 3D centerpieces. We also contribute a list of interaction design opportunities for platforms to more explicitly support web-based design exhibitions in social virtual worlds.

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