

Practical Insights for XR Devised Performances

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Abstract. Devised performances are produced through improvisations and theater games in order to develop a story. Devising has a tradition of using supplementary media. However, its collaborative storytelling process presents design challenges when using Reality Media (XR). We present a series of challenges and design insights derived from the production of a devised performance with XR, *The Safety Show*. This novel performance utilized 20 mobile devices networked to a stage manager running a shared XR experience with live actors. The work sketches a rich space for research and creative expression.

Keywords: Augmented reality, devised performance, interactive non-fiction

1 Introduction to XR Devising through The Safety Show

Devised performances engage a group of committed actors to develop a story through improvisational games and creative exercises. The production is developed in a participatory culture [1]. Increasingly, ensembles are supporting their work with computational media. Augmented, mixed, and virtual reality—referred to as Reality Media (XR) [2]—can now be integrated into the devising process [3]. To aid practitioners, we present design solutions to issues that arise during the production of XR devised performances. These insights are derived from a devised XR performance called *The Safety Show*. Additional inspiration came from scenographic theory [4]. The production, practice-based design research, was an experimental step in an emerging creative practice.

The Safety Show was performed in February 2019 at DramaTech, a theater at the Georgia Institute of Technology. It was part of a campus-wide collective art project entitled *I Feel Safe When* created and lead by resident artist Jennifer Edwards (2015-2018). For the show, six student actors devised stories about feeling safe. They included losing a friend, losing a grandfather, witnessing a birth, body shaming and empowerment, religious disillusionment, non-binary empowerment, mental health, self-discovery, friendship, and the campus police’s fatal shooting of Scout Schultz, a nonbinary engineering student in their senior year [5].

The performance was directed by Melissa Foulger and the ensemble. In total, 34 students participated [6]. The show was performed over two weekends with two performances per night. With the support of a grant, 20 iPhone 7 devices were rented and shared between audience members. Over the show’s run, 78 people attended. Their reactions varied depending on the night, their familiarity with XR, and how well the technology worked. The university wrote a news article heralding the work as innovative. A short video on social networks garnered thousands of views [7,8,9].

2 XR in the Production Process

The devising process is dynamic. Its variability can make implementing XR an obstacle to improvisation. While human factors can change quickly to suit a performance’s new direction, computational factors are procedural and cannot be altered with ease. Nonetheless, XR designers and developers need to be committed to the devising process.

In pre-production, actors practice engaging with XR that is invisible to them but visible to an audience. Once learned, the actor can use their movements to bridge the physical experience and the XR. The actor can become “a form of living scenery”, as scenography scholar Pamela Howard has written, “the human body may be considered as the primary plastic element for the scenographer to work with in creating the unity between space, object, light and performer” [10]. We challenge actors to create dramatic tension between their bodies, XR, and members of the audience.

In early production, an aesthetic play between the XR, actors, and set should be established. For example, an audience’s suspension of disbelief can be tickled by considering the physical space and its tension with the invisible yet present XR. In the show, this play occurred through a real-time multi-user network that enforced the XR’s social presence even when an audience member wasn’t using their device. Accordingly, XR designers should consider ways in which XR can create interactive, spatial, and visual tension [11]. The media should enhance the spatial presence of a story that develops from the actors’ gestures and the audience’s movement.

In mid production, rehearsals begin, the crew begins working out technical aspects, and actors solidify their script and choreography. XR designers focus on elevating details for dramatic effect through the creation of digital assets and prototypes. In *The Safety Show*, this process changed two physical platforms, meant to represent a mountain, into an XR forest with trees, clouds, and rocks—animated birds flit about as an actor told their story. As part of creating these and other assets, actors had their motions captured with the Orion iKinema system and an HTC Vive. Actors’ movements were rehearsed while practicing monologues aloud. Once satisfied, actors’ motions were captured. If necessary, they were re-recorded. The process lasted one hour per actor.

Audience placement is established during mid production and can be a challenge. The XR and actors looked best from certain angles, but *The Safety Show* allowed the audience to move freely. Actors gestured audiences toward these better viewpoints. We also considered stationary iPads for the XR. This could have been an effective primary setup for spectatorship or a secondary support to improve the XR’s accessibility for people with reduced mobility.

In late production, technical rehearsals are underway in preparation for the performance. The ensemble should look for ways to elevate aspects of established XR. In the show, the petals of a cherry blossom tree fall to the ground as an actor relates his grandfather's death. He gestures toward petals to create a shared dramatic moment through the XR. The petals were added in late production to enhance the existing XR tree. Another example: it became clear that actors' motion-captured models were stuck in the uncanny valley. Since the models' faces did not move, their monologues seemed disembodied. Accordingly, a ghost shader was applied to the models. This spoke to the biographical nature of the actors' monologues and improved their presence.

During late production, procedures for stage management should be finalized. This includes how the XR will be managed and how devices to access the XR will be deployed. For *The Safety Show*, XR was synched asymmetrically between the audience members' devices and the stage manager. Two apps were developed: one for stage management and the other for the audience. They were synched using the Photon Pun Network solution for Unity. The audience app provided only a screen to look through.

The stage management app was designed for an iPad screen. Each act had a screen of buttons to cue XR. These were deactivated after they were pressed to avoid repeated instantiations. When this method didn't work, it caused a cascade of failures as the stage manager would attempt to synch the performance. It is suggested that a fail-safe button that clears the XR while maintaining tracking be included to re-synch the performance.

Regarding device distribution, if the ensemble lets their XR experience run on their audience's personal devices, the app needs to be downloaded. Once downloaded, the ensemble needs to confirm that the app is working before the show. If providing devices, a procedure needs to be developed for their distribution and set up. In our show, a docking bay with fast-charging stations that accommodated 20 iPhone 7 devices was constructed. Before the performance, members of the crew would check the phones to ensure their volume was up, battery was charged, and app was running. The phones had Guided Access turned on to keep the audience locked into the app. The crew would then detect features with the application to track the XR. Once all of this was confirmed, the devices were handed off to audience members who were instructed to raise their hands should they run into any issue. The crew then practiced running phones out to audience members having difficulties. This was an imperfect process.

During tech rehearsals, the apps and the Wi-Fi network need to be put under a stress test. Using one or two devices is not enough. The performance space needs to be filled with people. We were informed by IT staff that the water in humans can interfere with Wi-Fi signals. If a theater is small and has an aging Wi-Fi network, a packed audience moving about the performance space can cause issues. Placing Wi-Fi repeaters and network boosters throughout the space can and did dramatically help connectivity.

3 XR in the Performance: Maintaining the Illusion

Keeping the audience engaged with the XR can be a challenge and even an obstacle to the performance. This challenge is caused by the weight of the devices, how hot they

get, unfamiliarity with XR devices, technical issues, and how easy the experience is to enjoy. The cumulative effect of these challenges is a listless audience.

Stage management can be a challenge depending on the XR platform used and the performance space’s connectivity. Timing the instantiation of XR material requires not just responding to rehearsed cues but also the audience’s participation and an actor’s impromptu gesture. Achieving these moments to dramatic effect takes practice. The person controlling the XR needs a small crew to help them distribute devices, achieve tracking with the app, and collect devices. During the show, there was only one person managing the XR. This proved untenable. The show’s XR ran best when there were at least three other crew members. It became easier to respond to the actors and audience.

The final challenge comes when the devices need to be collected, charged, and set up for the next show. Over an hour, devices running XR will lose a substantial amount of power. If the devices are to be used again, they need to be recharged and sanitized. There were two shows per night with about 30 minutes between them. Depending on the audience, there were only eight to 12 phones available for the second performance.

4 Challenges and Insights for the Set and Digital App

Hiding technical elements, maintaining a safe space for the audience to move, and facilitating stable tracking for XR can be difficult. Masking can be used to hide pieces such as charging stations and Wi-Fi boosters, but it can obscure trackable features. We learned that the efficacy of tracking will be impacted by lighting cues, the stage’s texture, and a device’s allocated memory for the experience. In terms of lighting, as cues change so too will features. This alteration will influence the effectiveness of the tracking algorithms. During *The Safety Show*, lighting cues were removed in order to keep lighting stable. Additionally, between scenes, the performance space’s light was cued to its originally tracked setting to aid feature detection. Both solutions were imperfect.

Mapping the space for features will be difficult if the stage’s texture is uniform. While minimalism can be pleasing to the human eye, computer vision has a difficult time ascertaining differences in symmetrical designs scattered across a stage with shifting lighting conditions. This applies similarly to props’ textures and dimensions.

ARkit provides memory-efficient affordances for object, plane, and light detection. However, the complexity of models’ textures and polygon counts for XR can use a lot of an app’s allotted memory [12]. For our show, we learned that iOS devices released from 2017 to 2019 running iOS 12.1 only allow an application a 1.4 GB memory footprint. Passing that threshold causes an experience to crash. The current AR services will utilize about half that amount and do not leave much space for complex models.

5 Conclusion: A Call to Create

The Safety Show was a highly experimental project and provided insight into the potential challenges for XR in devised performance. Multi-user XR performances are a rich creative space in need of exploration. We hope this paper encourages others to devise their own XR performances.

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