Exploring Auditive Story Worlds

Design Sensitivities for Multi-linear Real Time, Mixed Reality, Interactive Storytelling Systems

ARIEL BLOMKVIST ROVA
ABSTRACT

Like reading a book, stories told orally or acted out auditory invite subjective co-construction of narrative events through imagination. While an interesting characteristic, audio-based, fictive storytelling is not well explored in HCI.

Eavesdropper is a prototype system for Mixed Reality Audionarrative, the stage being a miniature house and the actors residing in a spatialized, virtual, audio world. This work accounts for development and evaluation of some contextually unconventional, properties of one current iteration of the system, aimed at facilitating an exploratory mindset: sections of the narrative unfolding in parallel, controlled by parameters the user is only partially aware of.

Through qualitative evaluation with users, I report on how these properties affected the way a story world was experienced, explored and interpreted.

The findings, coupled with reflections on the design choices made, are then synthesized to a set of design sensitivities meant to inform and spur discussion and further inquiry into similar systems exploring audio as the primary mean for conveying narrative.
SAMMANFATTNING

En historia som berättas muntligt, eller drama som ageras ut med rösten (t.ex. radioteater), låter lyssnaren subjektivt konstruera händelser som bilder i den egna fantasin. Det här är en intressant egenskap hos ljudbaserat berättande men inte särskilt utforskat inom Människa-datorinteraktion. Speciellt inte vad gäller fiktiva berättelser för ett underhållningssyfte.

Eavesdropper är ett experimentellt, Mixed Reality-system där det dramatiska berättandet har sin hemvist i den virtuella sfären men kontrolleras genom positionering i det fysiska rummet. I den aktuella iterationen är den fysiska platsen ett fullt inrett modellhus i liten skala som agerar scen åt skådespelarnas röster.

I den här uppsatsen beskriver jag utvecklings- och utvärderingsarbetet med den aktuella iterationen där särskilt fokus lagts på några berättartekniskt och designmässigt icke-konventionella egenskaper: Användaren uppmuntras att subjektivt utforska berättelsevälden och dramats olika trådar löper parallellt i realtid utan synbar logik.

Genom kvalitativa utvärderingsmetoder så undersöker jag hur dessa egenskaper påverkar hur användare upplever, utforskar och tolkar berättelsevälden.

Resultaten tillsammans med reflektion över designprocessen ligger slutligen till grund för en uppsättning mjuka riktlinjer vilka är menade att användas för att orientera framtida diskussioner om, eller experiment med, liknade system där ljudmedia är huvudsaklig bärare av dramatiskt berättande.
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Like reading a book, stories told orally or acted out auditory invite subjective co-construction of narrative events through imagination. While an interesting characteristic, audio-based, fictive storytelling is not well explored in HCI. Eavesdropper is a prototype system for Mixed Reality Audionarrative, the stage being a miniature house and the actors residing in a spatialized, virtual, audio world. This work accounts for development and evaluation of some contextually unconventional, properties of one current iteration of the system, aimed at facilitating an exploratory mindset: sections of the narrative unfolding in parallel, controlled by parameters the user is only partially aware of. Through qualitative evaluation with users, I report on how these properties affected the way a story world was experienced, explored and interpreted. The findings, coupled with reflections on the design choices made, are then synthesized to a set of design sensitivities meant to inform and spur discussion and further inquiry into similar systems exploring audio as the primary mean for conveying narrative.

KEYWORDS
Mixed Reality, Audionarrative, Research through Design, Interactive Storytelling

ACM Reference format:

INTRODUCTION
As computers moved out of offices and academic HCI developed its third wave, previous design ideals of usability, intuitiveness and transparency were challenged [6,22]. In context of interactive art and entertainment, from which this works draws inspiration, some relevant currents in this vein include designing for play, exploration and openness in interpretation [20,23,36]. More or less explicitly, similar ideals often show in works utilizing sonic feedback [1,8,17,24,33].

These audio-dependent examples all generate music or abstract soundscapes, while interfaces for audionarrative, story and drama, are more less common (although not non-existent, i.e. [11,15,21,35]). Museums and heritage sites constitute an exception context where audionarrative appears more frequently [14,16,27,34,38]. For these locations, the auditive is chosen for evocative potential, speed in the computational sense and for how it can be used complementary to our other senses.

In the humanities, some scholars have argued that audio narrative in a broader cultural sense is being overlooked in terms of its ability to convey compelling experiences of narrative [9,12,30,31]. Defending radio drama in particular Tim Crook wrote: By giving the listener the opportunity to create an individual filmic narrative and experience through the imaginative spectacle, the listener becomes an active participant and 'dramaturgist' in the process of communication and listening. This participation is physical, intellectual and emotional [12].

Put together, Crooks sentiment and the examples from HCI, forms the rationale for Eavesdropper. It is a prototype system for audiences to engage in auditory story worlds through a tangible interface. In stories playing out through Eavesdropper, playback of multiple pre-recorded dramatized dialogue running in parallel is controlled by moving a tracked marker in three dimensional-space. Inputting these coordinates into the system is what controls which dialogue tracks are being played back to the user. Further, a time-controlled algorithm tries to maintain an illusion of the world being oblivious to the presence of the user, while still delivering the main storyline.

I frame the work presented in this paper as Research through Design [39]. Through developing, designing and evaluating Eavesdropper, I investigate possibilities and challenges of creating compelling, immersive experiences of mixed reality interfaces placing audio narrative at the forefront. My primary knowledge contribution is
constituted of a set of design sensitivities [10,13] pinpointing and discussing some particularly interesting aspects for design of such systems. The sensitivities are synthesized through critical reflection on design choices made and their effect on user experience, studied through qualitative evaluation. Through this work, I hope to inspire further inquiry into the domain of multi-linear mixed-reality storytelling putting focus on audionarrative.

BACKGROUND

Mixed Reality Performance

Eavesdropper draws inspiration from games and Digital Interactive Storytelling, for example Façade where story blocks can be put together in a multitude of ways while retaining narrative coherence [28]. However, due to the apparent lack of control and agency, the user cannot simply be regarded as a player. In some respects, the role of the user is more closely related to that of an audience member, listening to an auditory, theatrical performance.

With this in mind, I cast productions made for Eavesdropper as what Benford & Giannachi’s refer to as Mixed Reality Performance (MRP)[3]. In MRPs, elements of games, interactivity and theatrical performance are blended and scattered across the virtuality continuum [32] giving rise to a new genre of cultural experiences. In this genre, an experience might play out over multiple physical and virtual spaces extending through various temporal structures. Further, MRPs might employ an array of interfaces and feature different roles such as actors, orchestrators and participants. The boundaries of roles might also blur, for example turning participants into actors or orchestrators in their own right.

MRPs by their nature come inherent with tensions. As a tool for resolving these, Benford et al suggest the notion of Trajectories, resembling participants to be travelers on a journey through the experience [4]. Typically, the authors of the MRP will have an intended travel path in mind, the canonical trajectory, aligning with aesthetic and functional goals of the performance. Meanwhile, participants are generally free to act as they please within the performance, giving rise to participant trajectories and an implicit tug of war with the authors intent. To resolve this, Benford et al suggests employing transitions where participants are temporarily forced to converge with the canonical trajectory before being allowed to diverge again.

Designers of MRP also needs to consider the temporal structure of the worlds they create [2]. Relevant to this work in particular is what the authors refers to as: plot time, i.e. the temporal spacing of events occurring along the canonical trajectory, and interaction time, i.e. the duration of participant engagement.

The sweet spot

Löwgren highlights how artefacts with diverse goals might benefit from employing different sets of interaction aesthetics: What is aesthetically appropriate depends on what the user expects from the interaction experience, which is in turn coloured by their initial appraisal of the product, its purpose, its use potentials in short, its genre [25]. Benford et al even suggests that some genres such as games, artistic performances and thrill rides might benefit from outright
uncomfortable interaction, used as a means to an end for achieving intense and memorable experiences [5].

In the same vein, deception, the deliberate use of misdirection and setting false expectations, has been explored as a way to make an interface appear magic [1,26]. Tieben and colleagues showed a strategy for encouraging explorative use by layering bite-sized curiosity inducing affordances in an otherwise non-sensical interface [37]. Dalsgaard [13], deliberately employed conflict as a way to instigate inquisitive use. A problem without a clear solution, can force the user into a mode of investigating systems by trial and error where new information gained from success or failure, continuously modifies their conceptualization of the system. Designing for inquisitive use, Dalsgaard writes, the designer has to start regarding users as resourceful cocreators of experience in the use interactive systems, capable of finding ways of making sense of installations that are not self-evident in their structure, presentation, or operation.

Gaver et al in a prolific paper [19] argued for ambiguity as a quality that designers can use to suggest ways of use in artefacts without imposing the way of use. This allows users to make their own interpretations facilitating subjective meaning-making stronger than if the use case had already been prescribed. This work was expanded on exploring strategies for multiple, co-existent interpretations including for example downplaying system authority and gradually presenting new opportunities to reinterpret an artefact [36].

Hobyte articulates how inner complexity, in his work partly achieved through non-linear algorithms, is one factor that drives exploration and meaning-making from audiences of his work [23]. Importantly, he notes, in conjunction with Gaver and colleagues [18], that too much ambiguity or complexity risks producing systems that users simply can’t make any sense of. Consequently, designers should strive towards striking the sweet spot between complexity for exploration and simplicity for understanding.

EAVEDROPPER

Due to its playful, cute appearance, the miniature house catches the eyes of the user. As she approaches, a small object and a sign showing a picture where the object is held over the miniature. She picks up the object and begins trying to figure out what this means. Hovering the marker far away from the miniature produces the sound of city noise and a distant harbor. As the marker sweeps in over the building, the sounds are replaced by voices of a co-living house in Stockholm, Sweden. It’s the early 70’s and she hear people going on with their ordinary lives. At first it appears like nothing in particular is going on, but in the midst of talk about what groceries to buy for the communal pantries and the latest Bob Dylan-single, she intercepts a common topic widely talked about amongst the inhabitants. It appears like a painting has been stolen across town and hasn’t the most recently moved in couple acted a little strange? Through listening, the user begins to form her own suspicions about what might’ve happened. Suddenly, the police ring the doorbell and the offenders are exposed. They jump out their window, fleeing the scene. At this point, and the installation goes silent, indicating the end of the performance.

Idealized experience through Eavedropper engaging with the Mariaberget 1972-scenario

Eavedropper is a multi-linear storytelling system in which a physical space is augmented with a virtual auditory world. Areas in 3D-space act as trigger points for the playback of pre-recorded dramatized dialogue tracks which the user controls through a light weight, handheld marker. The tracks are being played continuously, whether or not they are being listened to, their volumes set to zero when the marker is held far away from their corresponding locations. Under the hood, critical narrative pieces are made conditionally available based on time and user location, giving rise to multi-linearity. In the iteration of the system surveyed here, the logic of the system is never made explicit to the user/listener to create an illusion of being a fly on the wall in the world. The term user/listener will be used throughout the rest of this paper to underline the dual nature of interacting with a technical system and being an audience member at an theatrical performance.

The physical space together with the corresponding audionarrative is referred to as a scenario. For the purpose of this study a scenario called Mariaberget 1972 was constructed. The story takes place in a miniature replica of a 1970s co-living house in Stockholm, Sweden. The different rooms of the miniature house host invisible characters and serves as points of interest for the user/listener to explore. The activity in the house appear mundane at first, its inhabitants humorously discussing music, parties and politics, soon a greater crime drama begins to unfold.

Design Process

The prototype evolved from a piece of course work carried out by me and co-student Tania Christensen. This very first iteration was not constructed with a particular research
agenda in mind and was exhibited but never formally evaluated. Going into the current iteration of the project, we began by discerning and refining different ways the first prototype provided opportunity for research. For me, the elusiveness and deceptive qualities of the system, and how it might be made sense of, emerged as particularly interesting. Meanwhile, Christensen, in a parallel research effort, has investigated supporting the storytelling-aspect (Christensen’s work will be presented in another, forthcoming paper). Recording sounds and making the miniature for Mariaberget 1972 was done collaboratively. Christensen took bigger responsibility for the script, while I focused on the software.

Design goals

In developing the prototype and aligning design efforts to the newfound design space, the following goals came to take precedence in my work:

- **Fly on the wall-illusion** – Through the life-like time continuity and the non-linear way narrative is made available to the user/listener, unique and compelling narrative experiences are created.
- **Interpretative openness** – Through free, playful, exploration in between critical narrative chunks, or by ignoring the canonical trajectory to some degree, users are allowed to find their own way of enjoying the installation.
- **Hierarchy of modalities** – The narrative is primarily told through auditory means. The miniature acts as a stage providing scenography to aid allure and immersion.

Producing the drama

It was out of our scope in this iteration to recruit professional actors, so we recruited amongst friends of ours that had some acting experience.Chunks of narrative important to the higher order narrative, were pre-written. In addition to the pre-written pieces, actors were asked to improvis around relevant political and cultural events of the time depicted. We refer to the improvisations as non-critical dialogue, as they don’t contribute to the canonical storyline. Conversely, the tracks residing on the canonical trajectory are referred to as critical dialogue coming as either constituents or clues. Constituents (the beginning and the ending in this case) were written to contain a minimum amount of information necessary to understand the story. In the later described evaluation, they were set to be impossible to ignore. Clues, meanwhile, were written to stand out from non-critical dialogue but remain somewhat ambiguous, acting as independent puzzle pieces which an attentive user/listener can put together from each other.

Making the miniature

After an iterative process of sketching and roleplaying journeys through the scenario, we arrived at the design for the house, which was then constructed using laser cutting, 3D-printing and a variety of fabrics and paint. Through the process of making we evolved the aesthetics and added objects as either cultural markers of the time depicted and sometimes as visual aid in getting to know the characters (for example posters on the wall, unwashed dishes and a record player). In addition, some objects were added to act as affordances indicating locations that we wanted user/listeners to pay attention to them as they held particular importance in the main storyline (for example a guitar, a locked door and moving boxes).

Writing software and designing the algorithm

Software for Eavesdropper was written in Python utilizing the pyGame-library for timekeeping and audio playback. It can be used either through keyboard-input with the arrow keys (primarily for testing), or as in the evaluation, through Motion Capture.

To allow authorial control while preserving the apparent nonchalance of story world, Acts were added to constitute the highest level of system state in scenarios for Eavesdropper. Each act contains a list of critical dialogues available at that point of the narrative, how many of the these needs to initiate and conclude before progressing to the next act (min crit), and a time value specified in seconds (crit interval).When the systems clock reaches the value of the crit interval, it enters crit pending-mode, meaning that critical events are made available. Triggering a critical event results in playback of one piece of critical dialogue. When the duration of a critical dialogue-track is up, the time interval either resets so that another crit interval has to pass before critical dialogues are again made available, or, if the min crit-value has been reached, the next act is initiated bringing a new set of rules.

Event triggers comes in three varieties:

- **Stumble** – Starts immediately when the system is in critical pending-mode and the user/listener enters a new room. Will keep running if the user/listener leaves the room.
• Callout – Starts immediately when the system is in critical pending-mode. A character’s voice is heard globally, as if yelling across distance, urging the user/listener to pay attention to a certain location. Playback of the corresponding dialogue starts immediately, doesn’t wait for the user to arrive or pause if the user leaves the location. However, before arriving or in case of leaving, the dialogue track is still heard globally for its entire duration, volume set low to simulate it being heard through the walls of the house.

• Interruption – Starts immediately when the system is in critical pending-mode. Multi-linearity collapses with all characters going silent leaving space for a globally heard scene to play out.

EVALUATION

Experimental setup

The evaluation was conducted in a laboratory setting using Motion Capture to track the marker used by participants to interact. Audio was played back in stereo through eight speakers, circularly located around the user/listener and the installation.

Configuration of Mariaberget 1972 for evaluation

Preparing for evaluation, I chose the following temporal and narrative structure:

<table>
<thead>
<tr>
<th>Act</th>
<th>Crit Interval</th>
<th>Min Crit</th>
<th>Critical dialogue type</th>
<th>Trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>90 sec</td>
<td>1</td>
<td>Constituent</td>
<td>Callout</td>
</tr>
<tr>
<td>2</td>
<td>30 sec</td>
<td>2</td>
<td>Clues</td>
<td>Stumbles</td>
</tr>
<tr>
<td>3</td>
<td>20 sec</td>
<td>1</td>
<td>Constituent</td>
<td>Interruption</td>
</tr>
</tbody>
</table>

Table 1: Event schedule for Mariaberget 1972 used in evaluation

For act one, ample time to familiarize with the installation was to be given: the layout of the house and how to operate the interface. This act concludes after a character yells for all the house inhabitants, and the user/listener, to come hear a news report introducing the stolen painting.

In act two, the crit interval was kept low in order to ramp up the minimum pace of which the act is completed. Throughout, stumble-triggers were used for critical dialogue containing clues suggestive of what might be going on. The act concluded when two out of three available critical dialogues had played out.

In act three, the regular flow of things suddenly breaks down as a child has found the stolen painting in the room of the new couple. The perpetrators realize they’ve been exposed and are heard fleeing out the window as the police knocks on the door.

Participants

Seven participants were recruited with the requirement that they were unfamiliar with my work and had not been in contact with the initial, proof of concept-prototype. Five of them were co-students from KTH, Royal Institute of Technology in Stockholm, Sweden, currently or previously enrolled in the degree programme in Media Technology (MT). Two participants had no similar education and, importantly, less experience of HCI experiments and novel lab technologies in general.
However, this last piece of data was not utilized in analysis, its purpose already adequately fulfilled by the video recordings.

Following the test session, participants were asked about their subjective experiences in semi-structured interviews. Since Mariaberget 1972 was performed in Swedish, all participants were Swedish speakers and their interviews were conducted in the same language. Quotes that were to be used in the findings-section were later translated back into English.

Interview questions were formulated based on Wright & McCarthy’s framework for sense-making of experience with technology [29], inquiring into how participants anticipated, connected, interpreted, reflected, appropriated and recounted their experience. This particular framing of user experience was chosen due to its emphasis on subjective sense-making, prevalence amongst cited works and relative ease of adoption for a laboratory-setting.

**FINDINGS**

Analysis of the interview data was carried out through Thematic Analysis [7]. The transcript interviews were reviewed and annotated unconditionally in the initial stage, collecting a bird’s eye view of participants experiences. In the first round of coding, I partly switched to a deductive lens, looking for impact of my design choices in particular, but not discarding any data points. After a second round of narrowing codes down, I mind mapped to arrive at the final five themes.

Video recordings were examined in parallel and is where I shifted towards a semantic style of reading: annotating whenever participants thought aloud, how they acted, their gaze and their facial expressions throughout their interaction with Eavesdropper. This data was read carefully for latent, unspoken facets of participants experience which

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**Figure 3: Example user journey through Mariaberget 1972 with the configuration seen in Table 1.**

<table>
<thead>
<tr>
<th>Code</th>
<th>Age</th>
<th>Gender</th>
<th>Education background</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>23</td>
<td>Female</td>
<td>MSc-level student, MT</td>
</tr>
<tr>
<td>T2</td>
<td>25</td>
<td>Male</td>
<td>MSc-level student, MT</td>
</tr>
<tr>
<td>T3</td>
<td>25</td>
<td>Male</td>
<td>BSc-level student, MT</td>
</tr>
<tr>
<td>T4</td>
<td>25</td>
<td>Female</td>
<td>Graduated from MT</td>
</tr>
<tr>
<td>T5</td>
<td>27</td>
<td>Female</td>
<td>Graduated from MT</td>
</tr>
<tr>
<td>N6</td>
<td>28</td>
<td>Female</td>
<td>No education related to technology</td>
</tr>
<tr>
<td>N7</td>
<td>25</td>
<td>Male</td>
<td>No education related to technology</td>
</tr>
</tbody>
</table>

**Table 2: Participants partaking in the evaluation**

**Procedure and Data Collection**

Prior to seeing the installation for the first time, participants were verbally informed of their task. This information was pre-written and standardized and read: explore the installation, in any way they saw fit and at their own pace. Thinking aloud during the experiment was encouraged but optional. Finally, they were told that the installation would shut itself off when the experiment was completed. After hearing the instructions, they were allowed to ask any further questions which were answered as clearly as possible without spoiling the essence of the installation itself.

Once inside, they were left alone in the room with the miniature house positioned at a table, the marker, right next to it. At the table was also some printed images on a sheet of paper that showed a hand holding the marker above the house. Meanwhile, I entered a neighboring room, out of sight but where the sound output could be heard.

Participants interacted with the system for the duration of Mariaberget 1972, ranging between 6-13 minutes, depending on how long they wanted to spend listening to dialogues. Two cameras video recorded the action and the system kept a log of where the marker was at regular intervals. The log would provide the ability to reconstruct each participant journey as a two-dimensional image. However, this last piece of data was not utilized in analysis,
were presumed to be difficult, or undesirable, to articulate in the face-to-face interview.

Confusion and intrigue
All of the participants were confused to a varying degree coming out of the test session. Some managed to stay longer on the canonical trajectory, while some picked up only on the constituent critical dialogues which showed to convey too little information, causing a disjointed experience. To some participants (T1, T3 & N7) this was very frustrating. In the later parts of their video recordings and during the interview, they appear resigned, their further engagement driven by obligation rather than any excitement.

"I would say it’s frustrating. You try to find the meaning of this whole thing, exploring the rooms and trying to find connections between them. Perhaps it was a game of some kind? Sometimes it worked, and sometimes it didn’t. So what did I do different this time?" (T1)

T2, T4, T5 and N6 were intrigued, wanted to discuss, get explanations, propose suggestions or even try again (N6, T4) once interviews were concluded. T2, the participant who picked up most of the canonical trajectory-related dialogues, and T4, who was in the lower end, respectively said:

"This was very exciting. It was a good thing that you told me to explore it on my own, beside the small instruction on how to hold the marker. It was fun to get free rein." (T2)

"It’s very cute and very fun! I have no idea what the point was, But I don’t care that much." (T4)

Misplaced ambiguity
The instructions given going into the test session were interpreted very differently and this is possibly one factor contributing to confusion while also highlighting some flaws of the design.

In some cases, the instructions or the marker, rather than the installation, appeared ambiguous. In the video recordings, all of the participants are seen trying out a wide array of different actions, sometimes with the miniature itself (lifting and moving furniture around), but mostly the marker (rotating, moving it fast/slow between different rooms, poking the miniature etc.). T3, initially convinced that the installation was a kind of a game or a riddle to be solved through interaction with the marker, came to the conclusion that this assumption had been wrong. To him it appeared the installation did not have a greater purpose at all:

"I was very focused on identifying the problem which took some of the fun out for me. If I would’ve known there was none, I would’ve just explored and that would’ve been more fun for an extended time. I didn’t really listen to the conversations but instead I was looking for patterns (in the interaction). Like for example, what happens if I go from one room to another really fast, and then on to a third room. Or if I direct the spheres of the marker differently, will that change what I hear or who is talking?" (T3)

In practice, this meant that attention was directed away from the aspects of the prototype that was actually under study, highlighting a significant flaw of the design. In experimenting with the controls, participants often triggered stumble-triggers unknowingly so that even if they later decided to focus on listening for clues, the opportunity to do so was limited as many had critical dialogue tracks had already played out.

To some extent this was expected. There was always a possibility that some participants would not collect enough information to fully grasp the canonical story. However, a third unwanted property of the unforgiving algorithm also showed. T1, T4, T5, N6 and N7, given the instruction to explore, focused on rooms of the miniature appealing to them either visually or because they found a dialogue particularly entertaining. To them, the inevitable interruption-trigger, the ending, cut the experience off in advance:

"I would’ve liked to go on for longer. Stay in all the rooms for some more time. Somehow, I triggered so that it turned itself off. I wish it would’ve been slower, specifically since I enjoyed it and wanted to hear all the stories" (T4).

The “right” way to experience Mariaberget 1972
Plenty of interpretations and appropriations were suggested by participants as a consequence of the systems openness. Some were made during the test session and some were hypothesized afterwards in the interview. Simultaneously, all participants, in some way, discussed whether they had done what was expected of them or not. Although T5 went on to provide a multitude of alternative, desirable use cases and opportunities for the system, the critical dialogue introducing the stolen painting could not be ignored once it had been heard:

"I guess the point was to... Experience. It’s a story. That’s what I think. And, secondly to take part of several other, smaller
narratives. The first thing that happened was that I was assigned a quest, to solve a mystery. So, should I stay in a room, and for how long? Will doing so provide me with anything useful or help me with the quest? The quest isn’t for me to just stand around listening, but to solve something. I’m tasked to help with this lost painting and listening to a discussion about class society won’t help with that. So, at points I was kind of back and forth whether to stay or leave a room. And once I had heard one deep discussion, I decided that was the only one I was going to endure." (T5)

Concurrently, some participants did not make sense of the introductory critical dialogue at all. They went on to looking for other enjoyment, the validity of which then was questioned as soon the less ambiguous ending inevitably started.

"I think that, since the audio tracks were linked to the rooms, the purpose was to paint a picture of what was going on in the house. And since the ending contained the line ‘we got to run’, I guess there was some kind of murder mystery, I don’t know. Something along those lines” (T1)

Besides the aforementioned notion that the installation would’ve been adequately satisfactory as just a simulation of hippie life in the 70’s, several interpretations were made, even though some of them were also perceived as illegitimated through the ending scene. Some examples included:

“Immediately I thought it was going to be some kind of Cluedo. Something about going from room to room collecting clues and puzzling them together to a story” (T2)

“It was cozy. It felt like an art installation. If you go to a museum, the meaning of all works is not immediately made available to you. You got to make an effort to get into it. In a way, I wasn’t immediately pulled into this one, instead it required me to invest in it from the start” (T3)

T5 and N6 associated, in different ways to children’s play with dollhouses.

“In a way, this is very similar to how you would play. You didn’t have any explicit story or quest in the same way, but still you’d walk the doll into a room, dropping them off imagining them keeping on with their business meanwhile you continue moving another doll somewhere else.” (T5)

“The first thing I did, before even laying eyes on the marker, was to start fiddling with these (points to unwashed dishes in the kitchen sink), ‘Damn, it’s messy’. So, it’d been fun if you could tinker with the furniture and explore that way.” (N6)

Multimodal interplay

The miniature itself proved to add quite a lot of complexity. In the video material, participants gaze is seen drifting between different parts of the miniature at rapid pace. Visual and auditory cues, put in place to support paying attention to locations important to the canonical story, worked to a varying degree. T1, T3 & T4 were caught off guard by the callout-trigger, as they had not yet noticed the TV, and needed time to locate it. In interviews, T1, T2 and T4 said they noticed the odd door, were intrigued by it, but did not understand the role it played in the story. Meanwhile, T1, T2, T3 & T4 all became curious about objects in the miniature after they had heard mentions of them in the dialogues.

“Immediately I thought it was going to be some kind of murder mystery, I don’t know. Something along those lines” (T1)

Hearing about the lost painting, T2, T4 & N6 started looking for signs of it within the miniature.

“When I heard about the lost painting, I stood up, walked to the other side of the miniature trying to see if I could locate the painting.” (T2)

Being in Mariaberget 1972

Investigations of how the story time worked were present amongst all participants. Those who mentioned it explicitly were asked about their understanding of how story time operated in the scenario.

“I feared that I hadn’t been at the right place at the right time. If I had redone it, I’d sit in every room until I heard the complete dialogue. I’d do that six times so that I could hear everything. It was difficult to know… Now there’s a dialogue starting over here, and I don’t know if it’s worth listening to, there was no sign for me to go there. Would I like a flashing light indicating that I should move on? No! But maybe a lot of things happened that I did not perceive? Now when we speak of it, I get some real FOMO (Fear of Missing Out).” (T5)

T4 was unsure whether or not the dialogues were affected by the presence of a listener:

“Even though you don’t really interact with the characters, I get the sensation that I’m in control and indeed influence the course of events. I’m not sure… Perhaps the story would’ve been different if I wasn’t in a particular room at a certain time? Maybe they acted differently because I was listening?” (T4)
Participants were conflicted on whether more evident guidance would’ve made for a better experience:

“If it’s important that you explore the miniature on your own, I guess it shouldn’t have any additional guiding elements... But maybe it’d be good with a note stating that time continues with or without you, so that the user doesn’t spend time figuring that out and instead focus on exploring.” (T1)

“I know that there are instances of (immersive) theatre that works this way, going on everywhere around you. That’s certainly thrilling because it’s more real than classic actors-on-a-stage-theatre. But it’s a bit of a shame, since I wanted to hear all the stories... Still, it would’ve been weird if the audio tracks paused while I was not there...” (T4)

Further, some participants elaborated on how they experienced the very act of listening through Eavesdropper.

“It felt like I was invisible, like an invisible listener just hearing what went on in the rooms.” (T2)

“It was a little bit uncomfortable at first (laughter), and then it grew... It grew to be enthralling. To be in control. But also creepy in a sense, like I was being a little intrusive, even knowing that they are actors.” (N7)

**DISCUSSION**

Although my findings certainly uncover flaws in both system and experiment design, they also display potential for further inquiry. Gaver et al, in context of their work with domestic technologies, make a proposal for evaluation criteria’s of potential for open ended, interpretive systems: *Engagement, Reference, Accommodation and Surprise and Insight* [18]. The latter two are somewhat exclusive to longitudinal use, but the first two are present here. Some of the participants stayed after the interview to learn more, discuss and even try *Mariaberget 1972* a second time. All of them related the experience to other technologies or forms of entertainment in a positive sense, including films, escape rooms, immersive theatre, play with dolls, visits to museums and heritage sites, board games, and of course video games.

Addressing the flaws of experiment design, the way the experiment was introduced to participants stands out as a significant error source. Some participants spent much time trying to control the installation, through the marker, when the system is not meant to be controlled. The marker was discussed in the design process but ultimately, not designed or styled in any conscious way. This meant that participants used an object unfamiliar to them which, additionally, did not display any affordances of its own. The assumption was that when paired with instructions, particularly the printed images present at the table next to the miniature, it would suffice for this experiment, and thus enabling time to be diverted elsewhere. In hindsight, this prioritization appears to have been a wrong choice. If the marker for example visually had resembled an ear or a microphone, it itself might have communicated that the point of it was to use as a way to listen and nothing else. Time-efficient ways of reducing the effects without investing into designing the marker, would have been improvements to the instructions process. For example, the verbal information could have been more extensive, given in written form to participants to read at their own pace and even have been present in proximity of the installation for review during the test itself.

Looking forward towards further development and natural testing in social settings and outside of the laboratory, the reliance on Motion Capture-technology needs to be resolved. Equipment for accurate 3D-positioning remains expensive but small-scale electronics and sensor-based solutions should be explored. For example, utilizing a magnet stuck on the marker and installing sensors beneath or in the miniature allowing a micro controller to calculate position.

**Design sensitivities**

I will now discuss the challenges and possibilities that emerged from the findings.

**Space for Interpretation**

It is safe to say that the triggers in this iteration were not fitting and that the *sweet spot* between complexity and simplicity, was not hit. The evaluation showed that having the *choice* to disregard, or pay less attention to, the narrative presented as part of the canonical trajectory, is not the equal to *downplaying system authority* in the sense of Gaver and colleagues [36]. If not from the very beginning, space for re-interpretation as the user/listener goes along also diminishes when the existence of the mysterious art theft is known. In my evaluation, this part always appeared *more* important to participants than any other interpretations of purpose they might’ve had.

In order to have a canonical storyline but still support multiple interpretations, static triggers should be used very carefully, if at all. Instead, the canonical storyline could be told in a larger number of smaller bits pursuable at wish
making it more of an Easter egg to be found only by somebody who chooses to look for it. Alternatively, static triggers could be used more in conjunction with the introduction of additional player agency giving systems more of a game-like quality.

For both of these cases, an even higher resolution of authorial control through the software would be needed. Specifically, the ability to cut and paste within audio tracks even as they are playing while still hiding seams to preserve track changes sounding natural.

The right pace

The idea behind having critical dialogues to be played, roughly, at regular intervals was to provide a rhythm making sure the experience isn’t perceived as boring. However, the evaluation shows that choosing this time interval to fit all user/listeners, is very difficult and risks contributing to sensations that there indeed is one correct use of the system.

If desirable to implement and retain openness in systems like this, either the story could be made more multilinear, while offering different ways of reaching the end and not employ time limits, or the time intervals could be made variable, adapting to the interaction pattern of individual user/listeners.

Interplay Between the Audible, Tangible and Visual

Due to sheer number of objects present in the miniature, participants were unable to differentiate things there to indicate the location as important to the canonical story from those that were just pieces of the set. While this could be alleviated by stronger highlighting of important objects (e.g. a LED lighting up), this should be done carefully if the intent is to keep a continuous, non-linear temporal flow, as was the case in this instance.

On the contrary, it might be more efficient to employ auditive cues to prompt use of vision and touch. When a guitar was heard being played in a room, some participants noticed the physical little representation of a guitar in that same room. One participant even moved the marker closer, trying to interact with it, perhaps to make it play a different song.

Further, a few participants realizing the stolen painting might be in the house tried to visually locate it, in one case even lifting and moving objects around. Deliberate use of these alternative ways of interacting, is a very interesting opportunity, particularly if we want to investigate more ways of interacting with the system that can be employed in parallel.

Real time Multi-linearity for Active, Attentive Engagement

All participants investigated how story time worked in the scenario, many of them reacting strongly when learning of the real time multi-linearity, some were made uncomfortable in the sense that Benford et al [5] refers to as surrendering control to the machine. Some participants, afraid they’d missed out on something important, asked to try the installation one more time choosing a different route through the experience. In a broader sense, it appears like a real time, multi-linear, temporal flow has the potential to instill a sense of urgency which can prompt active, careful and attentive engagement.

Employing a continuous time flow in narrative might to some degree be transferable to other forms of streaming media (e.g. film, computer games) but could be significant in the specific context of auditive drama. Crooks sentiment about radio drama, the listener as an active participant and ‘dramaturgist’ [12], hints at an interesting design space, but the general perception he argues against, that of a “blind” and lesser medium, remains. Further, I would argue that the very act of being an active, attentive listener of radio drama is a slow and cognitively demanding activity compared to some other forms of entertainment, e.g. films and video games. Alternative ways of temporal structuring, such as the one employed in this study, facilitates novel opportunities for interactivity in the genre. These might in turn help the idea of consuming audionarrative appear fresh and exciting.

CONCLUSION

In this paper I have accounted for the development and evaluation of a system for facilitating auditive story worlds in mixed reality. Audio recordings of dramatized dialogue are played back based of the position of a marker in relation to a miniature house. The findings were analysed to inform four design sensitivities, discussions meant to serve as inspiration further work in the area. The first one, Space for interpretation, refers to ways of making story worlds enjoyable for users with different intents. The right pace highlights how these intents in turn demand different tempos of which events in the worlds unfold. Interplay Between the Audible, Tangible and Visual deals with multimodal opportunities in such Mixed Reality constructs. Finally, Real time Multi-linearity for Active, Attentive Engagement, suggests that perceived temporal unforgiveness, can enhance experiences of audionarrative.
REFERENCES


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