

Real-World Interactive Audio

Implementing Game Sound Mechanics in a Real-World Environment

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1. Introduction

1.1 Abstract

This project is both an interactive theatre piece and the system that was developed in the process. The piece is told entirely with sound using the authoring tool for the Audiokinetic's Wwise audio engine in conjunction with Pure Data, which acts as the 'game engine'. This system was developed to combine the benefits of game audio with theatre sound and provide a platform for designers to tell interactive non-linear stories within a real-world environment. This report is structured to outline the three main benefits of this system: the ability to tell non-linear narratives, create immersive worlds, and encourage real interactivity from an audience.

1.2 Submission Materials

- Folder of Pure Data Patches (Main patch: 'am_finalProject_pureData.pd')
- Wwise Project
- Arduino Code
- 'Playthrough' Video

2. Non-Linear Narrative

2.1 Introduction

The art of theatre evolved out of the need to more completely involve people in the stories we tell, to share a collective experience in order to better understand one another. When done successfully, the shared space of audience and performer(s) can create an experience so involving that it makes you forget everything outside of a single moment. Videogames cultivate immersive experiences by allowing players to actively participate in a narrative. By presenting a player with degrees of agency they provide a platform for stories that follow entirely new structures. This system aims to provide a platform so that these types of stories might be told in a real-world space.

Stories told in theatre tend towards traditional linear structures, as dictated by the director and playwright who aim to enthrall an audience with their telling. Immersive theatre productions aim to break audience passivity by bringing them into the action, but still typically follow a tightly controlled linear structure. While there are productions that are experienced non-linearly, I argue that they do not reach the level of non-linearity explored in games (Bayes 2015).

The role of sound in a theatrical narrative is usually a passive one, an accompaniment to the action rather than the driving force behind it. By removing the visual aspects and focusing on a system that is sonically rich, this work shows how sound can drive a real-world narrative. This section will discuss types of non-linearity, how they might be achieved by this system and ways they were implemented in this project.

2.2 Background & Relevant Research

A non-linear narrative can mean a number of things depending on the inherent restrictions of the media or conventions within the form. This section will discuss some of these and how they influenced this project.

2.2.1 Fixed Media

Non-linearity found in this form is essentially telling a story out of sequential order. Examples of this type of fixed non-linearity can be found in films, television, novels, radio and traditionally staged plays. It is a technique that can be used to generate mystery surrounding a certain situation, a character's arc within a narrative or tell parallel narratives. By definition, once experienced, a piece of fixed media cannot be changed and will forever be experienced in the same way.

For the purposes of this project we will treat traditionally staged theatre as an example of fixed media. Actors follow a set script with direction and are encouraged not to deviate from this pre-defined template. The arch of the story may be non-linear; but the same structure is followed every night, without any significant deviation.

Examples:

Memento – Dir. David Fincher (Film)

Westworld – Created by Jonathon Nolan and Lisa Joy (Television)

Slaughterhouse Five – Kurt Vonnegut (Novel)

2.2.2 Game Narrative

There are number of ways to experience a non-linear narrative within a virtual environment. This section will outline ways my own experiences influenced the direction of this project, however, there are a number of interesting cases that will not be covered here. For example, narrative structures within the genre of MMORPG (Massive Multiplayer Online Role-Playing Games) are worth exploring in more detail. See appendix A for definitions and examples.

Each type of non-linear structure requires varying levels of control from the writing and programming teams. If the player does an action how should the system respond? If the player does to C before, or instead of G, how does the narrative change? Thinking about narrative paths and interlocking structures in an open-ended RPG allows designers to imagine an entire ‘living’ world around a situation. If a player is to feel that they have influence over and are crafting their own unique story they must feel the impact of their choices within that world, otherwise it can breed resentment when they feel their agency over *their* imagined story is taken away from them (Clarkson 2012).

Within a virtual world it is easy to limit the way in which a player interacts with their surrounding environment. Invisible barriers can be placed, and the rules of physics rewritten. When restricting interaction in the real-world the number of interactions available within a space should not be reduced, instead the influence of an action over the system should be controlled. For example, a button press during one point within the story has a different reaction than if it were pressed in another section. Designing the sonic aspects of such a reactive world requires the equivalent of a dynamic game audio engine, capable of reacting to sudden changes in real-

time. This system aims to deliver that by processing real-world triggers into digital data.

2.2.3 Immersive Theatre Narrative

Immersive theatre companies such as *Punchdrunk* still work in linear storytelling but create shows that are experienced non-linearly. In their seminal show, ‘Sleep No More’, the audience is placed in a warehouse and given complete autonomy over where they go within the space. For the actors, scenes still occur linearly, and the sonic elements are played entirely linear (Lighthouse Arts 2015), but the audience experiences the show in a non-linear way. In the case of ‘Then She Fell’ from Third Rail Projects, interlocking narratives allow an individual to feel as if they are experiencing their own unique story. Eventually each audience member experiences the same scenes, but in a different order to the others. For a more detailed look into ‘Punchdrunk’ and immersive theatre narratives see appendix C.

2.2.3 Impact on Project

My research into non-linear narratives, directed me towards two possible ways to achieve videogame non-linearity in a real-world space:

- 1) Create a space in which the participant might explore, freely interacting with a number of objects in any order. Similar to the open world RPG’s or true sandbox games.
- 2) Provide a structured experience with a smaller number of objects acting as an ‘interface’ to control the progression of the story. Force the participant into making a series of moral choices.

2.3 The Narrative

2.3.1 Story Outline

In the basement of a top-secret commercial facility a long-neglected experiment, monitoring interactions between quantum particles, begins to report unusual activity. It was discovered that the observed phenomena are replicating the behaviour of audio waves and, when interpreted as such, fill the room with entirely new sonic worlds.

As a foremost researcher in experimental quantum communication, it is your responsibility to strengthen this connection, determine its source and what it could possibly mean for the world...

This narrative centres around a single moral choice which leads directly to one of two endings, do you destroy your own world (either purposefully or accidentally) or the world that is attempting to make contact.

The parallel world and quantum theory aspects of this piece were inspired by a joint paper from Griffith's Centre for Quantum Dynamics and the University of California (Hall, Deckert, and Wiseman 2014). While the idea of an aggressive other world came from the novel 'The Three Body Problem' by Liu Cixin.

2.2.2 Narrative Reasoning

At the beginning of the development of this system, I outlined two important restrictions that would influence the structure of the narrative:

1. I could only afford to build a limited number of interactable objects, due to budget and time constraints.
2. Unlike site-specific immersive theatre narratives, this story needed to be independent of the space as it would not have a permanent home.

Having a limited number of objects directed this project towards a form of restricted non-linear narrative structure resembling of the type described in the

‘Self-Driven Narrative’ section of appendix A. As such, a number of restrictions were placed onto the player both within the space and by the system, dependant on the point in the story.

For the full experience, participants were seated at a desk with the interactable objects, containing them whilst being consistent with the narrative. The two sonic worlds that can be moved between combated this lack of set by creating a diverse and dynamic sonic background to the story.

To help a participant move through the story, this piece has a strong emphasis on dialogue from two (technically three) distinct characters. They provide the participant with context about the worlds, their purpose in the narrative and present the player with the final moral choice. The mapping out of the narrative structure was inspired by ‘*Detroit: Become Human*’ and the visual way they display their non-linear narrative to players.

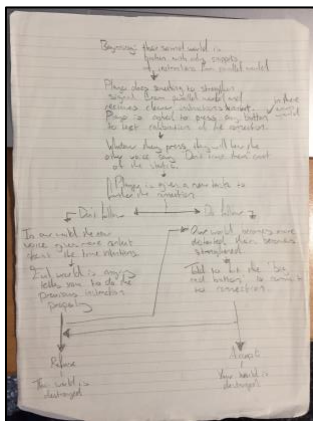
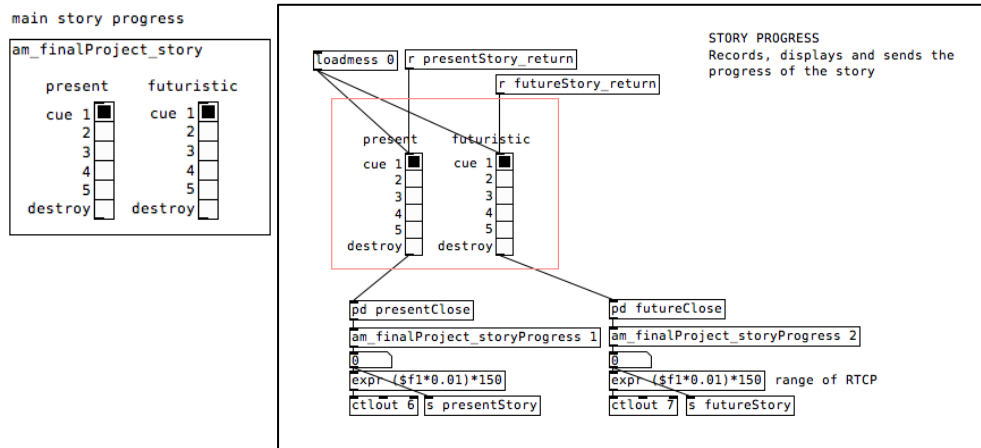


Figure 2: Story Tree for this Project



Figure 2: Detroit: Become Human Story Tree

In the core Pure Data patch, the progress of the story in each world is represented and controlled in this section.



Each progress bar represents the story progress in each ‘world’ and are both triggered by a variety of elements within the main patch. Critically, they progress independently or simultaneously depending on story logic or a participant’s interactions with the three objects. In this case by entering codes via the keyboard or listening to specific messages left on the tape recorder.

2.4 Continuing This Project's Narrative

The piece resulting from the development of this system is only one example of an implementable non-linear narrative structure. On taking this project further I would aim to explore other types of non-linear structures, inspired by those realised in virtual worlds, in a real-world space. When devising a new narrative path, care should be taken to note the type and number of interactions required as early in the process as possible.

2.4.1 Audience Participation

Increasing the number of participants will reveal entirely new challenges and opportunities to telling an interactive story. This project is the first tentative steps in the development of a system that is able to accommodate changes to a space in a dynamic way. It has the potential replicate and respond to any triggering action as an audio engine would within a game world, however, it will require a significant increase and wider range of technologies in order for the system to more accurately 'track' interactions.

Bluetooth beacon technology is a particularly interesting example I would undoubtedly seek to implement. Look to [Appendix D](#) for an in-depth look at this technology and ways it might be used to replicate game mechanics in the real-world.

2.4.2 More Open World

Develop a real-world space with a number of interactive elements. By keeping story beats vague and allowing the audience to piece together a narrative through

exploration of a space would be one way of achieving a narrative in this way. Or perhaps, have a number of possible scenes which lead into another set of possible scenes and so on.

This steers this type of production away from the '*Punchdrunk*' style of linear story experienced non-linearly, instead moving towards a narrative that can be influenced by the audience themselves. This could lead to more engaging productions and, while certainly relying on an audience being engaged, it is more likely to achieve if they have been given agency over the telling.

Taking inspiration from work in interactive installations and sandbox games, a story could be experienced by a participant in an entirely abstract way. "Theatre sound artist" Hans Peter Kuhn describes his installation work as being "deep and meaningful, but without a direct message", continuing this point by stating that he does not "want to tell them how to behave. I want everybody to develop their own story (or none, which is OK too), not to listen to my story." (Brown 2010)

This strikes a similar chord to how *Zelda: Breath of the Wild* builds a world that players can experience entirely on their own terms. This is certainly implementable using the system developed by this project.

2.4.3 Individual Agency

Interactive theatre productions tend to be democratic affairs. Votes are cast and consensus reached in order to determine the direction of the story (Nicklin 2012). But what would happen if a single participant in an interactive show were to, consciously or not, make a moral choice that influences the path of the entire story?

This type of small choice with future implications could cultivate strong emotional connections to a story, either within the entire audience or that individual. How did their choice impact the story? Do they feel bad about it, wishing they could take it back? Does everyone else know it is their fault? How do they feel about it?

It could also be possible to devise multiple narrative levels through the use of bone-conduction headphones to deliver messages either to individuals or entire subsections of an audience. Having a 'secret' level to a story may encourage certain choices, rivalries or allegiances within the audience. Generally, quite interesting potential plot devices. Developing an app that could be installed on participants phones to play or stream sound files could connect them to the core system.

2.4.4 Highlight Potential Cues with Sound

Sound not only has the power to describe worlds, but it can also drive people into doing quite specific things within a space. Visual and sonic cues are frequently used in videogames to encourage player interaction. Treating sound as both an element that can trigger certain results, as well as something that can be triggered, opens up a range of possible ways to drive a narrative forward. When a phone rings, it is instinct to pick it up. Hearing a door being knocked encourages you to open it, or to stay away. These are just two examples of sonic cues that can be presented to participants within a space.

2.5 Conclusions

Based on the feedback from the first demo, the narrative of the piece was received positively, with some comments specifically describing it as immersive. However, the short length of the story did have an impact over the final choice and there were requests for a short tutorial in the beginning. This could be achieved either in person or through further voiceover but, either way, some active interaction is needed to build confidence with the objects before they make a lasting impact on the narrative.

Having access to this type of technology could provide a platform for theatre makers to construct stories that match the increasingly intricate non-linear narratives being explored in virtual spaces. By using similar principles and the same technologies to develop performances, a common thread between game and theatre design might be drawn to inspire entirely new forms of interactive storytelling.

3. Developing Engaging & Immersive Worlds

3.1 Introduction

The goal of theatre is to take an audience outside of themselves; remove them from their current environment and envelope them in the world of the story. Sharing a space with the action can overwhelm the senses as they each engage with the performance unfolding in front of them.

In Britain, that shared space has remained the similar since Britain's first playhouse was established in 1576 (Victoria and Albert Museum 2011). Specific forms of staging have been developed in that time (proscenium, black box, in the round, etc.) that provide theatre makers with standardised platforms for expression. Besides giving an audience a number of ways to see a piece of theatre, each type of staging gives its own type of sonic experience.

Accidental phenomena which the audience sees or hears in the theatre... are assumed not to be part of the meaning of the production. Although these sounds are part of the overall acoustemology of 'going to the theatre', the audience, ushers, actors, production team and even the theatre architects conspire to prevent sonic accidents. (Brown 2010)

In the last few years a form of staging branded as 'immersive' theatre has saturated the market. These shows advertise an authentic theatrical experience that creates immersion by being specific to each site. In this scenario an audience is also presented with a unique sonic world to explore. By removing obvious speaker positions, they also offer a creative challenge for sound designers who look to augment each space with audio that helps to build the world of each play. Since this piece does not have a specific site in mind, this project creates each world entirely through sound.

3.2 Total Immersion

3.2.1 The Headphone Problem

Headphones, as primary a listening tool, are entirely unsuited for immersive theatre. Why sacrifice the relationship an audience member can develop with their surroundings for more control over the final sound? A production is not 'site specific' if the world is created inside an individual's head, unless that is the idea. (See: 'Séance' n.d.)

The properties of sound through headphone listening are profoundly different to those of the unaided ear, because they are not mediated by environment or the characteristics of the human body. Instead, headphone listening implies a singular and individual space isolated from the experience of others. (Wenn 2015)

Bone conduction headphones are a potential solution. By allowing the ear to remain open to its surroundings participants can have a personalised audio experience whilst remaining within the overall one. A writer could use this technology as a narrative device within their production. Some potential uses could be; sounds inspired by game interfaces, individualised radio communication, sounds which provide further information about the world or an object. It is possible for this system to send signals as well as receive them.

3.2.2 Hands-on Approach

While there are examples of companies developing ways of simulating physical feeling in virtual environments, see: ('Teslasuit - Full Body Haptic VR Suit' n.d.), nothing comes close to experiencing the real thing. Immersive shows capitalise on this by bringing another sense into the world of a production.

Developing real and tactile objects that exist within an overall system of interaction allows an audience to feel the repercussions of any choices.

3.2.3 World of Sound

The properties of a sound suggest a lot about its source; is it mechanical, futuristic, heavy, light, smooth, dense, etc. Filling a space with sound tells you a lot about that space and having a dynamic sonic world can “literally make one feel the drama” (Brown 2010).

Compared with similar storytelling artforms, theatre lags behind. Modern game studios task sound designers with creating entire worlds of sound; from the screech of a tyre to a distant thunderstorm, and the film industry continues to develop sophisticated technologies which can control every aspect of a sound within a space.

Theatre convention tends to assume ‘eyes front’ attentiveness, and to presume that peripheral noise is extraneous and therefore to be ignored in terms of any potential dramaturgical intent. (Brown 2010)

A real opportunity is presented to sound designers when front facing conventions are overturned. When the performance space becomes an integral part of the production that also includes its sound.

Populating real-world spaces with consistent soundscapes, from ambience to button presses, can suggest a living world that exists outside of that moment in time. Developing a reactive system that can control the ambience (inside and outside the space) as well as individual point sources would give theatre sound designers a new level of control over the entire sonic world of a play.

3.3 Between Two Worlds

3.3.1 The Design

It was known from the beginning of the project that developing a full physical set for the space was out of the question. The result is a piece that centres around two distinct *sonic worlds* and the ability to move between them at will. Each world was designed to contrast entirely with the other, in the project they are referred to as *futuristic* and *present*. Three sound ‘layers’ make up each world; outside the room, inside the room and the interactive objects.

While it was important to sonically represent the inside of the room, and the interactable objects within it, sonifying the world outside of the space gives participants an awareness about the world beyond that space. In this piece, the distant sound of creaking metal in the *present* suggest a certain roughness to the world, as opposed to the smooth synthesised machines in *futuristic*.

Interaction sounds are also heard as though they exist within their environment; control panel bleeps sound from an unseen source, tape machine buttons echo in the large *present* space and whirr into life in the *futuristic* world. Glitchy radio static between each world uses the assumed sound of the radio object which is otherwise behaving unconventionally.

These small details help to build a convincing world for an audience so having a system that works on a global scale allows designers to develop these cohesive worlds. While it is impossible to have the same level of control over sound that you have in virtual space, a sound designer can augment the existing sonic environment with their own sound to fit the narrative.

3.3.2 Speaker Positioning

The speakers were set-up to provide an all-encompassing sonic environment, for this production it was suitable to use a 5.1 surround set up considering participants were rooted to a single, front-facing, desk. However, a more flexible software solution will need to be designed as the Wwise authoring tool only accommodates up to a 7.1 set up.

Hijacking speakers within objects could produce interesting design choices. For this piece the speaker within the radio could have been used to transmit the audio messages left to the participant. Sending messages from the core system (OSC packets over a local network) to a *Raspberry Pi Zero W* carrying audio files, or the ability to stream audio, is one potential // relatively inexpensive method of producing sound from the physical objects themselves.

3.4 Designing in the Future

3.4.1 Speaker Positioning

When an audience cannot be entirely certain whether a siren, or a drip, or an appliance hum or noise, or even an echo, is a ‘real’ part of the auditorium environment, or a potentially meaningful piece of sound design, it enjoys the performance in a heightened, bristling state of aural attentiveness to its surroundings (Brown 2010)

Releasing an audience from the front facing positions imposed by traditional theatre spaces opens the way for theatre sound that extends fully into the action. Sound encourages people to be aware of their surroundings when physical objects around them emit noise or respond believably to interaction. Admittedly, the project did not fully explore speaker positioning in full, but steps can be taken to adapt to the needs of a more complex application.

3.4.2 Audience Tracking // Bluetooth Beacons

(see [Appendix D](#))

Knowing a participant’s rough position in a space provides the system with information that can be reactive or adapted to. Bluetooth beacons could provide a defined radius that acts similar to an invisible triggering object in Unity, changing a state or triggering a sound. For example, a phone near a participant could ring if they were found to be nearby at the correct point in the story.

3.5 Conclusions

This project and the piece resulting from it is an exploration into the important role sound plays in transporting people into entirely different worlds and their stories, regardless of the surrounding space and without the use of headphones.

Despite the daunting prospect of sonifying entire worlds, having strict control over each sonic aspect allows designers to develop a singular voice to describe the actions and environment of a story. Theatrical sound aims to create an audience “so transfixed by the scene that it forgets itself and its circumstance” (Brown 2010). In the case of traditionally staged theatre this includes a space that is constantly providing a distraction. Now site-specific productions can enhance each space with sound to help describe their worlds.

4. Interaction and Interface

4.1 Introduction

“It’s not empowerment just ‘cos you’re using your legs.”
(Daniel Bye, as cited in Bayes 2015)

Since the success of the immersive theatre group ‘Punchdrunk’ there has been an explosion of companies looking to capitalise on their success, resulting in an oversaturated market. Critics of the form say that many of these shows fail engaging for an audience. In order for them to feel their effect on the world, an audience should be given agency and receive real consequences to their actions.

Games are described as ‘immersive’ when the combined elements of gameplay, aesthetic and narrative align into a cohesive whole. When developing an experience that is intended to be interactive, theatre should follow similar guidelines. A multipurpose system for implementing interactive elements could be used by theatre designers ahead of time to develop an interactive show and this system provides it with the ability to demo a piece in Unity.

In essence this project aims to build a real-world interface, with physical objects as user input and the sonic space being the system. Since the input comes from participants who are not aware of how the system works, rather than performers who have rehearsed with the system, unique challenges have to be overcome.

This section covers some background into designing a truly interactive real-world experience for an audience, how this piece handles interactivity and my future predictions.

4.2 Audience-centric Design

The power of theatre comes from how ‘present’ it can be as an artform, the story literally unfolds in front of you. Anything that might take an audience out of its collective experience is highly controlled. If a phone rings in a cinema a film carries on, irrespective of what has just happened in that shared space and the audience disengages, however briefly or completely, with the media in front of them.

If the same phone rings during a theatre production, it might have significant effects on the performance taking place. Performers could either:

- 1) ignore it completely // hoping the audience re-engage
- 2) stop the scene // break the wall and starting again
- 3) improvise on it // bringing it into the world of the production as a ‘character’ or narrative device

This improvisation or ‘ad-lib’ is a key element that separates theatre from fixed media and is a powerful tool in an actor or ensemble’s arsenal. When devising a piece that is interactive, developing a way for the system to react ‘naturally’ to unforeseen circumstances poses the greatest technical hurdle. A certain degree of flexibility is required, however, each potential interaction from an audience member must be identified and accounted for.

Theatre creators should look to game and user interface design practices for inspiration on how a system might predict and contain user interactions. While it is unarguably easier to limit people’s behaviour a digital space, similar design practices might be transferred into the analogue one.

4.2.1 Game Mechanics

Videogames aim to create as immersive an experience as possible. While some titles have reached near-cinematic quality (see: the ‘*Uncharted*’ series) games primarily rely on their gameplay to draw people into the experience. If their interactions within a system feel frustrating or clunky, they are likely tune out entirely.

During the development of this iteration of the system, inspiration was taken from early videogames that successfully worked around hardware limitations to create an effective interactive experience (Iyer 2017).

Lindinger, working on the design for *Apparition*, suggested the example of game design’s use of different levels that seek to hook the user... in game design the programmer generally follows the logic of three levels: 1) the attraction level, allowing the user to become interested and slowly comfortable with the environment and the rules; 2) the engagement level, which draws the user into the game and allows quicker and more competent actions; 3) the experience lever, involving increasing complexity to sustain curiosity, energy and excitement with the player.
(Birringer 2008, pg 191)

Adjust the difficulty of an experience to give participant’s a natural learning curve and build their confidence in using that system. Naturally introducing them to a system and encouraging experimentation without serious consequences, lets participants know what their role is within the production.

Care should be taken when applying these barriers, “if the system is designed with high constraints, it will require extra work from the player.”
(Birringer 2008, pg 188) Establishing the rules and limits of a system through physical actions encourages an untrained participant through an experience.

4.2.2 User Interface

When designing an intuitive user interface, developers use an iterative design process as it would be impossible to predict how someone might use a system without letting them use it.

In game design the method of input is relatively consistent and is already familiar to a player (game controller or mouse and keyboard), the learning curve occurs when attempting to understand the mechanics of the game. In app or systems development, the interface is key to users easily understanding how to influence a system. This means it must survive rigorous user testing before officially released to the general public.

A real-world interactive audio environment has modes of input that might not be initially obvious to a participant and are scattered around a space. Somehow, this input should be relevant to the story, intuitive and not frustrating to use. For this type of theatre to work, certain predictions have to be made regarding how a group might act in the space. The psychology behind user interface design reveals how subtle design choices can subconsciously direct a person to interact in a particular way in quite specific ways. The same applies for an immersive theatre space. For a more detailed discussion into the similarities between theatre and user interface design see the articles from Sophia Lee (Lee 2017) and Whitney Quesenberry (Quesenberry 2005).

4.3 Interaction Between Worlds

4.3.1 The System

A basic layout of the system from input to sound:

Input	Modified physical objects are connected through an Arduino board into the serial bus of the computer.
Processing Data	Pure Data receives input from the physical objects and processes it based on the story logic outlined within Pure Data.
Output	Triggers and values are then sent through a MIDI connection to control game simulator values within Wwise, which acts as the audio engine (events, RTCP's, states, etc.).

Wwise was chosen out of the desire to develop a system of interaction that replicates types within game worlds. As a tool designed specifically to help generate entire worlds of evolving sound it encourages the type of thinking appropriate for this work.

Pure Data was used to develop the core story logic because it is a language that I was most comfortable using. It is certainly possible to use another programming language which has MIDI (or OSC) capabilities. This would even be advisable as, structurally, the Pure Data project was becoming cluttered and difficult to manage. It would be better to use a language where functions for each interactable object were created and called only when required. It might be possible to script the game within Unity and create an app which is controlled through MIDI or OSC. This method is untested but could potentially allow each show to run from a raspberry pi.

4.3.2 The Objects



Object from left to right:

Object	Function	Interaction Type	Tactile Elements	Sounds
Tape Machine	Inspired by the 'audio log' narrative device in videogames this object receives and plays messages from the two worlds.	Participants can play or stop audio message at any point.	The motor still works, and tape rotates while playing.	Voiceover narrative. Different play and stop sound in each world, mechanical vs digital.
Radio	Allows the participant to manually move between the parallel sonic worlds.	Rotating the dial results in static until a world is found.	Rotating the dial still offers some resistance.	Controls the 'Radio' RTCP which moves between full ambiances, with static in between.
Control Panel	Participants use this to enter any requested codes which move the narrative forward.	Physically typing in the codes.	Feels like a computer keyboard.	Omnipresent beeps from the 'system' with appropriate correct and incorrect motifs.

Primarily, the story was developed around the objects themselves, the types of interaction they can provide, and the types desired. For example, the radio was chosen because there had to be a way to sonically travel between the worlds and it seemed an obvious choice. This influenced the sound (static between worlds) and the method of telling the story (two different omnipresent voices giving opposing instructions).

It is presumed that participants would know to turn the dial of the radio and doing so revealed its wider reaching effect on the world and story. Significantly, this was all made clear to a participant through their own actions. Simultaneously explaining the mechanics of the ‘game’ and asserting that they are an integral part of this story and an effect on the world. The world exists outside of them, but this story does not. You can’t afford to be an idle observer.

4.4 Future Interactions

The first demo of this piece can be classified as the first test in the iterative design of this show. Participant feedback can be found in [Appendix E](#). From the responses and observations from the demo it was noted that a short, hands-on, tutorial is needed to begin the experience. This gives participants the time needed to become familiar with the ‘controls’ before they begin to impact the overall story.

As exemplified during the first demo, explaining multiple things all at once does not encourage an environment where people feel they are making their own decisions. Instead they end up feeling frustrated or pushed through their experience.

When developing a show with the goal of it being an interactive performance, it should be included from the beginning of the design process. Interaction for the sake of interaction is never intuitive to use and should always be tied to the narrative. This section outlines two other potential types of interactive show.

4.4.1 A More Open World

When directing a participant through a story, follow from video game examples by developing ‘game mechanics’ that appear relatively simple at the beginning but have complexity added through the narrative.

A show could have a number of interactable elements which encourages the discovery of a story through random, or informed, interactions within a space. For example, they could be discovering hidden ‘tapes’ around a room that provide backstory about characters and/or their world.

Increasing the number of and level of interactions for a longer form show will require designers employ a higher level of logical thinking. It should be noted again that when developing an interactive show all interaction should add to the experience and not overcomplicate things.

4.4.2 Hand to Guide You

Bringing actors into a system scene would combine the influence of both amateur and professional interactions. Actors would be able to react, prompt audience members or even activate elements themselves. They could provide a guide through a space, demonstrate interactable elements to participants or persuade them into a certain action which has some kind of consequence to the story. If an acceptable level of interaction is encouraged, actors could even react to specific cues from the system. For example, an alarm sounds in the space. How do actors respond, and does it cut off scenes that are already happening?

4.5 Conclusions

[the aim is to have] an active “user” who experiences not a static completed work, but an intelligent, responsive environment. Such a system requires the participant to engage the various interfaces that control and mediate the aesthetic as well as psychological processes the work harbors.
(Birringer 2008, pg 179)

Combined with quality sound, lighting, set design and an engaging story; one way to create a truly immersive experience for an audience is by allowing them to interact with any or all of those elements. Engaging a participant by presenting them with difficult decisions, or even just agency over the narrative, combats the ‘there in body but not in spirit’ problem experienced by immersive theatre productions. Having agency also instils a sense of accountability and an emotional investment in a narrative.

My project in its current form addressed some of these elements of interaction. The objects felt natural to use, their methods of interaction intuitive and the results unexpected and intriguing to participants. The feedback suggests that using tactile physical objects was a prominent contributor to their immersion.

However, it has become clear that a tutorial element is needed to introduce the interactable elements and build confidence in the participants using the devices. Overwhelming them with rushed explanation is not enough either, they must be demonstrated the limits of the system.

5. Project Conclusions

The primary goal of this project has been to develop a reliable interactive system that translates game sound principles into a real-world environment. It aims to provide a platform for theatre makers to produce non-linear stories, create immersive worlds and develop interactive narratives. To achieve this, I used the Wwise authoring tool as sound engine and Pure Data to translate the physical input into story logic. While Wwise offers an interface specifically set up to generate interactive worlds of sound, it does have limitations in its output which will cause issues at a later stage (only up to 7.1 surround). It is likely that a language other than Pure Data will also have to be implemented, but for the purposes of this project the combination worked seamlessly. By continuing to use Wwise there would even be the potential to virtually design and demo a show within Unity if access to the space was restricted.

The resulting piece was developed out of a need to showcase each unique aspect of this system and the live demo can be considered the first step in its iterative design process. Overall the feedback was positive, with participants stating that they felt immersed and involved in the narrative. However, there was a degree of nervousness around interaction that could have been lessened with the inclusion of a practical ‘tutorial’ to introduce participants to the ‘game mechanics’. I recommend future productions look to game design principles for inspiration on ways to naturally account for a participant’s learning curve with a system.

Overall, I feel this project was successful in its initial goals. The developed system is flexible enough for any future productions and there is room to include new technologies and interaction types, which I look forward to working on.

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Appendix A

A.1 'Traditional' Western Open World

In traditional, western 'open world' games involve setting up a premise for your character, providing a world to explore, a number of key story beats that the player will experience and a defined ending. Side quests can be experienced in any order, but the main story still progress in a linear fashion with each player essentially experiencing the same game.

Examples:

GTA V – Rockstar Games

Horizon Zero Dawn – Guerrilla Games

A.2 A More Open World

A branch of this genre sets the player up in a detailed world and allows them to go in any direction they like, aligning with factions and making moral choices that will impact the story and subsequent ending. Each progression still has a definite narrative path, but it is the players choice as to which one to follow. An intriguing example of this method can be found in *The Witcher 3*, which builds an entire world around player agency and ways in which choice can affect a narrative (dem 2016, 3).

Examples:

4) *Fallout Series* – Bethesda Studios

5) *Witcher 3* - CD Projekt RED

6) *Mass Effect Series* – Bioware

A.3 Sandbox

A more recent trend in open world games capitalises on a player's need to explore by keeping the structure of the narrative entirely open ended. Either there is no prescribed story, or the player is shown an initially unobtainable end goal to reach. Players are presented with a world and invited to create their own narrative or discover one by piecing together strands of information.

This type of narrative tends to avoid presenting a player with obvious moral choices, relying on a sense of mystery about the world, but your actions in the world may affect how it responds to you. There are no obvious answers, and a player might never find them all. Players are simply provided with "the ability to experiment with things more freely, in an open way. Having a powerful sense of autonomy and experimentation with the environment and the tools at their disposal." (Milne 2017).

Examples:

- 7) *Zelda: Breath of the Wild* – Nintendo
- 8) *Minecraft* - Mojang

A.4 *Self-Driven Narrative*

Some studio's take an approach to game narrative that closely resembles a choose your own adventure book, presenting the player with a series of moral choices that affect the narrative either in the short or long term. For a detailed look at this type of narrative (specifically the game *Detroit: Become Human*) see a copy of my blog post in appendix B.

Examples:

- 9) *Detroit: Become Human* – Quantic Dream
- 10) *The Walking Dead Series* – Telltale Games

Appendix B

Case Study // Detroit: Become Human

Posted on [July 5, 2018](#) by [hyperrealworldsystems](#)



Site: <https://www.playstation.com/en-us/games/detroit-become-human-ps4/>

‘Detroit: Become Human’ is a narrative driven adventure game, developed by Quantic Dream (Heavy Rain, Beyond Two Souls), with an emphasis on non-linear methods of experiencing a story.

Description of game from their website:

“Enter the near-future metropolis of Detroit in 2038 – a city rejuvenated by the introduction of highly advanced androids that exist only to serve mankind. But that’s all about to change...

Step into the shoes of three distinct android characters as this brave new world teeters on the brink of chaos. Your decisions dramatically alter how the game’s intense, branching narrative plays out. With thousands of choices and dozens of endings, how will you affect the future of Detroit?”

Oops, did I accidentally watch all of this 9 hour walkthrough for ‘research’...?

Analysis

This game is extremely cinematic, with music, ambiences, sound effects and dialogue deliberately falling into the hyper-real style of a Hollywood blockbuster. Its sound world fits its near future setting by blending familiar sounds of present day Detroit with ever-present digital elements to give the world a sci-fi flavour. Each playable character is an android and so there are also appropriately electrical interface sounds and blockbuster sci-fi style 'wooshes' when 'abilities' are enabled, including a complete sonic shift when Connor uses his heightened senses to investigate a crime scene.

Gameplay revolves around the idea of freewill, complimenting the narrative themes, which is explored by providing the player with a continuous series of choices. These decisions might appear while in conversation with other story characters or during action sequences, where the option is usually between taking either a violent or non-violient approach. Music and sound both respond to a player's choice by matching the tone of the resulting consequences, for example, if a decision results in violent action, as opposed to a non-violent option, the music and sound will change to appropriately underscore this. This is possible because most of the action plays like a series of cutscenes.

While gameplay is relatively linear, in that you are ushered from one choice to the next with next to no element of exploration, it is the numerous choices and multiple story paths which provide the incentive to play. It is even possible for a narrative to prematurely end at any time, reinforcing in the player the importance of their decisions.



One of the games many 'Story Trees'

Once a particular scene of a character's story has played out, players are shown a 'narrative tree' which displays any decisions made, how they impacted the story and where significant deviation from their narrative could have occurred. It does

not show the contents of the alternative narrative path but does provide an option to load the game from a checkpoint to remake a decision. However, changing a decision at any point will have a knock-on effect for the entire story so these story-trees also remind the player that each decision matters, encouraging multiple playthroughs.

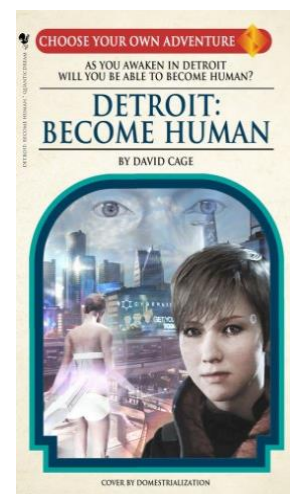
Using a story tree is a very clear method of mapping out a non-linear narrative: providing an increasing level of detail the closer it is inspected but also showing story structure at a glance. If this project were to move in a similar direction, I would make use of a similar visual story mapping method. Perhaps assigning a sound cue to each junction which alters some part of the story.



Summary

‘Detroit: Become Human’ is essentially an expansive ‘choose your own adventure’ story dressed up as a Hollywood movie, but by also implementing design choices from more traditional ‘point-and-click’ adventure games they provide an illusion of interactivity that extends the experience beyond the core game mechanic that is narrative decision making.

This way of non-linearly telling a story relies on providing a player with a limited set of options and forcing them into a choice. This series of predetermined ‘forks in the road’ steers a player down particular branches of the story tree. As is the case in this particular game, the music and sound still function in a similarly linear way to a blockbuster movie. When the player makes their choice, a predetermined (linear) path follows until another choice is required to move the story forwards in some direction.



Relevance to Project

Constructing a ‘non-linear’ narrative in this way requires choices to appear one after the other related to what came before and changing what might happen after. In a game world setting players can be physically limited in their options. In a real-world space, however, the audience have no restrictions on what they might interact with. Unless they were led down a corridor or path which contained only the available options, one after another, then it becomes impossible to predict // restrict a participant engagement with a space.

This causes particular issues with the sound of a production, which cannot behave in the same linear ‘they chose this story path, now play this cue until they reach the next choice’. It must behave in a way that reacts dynamically and evolves depending on a participant’s interaction with a space. This poses different challenges in terms of underscoring a narrative, which remains a key component of this project.

I have found that open world // sandbox games still have issues with linearity in their storytelling – i.e the player has reached this quest so will linearly complete it (with perhaps a few deviations based on given choices) or abandon it entirely. However, the most recent Zelda game (Zelda: Breath of the Wind (2017)) moves away from this type of open-world quest storytelling. It also gives the player an unrivalled level of interaction with its game-world while at the same time containing a story which players are encouraged to experience on their own terms. A future case study will explore the role of sound in this game and how elements might be implemented into my own project.

For the record, I would class productions developed by [Punchdrunk](#) as ‘open world’ exploration of a linear narrative.

In [this post](#) on his site Seb Chan describes his experience of *Then She Fell* by Third Rail, another company focused on immersive theatre. This particular production seems to function in a similar way to the narrative structure displayed in ‘Detroit: Become Human’ (as is noted by Seb with his own example of ‘Dragon Age: Origins’).

While he makes no mention of sound’s role in the production, it seems feasible to me that alternate cues could be triggered dependent on the choices made by participants. Their direction through the space by a cast member would allow them to be forced into a series of choices, the cast member could then lead them down their chosen path and, subsequently, the sound could be triggered to follow them on the chosen path.

The overall problem I can see with implementing this form of game sound in a real space lies precisely in this idea of the individual experience. Without the use of headphones (something I’d would like to avoid in this project) how can an participant be assured a unique sonic experience?

Since my project will not take place in an empty space large enough, or be a show that complex, this shouldn't be an issue for the moment. It will, however, be an area worth discussing in the final report.

Games and Companies Similar to Quantic Dream

- [Telltale Games](#) – one of the most prolific studios for these types of choice based narrative games. Have the rights to tell original stories using already successfully commercial properties, such as The Walking Dead and, more recently, Game of Thrones and Minecraft. Can be credited with popularising this genre of game. Sound is absolutely not a focus with these games.
- The [Mass Effect](#) series – simultaneously one of the most beloved and [derided](#) series in gaming. Where players have influence over a narrative that developed too many threads and tied itself in knots (also see... Lost) A great example of a how an excessive focus on non-linearity without a clear end can get you into trouble.
- [Daedalic Entertainment](#) – a more traditional 2D point and click adventure game studio. With non-linear elements to their fantastically funny stories.

Appendix C

Case Study // Punchdrunk Theatre

Posted on [June 30, 2018](#) by [hyperrealworldsystems](#)



Company website: <https://www.punchdrunk.org.uk/>

Punchdrunk in their own words:

“Since 2000, Punchdrunk has pioneered a game changing form of theatre in which roaming audiences experience epic storytelling inside sensory theatrical worlds. Blending classic texts, physical performance, award-winning design installation and unexpected sites, the company’s infectious format rejects the passive obedience usually expected of audiences.

Punchdrunk has developed a phenomenal reputation for transformative productions that focus as much on the audience and the performance space as on the performers and narrative. Inspired designers occupy deserted buildings and apply a cinematic level of detail to immerse the audience in the world of the show.

This is a unique theatrical experience where the lines between space, performer and spectator are constantly shifting. Audiences are invited to rediscover the childlike excitement and anticipation of exploring the unknown and experience a real sense of adventure. Free to encounter the installed environment in an

individual imaginative journey, the choice of what to watch and where to go is theirs alone.”

Lecture from graphic and sound designer Stephen Dobbie for Lighthouse Arts:

Notes Taken

- Aspire to be as fully sensory as possible.
- Their first show was called ‘Chair’ which was a one room experience for one person. There was no sound or performers so was more like an installation where the audience pieced together a story from set design and props only.
- First show where sound played a major role was “Sleep No More” which was inspired by Bernard Herman scores for Alfred Hitchcock.
- An omnipresent soundtrack which plays throughout the building, with specific sound zones (i.e first floor is one zone, the second is another).
- Sound for their earlier shows run from multiple cds, all timed to play at the beginning and are the length of the show (linear soundscape with no influence from the audience).
- To get around budget constraints the left channel and right channel of the stereo cd would be different soundtracks and fed separately around the building.
- For the next version of ‘Sleep No More’, which is still playing in New York, they have 17 sound zones fed into 90 unique spaces.

The Drowned Man

- Continued using sound zones.
- Moved onto using Qlab, still playing a soundtrack which is linear and the length of one performance. Still no interactive elements in terms of the sound.
- A focus on creating the sound world of the show, especially music selection, takes place early on when devising a new show in order to establish the overall mood // tone.
- Most common sonic elements of a Punchdrunk show:
 - Songs – pop songs of the era, usually obscure but recognisable. These are usually used to underscore significant moments in a scene. Some use of space with these elements, for example playing on a car radio then growing into the rest of the space.
 - Soundtracks – Music cinema soundtracks are a particular influence. Rarely do they compose their own music, choose to sample instead. A specific piece of music plays across all sound zones to let performers know they need to reset and begin the show again.
 - Soundscapes – expanding the space, imagining the world outside of the room. The music appears out of this more general ambience.

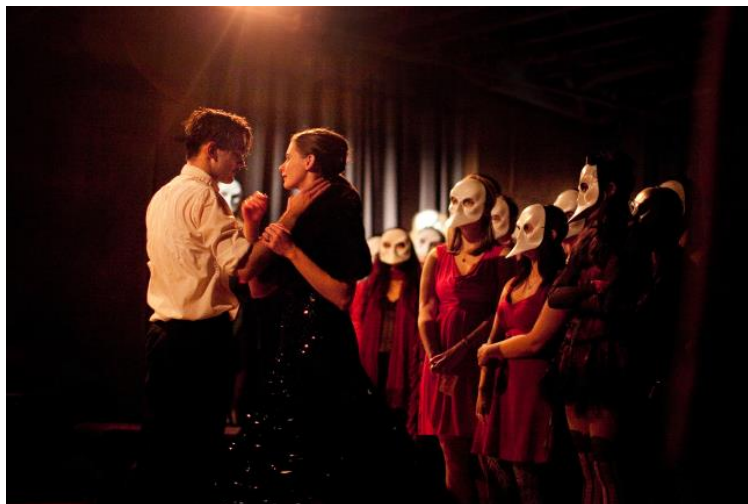
- Each sound zone is in the same key to combat any bleed between rooms (zones are usually only by plywood again due to budget restrictions)
- One on one performances (“art lap dance”) – performer takes an audience member to a smaller room presses a button and triggers a change in lights and sound for that room only. Still no interactivity, just plays a shorter one-off linear soundtrack.

Summary

Based on the points raised in this lecture about the use of sound in Punchdrunk’s productions, there does not appear to be any way the audience can influence the show, let alone the sound of it. This company focuses on their audience experiencing a story in a non-linear fashion in the sense that they have agency over the order in which they view scenes and scenarios. The sound runs the length of the performance and, while the performers do react to sonic cues, each scene and the show as a whole still appears to move from point A to point B.

However, it was interesting to hear about the intuitive ways in which the creative team worked around budget limitations, as is often the case when working in theatre, and sound that bleeds in from other rooms or ‘stages’. This will not be an issue for this project as it will be confined to one space, but something to keep in mind should this project expand.

Punchdrunk & Work With MIT



Audience members (masked) watch a scene during a performance of Punchdrunk’s ‘Sleep No More’ – Photo by Robin Roemer

See MIT media projects site for information about this project:

http://opera.media.mit.edu/projects/sleep_no_more/

and here for a first-hand account of the experience:

[https://gizmodo.com/5912789/\[object%20Object\]](https://gizmodo.com/5912789/[object%20Object])

Key points:

This project was primarily focused on ways in which virtual participants could experience a Punchdrunk show. This was achieved by pairing an audience member through an internet connection to a ‘player’.

Very interesting work with the masks, which were “equipped with a microphone, a temperature sensor, a heart rate monitor, an EDA sensor, a Bluetooth location sensor, and a RFID tag to capture an onsite participant’s activities, expressions, and state of mind. Masks were retrofitted with bone conduction headsets to allow operators to send audio messages to onsite participants which kept their ears free to listen to the immersive audio experience”.

A number of ‘portals’ were set up around the space where the virtually-connected user had influence the real-world environment. For example a ‘ghost’ typewriter which would tap out messages written by the companion. Other portals were automatically triggered when someone wearing an augmented mask is near, such as ghostly writing on a mirror or books flying off shelves.

Each cue controlled by the offsite participant was processed by a “master logic system” called ‘cauldron’. These cues not only controlled actions in the physical space but also controlled all the audio elements experienced by the virtual audience member.

“The audio systems for *Sleep No More* were based around a virtual streaming and mixing environment running inside Reaper. The audio experience was organized into cues, coded in XML, which were executed by the script engine. Each cue could smoothly alter parameters of effects, inputs and outputs, or play back pre-recorded material. Outputs were streamed in real-time to online participants, and android devices in the space using a combination of Icecast and Wowza streaming servers. Live inputs originated from performer microphones and could also be connected to telephones on the set and at participants’ homes. All content for the experience was encoded binaurally.”

There is no mention of whether any main sound elements were directly affected, Punchdrunk are notoriously cagey about releasing details, but based on the interview with Stephen Dobbie (which took place three years after the project) it can be assumed that there was no effect on main elements of the sound cues. The audience also had no direct effect on the narrative of the performance.

Inspirations for Project

Position Tracking System

Using my own positioning system to track participants position would be very beneficial to this project, this would be possible by using a Bluetooth system: such as iBeacon. Some examples are listed below:

<https://www.accuware.com/products/bluetooth-beacon-tracker/>

https://estimote.com/?gclid=Cj0KCQjw1NzZBRCoARIsAIaMwuvOINQG01ksEgYfwDWaJeeUUnPt9Fc6ujOUU9ZojmRcD8NpQGMRfw8aAkBKEALw_wcB

It also appears to be possible to build an iBeacon type system using Arduino or Micro:bit (which already contains Bluetooth capabilities) as seen here:

<https://lancaster-university.github.io/microbit-docs/ble/eddystone/>

This will be explored in greater detail and followed up in a separate blog post.

This could be useful for determining where a participant is in relation to specific triggers, what they are looking at and to control real-time game parameters (RTCP's) within Wwise. It might be possible to track participants mobile phones using built in Bluetooth capabilities, otherwise a small Bluetooth emitter could be used and either given to participants or worked into the narrative somehow, similar to the masks in 'Sleep No More'.

Categories of Sound

From Stephen Dobbie's lecture it seems that the company work with sound based on three defined categories: songs, music and soundscape. Thinking about my own project in terms of sonic categories will help me to define levels of interaction. During a performance it seems participants only have influence over the sound in a very localised sense, triggering songs from car radios etc, whereas the goal with this project is to have an entire sonic world which evolves based around participants actions within a space.

More References

['The Immersed Audience: How Immersive Theatre is Taking it's Cue from Video Games'](#) by Thomas Mullen for The Guardian

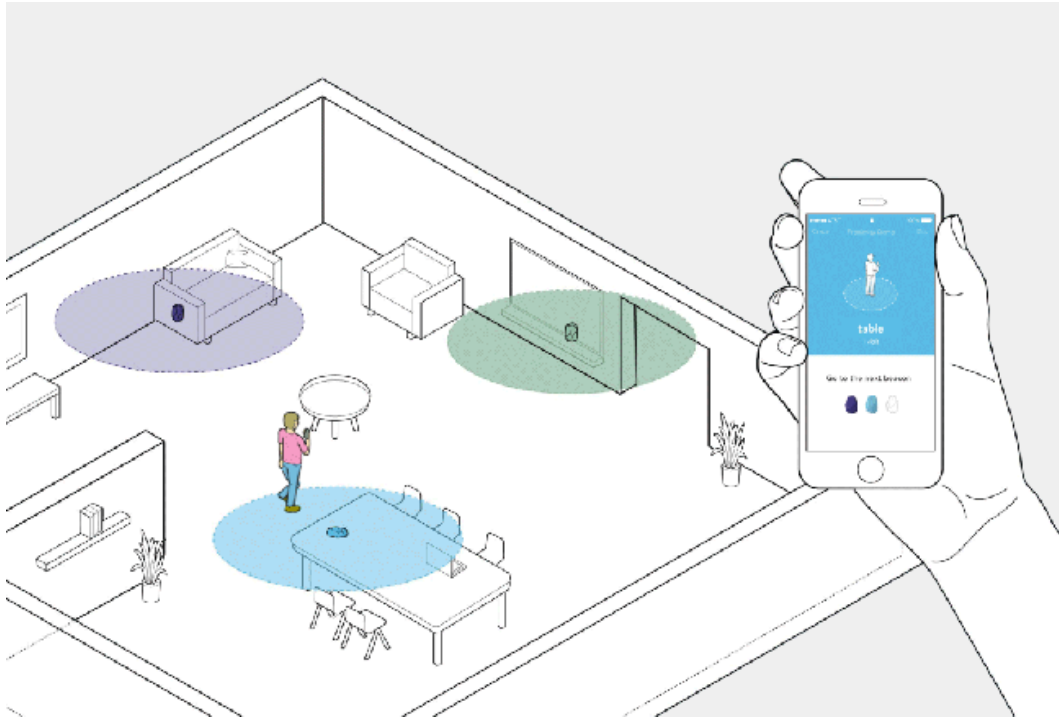
['Welcome to Fallow Cross: Inside the Secret Village Made by Punchdrunk'](#) by Lyn Gardner for The Guardian

['A Guinea Pigs Night at the Theatre'](#) by Dave Itzkoff for the New York Times

Appendix D

Technology // Bluetooth Beacons

Posted on [July 18, 2018](#) by [hyperrealworldsystems](#)



The Technology

See link below for an in-depth guide to Bluetooth beacon technology and general uses:

<https://www.blumaestro.com/ultimate-guide-bluetooth-beacons/>

Summary

Bluetooth beacons are Bluetooth low energy transmitters which broadcast or ‘advertise’ their unique identifier to any nearby Bluetooth capable devices, such as a smartphone or tablet. When in close proximity to a beacon, or within a specified range, the receiving device can use this information to trigger a specific action or set of actions. Generally, beacons do not receive information from other devices so cannot store information about nearby devices.

Beacon Protocols

[iBeacon](#) – Apple protocol released in 2013. Stable but locked down. Works with both their own and Android devices but more stable on Apple devices.

[Eddystone](#) – Google’s open standard protocol released in 2015. Can be implemented without restriction and offers developers more access to features. Works on both iOS and Android.

[AltBeacon](#) – Open source specification that defines a message format for beacon advertisements. All features are available to developers for no cost but is an underdeveloped platform.

What Can They Do?

The Physical Web

- Send notifications or URL’s to smartphones which are in range of the beacon. This has primarily been used by [retailers](#) to send offers to potential customers passing their stores, or provide information to people already inside.
- [Museums](#) have also used these technologies in their virtual tours, either in the form of triggered audio or broadcasting a URL with information relevant to the section of the museum they are in.

Proximity

- Beacons can be used to roughly determine a user’s position within a space. It is possible to roughly calculate a receiver’s distance from a beacon and you can work out their exact position within a space using triangulation.
- This is not strictly a feature of the beacons themselves but the smartphone which is able to do the calculations based on radio strength.

Telemetry

- A less common feature of this technology is to directly relay information from a beacon to a smartphone. Only a small volume of data can be transferred so this is mainly used for small data packets, such as weather // temperature reports.

For more examples of beacon use cases and in-depth case studies, see this page: <https://lighthouse.io/beginners-guide-to-beacons/beacon-use-cases/>

Pre-existing Use in Theatre

This talk by Dustin Freeman on his work on Joshua Marx’s ‘The Painting’ is the only example of Bluetooth beacon technologies use in a theatre production that I could find (there is no useful record of the production of ‘The Circle’ Dustin Mentions at the end of the talk).

<https://hackaday.com/2015/12/18/immersive-theatre-via-ibeacons-with-dustin-freeman/>

This production is useful experiment into this type of work and does an excellent job highlighting the issues they faced, potential workarounds and their ideas for the future of this type of work.

Notes on the Talk

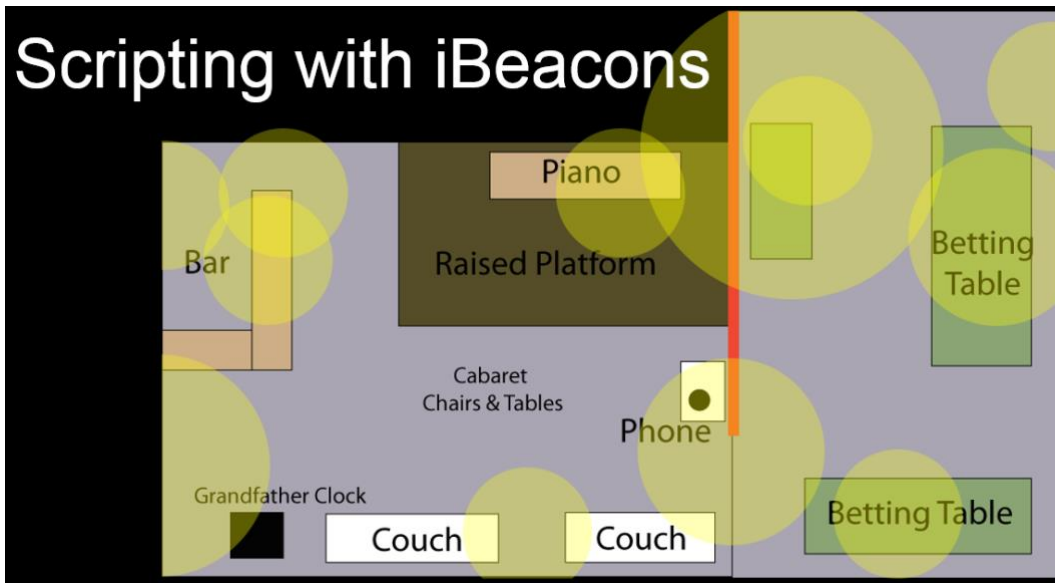
- Floodlight – theatre company.
- “Audience given the illusion of control”

Dustin’s Experience with iBeacons

- They work with scalars, not vectors. i.e they can roughly determine the distance but not direction.
- There is no ‘look vector’ to tell which direction an audience member is facing.
- For this show the entire experience with the iBeacon technology was within the phone, mainly consisting of listening to pre-recorded audio through headphones.
- Triggers depended on where the phone was placed on the participant.
- With this type of method, it was impossible to know what the ‘player’ was doing with an object. Book example – you pick it up and it tells you to turn to a page that directs you to another area of the room where it triggers another iBeacon.
- You can set up different levels of triggers, distant cues and closer proximity cues.
- What do you want the players experience to be? VS What do the players expect this experience to be like? (escape room time limit, or more casual)

My Thought’s on a Bluetooth Beacon System in Theatre

I would look to use Bluetooth beacons in a similar way to how audio events are triggered within a game. By using the radius of the signal as a type of box collider, it might be possible replicate some of the features of Wwise // Unity integration scripts such as ‘trigger enter’ (receiver enters the radius of a beacon) and ‘trigger exit’ (receiver exits radius). This would avoid the need to calculate the exact distance from a beacon, which would be advisable considering the margin of error ($\pm 50\%$ according to Dustin).



Dustin's iBeacon Graphic

I have seen examples using more of the sensors available in a smartphone device to better determine a position in space (see: <https://estimote.com/>) and, if this project were to develop to that point, this would be useful to more accurately trigger events or control RTCP's.

As for connecting to my existing system, it would be possible to connect a phone to Pure Data by developing an app which transmits the beacon triggers through the Open Sound Control (OSC) protocol into the central system. Whether a new app would need to be developed for each show or a universal app could be created is an area which would need to be explored in more detail.

It is also possible to use Micro:bit's as an Eddystone beacon:

<https://lancaster-university.github.io/microbit-docs/ble/eddystone/>

If objects in the space were already fitted with Micro:bit's, these might be simultaneously be used as beacons. This offers designers an extra layer of interactivity, for example, the book object could be given a radius of 'whispers' which are triggered when the participant is within range to highlight it's magical significance.

Can Bluetooth capable Arduino boards be used as a receiver?

Perhaps a Bluetooth Lilypad Arduino could be made into a wearable receiver that could be incorporated into the story of the show. By controlling where the receiver is placed on participants it might be possible to counter some of the triggering issues encountered by Dustin in 'The Painting'.

Beacons could also provide further context to a show by broadcasting information to be displayed in the app such as story cues, suggestions or directions. They

could also prompt audio cues which are reserved for individuals, which could be listened to in either traditional or bone conduction headphones.

Conclusion

Overall, this technology could significantly advance this project and is worth exploring in future experiments. Giving the system some sense of the surrounding space brings the immersive experience one step closer to a virtual world scenario where everything can be strictly monitored and adapted to. Further studies into 'The Physical Web' would also benefit this.

More Resources

- [Accuwear](#) – Bluetooth beacons focused on tracking people and assets.
- [Dustin Freeman](#)'s Homepage
- An [Arduino iBeacon Project](#)
- [Kontakt's 'Ultimate' Guide to Beacons](#)

Appendix E

First Demo // Feedback

Posted on [August 12, 2018](#) by [hyperrealworldsystems](#)



Story Outline

“In the basement of a top-secret commercial facility, a long-neglected experiment monitoring interactions between quantum particles suddenly begins reporting some unusual activity. It was discovered that the observed phenomena are replicating the behaviour of audio waves and, when interpreted as such, fill the room with entirely new sonic worlds.

As a foremost researcher in experimental quantum communication, it is your responsibility to strengthen this connection, determine its source and what it could possibly mean for the world...”

Objects



Radio – Allows the participant to tune into the two worlds by rotating the dial to a specific frequency.

Tape Machine – Acts as an ‘audio log’ (as featured in games such as ‘Bioshock’) where messages are left for the participant to explain story and give specific instructions.

Control panel (Wireless Keyboard) – Used to enter any codes and trigger ‘pairing’.

Speakers were set up in 5.1 surround.

Feedback from Participants



Questions:

- How obvious was story navigation?
 - Was the purpose of your mission clear?
 - Did the objects behave as expected?
 - Any other thoughts?
-
- I did not have a problem with story navigation, thought I also had a co-pilot and an invisible engineer in the background helping to make my choices clearer.
 - That first speech was very important.
 - I liked that our home world lined up with Scotland.
 - What a neat project. I would be interested in playing around and finding out more about the in-limbo people. The messages left for us reminded me of the Zombies, Run! App. Good job on creating the level of immersion that you did.
-
- The story navigation was fairly straightforward although, I didn't know that I was supposed to press the stop button after every message.
 - Yes, the purpose of the mission was explicitly explained in the narration.
 - No, the objects did not behave as expected and that was my favourite aspect about the project. Making a user utilise a radio as a teleportation/transportation device between the two worlds really contributed towards the immersive experience.

- Great voice acting and amazing sound design!
-

- The navigation was fairly clear once I understood to press the play button. Searching on the radio was a little tricky as I couldn't remember my original frequency.
 - Yes, the explanation was clear.
 - In action (pressing buttons, rotating the dials) yes, however their in story use was fantastically creative – dialling into a different world!
 - Really enjoyed the sound effects, the space created with the sounds were deep, multi-layered and full of texture.
-

- Navigation was clear, it wasn't hard to figure out generally.
 - Yes
 - Yes & No, beautifully sounding but would have loved the experience to be more interactive, e.g. once putting in the code something happens.
 - Gorgeous sounds beautifully put together to feel very immersive. Specifically liked the placement of lighting, tape player and radio as it set the mood.
-

- Although I at first was overwhelmed by the amount of controls and objects to keep track of, by the end of the scene I grasped the concept well. Knowing when to press “stop” and “start” on the tape recorder was the main thing I struggled with since I was worried I would mess up the scene/dialogue.
 - The introduction was helpful in explaining goal. Perhaps continuing to build on the environment and expanding the space could be helpful in cementing my role (adding more props).
 - The action of the object was great, and the diversity of the wheel, buttons and typing was great for making it more interactive.
 - I really love the direction of this project and its future possibilities. Interacting with real objects in a cyber/space is very innovative and exciting. The idea of possible endings is also very cool and I would love to see more theatrical pieces in this format combining game mechanics and theatre.
-

- Story navigation was very clear and obvious once instructed. I would suggest a quick 1-min video or written list of instructions as a “prop” so that people can refer back to it if they forget to press stop, etc.
- Yep.
- No, but that's what I loved! The sensitivity of the radio made the tension so much more palpable, and the fear of losing connection more intense.

- My only other feedback (which I told you) is that the dialogue needs a proper scrub down. Remove clicks, EQ and compress and process it to be more radio-like. Will increase immersion 100%. Also pan center!! *****
-

- Amazing stuff, Adam! I understood and don't understand at the same time how you did it all – seriously clever.