Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Humanities
Department of Music

Jon Fredrik Eid

# The Value of Video Game Sound Design

## Assessing value of sound design for an improved player experience, in a sci-fi first-person shooter

Master's thesis in Creative Music Technology
Supervisor: Heather Frasch
November 2023

NTNU
Norwegian University of
Science and Technology

Jon Fredrik Eid

# The Value of Video Game Sound Design

## Assessing value of sound design for an improved player experience, in a sci-fi first-person shooter

Master's thesis in Creative Music Technology
Supervisor: Heather Frasch
November 2023

Norwegian University of Science and Technology
Faculty of Humanities
Department of Music

NTNU
Norwegian University of
Science and Technology

# Abstract

In this thesis I will assess the sound design I've created for a sci-fi multiplayer FPS game. In collaboration with Riddlebit Software, I have worked on the game Setback, and contributed to the exploration the game's audible identity. Through the resulting sound design, we will look to the many properties and values that sound design contributes with to enhance the player experience. We will examine how sound conveys meaning through auditory icons, iconic sounds, and localization, as well as its worldbuilding properties to establish perceptual realism and presence in a virtual world. I will also cover how cohesive sound design, unity to visual elements, and dynamic playback can help meet player expectations and maintain player immersion. We will explore the complexity of timbral qualities, and how this can relate to subjective taste and the enjoyment of sound design. Finally, we'll also examine how establishing a design process, utilizing listening modes and interdisciplinary teamwork can help facilitate the creative process.

# Sammendrag

I denne oppgaven skal jeg vurdere lyddesignet jeg har laget for et sci-fi flerspiller FPS-spill. I et samarbeid med Riddlebit Software har jeg jobbet med spillet Setback, og bidratt med å utforske spillets lydlige identitet. Gjennom det resulterende lyddesignet skal vi ta for oss de mange egenskapene og verdiene som lyd bidrar med for å forbedre spillopplevelsen. Vi skal undersøke hvordan lyd har iboende mening gjennom auditive ikoner, ikoniske lyder og lokalisering, samt dens egenskap til å etablerer tilstedeværelse og opplevd virkelighet i en virtuell verden. Vi skal også ta for oss hvordan sammenhengende lyddesign, enhet til visuelle elementer, og dynamisk avspilling kan bidra til å møte spillernes forventninger og opprettholde spillerens fordypning i spillet. Vi skal utforske kompleksiteten ved klangfarger, og betydningen det har for subjektiv smak og opplevd nytelse av lyddesign. Til slutt skal vi undersøke hvordan etablering av designprosess, bruk av lyttemoduser og tverrfaglig samarbeid kan bidra til å fasilitere den kreative prosessen.

# Preface

Video game music is an amalgamation of my two great passions, music, and video games. When I started my academic journey at NTNU, I had already decided that I would work as a composer for video games in the future, and my bachelor thesis was on the subject of dynamic music in video games. Through this I became more familiar with audio engineering, and over time I became increasingly interested in everything related to audio for video game. My intention with this project is to explore the possibilities of sound design, with the hopes of becoming more competent within a field of game audio, that I feel like I've neglected.

This thesis is intended for those who want to work with sound design for video games and those who want to understand the functions and properties of sound design. Hopefully it can also contribute in some way to the field of academic sound design by pointing out values that can enhances the player experience.

A big thank you to Riddlebit Software for an enlightening and fun collaboration, this thesis would not be possible without you. Thank you to my supervisor Heather Frasch for compelling conversations and academic support, and to master forum for your feedback and insight. A warm thank you to all of my fellow bachelor- and master students for five amazing years at NTNU. And finally, a very special thanks to my partner Vegard for his compassion and contentious support in the writing of this thesis, and my academic endeavors.

## Table of content

## Figures



## Tables

# Glossary and abbreviations

## Game

**FPS** – First person shooter – a genre of video games.
**Mechanic** –gameplay elements and how they function, often a player ability.
**Zoning** – The action of keeping someone out of an area.
**Item** – Special powers that can be picked up and consumed on use.
**Bug** – An error in game development that causes something to not function as expected.
**Raycast** – Sending an invisible ray from a sound source to the player (in this context)
**Setback** – the name of the game I'm working on
**Setbacking** – being rewound when reduced to 0 health points (HP)

## Game Engine

**Game Engine** – The program where the game is built.
**Unreal Engine** – The game engine I've used for this project.
**Sound source** – the instance of a sound with a position in the game world
**Blueprint** – the visual coding asset that adds functionality to the game.
**Metasound** – a DSP rendering graph for visual programing of audio in Unreal Engine.
**Middleware** – third-party programs made for game engines which handles audio and Digital Signal Processing (DSP).
**Spatialization** – Sounds in the virtual environment and their movement in virtual space.
**Attenuation** – Scaling of volume based on distance between sound source and player.
**Occlusion** – The masking of sound sources that are obstructed by objects in game.
**Convolution** – Filtration of the sound source through an impulse response.

## Sound Design

**Sound source** – the samples used in the sound design.
**Redesign** –using the old sound material to create something new.
**Sound event** – a sound sequence in its temporal context.
**Timbre** – the qualities of a sound, a perceptual property (Kowert and Quandt 2015)
**Auditory Icon** – the encoded meaning in sound
**Audiation** - a cognitive process by which the brain gives meaning to musical sounds.
**Sonification** - the use of non-speech audio to convey information. (ICAD, 2011)

# 1. Introduction

## 1.1) Theme

My thesis is a report for the practical work I've done in my internship at Riddlebit Software. During my internship I have created sound design for their up-and-coming sci-fi multiplayer FPS game named Setback. A sizeable part of my thesis will cover the process and resulting sound design. To approach the results and assessment of the sound design, I will **first** establish the field of sound design, through games, film, audio, listening, timbres, and the role sound design has in media. My thesis is directly tied to the game I've designed sounds for, so I will also contextualize the project and explain some of the methods and tools used to create these sounds. **Then**, I will present the resulting sound design. For each of the sounds I've created, I will contextualize it through its game play element, go through my design process and potential challenges associated with the design. I will also compare my resulting sound design to the previous sound and investigate what the sound design provides to visual- and gameplay elements. **Finally**, I want to pose a research question: How can I approach a meaningful assessment of the sound design I've created, and determine its values related to the player experience. I want to explore this through a discussion based on the established field of sound design and show how this relates to the value of my results. We will look to how sound design can contribute to a better player experience through cohesion, unity, dynamic playback, role, meaning and enjoyment. We will investigate how sounds share audible traits, builds the identity of the game, promotes player immersion, adds to visual elements, communicates information, and satisfy expectations.

## 1.2) Delimitation

I've been a consumer of video games my whole life and use this as a foundation for my creative work. I'm not going to compare my work with sound design from other games however, as this would involve a decision on what I should compare my work to. While this would be an interesting comparison for evaluating the sound design, including this would push the scope of this thesis far beyond what I have planned. I also want the thesis to work at its own merits, without any requirement to prior knowledge of video game audio. During the project I've looked to multiple modern FPS-games for reference, as a point of comparison. Games are also different from one another, and this thesis is specifically referring to the FPS-genera and the game Setback. I should also add that the sound design is created for PC-users with audio playback through headphones in mind, meaning that the audio examples in this thesis is recommended to be experience this way as well.

I don't have any experience working with the game engine or sound design on large-scale projects before this project. I have worked with sound design specifically, but also with audio programming. As a result of onboarding in the middle of Riddlebit Software's project, I have worked with production specifically, and not with pre- or post-production. Since this thesis is heavily tied to the internship of a start-up company, certain aspects of audio are omitted. Meaning that mixing, dynamic volumes and reverberation handled by the game engine is not implemented. Many of the sound designs are still open for changes and iterations as well, as the game is by no means finished as of finalizing this thesis.

# 2. Background and theory

## 2.1) A brief history of the first-person shooter, game technology, and game audio

The video game genera "FPS" (first-person shooter) came to be in the 1970s and was arguably perfected in the 1990s with Id Software game titles: Doom and Wolfenstein 3D. The game is played in the first-person perspective, which reinforces the idea that you are looking through the eyes of a protagonist, or by inserting yourself in the game world. Doom and Wolfenstein 3D got a lot of attention, and the genre became increasingly present in the media landscape (Galloway 2006) (Therrien 2015) (Collins 2008). The Counter-Strike- Call of Duty-, Half-Life-, Halo-, and Doom-series, to mention a few, has released multiple titles the last decades, showing how that the FPS genera is still very much relevant today.

Through the fifty years of commercialization of games there has been many advancements in technology that has shaped the FPS genera. Kowert and Quandt (2015) gives a brief overview of this:

> "The 1990s saw home video games begin to feature expanded production budgets and innovations such as three-dimensional graphics, faster processors, a shift from game software using ROM cartridges to optical CDs that could hold much more program data, and the ability to hold multi-player sessions using Local Area Network (LAN) connections and the Internet" (Kowert and Quandt 2015)

When game developers had access to more storage, computational power and more optimized game engines, the ambition to create realistic virtual worlds became more prevalent. The switch from 2D- to 3D-games, physics-engines, dynamic lighting, complex animations, and other advancements in the field allowed developers to create more convincing game worlds. Local multiplayer added a social element to video games, and while online multiplayer did the same, it also introduced a competitive landscape.

These same advancements in technology and hardware have had an impact on the field of videogame audio as well. With higher amount of storage at our disposal, we have more freedom in terms of quality and quantity of sounds. In early iterations of sound design, designers heavily relied on sound synthesis, sound fonts, and short heavily compressed samples, just to save space. These techniques can be viewed as the foundation for video game audio. The 1990s introduced both capabilities of MIDI and surround sound in games. Even though sound design in modern video games still use techniques like looping and triggering sound effects like they did in the 1970s, the tools we use have improved drastically. In modern video games it's not uncommon to have hundreds (or even thousands) of sound effects. With so many sound assets the need for organizing them in a meaningful way also arose. Modern game engines and middleware like Wwise, FMOD, and ISACT provides a more intuitive user interface and better solutions for sound design. These new solutions and middleware programs allows for real time DSP, which can respond to physics to create more realistic sound effects in real time. (Collins 2008)

## 2.2) Audiovisual origins

To better understand how we design sound today we can look to the history of sound design in media. The early practice of sound design for video games are grounded in the traditions of sound design for film. Michael Chion is a film critic and composer who's focused on the importance of sound for cinema. In his book Audio-Vision he has coined multiple terms which is still relevant to sound for film today. One of these terms is *Synchresis*, which is formed by fusing the words synchronism and synthesis, described as: "The spontaneous and irresistible mental fusion, completely free of any logic, that happens between a sound and a visual when these occur at exactly the same time". Another term coined by Chion is *added value*, which explains how sound enriches the image and create the definite impression (Chion 1994) (Jørgensen 2008). Synchresis is a phenomenon which gives sound designers some leeway to the creative process. This is because the listener often accepts the sound when combined with an action. Added value brings up an interesting quality of sound for media, which visual elements struggle to communicate. It can create nuanced information about an object, that is not visible to the viewer. It can also give information about something happening outside of the images on screen. Examples of this could be, the squeaking of wooden floors in an old house, the howling wolfs on the horizon, or the honking horn of a car in an impending car crash. These examples illustrate how sound can make the world come alive by imposing feelings and provide information about the qualities of objects.

Since the practice of sound design is based in film, it's interesting to look to what is differentiating the two mediums. Film and games are distinguishable in two noticeable ways. The first being that film follows a strict timeline, while games in comparison, are considered non-linear. The player explores the game world at their own pace which puts a new responsibility on the sound design. Instead of playing sound based on a timeline, we rely on triggers and in-game events to play sounds at the right time. This means that audio playback reacts to changes in the game states or in response to a user. This is what is known as *dynamic playback*. Grimshaw-Aagaard (2007) explains it as follows: "… the game sound designer works to a non-linear, multi-branched script: It isn't possible to make every gunshot sound unique if you don't know how many gunshot sounds are needed!" (Grimshaw-Aagaard 2007). The other distinguishable quality is how we interact with games. Watching a film is a passive activity and does not consider the viewer, while games need the player to engage with the medium. How the consumer is changing from audience to participator heavily influence how we need to consider sound design. It is no longer merely a supporting asset to storytelling. (Jørgensen 2010) That being said, sound is still a contributor to the narrative storytelling and world building in video games.

## 2.3) The role of sound in video games

A common way to organize audio in film is to separate between diegetic and non-diegetic sounds. In this separation diegetic sounds belong to the narrative of the fictional world, and non-diegetic doesn't. Traditional diegetic and non-diegetic division in film audio quickly becomes complicated in games. This is because the player is partly responsible for audio playback by interacting with the game (Collins 2007).

Because of games interactive nature, and the short comings of diegesis, there has been multiple attempts at defining the roles of video game audio. There is no uniform way to distinguish between the different roles of sound in video games. Mainly because sound design can fulfill multiple roles at the same time. Kristine Jørgensen (2010)

distinguishes between world building and informative sound design. "All game sounds have a function with respect to the game world, be it to provide information relevant for gameplay or to provide a specific atmosphere." (Jørgensen 2010). I would like to add that *Spatialization* is an important contributor to both world building- and informative sound design, by acoustically processing sound in the virtual environment.

Unlike other assets in video games, sound has the unique property of inserting real-world qualities into the virtual world. An example of this is how real world recordings of weapons can trigger whenever the player shoots a gun within the game. (Grimshaw-Aagaard 2007) Sound is known for being a strong contributor to create a convincing and immersive experience, which aims to create a sense of presence. Presence is an important concept when creating virtual environments, and can establish a sense of being in the game world (Jørgensen 2008). This presence in the game world also promotes player immersion, which Grimshaw-Aagaard (2007) describes as follows:

> "Player immersion, then, may be (…) a shift of perceptual focus, from an awareness of 'being in and part of' reality to 'being in and part of' virtuality such that, in the ideal case, virtuality becomes substituted for reality. This immersion is, in part, enabled through a system of sonic perceptual realism which is technically enabled through the FPS game engine's sonification capabilities."(Grimshaw-Aagaard 2007)

The "sonic perceptual realism" that is mentioned here is likely referring to spatialization, and how sounds are played back in 3d-space. Spatiality is an integral part of gameplay, as surround sound is assisting in creating a more realistic and immersive environment in games (Collins 2008). In Unreal Engine there are multiple parameters which adds to the acoustic ecology of the virtual space. Attenuation is simulated by the distance between the sound source and the receiver (player character). Through this we can scale both volume and low-pass cut-off frequency. Occlusion simulates sound absorption and masks sounds sources behind solid objects. We can also use convolution to simulate sound fields with the use of impulse responses and geometrical acoustics algorithms.(Fırat, Maffei et al. 2022) Together these parameters aids in the creation of a convincing three-dimensional worlds. Grimshaw-Aagaard (2007) continues: "Sonification that provides information about the game and character status, is also an important aspect of player-player communication. It provides a relational framework for the player to begin to contextualize themselves within the spaces of the game world." (Grimshaw-Aagaard 2007) This shows us how sound can provide information through *localization*. Being able to hear an opponent and determine where they are is especially important in a multiplayer setting. How sounds are masked, how loud they are, and what material enemies are traversing in the games environment are examples of information that can assist in localization. (Johanson and Mandryk 2016) Spatialization can also inform the player about the game state, provide awareness, and orientation. Jørgensen (2008) describes how sounds act as an informative system, providing information about what is going on in locations not visible to the player, and how the game will respond to the players presence in the game world. This ties in to how the *acousmatic function*, where one can hear a sound but cannot see the source:

> "In games, acousmatic sounds are important since they provide information to the player in situations where the visuals have no power to do so. Sound may also be used as an informative system that enables listeners to pick up a higher amount of data compared to the visual system, and sound is therefore suitable when providing a lot of simultaneous information to a listener. In computer games this means that the player will receive less detailed information about events and processes in the absence of sound" (Jørgensen 2008)

Informative sounds is heavily tied to *Auditory icons,* which means that sounds can have encoded meaning. (Grimshaw-Aagaard and Schott 2011). Understanding these auditory icons is a critical part of mastery during gameplay. Auditory icons can be divided into three categories: preemptive sounds, reactionary sounds, and feedback sounds. Pre-emptive sounds tell the player where the enemies are located before they engage, reactionary sounds indicate the location of an enemy after they have engaged, and feedback sounds indicate when damage has been applied to the player's avatar (Ng and Nesbitt 2013).

To summarize, sound design is used to provide a specific atmosphere to games. By building a convincing game world we establish presence which promotes player immersion. Sound design also has the unique quality of providing feedback to the player about what is happening in the game. Auditory icons, localization, and the acousmatic function are examples of how sound is an informative system. Spatialization adds an acoustic ecology to the virtual world, which adds to both informative and world building sound design.

## 2.4) Modes of listening

Academics within sound have made multiple attempts at categorizing different modes of listening. What these different forms of categorization have in common is that they aim to provide different perspective of how a sound is perceived. As an example, if someone is introducing themselves in a film, are we listening to what is being said, the tone of voice, characteristics of the voice, where the voice is coming from, how the voice reverberates, the quality of recording, post processing techniques, etc. This example illustrates that a sound has many different qualities and meanings. How we choose to listen is key to how we access and perceive these different attributes.

Chion (1994) recognizes three modes of listening. He defines them as causal-, semantic-, and reduced listening. Causal listening consists of listening to a sound in order to gather information about its cause or source. Semantic listening refers to interpreting messages through codes or language. While reduced listening, a term coined by Pierre Schaeffer, focuses on the sound itself, its traits, and qualities, independent of its cause and meaning (Chion 1994). Hermann and Ritter (Hermann and Ritter 2004) expand upon this idea with the meaning of sound, which I have structured through the table below (Table.1).

| | |
|---|---|
| 1) Sound and Meaning in Speech and Music: | verbal communication, non-verbal communication, prosody, and expressing emotion through music. |
| 2) Meaning From the Perspective of Function: | alerts, auditory localization, iconic meaning, acoustic scenery, coordination of actions. |
| 3) Meaning From the Perspective of Listening: | listening types: musical listening, sound source (create a mental model), analytical everyday listening. |
| 4) Meaning From the Perspective of Physics: | interaction sounds, laws of physics, intensity, frequency, envelope. |

*Table 1. Hermann and Ritter (2004) - meaning of sound illustration.*

Herman and Ritter (2004) also, through the *perspective of listening,* argue that causal listening often can be analytical by: "discerning various attributes in analytical everyday listening, like size, shape, velocity, material of colliding objects, or the underground of rolling objects." (Herman and Ritter 2004) *Interaction sounds* is interesting in this context as well, because this is something we are all familiar with from our everyday lives. We often know and expect how something should sound based on weight, density, and material. *Iconic Meaning* refer to our ability to differentiate between sounds and rapidly apply meaning to new sounds. (Hermann and Ritter 2004) This means that the listener often can distinguish between different materials, how they behave, and discern whether or not materials match the visual elements and their behavior in games. This again, can be tied into our perceptual awareness, which is an important aspect of working with sound design. Farnell (2010) points out that:

> "Good sound design is more analysis than synthesis. Most of it is component analytical, reduced, critical, and semantic listening. (…) Work like a painter, occasionally stepping back to see the whole picture (semantic listening) and sometimes zooming in on very fine features invisible to the ordinary listener (component analytical listening). Stepping back is important because sound can be seductive and hypnotic. It is easy to get stuck in a certain perspective and lose sight of the whole. (…) occasionally letting go of technical considerations and engaging in reduced listening, which allows an intuitive impression to form." (Farnell 2010).

Depending on what mode of listening a sound designer is using, they can 1) hear connections between sounds, 2) zoom in to work with sound properties, and 3) deconstruct the sounds individual qualities, both in terms of layers and temporally. The sound designer should maintain perspective and clear goals, while also being able to "zoom in" to sculpt the finer details of the sound. Through reduced listening we can deconstruct the sound and discern their individual inherent qualities. When we talk about a sound's quality, we are often referring to the sound's timbre, which is an important topic for sound design.

## 2.5) Timbre and Audiation

Timbre is a set of auditory attributes and together with pitch, loudness, duration, and spatial position describe musical qualities, which contribute recognizing and identifying a sound source. A sounds timbre encompasses the many properties a sound has, such as brightness, roughness, attack, quality, richness, hollowness, harmonics etc. Such qualities are perceptual, which further complicates the topic of timbre. (McAdams and Goodchild 2017) Because of the temporal nature of sound, and these many properties in which timber can be expressed, it is also difficult to measure objectively. McAdams & Winsberg (1995) explains the complexity of measuring timbre:

> "… timbre was considered to be a perceptual parameter of sound that was simply complex and multidimensional (…) This multidimensionality makes it impossible to measure timbre on a single continuum such as low to high, short to long, or soft to loud, and raises the problem of determining experimentally the number of dimensions and features required to represent the perceptual attributes of timbre and of characterizing those attributes psychophysically. (McAdams, Winsberg et al. 1995)

Because of the multidimensional and temporal nature of timbre, it can also be challenging to approach this topic through language. When talking about timbre we don't

have a uniform language to rely on, but we can approach describing sounds and sound qualities in different ways. We can approach the sounds qualities in detail by breaking them down in to smaller parts. We can describe it through the use of metaphors and onomatopoeia to give an idea of what we want to convey. We can also use technical language for digital signal processing and sound analysis to more accurately talk about certain qualities of the sound (Collins 2020). I would like to add that we can also look to other sounds as a reference, as a point of comparison, when discussing timbre qualities.

In media production, there is often a stage where the visual elements are established, and sounds are added later to form the full impression. The process of mentally invoking sounds related to images is called *audiation*, where one's own experience and imagination is used to do so (Grimshaw-Aagaard 2007). When visual elements are presented to us with the absence of sound, we form our own impression of what they could sound like. This could be by the artefact's movement, material, speed, mass, esthetic, etc., but may also be formed by conventions and previous experience. Because timbre does not have a uniform language, and we often rely on indirect ways to communicate timbral qualities, it can be difficult to access this information in a meaningful way.

## 2.6) Futuristic and realistic sounds

When we design sounds for video games, they can often be labeled in three ways, as realistic-, mimetic-, and caricature sounds. Realistic sounds would be those recorded in the real world and inserted into the game. Mimetic sounds imitate the real sound, and caricature sounds are liberated from their real life equivalent while still retaining similarities to its source. Using caricature sounds would suggest that we are moving away from realism. However, a reduced realism based on conventions and expectations is often adequate to achieve an immersive player experience. Meaning that whether the sound design is realistic, memetic, or caricatures, a perceptual realism may be achieved. As far as realism is concerned, a perceptual realism may be enough to establish player immersion within the FPS game acoustic ecology. This is true for the sound design itself, its consistency, and by simulating acoustic spaces. There are many sound effects in FPS games that aim to provide perceptual realism like environment sounds, ambience, and footsteps. (Grimshaw-Aagaard 2007) (Grimshaw and Schott 2008). Perceptual realism means that the virtual environment is perceived as real by the player, while reduced realism concerns the level of realism. The further we move away from inserting real recordings of sounds in the video game, the more we are establishing a reduced realism. Mimesis and caricatures contribute to a reduced realism, a verisimilitude that can still be perceived as real by the player.

Through mimesis, caricatures, and the leniency of synchresis, sound designers can often exaggerate sound design to create a desired effect. In futuristic sound design we have a high amount of freedom when applying sounds to artefacts like objects, actions, and events. Farnell (2010) describes *hyperrealism* as sounds with a base in reality which then go beyond their original meaning to explore new sounds. With sounds no longer based in reality, we are free from conventions of natural familiarity. We are discovering the potential of the unreal, and as sound designers we need to be sensitive to the meaning in sounds. Not all sci-fi sounds are synthesized, and unreal sounds can very much be created from real world sources. It is not uncommon to blend samples from recordings with synthesis within hyperrealism (Farnell, 2010). I agree with Farnell that creating sci-fi sounds are different from the established conventions of realistic

sounds. I would argue however, that consumers of media where the narrative takes place in a futuristic setting, already has formed some idea of what futuristic and unreal artefacts could sound like. Popular media establishes conventions, and our interaction with the sci-fi genera form a familiarity, even with the hyperrealistic.

As sound designers we are also responsible for creating a perceptual realistic acoustic ecology. As such it is not our place to add reverb to sounds, as this should be handled through DSP in the game engine (Farnell 2010). Because of this we record sounds with as little reverb as possible, which complicates the authenticity of realistic sounds even further. Collins (2008) explains how all sounds created and recorded by the sound designer, have to be made sound real in post-production or through real time DSP. Without a real reference to the space they were created, they are arguably "less than real", and in many ways sound designers compensate by creating "more than real" sounds. Collins (2008) continues:

> "Typically sounds are manipulated in the studio, treated with various effects, or sweetened to create a more exciting sound (…) This usually involves layering sounds, adjusting various elements of the sound, equalizing and compressing the sound, or using various digital signal processing (DSP) effects" (Collins 2008).

These techniques allow us to create a wide range of sounds, from mundane realistic sounds to fantastically futuristic sounds. Through hyperrealism we can explore the potential of fictional worlds outside the scope of reality. Considering the possibilities of real time DSP provided in engine and middleware, we can also apply dynamic properties to sounds which would be impossible to achieve in the real world.

# 3. Materials and Method

## 3.1) Contextualizing the project.

I've worked with a game company based in Trondheim called Riddlebit Software, in relation to this thesis. In 2020 they started development on a game called Setback, and I onboarded as an intern in February 2023. Riddlebit Software is comprised of twelve employees, but none of them are dedicated to audio, as a result, the developers of Setback have mainly relied on placeholder audio. The collaboration with Riddlebit started out with determining what I wanted to work on in their game, and how this would relate to my thesis. They offered me autonomy in terms of what I wanted to work with, as well as the workload for the internship. I offered to design sounds for newly added content, and meanwhile I would look to improve their existing sound design. This would help them move away from placeholder assets and contribute to shape the auditive identity of the game. Haakon Dale, a previous music technology student, has also worked on sound design for Setback in relation to his master thesis in 2021/2022. Some of the sounds in the game has already been designed by him, but I was unaware of which sounds this was until September 2023.

In the early stages of my internship, I made a list of all the sounds in the game, and a priority rating for which sounds to design first. Which sounds were prioritized was primarily decided by me, but I also discussed this with the developers and the producer. I spent the first few months familiarizing myself with the project, the game engine, and new software for sound design, with a learning-by-doing approach. I got my own office space at the company so that I could work closely with the developers and artists. This was important for me to better understand their vision, future plans for the game and partake in discussions regarding sound in Setback. Since I onboarded at Riddlebit we've had play tests every other week, seasonal events, and tournaments. These events have been an opportunity to get feedback from the team on the sound design I've made, and a way to test how all the sounds fit together, in the way that they are intended to be experienced.

## 3.2) Sound design-process

Sound design as a process is something I became more familiar with during the project. In the beginning, I had a more explorative approach, probably as a result of being unfamiliar with the game engine and the project. Over time, I started researching, documenting, and identifying the needs and wants from my colleagues as part of the design process. Looking to established models of design, and combining them with my own process, I have created a design process that fits my needs as a sound designer. In the table below (Table 2.) I've illustrated the different stages of my process. We identify what the sound provides, research the subject, and plan a procedure for the design. Then we create sounds and implement it in the game engine. Lastly, we test that everything works as intended, and iterate on the design to improve upon it.

| STAGES: | TASKS: |
|---|---|
| **1) IDENTIFY** | What is the in-game asset or mechanic?<br>Does it need sound?<br>What does the sound provide? |
| **2) RESEARCH & PLAN** | Research conventions and solutions<br>Procedure to creative process |
| **3) CREATE** | Source material - Record, synthesize, sound libraries<br>Design - Shaping, layering, filtering |
| **4) IMPLEMENT** | Trigger and/or place actors<br>Dynamic playback<br>Spatialize |
| **5) TEST** | Does the sound achieve the desired effect?<br>Does spatialization and dynamic playback work as intended?<br>Does the sound fit with other sounds? |
| **6) ITERATE** | Solving issues<br>Improving sound design |

*Table 2. Jon Eid - My sound design process.*

## 3.4) Sound design-tools

When designing sounds for Setback I have primarily used two tools to achieve the design. The DAW Ableton Live Suite 11, and metasounds in Unreal Engine.

I have used Ableton Live Suite 11 as my choice of DAW for this project and use many different plug-in effects and virtual instruments when designing sounds. Ableton Lives native plug-in Vocoder and Spectral time has been used for many of the sound designs. This is done consciously to create a cohesion between different sound designs. I've used Phaseplant and Ableton Live's Operator as my main virtual instruments for sound synthesis. They have been used with an explorative curiosity and a learning-by-doing approach, as I have not used them before this project began.

Setback is being developed in Unreal Engine 5. Most gameplay features are actualized through the visual coding asset called blueprints. I can add an audio component to a blueprint and play sounds attached when the blueprint is called in game. But instead of adding a sound file to the blueprint I have used Unreal Engine's newest feature called *Metasound*. A metasound offers a DSP rendering graph, a visual programing interface for audio, much like Max MSP. It is a visual programming interface based on nodes that can handle audio in many different ways. These nodes can create oscillators and noise-generators, play samples, process sounds by modulating and filtering signals, randomize parameters, create sound-sequences, and blend sounds through layering. What makes metasounds so interesting to me is that we can use in-game variables to apply changes to the sounds in a very approachable way.

## 3.3) Sound assets

When creating a new sound for the game, I usually start with the sound producing material. I have identified four ways that I can acquire sound assets. I can 1) Redesign, meaning that I recycle assets already in the project to create something new, 2) use synthesis and virtual instruments, 3) use sample libraries, and 4) record new sounds. I have mainly relied on synthesis and sample libraries for this project, layering and processing them to create new custom sound design. For instance, the weapon sound design in Setback is heavily synthesized, but I've also added samples from drums to add a clear transient. Once I have created a sound I render it for use in the game engine, but when it is rendered, it will play back identically every time. To add dynamic properties, we will have to apply changes to playback in the game engine to compensate for this.

## 3.4) Sound implementation

Earlier I mentioned how games are non-linear, and how we can't rely on a timeline to determine when a sound is going to play out. Say for instance that the player presses the space-button and executes a jump-action. In the game engine, this would execute the jump-blueprint, moving the player character. At the same time, this also executes the appropriate triggers to animation, sound, and other executables related to the action. When a sound is triggered, it spawns a metasound-actor in the game environment, and when it is finished it will destroy itself. This is true for most sounds, but some sounds are persistent and are placed in the level itself, like environmental and ambient sounds.

Due to games being interactive I can't always know how long a sound is going to last or repeat during gameplay. In this case it makes sense to use *looping sound* to play during the event or action. When designing a looping sound, it's important to create a seamless loop, to avoid pops in the transition between the end and start of the sample. Using loops is also adaptable to changes that developers make during production. So that the sound designer doesn't need to make new sounds based on duration values. Also, when working with rendered sounds we want to avoid exact repetitions on playback. In a metasound we can apply randomness to the pitch of a sample on playback. This is a common technique to avoid exact repetitions, which can breake player immersion.

When sounds are played back in the game engine, they can be *spatialized*. Spatialization is common in 3D-games and allows us to simulate real world behaviors of sound in the game engine. Parameters like *attenuation, occlusion, and convolution* can help create this effect. Attenuation allows us to scale volume based on distance between the player and the sound source. Occlusion raycasts (checks for line of sight) from the sound source to the player character. If it can't raycast occlusion is applied to the sound, reducing volume, and applying a low pass filter. We can also assign audio volumes to the level. When the player enters an audio volume, sounds are filtered through an impulse response by multiplying frequency spectra. This is called convolution, which simulates reverberant spaces.

# 4. Sound design results

## 4.1) Presentation of sound design

In this chapter I will present a selection of the sound design I have created in Setback. Due to the extensive amount of sound material, I have decided that it would be best to have a selection of sound design rather than presenting all of the sounds I've created during my internship. Some sounds only take place during gameplay, like the audience system, announcer, and fireworks, so these are more challenging to showcase in an isolated environment. Other sounds have been omitted because there were few interesting aspects to point to, or major similarities to other designs. I have decided to present the new sound design and compare it to the placeholder and previous sound designs. While placeholder assets are intended to be temporary, it was the actual state of the game until I became part of the project. While not a fair comparison to industry standards, it clearly illustrates the progression of the sound design during my internship. For some sound designs this is not possible however, as a result of content being added to the game during my internship. These sounds won't have a point of comparison as they didn't have a placeholder asset to begin with.

For each sound design, I will include a video file to better contextualize the sound to on-screen elements. How the artefact or mechanic behaves in game is of importance to understand the sounds meaning and function related to gameplay. I'm also going to describe the game mechanics to further contextualize them, as I believe that sounds created for video games have less meaning detached from the context they are created in. Through this context I can give a better insight into the creative and technical process of sound design. Optionally, I will include a spectrogram to visually represent the sound. Spectrograms can be useful to point to the qualities of a sound, its motion, patterns, and timbre. Note that these spectrograms are based on the same audio as the videos. I will also include images and videos of metasounds to illustrate how I've worked with real-time DSP and visual programming where applicable. We will also explore the challenges, solutions, and future plans related to the design, and I will share these if it's an integral part of the design process. Feedback and future plans for sound design can also lead to some reflection and discussion as well. I will discuss it here if it is only relevant for a specific sound design.

I should also mention that sound design is an iterative process and is prone to change based on personal taste and based on feedback from the team and player-base. As a result of this, some of the sound designs been through multiple iterations while some are still in an early iterative stage. In addition, some sound designs have been pushed back due to production schedules and prioritization.

## Sound design categorization

I've structured the presentation according to how they are categorized in development, shown in the table below (Table 3.). Some sounds have multiple purposes and won't fit in to any single category, while other sounds are unique and won't fit in to any category, they are labeled "misc." (miscellaneous).

| NAME: | TYPE: | NEW DESIGN: | INCLUDED IN THESIS: |
|---|---|---|---|
| **SETBACKING** | Effect, Misc. | | X |
| **JUMPING & LANDING** | Movement | | X |
| **SLIDING** | Movement | X | X |
| **BASH** | Movement, Misc. | | |
| **SCOUT** | Weapon | | X |
| **SHOTGUN** | Weapon | | |
| **AUTORIFLE** | Weapon | | X |
| **FLASHBACK** | Item | | X |
| **MOLOTIME** | Item | | X |
| **ORBITAL STRIKE** | Item | | X |
| **BLOBS** | Item | | X |
| **TORNADO** | Item | X | X |
| **BUBBLE SHIELD** | Item | X | X |
| **LAUNCH-RING** | Interactable | | X |
| **PORTAL** | Interactable | X | X |
| **WATERFALLS** | Environment | X | X |
| **TORCHES** | Environment | X | |
| **AUDIENCE SYSTEM** | Environment, Ambience, UI | X | X |
| **WIND SYSTEM** | Ambience, Misc. | X | X |
| **STAGE AMBIENCE** | Ambience | | |
| **ANNOUNCER** | UI | X | |
| **FIREWORKS** | UI / Environment | X | |

*Table 3. Jon Eid - List of sound design results.*

***Instructions for video-files:***

*By adding the PDF to the unpacked zip-file you should be able to use the hyperlinks in the thesis. If this doesn't work, refer to the folder named Master Material, where you will find folders for every sound design. They are structured in the same order as the thesis for your convenience. In these folders you will find a .mp4 file with the sound design in context to on-screen elements. Note that some sound designs have multiple video-files to showcase metasound functionality.*

## 4.2) Setbacking

Master Material/1. Setbacking/Setbacking.mp4

Setbacking is the core mechanic of Setback. This happens as a result of your player character being reduced to 0 health in the game. When this occurs the player character will temporarily be put in a fixed animation and temporarily removed from gameplay. During this time the player is rewound back to a previous position. Setbacking is designed to impose control of other players in the game by altering their positions. Ultimately, this is the aim and result of combat, giving you space to complete the games various objectives. The mechanic also ensures that the players are always relatively engaged in combat, unlike many other FPS-games. Setbacking is so fundamentally integrated to the games design that it defines how modes and maps are being developed. Since setbacking is so important to the games identity the sound design needs to be carefully crafted. Unlike other sound designs, the sound of Setbacking will be a major contributor in defining Setbacks identity as a game. Because this sound design is so important in defining what Setback is, I spent a lot of time exploring different approaches. I did not perceive the previous sound effect to be complementing this mechanic. I perceived it more as entering a shadow realm, rather than being technologically rewound back in time. When identifying and planning what setbacking could sound like, I explored metaphors for time like sand in an hourglass, the flow of time, etc., but I ultimately took inspiration from rewinding records. I also wanted this sound design to feel massive, like a punch in the gut, to reflect how someone has just bested you in combat.

I found multiple samples of rewinding records and experimented with different combinations. To complement this, I added a transient with a kick drum and sub-bass to increase the impact of being setbacked. I also reversed a cymbal sample to add some anticipation to the end of a setback. I wanted to keep the audible feedback when they get control over their player character again when the setback is over, and heavily tied this to the visual effects of the mechanic. There is a shatter-effect on the screen which is reconstructed at the end of a setback. I reversed a sample of glass breaking, doubled it and transposed one of them an octave down. I further processed the sound with the Ableton plug-in spectral time, to create a shimmer-effect. I added another kickdrum for some impact on this part of the sound event as well. The necessary triggers for entering and exiting a setback-sequence was already in place, so all I had to do was replace the audio files in the Metasound.

In the figure below (Figure 3.) I've visualized the sound with a spectrogram. This illustrates its behavior in time and the difference between the sound designs. Compared to the old design, the new design is richer in high frequencies, features some rhythms and motions in frequencies. In the low-mid frequencies we can see the rhythms slowing down until the setback ends. There is also a clear line from the beginning of a frequency dropping from 10 kHz to 1 kHz, as well as a subtle rise in frequencies at the end of the sound design. These motions and rhythms do not provide any evidence that this is a "better" sound design but could indicate that the new sound event has a stronger narrative and is of higher fidelity.

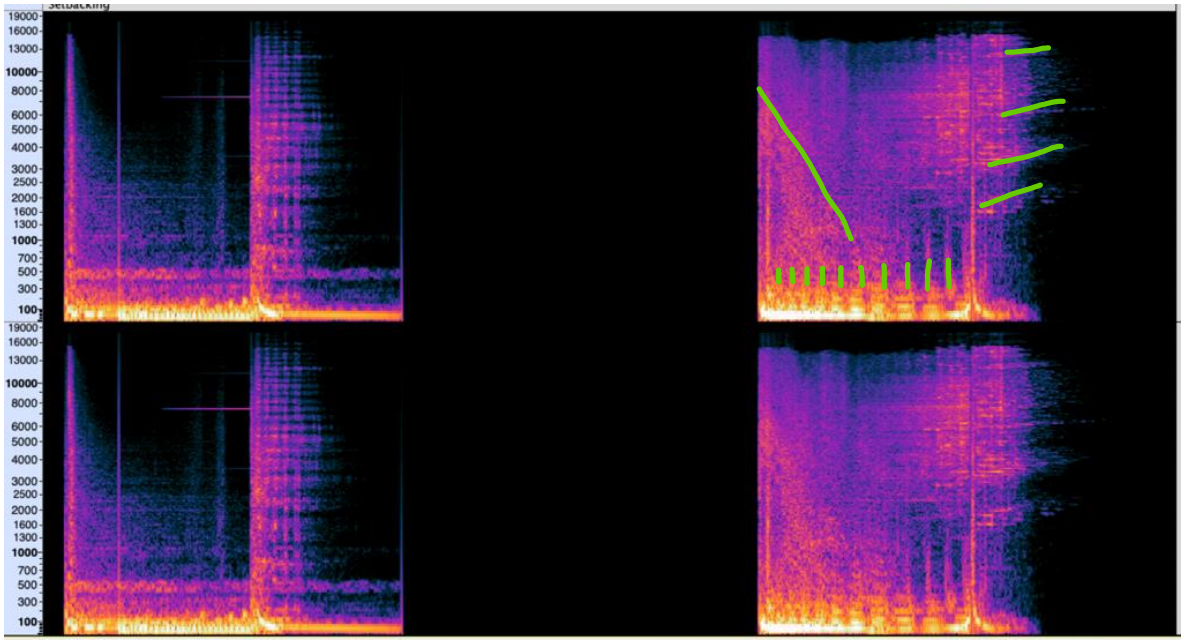



*Figure 1 - Setbacking - Spectrogram*

There were no concrete challenges related to this design, but I felt a major responsibility when designing something which is so core to the games identifying mechanic. Especially when the games lore is not established enough to give me a good idea of what it could sound like. There was a concern from a coworker was that it was "too much". This is a great example of the type of feedback I can get on a design, and I wasn't provided any other descriptive details. Although there might be some truth to the design being "too much", I interpreted this as a difference in preference at the time, as my intention was to create a massive sound design. I should also consider that the feedback is related to gameplay. This design has mainly been tested by me in an isolated environment, and maybe hearing this sound many times over could be perceived as overbearing. If I were to add to the design, I would apply some more changes on playback, as I was pressed for time to get this sound design finished. I would try to have a few different combinations of layers chosen at random on each playback, to create a more dynamic sound design. This is especially important considering you will be setbacked many times during one match. Whether the feedback is concerning repetitions in gameplay or taste, I should still treat this as valid feedback. At the same time, I also have to balance this with my own taste and the positive feedback I received on the design. Maybe another iteration could cater to their taste, or maybe we have different opinions of what Setbacking should sound like.

## 4.3) Player ability – Movement

Most FPS-games use movement and gunplay as the main mechanics for the player to interact with the game world, and setback is no different. Together we can categorize moving and shooting as the innate players abilities. We will get to the weapon sounds in the next section, but first I want to present a selection of sounds created to traverse the arenas of Setback.

Moving is an action that the player is taking part in most of the time. Designing movement sounds might not seem as the most exciting part of video game audio but can be a surprisingly challenging endeavor. This can be explained by the meaning of interaction sounds and physics sounds. Since everyone has a fundamental understanding of what movement and materials sound like, the player will be quick to pick up on any transgressions to the expected. For this reason, sounds related to movement are based in reality. It is also important that movement sounds are not perceived as disturbing, as these are sounds that will trigger at most times during gameplay. Giving some audible feedback to the player on their movement gives the action more meaning, especially when it is a movement ability that does something out of the ordinary. In a multiplayer setting, movement-sounds are especially interesting, because the sound takes on another meaning. Suddenly the sound of another players movement can be valuable information through localization, identifying the enemy's location without seeing them.

### Jumping and landing

Master Material/2. Jumping and landing/Jumping and landing.mp4

Jumping is a tried-and-true mechanic in most 2d and 3d games where you control a player character. The character you control in Setback does not have any technology equipped that would enhance or modify how a jump would sound, meaning that the sound design should be rather simple and realistic. The previous design had a jumping sound that was more akin to a landing sound, and there was no sound for landing. The new sound of jumping tries to handle this issue. When starting a jump, it is not as transient-heavy, but more of a sweeping-motion. This is achieved by combining samples like shaking clothes and pillows and short, cut, shoe samples. In reality standing still and jumping would likely not create this sound, but since we want some sound for this input, having a subtle sweeping motion is a common approach in FPS games. The landing sound is more similar to the old jump sound, but I did implement a double transient to give the impression of two feet hitting the ground.  As we can see in the spectrogram below (Figure 2) the new sound design has two distinct sounds related to a jump-action, where the old sound design only had one.

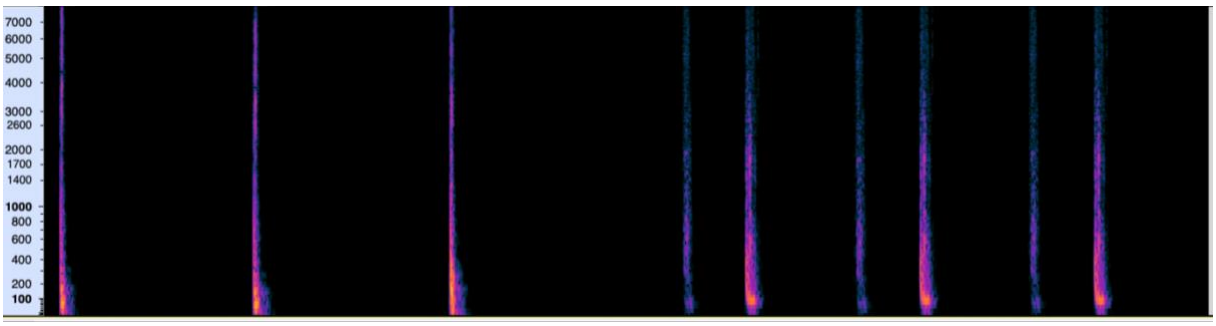



*Figure 2. Jumping - Spectrogram*

When creating a jumping sound, I underestimated how challenging it would be to achieve a convincing result. I could not find any good samples for the sweeping motion, so I had to break down exactly what I wanted it to sound like. Using the sound of pillows and clothes to create a sweeping motion is not intuitive, but works well for the effect I wanted to create. This is an example of analyzing sounds timbre and engaging in reduced listening. Finding the right timbres without being interested in what the sound source is. Creating a double transient on landing was also an iterative process. The samples have to blend together while also retaining some separation between them. I found that I could achieve this by placing them around 50ms apart from each other.

## Sliding

Master Material/3. Sliding/Sliding.mp4

In setback you can perform a slide which gives the player a slight burst of speed, which is gradually decreasing the further you slide. This is an action that has been in the game for a long time without a placeholder asset. It's not a particularly interesting design, as its only expectation here is a sound that convey movement of your character. It can be described as a swoosh- or a brush-sound, with an added transient indicating the player characters weight hitting the ground.

From a game design standpoint this movement mechanic has become more interesting during development. By canceling the slide early with a jump, the player can retain the initial speed burst from a slide. Since this is an intended technique game design-wise, the sound effect must be able to stop early when exiting a sliding-state, and should transition nicely into a jump. In the video example I showcase this technique, to show how the sound design stops and transitions into a jump. This is further visualized in this metasound (figure 3.) where the cancelation of a slide triggers the release of an envelope.

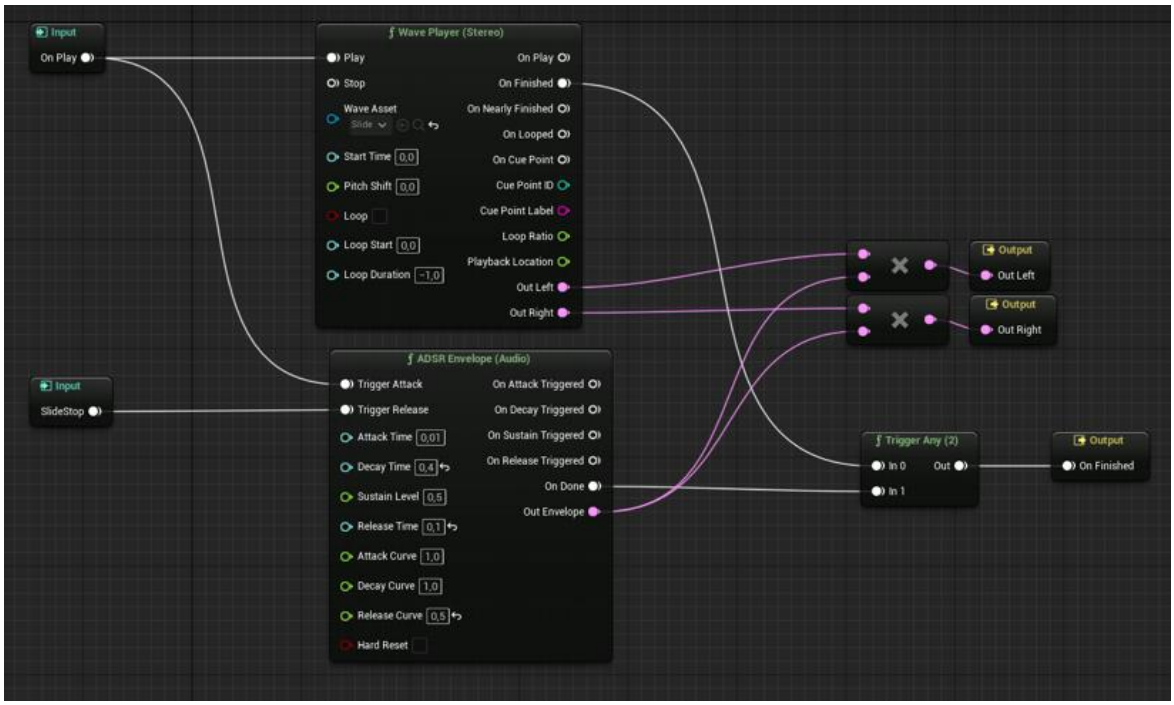



*Figure 3. Sliding - Metasound*

## 4.4) Player Ability – Weapons

Gunplay is also at the core of setbacks mechanics, and it's the main way to impose a setback on other players. In setback you have multiple weapons to choose from with their own unique models, projectiles, and behaviors in game. I worked at three weapons sound designs before the weapons was put on hold until new weapon models were developed. Working on weapon-sounds was the second task I got assigned during my internship after interactable objects. Through this I became familiar with triggering sound from player input through blueprints.

### Scout

Master Material/4. Scout/Scout.mp4

The Scout is the most precise weapon in setbacks weapon roster. It shoots one bullet on each input and is an effective weapon on long ranges. I perceive that this precision-identity is also communicated in its visual design, by being slim and elegant compared to its counterparts. This is something I want to communicate through sound as well. Designing around the visual elements on the screen aims avoid a conflict in the overall design. The resulting sound design is comprised of two layers. It has a heavy transient to convey the weapons power, and a synthesized sound as the body and flavor of the weapon. These two parts are what we can work with to convey the weapons identity. I made the sound by combining samples of transients like snares and kicks, and synthesizing laser-sounds in Phaseplant.

The main challenge related to the Scouts sound design was exploring an interesting audible identity for the weapon while also keeping the samples short. The weapon has a high fire-rate, and the samples length should be close to the interval between each shot. Because the samples need to be so short, there is little room for development in the sound. Meaning we need to convey both power and flavor in a short amount of time. This design has gone through the most iterations of all the sound designs in the game, and I'm not that satisfied with it personally. Over time I think I've come to like the original sound design by Haakon Dale better than my own. This is only something I've thought of recently however, and to be clear, I did not base my design on his in terms of samples nor esthetic. The main reason I'm not happy with the design is how it presents itself in a multiplayer scenario. When four to six players use the weapon at the same time, I perceived it as overbearing. In Setback shooting is something the players engages in most of the time. Finding a good balance between esthetic and how it works in game is challenging, and a good lesson learned when working on this design. Maybe the sound design works fine the way it is and would work better in a multiplayer environment by adjusting the attenuation radius.

## Autorifle

Master Material/5. Autorifle/Autorifle.mp4

The autorifle is the only fully automatic weapon in setback. It alters the aim of the player over time, simulating weapon recoil, and implying its power. The visual flare of this weapon is its spinning barrel. When I was exploring sounds for the autorifle we decided to put weapon sound design on hold until the weapons new visual design was created. Therefore, this is not so much a sound design as a change to dynamic playback, and the samples used for this sound design is created by Haakon Dale. I still wanted to include this design, because something interesting happens when playback changes based on the weapons remaining ammo. I can track the variable of ammunition and translate that into something meaningful for audio. In this case I wanted to scale the remaining ammo with the pitch of the sample. The less ammo you have, the higher pitch the sample will be played back at, as we can see in the figure below (figure 4). This might not make much sense from a realistic standpoint, but from a game design standpoint something interesting happens. By doing this, we give the player audible information about how much ammo they have left. The sound takes on a new meaning in this case. Earlier, the sound provided audible feedback on the players action, as well as some flavor to the visual design. Now however, the sound provides additional information about the how much ammunition you have left. The sound is notifying the player, and now references the UI-elements on the screen. In a chaotic game-scenario the player might not always have the time to look to UI to get this information. Sounds has a unique property where it can provide this information in a non-intrusive way. Even though the information was available on screen already, this might be easy to overlook in a chaotic game-scenario.

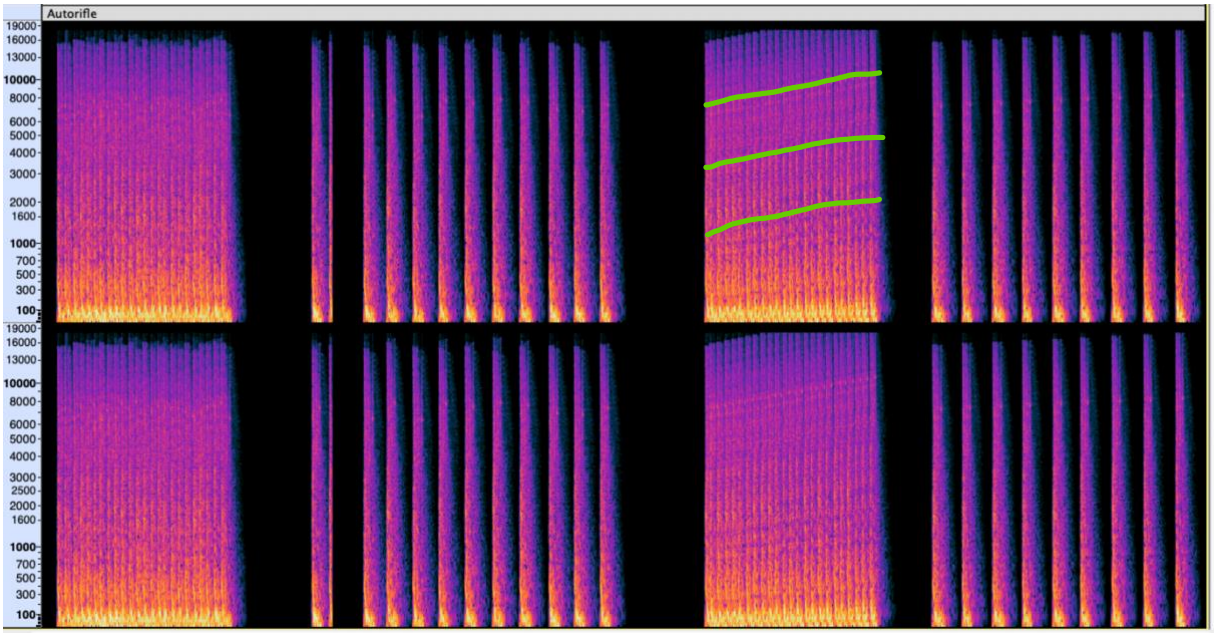


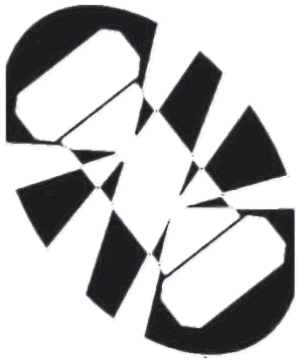

*Figure 4. Autorifle - Spectrogram*

## 4.5) Items

In Setback there are multiple items that can be acquired during gameplay. These powerful one-time-use abilities can have a meaningful impact on the state of the game in many different ways. They can be used to impose setbacks, displace enemies, power-up the player character and used as movement abilities.

When I onboarded at Riddlebit, most items-sounds made use of place-holder assets. This was a good temporary solution to get audible feedback when the item was used, as well as give an idea of its effect to the players. Items is a category of sound that has been prioritized for my internship. Many of the item-sounds already gave a good idea of what the item did, but some also had major design flaws. Some examples of such flaws were timbers that didn't match the visuals, looping sound-assets which weren't seamless, and low fidelity sounds.

### Flashback



Master Material/6. Flashback/Flashback.mp4

The flashback is a throwable item which explodes after a short delay, on collision with a wall or the ground. If a player is within this explosion radius the player will be setback to a previous location. Since this is such a powerful item, I wanted to explore the whole lifespan of the item. The lifespan of the item is composed of three parts: 1) when the item is thrown, 2) the windup when it bounces of a ground or wall, and 3) the explosion that quickly follows the windup. By providing information that the item is thrown we can give opposing players a chance to react to the threat, and the item now functions as a preemptive sound, a type of auditory icon. The ignition before the explosion also builds anticipation to the impact of the item. The previous design had an explosion sound, but no information about when an item was thrown, and no audible windup before the explosion occurs. The flashback throw sound effect is created with Phaseplant. I'm using an analog sample modulated through AM and FM as the base sound, and another LFO to modulate the AM and FM frequency over time. The bounce ignition is created by combining some sci-fi samples, one with a distinct flutter, one with some metal timbre. I also used Ableton operator to create a reverse sub-sweep to build anticipation. The explosion sound is composed of three different samples. An explosion sample, a sci-fi metal-like sample which is the body of the sound design, and finally, a part of the ignition sound to tie it all together.

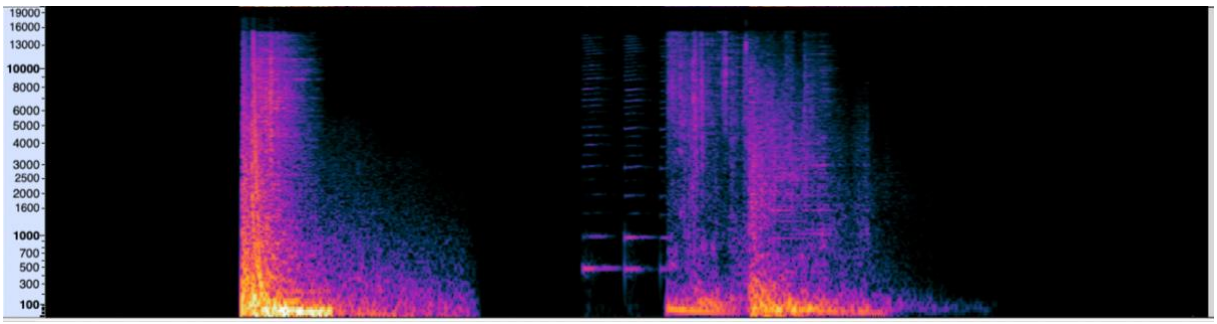



*Figure 5. Flashback - Spectrogram*

As we can see in the spectrogram above (figure 5.) the old flashback has a long decay, reminiscent of reverberance. This is something that we usually don't want to add as sound designers, but rather have sounds reverberate based on audio volumes (convolution), handled by the game engine. This ensures that the reverberations are tied to the environment it is used in. We can also clearly see the three parts of the new sound design in the spectrogram. By comparing the two, we can also clearly see how the old sound design is louder. A loud sound for this item is probably what we want, because of the big impact it can have in game. The explosion sound also works really well, but the developers expressed that they wanted something with more of a sci-fi esthetic.

One oversight that I made with this design was not knowing the time delay of the ignition bounce and explosion. As a result, my rendered sound did not fit with the event in game, and I had to cut down parts of the sound. Measuring time related to gameplay elements is something that I incorporated into my design process, to have clear boundaries in what I create. This also brings up an interesting challenge in sound design. If the time-values were to change to the item later, I would ideally create sounds that could follow these changes. If I don't, I would have to create a new sound every time changes are made to time values. Another aspect of this is changes to the visual design. After the sound design was made, a swirling particle effect was added to the visual design of the explosion. Because visual additions are included a free-flowing manner, I could not plan for this to happen. Through a more structured design process this could've been established earlier, but it's not something I've expected from the team during my internship.

### Molotime

Master Material/7. Molotime/Molotime.mp4

Molotime is an item based on the Molotov cocktail, a common item in many FPS-games. This is a zoning, throwable, persistent item which can be used to force enemies to move out of an area or keep them from moving through an area.

Molotime is a sound event composed of three parts: 1) thrown, 2) burning (loop), and 3) extinguishing. The new design is composed with many different samples. It features glass breaking and expanding flames which transitions smoothly into a loop. The loop ends with an extinguishing "swoosh" sample paired with the loop sample fading out. This is done to maintain the same textures in the extinguishing as in the loop. Together this creates a sound event that communicates the items behavior and visual elements through sound. There are some noticeable differences between the previous and new sound design. In the figure below (Figure 6.) we can see an illustration of how the sound designs are different. The old sound design was loud in lower frequencies, which made the sound effect sound muddy and low fidelity. I aimed to change this with the new design by cutting frequencies under 60 Hz. In addition, by adding samples of glass breaking, expanding- and extinguish flames, I intended to communicate the visual and physical properties of the item through sound.

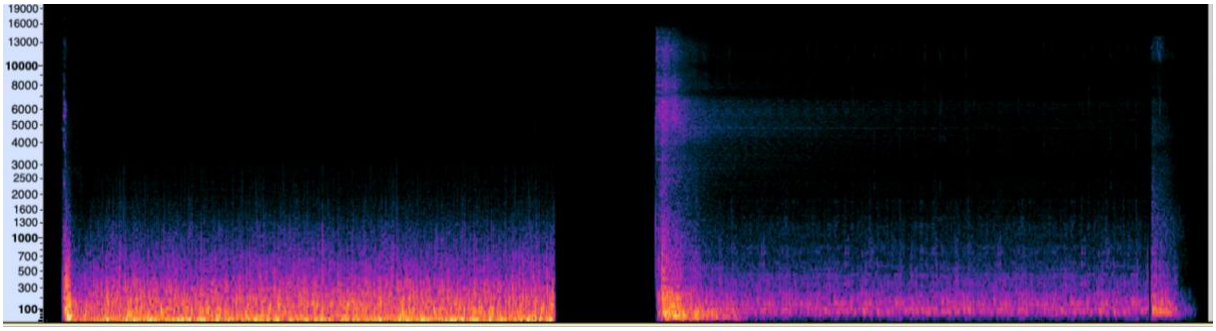



*Figure 6. Molotime - Spectrogram*

I got feedback on this design from one of the developers of setback, where they wanted it to sound "more sci-fi". I added a new layer to the sound design, where I wanted to tap into motions and timbres that would make the sound effect more uniform with other sound effects in the game. I experimented with different samples and heavy processing through spectral time. This effect creates some interesting motions and textures, which can give an impression of something sci-fi or magical happening during molotimes lifespan. It can be seen in the spectrogram at about 5-8 kHz. Combined with the sound design, we get a sound event with some added flair that arguably fits better into the game world.

### Orbital Strike

Master Material/8. Orbital Strike/Orbital Strike.mp4

The orbital strike is possibly the most massive and powerful item in Setback. When you use the item there is a brief delay before an area is subject to an orbital strike coming from the sky, imposing setbacks on anyone caught inside the area. The place-holder asset was well designed in regard to the narrative of the sound event, but somewhat lacking in choice of samples and implementation. The old design featured a sample which I clearly experience as wood breaking. This was in conflict with my expectations to the visual elements on screen and can potentially break immersion. Neither does it make much sense when there is no such material on the field, and if there were, I would expect this material to be broken afterwards. In addition, the loop was not seamless, so you could hear a distinct pop during playback of the sound. It also has an abrupt ending because the sound is directly tied to the gameplay element, and not spawned into the world as its own entity. The new design aimed to fix these issues, while also exploring the items esthetical audible potential. Even though I point out many of the shortcomings in the old design, I want to emphasize that the idea is still good. The new design was based on it because it has a strong narrative, building anticipation before the impact we are highlighting the powerful identity of the item. This is illustrated in the figure below (Figure 7.), where we see the similarities between the old and new sound event. Through this figure we can also illustrate the issues we've discovered. We can see how the sound stops abruptly as we mention previously. How the old design explosion is rather loud in the entire frequency spectrum, likely a result of the wood breaking sample. I also want to point out the difference in downtime between the buildup and explosion. When the downtime is short, we get temporal proximity, so we perceive the sound events as belonging together, and without it we risk that they are perceived as different sound effects. The Orbital Strike also provides meaning as a preemptive auditory icon.

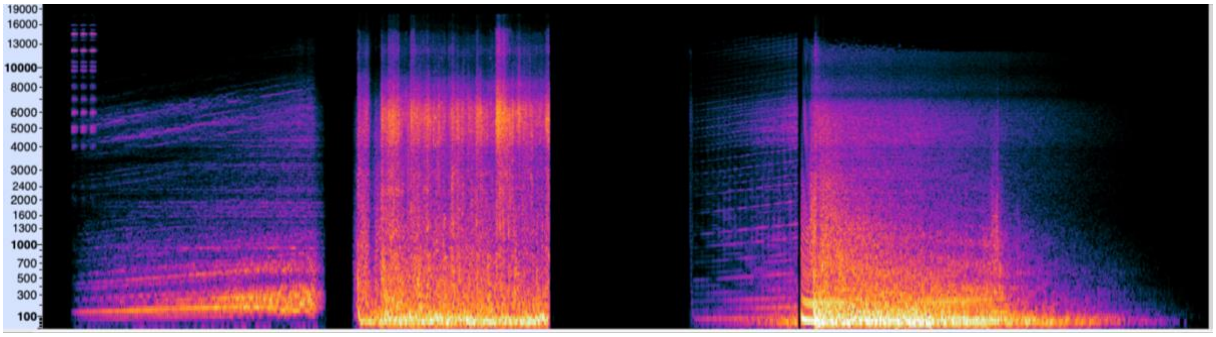
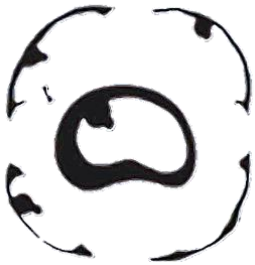



*Figure 7. Orbital Strike - Spectrogram*

This sound design has two parts to it, the buildup (anticipation), and the explosion (release). The build-up is based on reversed explosions, cymbals as well as a synthesizer native to Ableton Live. The explosion uses the same instrument for the laser sound, an explosion, and a fire-spell sample. These samples are then processed with spectral time to tie it to other sound designs, and to apply a sci-fi element to the sound event. For this design I had a very clear audiation, and created a sound design which both I and the team were happy with, without iterating a lot on the design.

### Splat bomb



Master Material/9. Splatbomb/Splatbomb.mp4

The splat bomb is a throwable persistent item, which spawn "blobs" that the players can bounce on. This item is interesting from a game design standpoint because it can be used in different ways. It can be used to "zone" enemies by keeping them out of an area, move enemies when thrown at them, or as a movement ability when thrown directly under the player character. This makes the sound design process complicated because it can be used as a zoning tool, an aggressive item and a powerup. Items are usually confined to one of these categories, and the type of item often has an impact on the sound design. According to the developers, the splat bomb was designed to be a type of deployable obstacle, and it was only discovered later to be used in other ways. The splat bomb and its visual design does not look like any other item in the game, which I've interpreted in two ways. The splat bomb is different and should sound different, or the item looks different but should be unified with other items through sound. In my opinion the old sound design was different from other sounds in the game, so I tried to unify the sound with other items. Ironically, this is one of the sound designs which ended up sounding a lot like the original. I really liked how the blobs "pop" and wanted to keep this aspect of the sound design. This is also partly tied to the animations, which make it look like the blobs pop when eighter stepped on or shot. I find it interesting how I planned to make changes to this item and ending up with a similar result as the placeholder without recycling any of the sound material. There main difference between the designs is that I perceive the new samples as lighter, and less "squishy", due to the sample's fidelity and timbre. I also removed a randomizer that had a small chance of playing a "burp"-sample, which was added for comedic effect early in the item's development.

## Tornado Field

[Master Material/10. Tornado/Tornado.mp4]

The Tornado is the latest item implemented in Setback during my internship. It behaves a lot like the splat bomb in that it's a deployable, persistent, non-lethal item, that can be used to your advantage or to displace and zone enemies. When the item is thrown on the ground, it spawns a tornado that will launch any character inside high up in the air. The metasound is attached to the moving tornado and a wind sound is set to loop once the item is deployed. There is also a trigger looking for players coming into contact with the tornado, and a sound is played when a character is launched into the air.

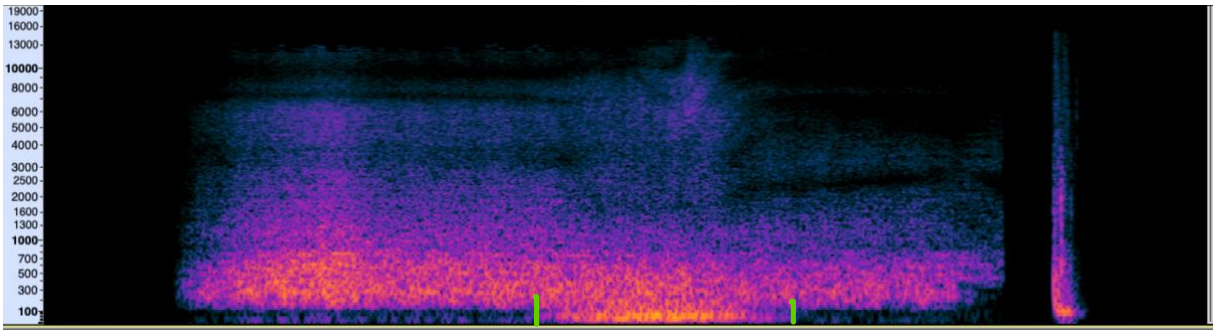



*Figure 8. Tornado Field - Spectrogram*

In the figure above (figure 8.) we don't have a comparison, as there was no placeholder for this item. We don't get the best visual representation of the item, because the player is moving, and the binaural playback shapes the sound. We do however illustrate the interactive properties, when the player character enters the tornado, marked in green.

The design of this item was somewhat rushed due to deadlines. Ideally, I would've liked to make the item more in-line with the other sounds in the game. I got feedback on the sound, and was described as "too calm", as a tornado often is more violent. This is something I would've liked to explore this further through iteration on the original idea. The sound effect also stops abruptly because it is attached to the tornado, which was a quick solution to implementation. With more time I would like to find solutions for this, so that the sound effect can have a more natural release.

## Bubble Shield

Master Material/11. Bubble Shield/Bubble Shield.mp4

Unlike other items, the bubble shield is a power-up item. It is not deployed in the level, but rather effects the player using it. The bubble shield protects the user by absorbing damage from other enemies. Since this sound design did not have any previous design or placeholders, I looked to other games for similar items and abilities. I wanted to have an ambient pulsating loop that tells the player their shield is active. I created a shield activation- and destruction sound because I wanted to provide immediate feedback on the shield's status. In addition, I added a unique sound to play when the shield is hit instead of the player. In setback there is a sound effect that tells you when you are hit by the enemies. Having this sound change implies that the bullets are being absorbed, communicating what the shield does through audio. This is a type of feedback sound, another type of auditory icon. The hit-sound is played back with some amount pitch-randomization, to avoid exact repetitions. Because a shield can endure many hits from a weapon, we can potentially trigger many hit-sound in a short amount of time. How the shield behave is illustrated in the metasound below (Figure 9.).

I created the bubble shield loop and activation sounds through synthesis with Phaseplant. The shield loop is based on a square wave and the pulsation effect is achieved with AM controlled by an LFO. The activation sound is based on a wavetable, where the harmonic-parameter and the position of the wavetable is modulated by a line segment. The hit-effect is created with a tom-tom drum sample filtered through the spectral time plug-in.

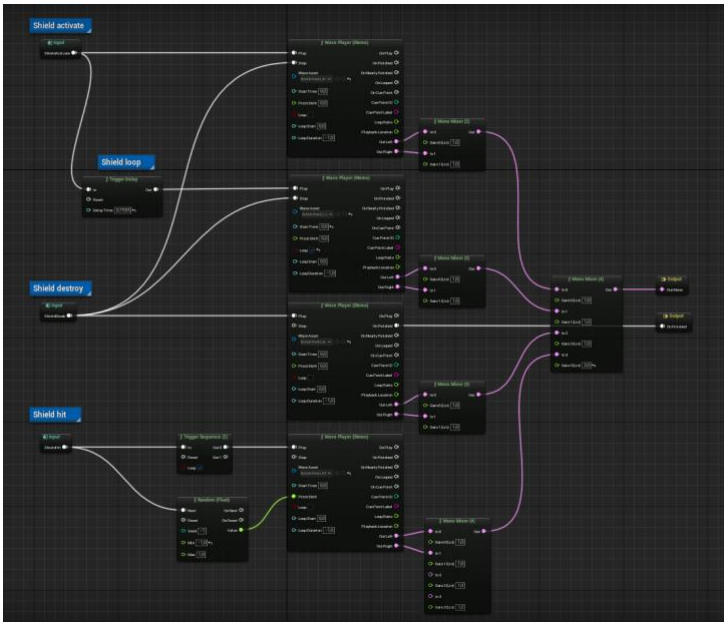



*Figure 9. Bubble Shield - Metasound*

In the video example, I show how the item behaves on its own, and when the shield is subject to damage by throwing a molotime on the ground. This showcases an issue with the bubble shield. As the molotime applies damage multiple times per second, the hit-sound effect does not come through as clearly as I would've like. We should consider having a set delay on trigger, so this does not happen when the shield takes damage in rapid succession. This is a good example of how sound can influence each other during game play, and how they need to be considered in relation to one another. In the spectrogram (Figure.10), we can clearly see the pulsating motion that I intended in my design process, marked in green. The shield being activated and destroyed is also clearly visible by upwards and downwards motions in frequencies, much like how engines and appliances are powered on or off.

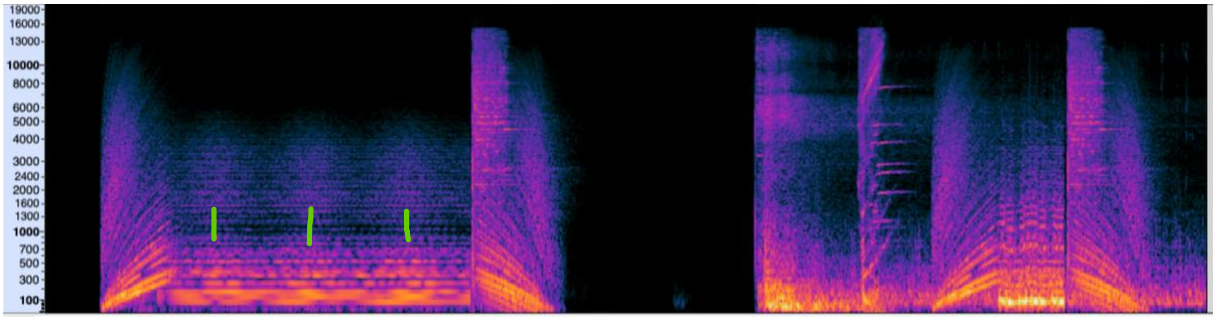



*Figure 10. Bubble Shield – Spectrogram*

## 4.6) Interactable Objects

There are certain points of interest in Setbacks levels that feature stationary interactable objects. This category of sound can be of use to the players of both teams and introduces new ways to traverse the levels of setback. As of now there are two such objects in Setback, launch-rings, and portals.

### Launch-ring

Master Material/12. Launch-ring /Lanuch-ring.mp4
Master Material/12. Launch-ring /Launch-ring Metasound.mp4

The launch-rings are stationary objects which can launch the player in a specific direction when the player comes in to contact with them. Note that in the video example I am using its equivalent launch-pad, which uses the same sound design.

My approach to designing sound for the launch-ring was that I identified what I liked about the original sound design, and what I would like to change. The old design had a noticeable transient while in the air, which is something that I wanted to change with the redesign. I liked the flutter-effect from the original design, and I re-purposed this to fit in with my new design. I also like how you get immediate feedback when interacting with the launch-ring. To add to this design, I layered an element of rising pitch, to signal that the player is launched upwards, and achieved this with a grain delay node in the metasound. By doing this, the sound design establishes a connection between rising frequencies and rising elevation for the player character. This is illustrated in the figure below (Figure 11), marked in green. Together the sound design is made up of an impact providing feedback, a riser that is providing meaning, and a flutter that adds flavor and meaning to the design. For this design I have two videos, one for gameplay, and one for the metasound. I included the metasound video to better show the different layers of the design, as well as some of the functionality of metasounds. In this case I have exported different samples from my DAW so that I have better volume control in the metasound.

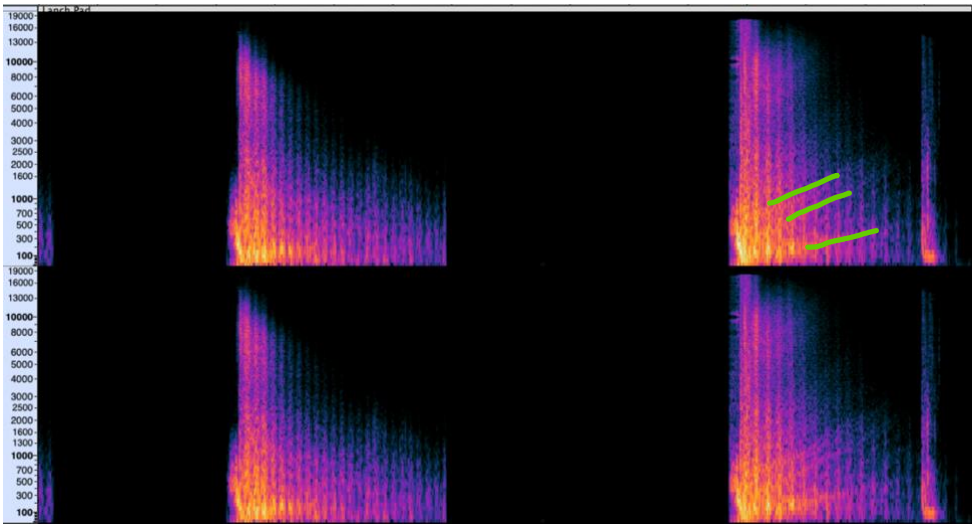
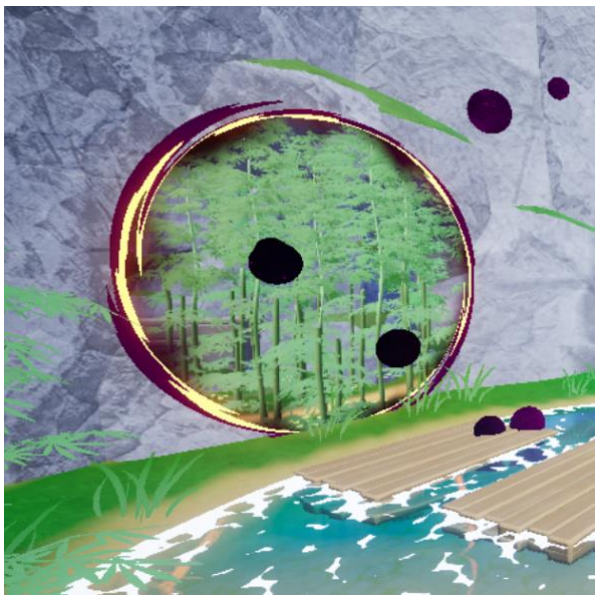


*Figure 11. Launch-ring - Spectrogram*

Most sound design for videogames has some randomness applied to the pitch on playback, to avoid exact repetitions. Here I instead use randomness to change parameters in the grain delay node, creating variable changes in time. This was a challenge because if the randomness has too much variance it starts sounding like something else entirely. I tested for edge cases when the randomness was at its minimum and maximum value to ensure that the sound would retain its qualities, while also being creating interesting changed on playback

## Portals

Master Material/13. Portal/Portal.mp4
Master Material/13. Portal/Portal Metasound.mp4



Portals is the other interactable object in Setback. They allow the player to teleport from one portal to another by moving through either of them. When getting close to a portal an animation plays, opening the portal, letting you see through to the other side. Because of this animation, I expect the portal to make some sort of ambient sound. It is also animated with a swirling motion, which is an attribute that would be interesting to explore in the sound design. This would later translate to a pulsating sound quality. Since teleportation is not a very common mechanic in Setback, and is not based in reality, I had a lot of freedom associated with the creative process.

The portal sound effect is comprised of two parts, the portal ambience, and the portal activation. The portal activation is based on three samples. A chord from an electric piano, a buzz sample, and a reversed orchestral hit, which is rendered together

and simply triggers when the player moves through the portal. The portal ambience loop is created with the Analog Dream VST synthesizer. The sound source is persistent, meaning it is playing all the time, but is only audible within a short radius. As a result, the player can only hear it when close to it. This effect is made possible by attenuation, which is looking for the distance between the portal and the player character. This is expressed in Unreal Engines unit-system and later mapped to a normalized variable from 0 to 1. The closer you get to the value of 1, the closer you will be to playback at maximum volume. I found the attenuation parameter interesting and wanted to see if this could be used for something else then volume. Through experimentation I found that I could use attenuation to change the frequency of an oscillator, which in turn, modulates the sample with ring modulation. I have included a metasound video and the figure below (Figure 12.) to illustrate this processing.

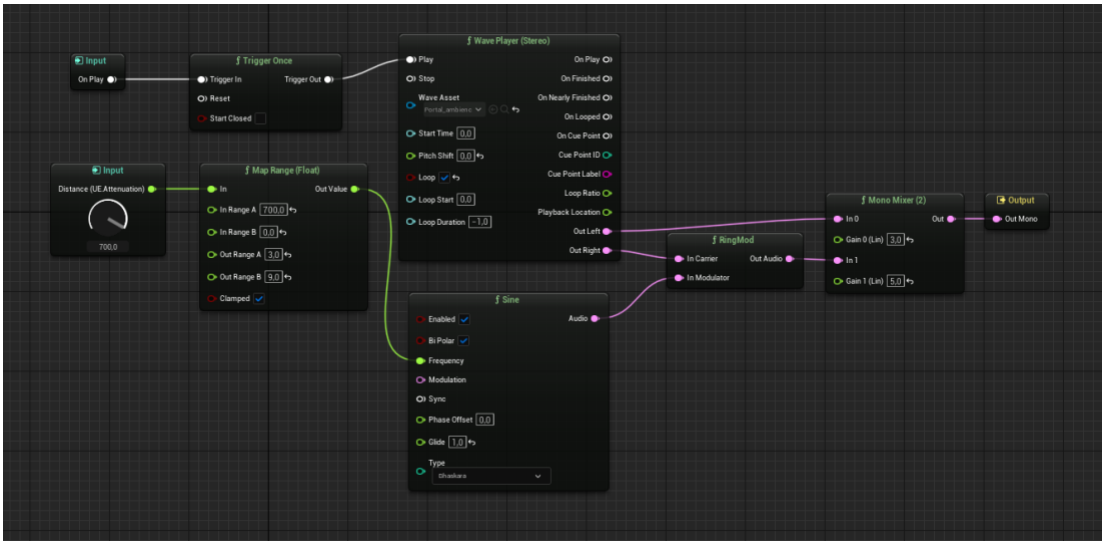


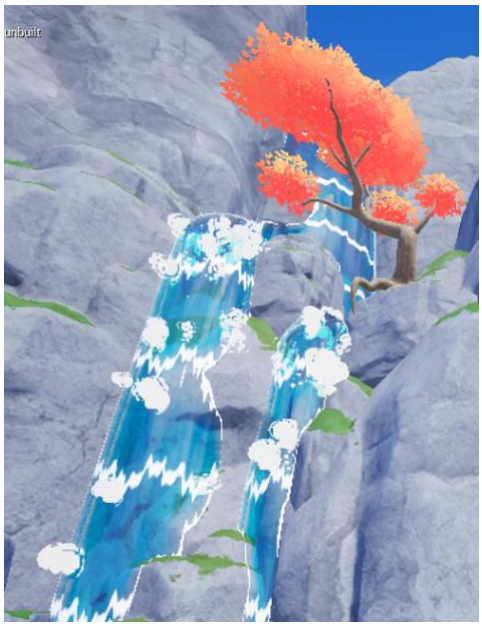

*Figure 12. Portal - Metasound*

The only challenge related to the portals design was the ring modulation values, which I had to iterate on to sound esthetically pleasing. In retrospect I would have aimed for more cohesion between the portal activation and portal ambience. I don't think the resulting ambience- and activation sounds have enough in common, partly because of the modulation which gives the portal ambience a new timbral quality. I did however get to experiment with the possibilities within metasounds, specifically with using attenuation to control other parameters then volume and equalization.

## 4.7) Environment

Environment sounds are objects in the levels which you can't interact with. Sounds in this category does not have an impact on gameplay and is merely world building sound design. With animations and movement there is often an expectation of sound. We can use this as an opportunity to create a sense of space in the game world. As stated previously, with sound we can use added value to give more detailed information about the visual elements on screen. Inserting environment sounds can contribute to build a believable breathing virtual world. Additionally, environmental sounds can be used as audible landmarks to help the player familiarize and contextualize themselves with the game world.

## Waterfall



[Master Material/14. Waterfall/Waterfall.mp4]

In one of Setbacks maps, there are two waterfalls, and when looking at the animations, there is an expectation of sound associated with them. I have never heard what a waterfall sounds like in real life, so I had to rely on references and my perceived realism when approaching this design. From this, I deduced that I could use noise generators in metasounds as the base for the sound design. I also noticed how different frequencies and timbres are present depending on how far away the listener is from the sound source.

The metasound is based on a pink noise-generator to produce sound. By splitting noise into different frequency bands, I can apply a custom attenuation to low frequencies dependent on proximity to the sound source. The bandwidth is also modulated by an LFO, to create some subtle motion in which frequencies are being processed this way, illustrated through the metasound below (Figure 13.) Together with the occlusion and attenuation settings for the sound source, this sound design changes in multiple ways. It changes volume based on distance, is masked by other objects through occlusion, and is modulated by an LFO (0-10 Hz). This approach is a combination of my own understanding of what happens physically, and what I felt was esthetically right for the sound design. Maybe I would have achieved a better result by applying acoustics theory when approaching this task. This is more of an afterthought however, and not something I thought about when designing the sound. I was more concerned with learning how sound sources behave in 3D-space, and how parameters like attenuation and occlusion can insert acoustic ecology in a virtual world.

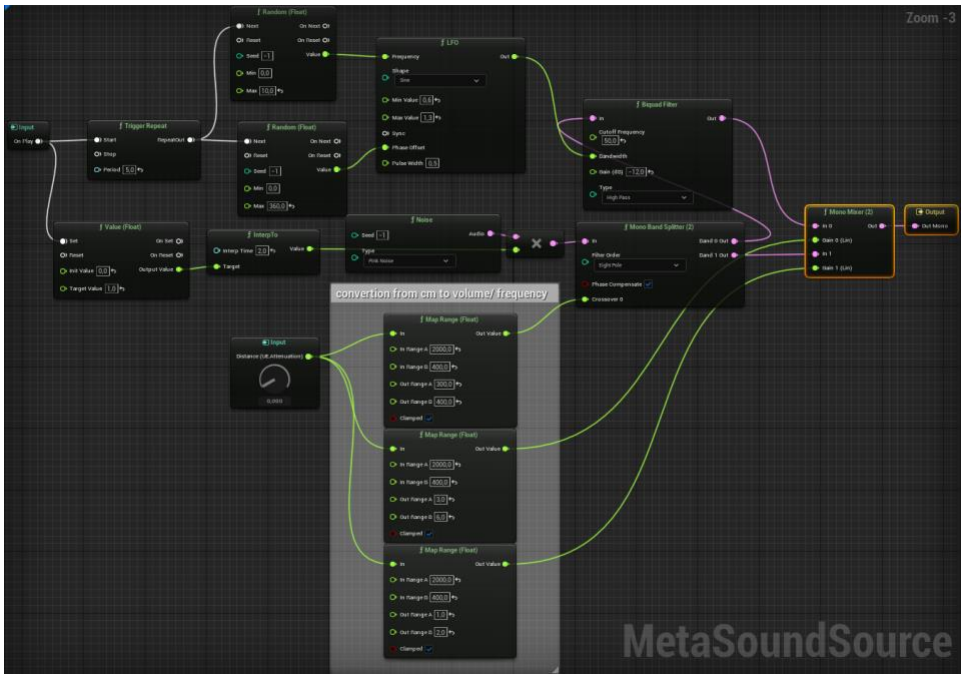



*Figure 13. Waterfall - Metasound*

There were two challenges related to the waterfall design. The first being that we want the sound to occlude when inside houses and caves. Occlusion is regularly applied if the sound source position doesn't have line of sight (ray casting) to the player. The issue is when smaller objects like trees and rocks applies the same effect, where we would expect the sound to diffract. After talking to the developers, this is not something I can solve through the occlusion parameters. Since this is a low-priority task we didn't get around to create a good solution for this either. I also wanted to play water-droplet samples when standing close to the waterfall. I tried a few iterations of this but did not achieve a good result and decided to move away from the idea. This was fine however, as this was more of a bonus feature for worldbuilding and flavor.

### Audience system

Master Material/15. Audience system/Audience System Metasound.mp4

One of the levels in Setback takes place in a sports stadium, and this is the setting in which all of the games of setback will take place in the future. On the stands surrounding the arena the audience is moving about energetically. These animations should have some sounds attached to them to sell the idea that people are actually watching a game of sports. The audience system is difficult to put in any single category. On one hand the audience has a position in the game world and could thereby be called an environmental sound effect. Part of the system is similar to ambience, and part of the system has more in common with UI, giving the player feedback on their progress and the state of the game. It was also not easy to isolate this sound in a gameplay environment, so I decided to show this design through the metasound instead.

The audience system metasound plays a loop of audience ambience and can trigger cheers at eventful times during a match. This is very much an early implementation of this system, and we have some plans to improve upon it. As of now, the sound design is a general audience that reacts equally to both teams. In the future we would like to expand this to a more complex system that can react to the match, the team, and the individual players progression in the game. The creative process for the audience system is limited. I've used EQ to make the recordings clearer while also removing lower frequencies to make room for gameplay sound effects. I've also balanced volumes between ambience and cheers, so they seamlessly transition into each other. The trigger for the cheers reduces the volume of the ambience over time, and after a set amount of time the ambience fades back in.

The most challenging part of creating the audience system is finding the right sound assets. Ideally, we want to use assets recorded far away from any person that has a clear voice, as we want the sum of the audience when listening to it in the arena. We also need a recording that matches the environment. Recordings from in-door arenas often has a distinct room tone that won't fit the virtual environment. In addition, many of the recordings I found are from real life sports arenas, which often has fans chanting and singing. This is also a problem for us because we don't want the player to recognize a

sports iconic chant, languages, or songs associated with the sport. Finally, the sample needs to have the right energy to create an engaging atmosphere. The sum of all these factors renders many of the recordings found in sound libraries useless for the purpose of our audience system.

I should point out that we've placed sound actors in four locations in the level, and this 3D effect is not showcased in the video example. This could possibly be solved with ambisonic assets as well, which unreal engine has good support for. This way we don't have to place sound actors in future stages, and we achieve a 3D effect through binaural playback instead. We would also like to add a ducking system to this in the future, so that the ambience makes room for sounds related to gameplay. The ambience system is an attempt to rework the old design, but I did not get as far as I would've liked. I still wanted to include it here however, because it contributes to world building through the lore of Setback and provides feedback on progress related to game play.

## 4.8) Ambience

Ambience is a category of sound that is usually associated with background sounds that builds the soundscape of the game. It provides a sense of space and information about the place you are in. These sounds also provide a context for other sounds and can be viewed as the foundation for building a believable virtual world through sound.

### Wind system

Master Material/16. Wind system/Wind System.mp4

Earlier I mentioned how sounds in game are either placed in the game world or executed through triggers. This is true for most sounds, but this sound design is different in that it is a persistent sound connected to the player character. This is because the wind system needs to be experienced as an individual sonic experience that other players cannot hear. It uses variables from the player character, to shape the amount of wind based on velocity, simulates wind direction, and considers head movement.

Initially I was inspired by the sample game LYRA which Setback has drawn inspiration from through its development. In this game the player character is ray casting in five different directions, and based on how many surfaces are hit the wind system gets an idea of whether the player is inside, outside, under a roof, and so on. This information is then translated to where the wind is coming from and how strong the wind should be. In technical terms, there is no wind in the game, but is rather simulated and dynamically played back based on the player characters position in the game. When I started designing this system, I based it on a tutorial for creating a wind effect within metasounds. The metasound uses four noise generators, two for handling high and mid frequencies, one for low frequencies simulating when wind hits the eardrum directly, and one for whistling, a quality often associated with the wind. This worked great for an ambience that could change dynamically based on randomness, LFO's and filters. Later in production we decided we would use ambisonic ambience themed around the different regions instead. As of now, we are using custom ambisonic stage ambience, which has replaced this part of the wind system. The ambient wind system could be expanded upon to create different winds for each stage, but this has so far yet to be explored.

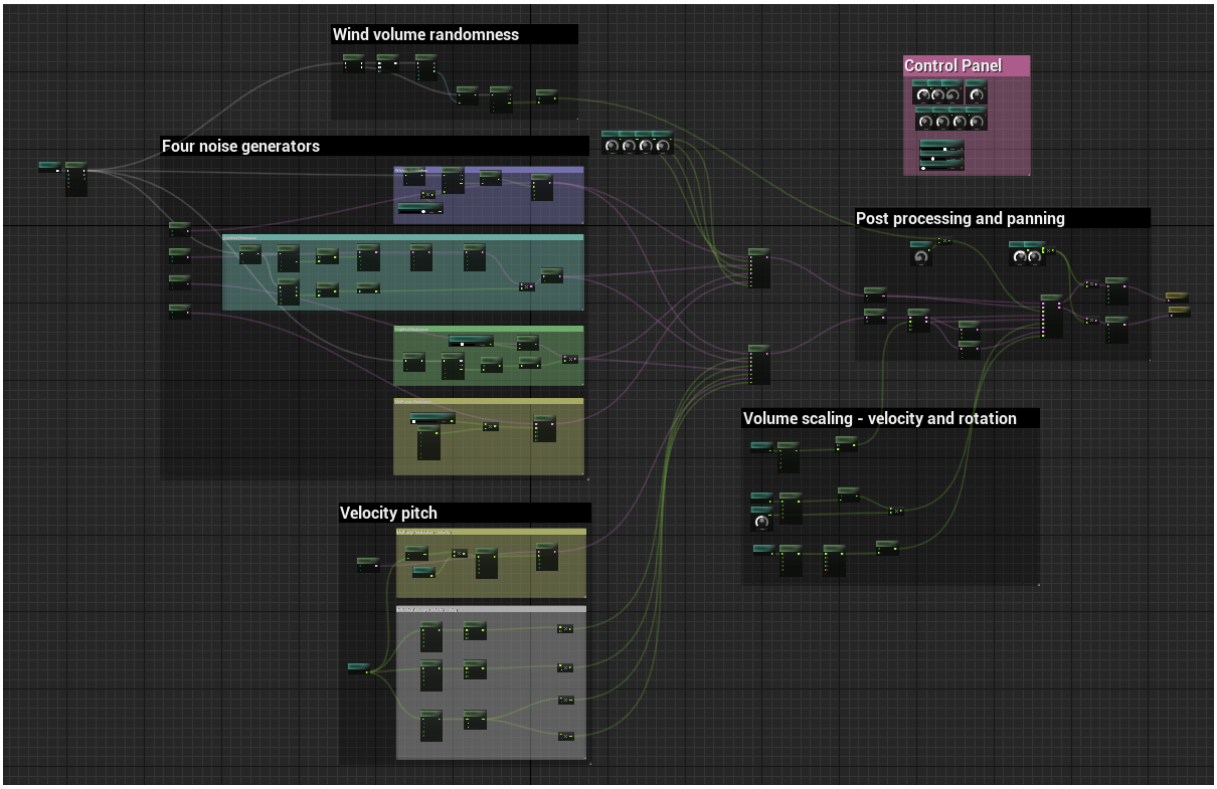



*Figure 14. Wind System - Metasound*

The other part of the wind system was added to create a sensation of movement. This part of the wind system is arguably not part of the ambient category, but more accurately part of a niche category of sounds - physics based sounds. They provide a sense of realism by adapting to the players movement. By tracking the velocity of a player character, we can determine changes to both volume and frequency based on how fast they are moving. This feature was a welcome one for the team and seems to add value to movement in the game. When this feature had been implemented, there was a concern regarding the wind feeling two dimensional. When the player character is moving their head, they were expecting the wind sound to change based on the direction they were traveling. This was the next step in the wind systems development. By using the meta sound node ITD panner, I achieved panning based on the player characters head rotation.

The Wind System metasound became quite sizeable over time, and I've included a figure (Figure 14.) that give an overview of its functionality. In the video example I am running around to show how the wind system subtly produces winds in the direction you are moving. This is more clearly demonstrated with the use of launch-rings, where the pitch and volume increase when the player character is moving at higher velocity.

The result is a baseline ambient system solely based on noise generators as the source sound. The wind system also reacts to movement both in velocity and rotation. Designing the wind system for Setback was technically challenging. Using in-game data, scaling these values by curves, and mapping it to meaningful values for sound was an iterative process. Exploring what I would expect the wind to sound like, and choosing which iteration of the system I liked better, was an extensive process that tested my listening skills and understanding of physics sounds.

# 5. Discussion

In this chapter I want to discuss, reflect, and challenge my own practices and approaches to sound design. Through this, I want to find answers to how I can assess my own sound design and procedure in a meaningful way, and what value sound design contributes with to the player experience.

## 5.1) Structure and design process

### Explorative approach and the emerging need for structure

Design as a process is not something I have any formal experience with. As mentioned earlier, I had a more explorative approach with no clear plan or process in the beginning of my internship. My intention was to improve Setbacks audio, and as such, I was mainly concerned with the creation (step three) and implementation (step four) of the design process presented in chapter 3.

I am grateful for the autonomy I received in collaboration with Riddlebit Software. They were appreciative of any sound design that I could contribute with and were flexible in terms of tasks, so that it could better relate the work to my thesis. During my internship I experienced an emerging need for structure. Ironically, because I was free to work on everything, I had a difficult time deciding to work on anything. Between March and April, I had a strenuous attitude towards the project, where it was difficult to even get into the office. As a solution to this I called for a meeting with Setbacks producer. He suggested that we could have "soft deadlines", and themed weeks where I would focus on a specific sound design or category of sounds. My supervisor, Heather, was also supportive in this, suggesting that I should reach out to Sit counseling. I scheduled a meeting with them, and this session helped me decompress, reflect on my own practice, and what actions I could take to establish more structure in the project. These conversations were of great help to my project. Over time, I got better at scheduling time at the office, setting personal goals, and meeting expectations of deadlines.

### Implementing design process

In May Riddlebit Software was asked to talk about sound design at IxDA (Interaction Design Association). The producer asked me if I wanted to represent their game and hold a presentation about sound design in Setback. I agreed to present on their behalf at the event. When planning my presentation, I wanted to relate the content to interaction designers, and because of this I researched design as a process. Models like the *double diamond* and *engineering design process* are examples of how I approached the presentation. These design models were fused together with my own process over the course of the project, resulting in the design process presented in chapter 3.

While it is possible to create convincing sound design without an established design process, the value of design process cannot be understated for my project. I believe I've used some principles of design process subconsciously before I even started the project, but actually having a routine contributes to structure, and arguably better resulting sound design. Spending time planning, researching, and identifying the mechanic or artefact I produce sounds for, functions as a solid foundation and framework where I can engage in creative activity. It will also contribute to streamlining the design

process, so that I can focus on tasks in a more structured manner. Testing procedures ensures that the sound design behaves in the intended way. Avoiding that sound related bugs make it to the live service is important because it can break player immersion, or even worse, render the game unplayable. Iteration is the process of reworking the design by creating and implementing new solutions to better match the desired result. Including iteration as a step in the design process also communicates that changes are welcome based on feedback and new ideas, recognizing sound design as a moldable process.

### The absence of design documents.

In the production of setback, the traditional design document is not part of the game design. Instead, we have used Notion, acting as a pipeline to keep track of development, sharing resources, and documentation. Since there is no designated sound designer in the team, there is no procedure for documenting information related to audio. Documenting detailed accounts for each mechanic and artefact is a time-consuming and iterative process. Understandably this is not a prioritized task, but such information would've been a great resource for me as an onboarding sound designer. Such a document would be useful to me in a design process where I'm identifying, planning, and researching, as it would provide information about intentions, identity, and lore. Planned future development could also be included here, as this was not clearly communicated through documentation. On multiple occasions I would learn that the visual element had future plans for development, only after I had created the sound design. Having this information beforehand would allow me to better prioritize which tasks to work on and avoid reworking sound design to fit the new visual effects. Usually we've had a freeform discussion regarding sound design, emerging in the form of feedback or suggesting approaches to the design. Audiation, intentions, and future plans were often expressed vocally through feedback on the sound design, which stands as an example of why communication, planning and identifying ideas about the design is so important in an early stage. If this was documented somehow, I would be more effective in creating sounds, and iterate less, to reach results that are harmonious with the team's ideas and future plans. I also recognize that I could've been more vocal about my need for more descriptive properties and esthetic qualities of sound design. At the same time, I wanted to be considerate of their time, since everyone has a lot to do before the games release.

## 5.2) Listening modes

### Utilizing listening modes

During this project I've become more mindful of how I listen when designing sounds. Depending on which part of the design process I am in, I consciously use listening modes to focus on the different elements of sound design. I'm basing this understanding of modes of listening on the presented material in chapter 2.4 of this thesis.

After I have established some idea of what the in-game artefact can sound like, through design process and audiation, I use **component analytical listening** when working creatively with sound design. With this listening mode, I am zooming in on the sound, exploring in-game artefacts identity through different samples, instruments, and filters, sculpting the sounds timbre into the desired result. I engage with **Semantic listening** to maintain consistency between sound design, most often when testing sound in a game-play scenario. Here I am investigating whether the new sound design exist

cohesively with other sounds in the game. I also engage in **Critical listening** in the testing-stage, but rather than determining multiple sounds consistency, I am examining if *the sound itself* works in the game. This could be related to repetitions, spatialization, unity with visual elements or based on my own perception of quality and identity. When I introduce new sounds, I aim to maintain a healthy skepticism, and I'm interested in the sounds potential for improvement. I enter **Reduced listening** when deconstructing sounds. Traditionally we enter reduced listening while detaching the sound from its source. This is not something that I do very often with sound design, and I've always viewed the core of reduced listening to deconstruct sound to find interesting qualities and properties. Reduced listening, to me, is perceptual inspection of timbres and the ability to use this information to determine audible qualities. I engage in **analytical everyday listening** when I play the game. I try to be aware of when I would engage in more critical or semantical listening. This is probably the listening mode that is closest to what the player actually hears when playing the game. Considering that sound is an integral part of my professional life, I arguably have a complicated relationship with the sound design. Because of this, I can probably never approach listening in the same manner as the player would, which is frustrating because sound design is created with the intentions of enhancing and supporting the player experience. How audio guides them through gameplay, how meaning of auditory icons are understood, and how sounds are perceived as part of the game world is ultimately what I am concerned with as a sound designer.

Engaging in different listening modes can be of value in different parts of the design process. The perceptual awareness of the sound designer is therefore an important aspect of assessing meanings, roles, qualities, consistency, and unity to other assets. As far as I am concerned listening is often an overlooked topic in sound design. Of course, I don't listen my way to great sound design, but in my view, perceptual awareness is how we come to understand the *value* of sound design.

### Listening, testing, and comparing.

The analysis of the sound design is mostly done through listening during the testing stage. The different listening modes previously discussed can be used to analyze the sound design through different means. If I deem a sound design to not fulfill its potential, role or function I could iterate on the design. I would often export multiple versions of a design and test them in the game environment in form of A-B testing. I would also compare the placeholders and old designs to the new design, as a point of reference to how it used to be. This is also part of the reason they are included in the thesis. I could also look to references to other games, and while this is not something I've focused on in this thesis, it is something that influences my preferences and judgement of sound design. I have played games my whole life, and the accumulation of experience is also a body of knowledge I rely on when analyzing and creating sound design. This means, in the case of an A-B test, I am basing the discission on my own taste and preference, shaped by the accumulation of all the sound design I enjoy. While my own idea of good sound design might not resonate with others, this is the only perspective I have to deem sound design as esthetically pleasing. I've also included spectrogram in the thesis to aid in the analysis of sound design. Together with listening, spectrograms can help point to qualities of timbre and fidelity, and the temporal developments of a sound event.

## 5.3) Interdisciplinary teamwork

### Partiality and audiation

With partiality, I am referring to the particular fondness towards sound design, and we can approach this from my own, and team members point of view. I have the aspiration of not getting overly attached to sound effects that I've created. Being open to feedback and involving iteration as a natural part of my design process.

An interesting aspect of entering the production at a later stage is that the team already has a relationship with existing sound design and placeholders. I perceive it as that they have formed an emotional connection to the placeholders. This might be ingrained through repetition and familiarity, as they have heard these placeholders for months or even years, gradually accepting the temporary sounds. Maybe this exposure has solidified the idea of what the sound design should be, resulting in skepticism when introduced to new sound design. While this might be the case, other members have shown less attachment and more awareness of the temporary state of placeholders, welcoming new sound design. The passage of time is also interesting here. I experienced that my colleagues first impression of new sound design is very different from what they feel when the sound design becomes more familiar. On a few occasions during my internship, I have introduced new sound design, which has been met with concerns from a coworker. Usually, I would let the sound design settle for a while before making changes, and more often than not, the coworker expressed how they liked it better once they were familiar with it, either on their own, or through my inquiry. This is a very particular scenario, and I could not find any academic sources that confirmed or denied this phenomenon. Exactly what familiarity or establishing relationships with sound design means could be interesting to explore, but for now this remains a mere observation.

Audiation is an interesting phenomenon in two distinguishable ways, based on who's audiation we are examining. The first being the sound designers audiation, where audiation is used to form an intuitive impression of what visual elements could sound like. Because I got involved in the production at a later stage, audiation has arguably not been very prevalent for me as a sound designer. Mostly because visual impressions are colored by existing placeholder assets and sound design. I believe that these assets, inspire and influence my own creative process in some way. The Orbital Strike-item for instance was one such sound design. The structure of the sound event and the intensity curve associated with it was already suggested by the placeholder asset, and I merely replaced the samples and adjusted timing. This means that I never formed intuitive impressions based on visuals alone. The other aspect of audiation occurs when working within multidisciplinary teams, where visual artists also invoke audiation. This can result in a disconnect between their mentally invoked sound, and the sound produced by the sound designer. The skill in describing timbres and sound qualities becomes important here, because now, there is value in being able to articulate sound qualities from a mental construct. In doing so, game developers, artist, and sound designers can convey their own audiation, better contribute to discussions and provide feedback in a more precise manner. The item Tornado Field is an example of conflicting audiation. A team member had perceived the visuals, and name of the item, to imply that the sound should be more chaotic. This is the opposite of what I had envisioned, as I perceived the tornado as controlled and small compared to an actual tornado in real life.

## Feedback and communication

Talking about sound design in interdisciplinary teams is not the easiest task to approach. The feedback often comes in the form of subjective taste, where they either like it, or dislike it. While I'm flattered when they express that they like something I've made, I am most concerned with what they dislike, and I want to investigate the matter further. I experience a clear language barrier here, where we rely on metaphorical descriptions, onomatopoeia, and references to other games. While I don't expect them to have in depth knowledge about sound properties or signal processing, I experience that they can't articulate what they mean in a direct way. The other methods of communication often struggle to extract the essence of the issue. It can often get lost in translation, where I have interpreted the information and misunderstood what they meant.

During the project I got my own workspace in the office environment. This proved to be a of great importance when it comes to feedback and collaboration. It allowed me to partake in the game development as a whole, invite to discussions about audio, and put audio on the agenda for Setback. Working so closely with the team also allowed me to experiment with audio engineering, with a low threshold to ask help from the developers. Being in the office also made it easier to receive continuous feedback and invite to give feedback on the sound design I created. Through bi-weekly playtests my sounds were implemented in the game, and this was a natural way to gauge the reactions of my colleagues. This was a good solution, as opening up a discussion involving everyone would be too time consuming.

With feedback I should also acknowledge the social aspect. Some team members can be overly polite towards me, and not express their concerns with the sound design. I hope this is not the case, and I have not gotten this impression, but it should still be considered. Ideally there is a low threshold to ask if I want feedback, and for them to speak their mind regarding sound design. While I appreciate all of the feedback on the work that I've done, I've also received unsolicited feedback. An example of this was when I received feedback on an iteration of the scout weapon. They said that the resulting sound was not what they expected and got connotations to "copper tubes", which they didn't like. I had not used any samples that could've added to this, and while this could've been a result of signal processing, I was still unsure of what they meant exactly. They proceeded to show me an example of what it could sound like. Neither this, nor the notion of what it shouldn't be, was that helpful information in determining what it actually *should* be. From this I interpret their information and can use this to make a new attempt at the sound design. While their feedback is valid, I have to trust my own instinct as well, as one person's taste should not be the determining factor in deeming whether a sound design is enjoyable or not. As a solution to receiving unsolicited advice I suggested that I would ask for feedback. This would give the sound design time to settle, and build familiarity, instead of being a first impression likely in conflict with their mentally constructed sound. I also wanted them to ask me if I wanted feedback, giving me time to mentally prepare for such a conversation. For me, receiving feedback was a form of quality assurance for the sound design. If both me and the rest of the team like the resulting sound, this would suggest that the players might like the sound design as well.

## 5.4) Assessment

Through design process, listening, and interdisciplinary teamwork we can look to the actual properties that determines the value of the sound design. I've identified three topics in which we can do so, which are expectations, meaning, and enjoyment.

### Meeting expectations – consistency, unity, and dynamic playback

Meeting expectations is a crucial part of sound design, not in terms of the qualities of timbre, but rather in how it is presented. We can divide the topic of expectations into three parts: Consistency between sounds, unification to visual elements, and dynamic playback.

Consistency is the framework in which we design sounds. The value of consistent sound design is achieved through perceiving all sounds as belonging together in the same virtual world. This includes both consistency in fidelity and consistency between individual sound designs. On the topic of fidelity, we don't want an individual sound design to stand out because of low quality samples. An example of this is the old molotime, which I perceived as lo-fi compared to all other sounds. I have mostly been concerned with this when using sample libraries, where I've avoided low quality samples. I've usually used critical listening to discern whether or not a sound is of low quality, but we can more accurately analyze this through the use of spectrograms. The topic of consistency between individual sound design is more complicated. Ideally, we want to balance the value of consistency with diversity. If consistency was our only priority, the sound design could be perceived as bland. Having clear audible differences between gameplay elements makes it easier to communicate what is happening in the game. Because the game has such a wide range of artefacts, both in terms of impact, animations, and models we want to explore the sonic possibilities of each artefact based on their own premise. Meaning that, when I'm exploring the unique identities of weapons and items in Setback, I want them to stand out, while still belonging together in the same world. As an example, I cannot find anything tying the splat bomb and flashback together in the Setback universe. My attempt to promote consistency between sounds is using the same plug-ins in different sound designs, while also exploring the identities of each artefact. While my solution might not be the ideal one, using parts of the same sound material and effects could contribute to this.

Unification between audio and visual elements is also conforming to meet expectations. With motion there is often an expectation of sound. By adding sound to visual elements with motion, we contribute to building a believable game world. In addition, through added value, I can offer a more detailed account of the properties of said visual elements. I should also mention that synchresis helps create a mental connection between the sound and the object, unifying them when played in conjunction.

Dynamic Playback is also important because our ears are sensitive to exact repetitions, which is perceived as unnatural. We can use dynamic playback to create subtle change on playback to avoid this. The most common approach to solve this is through applying pitch randomization and random selection from sample arrays through real-time DSP. I wanted to try new solutions to this with the launch-ring sound design, where I instead change parameters in a grain delay to create more interesting changes. This attempt seems to work, but depending on what values are selected, it risks shaping the samples to be unrecognizable. We want to maintain consistency to preserve the identity of the launch-ring, while also applying interesting changes.

## Roles and Meaning

In the scope of this thesis, I have decided to base sound design roles on Jørgensen's divide between world building- and informative sound design. In this view, all of the sounds I've created contribute to Setbacks audible identity and world building. In my view however, each category of sound will contribute with this in varying degrees. Setbacks movement-, environment- and ambience sounds strengths is their contribution to world building and perceived realism. By inserting perceptually real sounds we establish a presence, which in turn promotes player immersion. Core mechanics like the setbacking, weapons- and items sounds are contributing more in terms of shaping Setbacks audible identity. The world building role is very transferable to the consistency we discussed earlier. The other category is informative sound design, which is closely related to meaning and the perspective of function sounds. The ability to interpret acoustic information is the core of sound design meaning. In the table presented in chapter 2.4 by Herman & Ritter, I summarize their different meanings of sound. We are mostly concerned with category 2) function sounds and 4) physics sounds in relation to the resulting sound design.

The perspective of function sounds is concerned with being able to differentiate between sounds, and what sounds represent. Most notable here are alerts, auditory localization, and iconic meaning. An example of alerting sound design in Setback is the throwing sound of a flashback and the buildup of an orbital strike. Here I'm using sound design to warn the player of a potential threat, acting as a pre-emptive auditory icon. While the bubble shield hit effect acts as a feedback auditory icon. Localization is also a type of informative sound design. Being able to interpret acoustic information to locate other players is a value that is especially important in a multiplayer game. This is an example of how the acousmatic function where sounds provide information in a way that visual elements cannot. This is mainly handled through spatialization in the game engine. Being able to understand the meaning of sounds is important in this regard. Over time, the sound design will form an iconic meaning. Through repetitions and familiarity with the game, the player will begin to associate sounds with actions and events in the game. As an example, the flashback throw sound is warning the player, but this meaning will only be understood through experience. Consider someone who is not familiar with Setback, will they be able to understand the meaning of this sound? I imagine they would draw from their cultural understanding, depending on what alerts sound like in the place they're from. They could also base their understanding on other visual media like films, series, and other games. Together, these functional sounds create meaning through information which guides and notifies the player about what is happening in the game.

The perspective of physics sounds is concerned with interaction sounds, laws of physics, intensity, frequency, and envelope. The share amount of experience with how sound behaves in the real world is to an extent ingrained in our understanding of sonification. Examples of this is our ability to discern the audible qualities of materials, how they are spatialized and behave through motion. This ties into the expectations mentioned previously as well as how sound provides added value to an image. An example of this is the jump sound design, where the old design has the wrong envelope and material associated with the action. However, a perceived realism is often all that is needed to establish an impression of realistic physics. With the wind system I aimed to impose a feeling of movement, as well as audible feedback based on how fast the player moves through the air. Even though the values are arbitrarily mapped to sound parameters, and has no relation to real life physics, it still adds to the perceived physics

of Setback. I have received feedback that moving fast feels better in the game with the implementation of the wind system for two reasons. The sensation of moving adds to the realism of the game, and because moving fast provides scaled feedback through audio the player wants to move fast to increase volume and pitch. I also want to point out how mundane sounds might be best suited to convey interaction sounds. We don't necessarily want to insert the actual sound of jumping and sliding when we can use caricatures and mimesis to achieve a perceived realism. Such sounds often can be more polished or exaugurated, to better communicate the action we are performing in the game. Intensity, frequency, and envelope is not as relevant in terms of meaning in sound design but is very relevant for consistency and expectations related to sound design.

### Enjoyment and subjective taste

The topic of subjectivity and enjoyable sound design is not something I've been overly concerned with in this thesis. But whether a sound design is perceived as good or bad could be considered an important part of sound design assessment. I think it's important to separate between a sound designs values and subjective taste, however. The properties already discussed have value in terms of meeting expectations, function and meaning. Whether they do or don't provide value in this regard is more objectively approachable through analysis and measurements. To what degree informative sound design and auditory icons is understood and contributes to the player experience can be tested, while unified and cohesive sound design will add to meeting expectations and conforming to conventions. That being said, I can see how sound design can meet expectations, contribute with meaning, and fulfill roles of sound design, while still not being very interesting. So, considering enjoyment as an important part of sound design assessment, how can this be approached?

When working with sounds for setback, creating interesting sounds was one of my ambitions. Hyperrealistic sounds that are core to Setbacks identity, like setbacking, weapons, and items, aim to be experienced as interesting and enjoyable. As a sound designer I have to rely on my own taste and references which I find enjoyable, as this is the only perspective I have on the matter. I shouldn't rely solely on my own taste of course, and this is the main reason why I've asked for feedback and invited to discussions about resulting sound design. Subjective taste is complicated to approach as a sound designer. As far as I can tell, we are more concerned with timbre and motions of sound when determining whether we like a sound or not. The multidimensional property of timbre makes it difficult to access this information, and is more commonly used to *describe* sounds, not as indicators of whether or not we *like* sounds.

Since the study of timbre is not concerned with the intuitive impressions formed when encountering sounds, maybe the field of neuroscience and the topic of auditory cognition have more to contribute with on the enjoyment of sound design. This is out of the scope of this thesis but would be an interesting continuation. Ideally, I would've liked to take the aspect of enjoyment into account earlier. I could've then organized listening tests to determine whether a particular sound design is more enjoyable than another. It could also be used to rate new sounds compared to previous sounds, describing sound properties and determine if the meaning of sound is understood, which would all be interesting additions to the thesis.

# 6. Conclusion

Through a collaboration with Riddlebit Software I have designed sounds for a video game named Setback. I replaced many of their placeholder audio assets and added sound to newly developed gameplay elements. I have become more familiar with design as a process and the importance of preparatory work like identifying needs, researching solutions, and forming a plan before engaging in creative activity. The design process becomes a reliable routine for working with sound in a video game and structures the creative work. During my internship I have designed sounds in many different categories to the game, which has challenged me creatively and made me more proficient at audio programming in Unreal Engine.

I've worked closely with the developers, putting audio on the agenda for Setback, engaging in discussions, and shaping Setbacks audible identity. In doing so I've experienced a clear language barrier in how we talk about audio, working in interdisciplinary teams. This is especially prevalent when discussing sound properties in the form of feedback, where we often rely on references, metaphorical descriptions, and onomatopoeia to express the timbral qualities of sound. In addition, the temporal nature of sound, multidimensional properties of timbre, and the absence of a uniform language, makes it difficult to access the essence of the. I've theorized that the relationship formed by long term exposure to temporary sound assets also contributes to solidifying ideas regarding sound design. Through the use of listening modes, we can better access different aspects of sound, be it through semantic-, critical-, reduced or causal listening.

In this thesis I've identified a number of values, qualities, and features of sound, that enhance the player experience. Through designing sounds for Setback, I have obtained a better overview of what sound design can provide, both in terms of gameplay and what it adds to visual elements. Sound design can provide information relevant for gameplay through auditory icons, iconic sounds, and localization. Localization use the acousmatic function and spatialization to determine the position of sound sources outside of the players view, which is very useful information in a multiplayer setting. Auditory icons inform through warnings and alerts, while iconic sounds are the cognitive connection between in game events and sound effects. Unity between audio and visual elements is realized through synchresis. Once a sound and visuals are perceived as one, added value has the unique property of supplementing detailed information about the visual element. Setback has various different in-game artefacts with their own identity. The potential of each artefact can be expanded upon through sound and added value. We should also be mindful of balancing this diversity with consistency when designing sounds. The sum of all sound design contributes to the audible identity and world building of Setback. Sounds not related to gameplay are mainly concerned with world-building and establishing a perceived realism. Here we want to create a sense of presence in the virtual world, that promotes player immersion. Perceived realism can be achieved through a reduced realism, meaning that sounds that are considered mimetic- or caricatures of realistic sounds can still be perceived as real. Considering the player as a critical listener they have the ability to discern realistic properties based on familiarity and expectations from the real world. They can use this body of knowledge to determine what materials and objects in motion would sound like. The player has expectations to cohesion in sound design (that all sounds fit together in the same virtual space), unity to visual elements, and dynamic playback, which can be used to avoid unnatural repetitions of rendered audio.

By assessing the value of my sound design I wanted to find which properties of sound contributes to a better player experience. I've determined some factors that plays into this, and while there might be others, these are the once that were most prevalent in relation to this project. I've also pointed out how we can use design process to achieve structure, use listening modes to analyze sound to facilitate the creative process, and the complexity of formulating why we like sounds and describing qualities of sound clearly. Sound design is more than mere accompaniment for visual elements, functioning as a resourceful informant and an important contributor to build convincing virtual worlds.

# 7. Citations

## In-work citations


Chion, M. (1994). Audio-vision : sound on screen, New York : Columbia University Press, 1994.

Collins, K. (2007). An introduction to the participatory and non-linear aspects of video games audio. Essays on Sound and Vision.

Collins, K. (2008). Game Sound: An Introduction to the History, Theory, and Practice of Video Game Music and Sound Design, The MIT Press.

Collins, K. (2020). Studying Sound: A Theory and Practice of Sound Design.

Farnell, A. (2010). Designing Sound. Cambridge, Mass, The MIT Press.

Fırat, H. B., et al. (2022). "3D sound spatialization with game engines: the virtual acoustics performance of a game engine and a middleware for interactive audio design." Virtual Reality **26**(2): 539-558.

Galloway, A. R. (2006). Origins of the First-Person Shooter. Gaming: Essays on Algorithmic Culture, University of Minnesota Press. **18:** 39-69.

Grimshaw, M. and G. Schott (2008). "A Conceptual Framework for the Analysis of First-Person Shooter Audio and its Potential Use for Game Engines." International Journal of Computer Games Technology **2008**: 720280.

Grimshaw-Aagaard, M. (2007). "Sound and Immersion in the First-Person Shooter." Games Computing and Creative Technologies: Conference Papers (Peer-Reviewed).

Grimshaw-Aagaard, M. and G. Schott (2011). "Situating Gaming as a Sonic Experience: The acoustic ecology of First-Person Shooters." Games Computing and Creative Technologies: Conference Papers (Peer-Reviewed).

Hermann, T. and H. Ritter (2004). "Sound and meaning in auditory data display." Proceedings of the IEEE **92**(4): 730-741.

Johanson, C. and R. L. Mandryk (2016). Scaffolding Player Location Awareness through Audio Cues in First-Person Shooters. Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems. San Jose, California, USA, Association for Computing Machinery**:** 3450–3461.

Jørgensen, K. (2008). Left in the dark: playing computer games with the sound turned off, Ashgate.

Jørgensen, K. (2010). Time for New Terminology? Diegetic and Non-Diegetic Sounds in Computer Games Revisited. Game Sound Technology and Player Interaction: Concepts and Developments. M. Grimshaw. University of Bolton, UK, IGI Global**:** 78-97.

Kowert, R. and T. Quandt (2015). The Video Game Debate: Unravelling the Physical, Social, and Psychological Effects of Digital Games.

McAdams, S. and M. Goodchild (2017). Musical Structure - Sound and Timbre. The Routledge Companion to Music Cognition. T. R. Ashley R. New York, Routledge.

McAdams, S., et al. (1995). "Perceptual scaling of synthesized musical timbres: Common dimensions, specificities, and latent subject classes." Psychological research **58**: 177-192.

Ng, P. and K. Nesbitt (2013). Informative sound design in video games. Proceedings of The 9th Australasian Conference on Interactive Entertainment: Matters of Life and Death. Melbourne, Australia, Association for Computing Machinery**:** Article 9.

Therrien, C. (2015). "Inspecting Video Game Historiography Through Critical Lens: Etymology of the First-Person Shooter Genre." the international journal of computer game research **volume 15**(issue 2).

## Bibliography

Ekman, I. (2005). *Meaningful Noise: Understanding Sound Effects in Computer Games*.

Dale, Håkon (2022). *Design og implementasjon av lydeffekter i et futuristisk dataspill.*

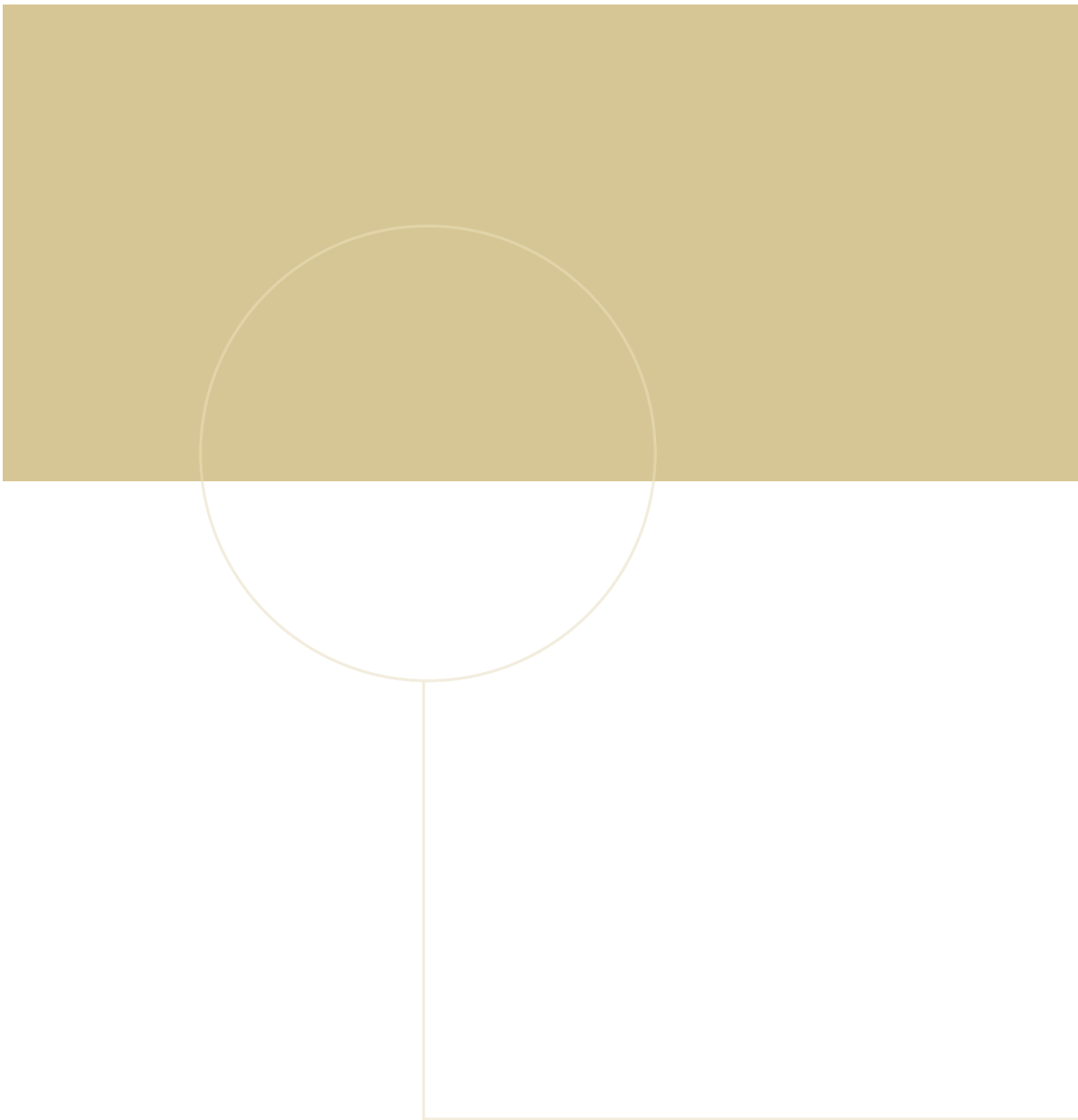
Jørgensen, K. (2006, Oct 11-12). *On the Functional Aspects of Computer Game Audio* Proceedings of the Audio Mostly Conference.

Kane, B. (2014). 15Pierre Schaeffer, the Sound Object, and the Acousmatic Reduction. In *Sound Unseen: Acousmatic Sound in Theory and Practice*. Oxford University Press.

Krzywinska, G. K. T. (2003). Gamescapes: Exploration and virtual presence in game-worlds. In M. C. J. Raessens (Ed.), *LEVEL UP - digital games research conference* (pp. 108-119). Utrecht University.

Stockburger, A. (2003). The game environment from an auditive perspective.

Tuuri, K., Mustonen, M.-S., & Pirhonen, A. (2007). Same sound–different meanings: A novel scheme for modes of listening. *Proceedings of Audio Mostly*, 13-18.



NTNU

Norwegian University of
Science and Technology