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Adaptive Mood Audio

- Rethinking Audio for Games

Anders Alléus
Jesper Palm
Pontus Stensgaard

Handledare: Pirjo Elovaara & Sebastian Hastrup
Examinator: Peter Ekdahl
Blekinge Tekniska Högskola, Sektionen för planering och mediedesign

Abstract

The focus of this thesis is to study the way that adaptive audio can be used in digital games and how it can be used to portray different moods to the listener, how games can reflect different feelings and how quickly those feelings can change. Games audio environment is significant to be able to adapt to the ever changing narrative of the game. The purpose is to gain insight in how immersion in digital games can be improved with the use of adaptive audio - to study if there's an easy way to implement a system where audio can be mixed and adjusted in real-time to mirror the events in the game and project accurate feelings. To study this we will create a parameter based system in the sound engine of the game we will make during the production phase, with different parameters based on a number of different factors.

Keywords: Adaptive Audio, Parameter System, Mood Music, Digital Games, Game Production.

Abstrakt

Syftet med detta kandidatarbete är att studera hur adaptiva ljud kan användas i digitala spel, hur de kan användas för att beskriva olika stämningar till lyssnaren, och hur spel kan spegla olika känslor och hur snabbt dessa känslor kan förändras. Det är viktigt att ett spels ljudmiljö kan anpassa sig till den ständigt föränderliga berättelsen i spelet. Syftet är att få en inblick i hur immersion i digitala spel kan förbättras med användning av adaptiva ljud - att studera om det finns ett enkelt sätt att implementera ett system där ljudet kan mixas och anpassas i realtid för att spegla händelserna i spelet och återskapa äkta känslor. För att undersöka detta kommer vi skapa ett parameterbaserat system i ljudmotorn till spelet som vi kommer göra under produktionsfasen, med olika parameterar som är baserade på ett antal olika faktorer.

Nyckelord: Adaptivt Ljud, Parametersystem, Stämningsmusik, Digitala Spel, Spelproduktion.

Table of Contents

1. Introduction

Games have since their first appearance relied on sound to connect the player with the in-game world, and even though they were simple bleeps and tones they could still immerse the player in their fantasy worlds. Today we have far superior technology and we can create complicated soundtracks. If the simple sounds like the early games had could reach a player the way they did and create nostalgia for years to come, think of what can be achieved with today's industry standards and the further development of these.

Music composers and sound designers for video games have always had the dream of being in complete control of their work, making the player feel what the characters on-screen are feeling. From happiness and a sense of freedom to sadness and danger, this dream can be a reality with the use of adaptive audio, sounds that change according to what happens in the game. With this technology we can make our ideas a reality, and rethink what audio can accomplish in games.

2. Problem Area

In this chapter we will explain the background of our problem area, where we will give a short description of the area and the problems we have chosen to focus on. We will also explain the problem's history.

2.1 Background

When video games first arrived there were little to no focus on music and sound effects. Simple beeps and tunes turned into samples and soundtracks which in turn were developed into what we have today; *adaptive* audio (sound effects and music that adapts and changes according to the situation in which they are played).

Since digital games are an interactive medium it is an advantage if the sound design reflects the feeling that the game is projecting with its graphical and storytelling aspects. Through the use of adaptive music and sound design you can enhance the visual part of the game and engage the player in the game's story and world. There are many methods in use for bringing the player forward in a game using transitions between multiple pieces of music but they all focus on tension and volume. We feel that mood and feelings play an equally large role in adaptive music.

Adaptive music and sound design is well established in the current game industry (Brandon, 2005, p.84) and we believe it's a great way to keep the player interested and engaged in a game, which is one of the most important aspects when creating a game. Stimulating the player can be achieved in many ways including graphics, aesthetics and rewards. We believe, however, that sound design plays one of the bigger parts which is why we want to explore and expand on it.

The implementation of adaptive audio can be a daunting experience and if anything can be done to make it an easier and more intuitive process than it should be. Keeping this in mind we want to create a

parameter based system for implementation that will cooperate with the adaptive audio and stem based music. We define stems as short parts of music that will work together, no matter which ones you play at the same time. This will make it possible to create many different music tracks that can be combined and experimented with in real time to get the perfect mood for the particular scene you are working on.

2.2 Research Question

How can adaptive music and sound design be used to create a living audio environment[1]?

- How can you create a parameter based system for music and sound handling in a game production?

2.3 Aim

The purpose of this study is to create a better understanding of how adaptive music and sound design can affect a game's audio environment. We also want to get more into the procedure of implementing and handling music and sound in a game production.

In the second part of this course, the production phase, we will work together with two other groups (a total of seven people including us) in making a game. Here we will use everything we have learned, and together with the graphic and story elements we will hopefully be able to create a truly immersive gaming experience.

[1] Our definition of what can be heard and experienced within the game.

2.4 Previous Research

As our research depends on earlier methods and research we will in this section define what sources we have found to be relevant to our research. We will also define what we have learned from every source and how we can and will apply it to our own research and project.

The feelings that a game's design is supposed to project is quite a subjective matter, since every person can respond differently to certain music. There are many factors that weigh in on feelings in music and sound in games, not only the music in itself but also how it is combined with the graphics and storytelling in the game.

So how does mood based adaptive music work and what can define different feelings, and how can we develop a system that allows us to in real time change the current mood? Before we can determine what feelings can be linked to certain musical pieces, we need to establish what most people think about the pieces. It is impossible to provide music that applies to the same emotion for all people, but it is however very possible to create an understanding for what most people feel when hearing certain music.

To successfully be able to blend between these different musical pieces that represent different feelings and events, we need to analyse current methods of producing and implementing adaptive music and adapt it into our way of thinking.

2.4.1 What is Adaptive Audio?

Adaptive audio is an expression coined by the game industry (Brandon, 2005, p.84) that basically covers how music and sound is driven by game conditions; for example, if the player character's health (a numeric value that defines if the character is alive or dead) is low in the game *Fallout 3*, a heartbeat can be heard that represents that condition (Bethesda, 2008). It means that whatever the game design wants to emphasize can be reinforced by audio in an seemingly adaptive way.

"A theater director once told me to treat the music as if it were another character on stage, adding its own personality to the performance, interacting with the other performers."
(Whitmore, 2003)

Adaptive Audio has been used for years to drive the story and put the player in the environment of the game. It has been found to be a versatile way of adding depth to the game. (Whitmore, 2003)

2.4.2 Differences between Static, Interactive and Adaptive Audio

To further understand what adaptive audio is and how it can be applied in games we have to take a closer look at what differs between adaptive, interactive and static audio. It can be difficult to find research on this subject due to the fact of the widespread misunderstanding of the terms. Since these terms have not been standardized in the gaming community people often get them mixed up. This chapter will explain and conclude the difference between these terms described by Karen Collins (Collins 2007) and Guy Whitmore (Whitmore 2003).

Static audio is the type of audio that doesn't change no matter of what happens in the game and it will play exactly the same regardless of how many times the game is played. Static audio is often used with background music where a track is played and in the end of the track it will loop back to the beginning and restart.

Interactive game audio, on the other hand, is when the audio reacts to the player's choices in the game and in reaction to the *gameplay* (a term used to describe the rules and mechanics of a game). For instance if the player presses a button that opens a door in the game and that door makes a specific sound that will repeat every time the player opens the door. This is an interactive sound effect - the player is in direct control of the sound.

Adaptive audio is very similar to interactive audio except that instead of responding to feedback from the player's choices within the game it changes depending on the gameplay.

"'Adaptive audio' is a term used to describe audio and music that reacts appropriately to - and even anticipates - gameplay." (Whitmore in 2003)

It's important to have a clear understanding of these terms to minimize misunderstandings and to properly explain the sounds purpose in games. Adaptive audio can be manipulated in real-time by either program code or by *RTP's* (Real Time Parameter[2]) that have been set in the *game engine* (software with a set of tools for creating video games). For example when the game transitions from different areas or events, such as encountering enemies (hostile characters in the game that will attack the player character) - the more of them there are, the RTP value will increase and thus change what musical stems will be played. This is used in *Serious Sam: The First Encounter* (Croteam, 2001).

This will produce an adaptive audio environment that reinforces the gameplay, in comparison with static audio where the music would be predefined into the events resulting in players maybe wanting to turn off music because they become tired of hearing the same piece over and over again (For example the battle music in the *Pokémon* (Nintendo, 1996) franchise).

There are many games that utilize adaptive audio, and thanks to the development of *audio engines* (software with a set of tools that allow the audio designer to implement and design how music and sound effects will be played back in the game) that has been taking place during game production, we can analyse past as well as contemporary games methods of producing interesting audio designs.

2.4.3 Diegetic and Non-Diegetic Audio

In this chapter we will describe how adaptive and interactive audio[3] can be used to describe emotions and feelings in a game. All sounds in a game can be broken down into different types of audio: Diegetic (sounds that the characters hear in the scene) and non-diegetic (sounds that only the audience hear).

Adaptive non-diegetic sounds react to the gameplay but are unaffected by the players choices such as

[2] A set of parameters with values that can be manipulated in real time in the game.
[3] Sounds that reacts and changes to the players direct interactions such as sword swings or jumps.

movement and interactions. These are sounds that are outside the gamescene and only meant for the audience to hear (not the in-game characters). These adaptive sounds are often linked to different types of events (such as a daytime cycle) in the game in which the player cannot directly control the sound without playing the same event again. Adaptive non-diegetic sound can therefore be described as a gameplay-controlled sound that only the audience is meant to hear. Adaptive diegetic sound however is almost the same except the characters in the scene is also meant to hear them (such as crickets or a radio).

Interactive non-diegetic audio can consist of sounds that are meant to describe a situation to the audience such as a critical hit indication (for example: *Skyrim* Bethesda (2011)) or health regeneration.

2.4.4 Musical Stems

When creating a soundtrack for a game many people think of the process as writing and recording a song, then the next one and the next after that until the score is completed. This is a traditional way of making video game music, but these days there are more ways to create and implement music that are perfect for adaptive music design and one of them are musical stems. (Hayes, 2011)

Stems are, according to us, short 'parts' of a song that can all work together to create music tracks, which is achieved by using the same key, tempo and time signature for all the stems. One game that uses this way of music design is *Red Dead Redemption* (Rockstar Games, 2010). In the game the stems are used to create many different musical pieces that helps to establish a mood in the scene. For example when your character is walking normally there is almost no music. but when you start riding a horse a bass guitar starts playing to make the scene more exciting.

A method of playing back stems that adapt is by using a method called *stitching*. This method relies on that the stems are being composed with build-up in mind because when for example another *tension* level (a term used to describe how tense a situation in the game is and how music is reacting to it) is triggered, the current loop is either played to its end or is aborted by the next stem which add dynamics, tension and/or a different mood (Fish, 2013). This method is often used in first-person shooter games

where the tension level is determined by how many enemies the player is facing.

There is a second method of using stems that is called *crossfading*. When using crossfading the stems are often longer, borderlining on complete tracks on their own, and they are often not usable with each other. They are used separately and are faded between depending on the situation that calls for them, for example when facing enemies in *Left 4 Dead 2* (Valve, 2009). Before the horde of zombies are introduced there is next to no music aside from small stingers and short melodies in the background while the player is walking around with no enemies around. When the undead burst from the shadows a new track fades in, often with drums playing a tense beat to get the player excited and stressed.

2.4.5 Mind Music

Earlier research in the field of adaptive mood music was conducted by Eladhari and Nieuwdrop (2006) in a report called 'The Soundtrack of your Mind', but with focus on playable characters and how their feelings and current mood affect music. They refer to four different factors that can be used by their so called 'mind module' (a piece of code that tracks the current conditions of the player character and outputs his 'mood' into the Audio engine which in turn adapt the music to mirror the mood.); Personality, Emotion, Mood, and Sentiments. (Eladhari and Nieuwdrop, 2006)

Depending on what input the mind module gets, it will tell the audio engine to play a piece of music that matches its input. For this to work in a musical manner the composer of the music needs to have control over what scales are bleeding into each other and that they actually sound good together. This factor is considered in the report as two different compositional properties; time signature (beat) and harmonic scales (tones).

The research in the report about 'Mind Music' provides us with the basic methods of provoking different emotions by music. Since musical composition is of great importance to our final product, this particular report is of great value. Music composed according to our own and this reports take on emotion will be used to on testing groups to determine whether we succeed in provoking intended emotion.

2.4.6 Musical Instrumentation for Characters and Places

An important part of musical composition for games is recognizability. Games with music that stand out tend to 'live' (be remembered) longer than games with a generic and bland soundtrack. Examples of games that utilize musical themes are *The Legend of Zelda* (Nintendo, 1986-2011) and the *Mass Effect* (Bioware, 2007-2012) series. These particular game's music is made to correspond to events that happen to certain characters or places. There is a term used for linking characters and places to music; *leitmotif* (BBC, 2010).

For example, in Zelda, the main character (Link) is accompanied by an ocarina (a kind of flute instrument) which appears both in game and in the characters theme song, which is played back when the player completes difficult tasks or defeats certain enemies. In Mass Effect the main villain, called Saren, has his own musical theme that is often played when he is on screen. The track also plays when the player is defeated in the game, in the Game Over screen, indicating that Saren will be successful in his task now that the player is dead. This links the soundtrack to events and characters as well as to the players memory, and if the music is 'good', the player will be able to relate to certain events and feelings that it felt while playing the game. The effect will also work in reverse, with events that are considered scary or horrible (in terms of story), making the player feel as the game is meant to be felt.

Musical instrumentation is key to understanding and creating 'living' (our definition of audio that adapts to what happens in game - therefore it can be perceived as living) environments in games, by clearly linking musical themes to characters players can relate to specific events and moods that the characters go through. We believe that the story of a game will be experienced with more focus if the music express what feelings are shown on screen. In the words of Clark;

> *"Interactive music is the game industry's answer to the Hollywood film score."* (Clark, 2003)

2.4.7 Summary

To keep players interested in a game is a combination of factors such as gameplay, mechanics and of course sound design. We believe that the audio weighs heavily among these three. A living adaptive audio environment could be the fall or rise of a player's gaming experience and to create a memorable game.

Previous chapters explain that an adaptive sound environment in a game can help motivate the player to continue playing. We have discussed how adaptive audio works and how to correctly refer to it without the risk of misunderstanding. Adaptive audio is in short a changeable audio environment in a game, and this audio is controlled by the gameplay and not the player in contrast to interactive audio. *Diegesis* (whether it is diegetic or non-diegetic) is another term used by sound designers to describe where the audio source is located. To choose a sounds diegesis depends entirely on what is meant to be described by the sound.

Researching adaptive music consisting of stems in different keys and time signatures provided us with the knowledge we need to compose and implement the music into our game. The importance of basic musical theory can't be overlooked when composing the music, as it can make or break how the music is played back in our parameter based system. The music in itself is a risk that we hope to overcome by relating and testing the research we have conducted.

As feelings and mood play a important role in our research question (the parameter system will be based on several keywords that define feelings), our research in mind music has provided us with the knowledge of how to represent these different feeling with music. We do however need to produce music based on this research and play it to a focus group to know if our interpretation of feelings are the same (or close to) as what other people feel.

When creating the music for our game we will be using leitmotifs. Different instruments and musical pieces will be linked to certain characters and places to create recognisability with them in the game.

Our goal is to use this technique to combine our knowledge in leitmotifs and adaptive audio to create new adaptive music where the players will recognize the music in certain areas and events in the game and also to feel the musical environment changing.

This, combined with our research in mind music and adaptive audio, will be very important when producing a living audio environment for our game.

3. Method

This chapter will present the decisions and methods we chose to produce the audio content and implement the technology needed into our game. We will also explain our thoughts behind the most important decisions and the planning of the process and production.

Before we begin we would like to clarify what our game is about, so here is a short synopsis of our game *Eria's Tale*, a game set many years ago, before modern technology, in a Nordic environment inspired by Asian culture.

Eira's Tale is an action RPG (Role Playing Game) where you take the role as a young woman from a tribe of nomads. A strange illness has befallen Eira's dear brother, so she sets out to the great forest in the north to find out what caused it and why. On her way towards answers, she will encounter foes aplenty and a few unexpected allies.

3.1 Overview

Producing adaptive music for a game can be quite a daunting task. There are many variables to consider when composing, and even when implementing it. Variables such as; will these scales go well together in the game? Will they collide and produce 'sour' notes? What in-game events will impact our adaptive music system? Will this system impact system performance in ways that make the game unplayable? These were primary concerns in the beginning of our production.

Thanks to previous research and the idea to implement the system into an actual game made it possible to actually test the system in an environment where it would be heard exactly as it would be in-game.

3.2 Methods for Ideation

During the research phase of our thesis we began a discussion with the other two groups (Graphics and Game Design) about what kind of game we were going to make. It was crucial to actually decide what kind of game it would be before we established its visual theme, story, how it would sound and how the visuals would be represented by feedback from audio. We wanted the audio to get much space in this part of the planning process, to ensure that our system would get the amount of attention it needed. To make this process fair to all parts of the team we had group sessions in which we blurted out all of our ideas and put them in mind maps and brainstorming sessions. (Wikipedia, 2013)

A mind map is a great way of igniting the creative process of team members. In our case, a common theme that was to be explored was our genre 'RPG', so we used that as a starting point from which we could branch with our own tastes and ideas. This was the part where components such as story, setting and theme were discussed and set, and from these ideas even more functions and ideas were added thus leaving us with a mind-map (fig.1) that would serve as a basis for the production phase. (Wikipedia, 2013)

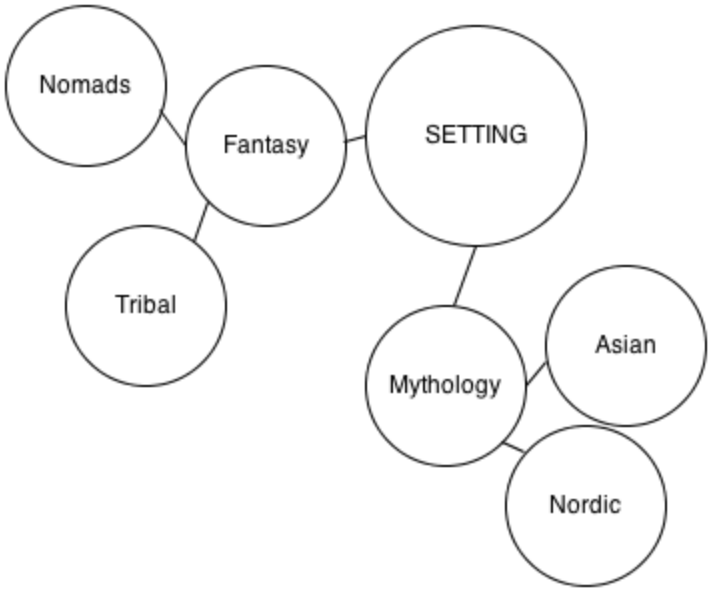

fig.1

The results from the mind map added with sporadic brainstorming sessions were condensed into what would later become the final game design document, which will be further described in the following section.

3.3 Methods for Planning

When planning for our production we realized early on that we needed a system in which all the involved groups could see what the others were doing, and what was left to do. We decided to use the website *Trello* (https://trello.com). There we could make plans for each week of production, listing all the different sounds, music, objects, and programming that needed to be done by the end of that week. The general design document and asset lists for the game was also uploaded here, so that everyone could easily access them.

Design documents are the backbone of a good game production. Having a clear image of what's going to be in the game and how the game's mechanics, music, sound effects and story are all going to work together to create a memorable game. The story of the game and the world it's set in is told and all the characters and their personalities are explored in this document. In what way the music and sound effects will work in with the different parameters are also explained here. (Ryan, 1999)

In addition to the design document we created an asset list (part of a sound design document) in which we listed all the different music stems and sound effects we were going to create, along with their full file names and what format they would be in. We decided to merge our sound design document with the game design document so that it would be easily accessible for all members of the team. The asset list helped us greatly when exporting the audio files from their respective programs as the names and such had already been decided in forehand, making the process that less time consuming. (Sound Librarian, 2013)

We ran into a problem while deciding on which name convention to use as our initial convention proved to us misleading and confusing (as you can see below).

Initial naming convention: “MM_Vill_Mood_Neutral_Contrast”

- MM : Mood Music (Type)
- Vill: Location (To know what location the music is intended for)
- Mood: (Attribute 1; used by the different parameters)
- Neutral (Attribute State)
- Contrast (Attribute 2 State, depends on attribute 1)

When we were well into the process of having all the sound named and ready for implementation into the game, we noticed how cumbersome it was to find the appropriate sound for an event in the game. This meant that we had to rename every audio file that was using the old convention and replace it with a new one that would make sense while implementing. This proves how important naming convention is in productions of any kind where many objects need to be categorized for later use.

New naming convention: “MM_Vill_Con_Medium_Neutral”

- MM : Mood Music (Type)
- Vill: Location (To know what location the music is intended for)
- Con: Contrast (Attribute 1; used by the different parameters)
- Medium (Attribute State)
- Neutral (Attribute 2 State, depends on attribute 1)

In comparison with the earlier attempt to determine a naming convention, this is easier to understand and use.

After we had set up the Trello page, were finished with the design document and had begun writing the asset list, we had to plan a method of creating the game. It was decided that we would create one zone

(playable environment) in the game at a time, making sure that most of that particular zone was done before moving on to the next. This included most of the graphics, objects like NPCs (Non Player Characters; other people and creatures in the game that are not controlled by the player) and music. One of the exceptions to this plan was the sound effects, which work the same in all the zones.

When planning for how the music was going to be created we had to keep in mind the two most important parts of our research; stems and mood music. Which instruments to use according to the culture and time period of the game was also decided here. We had to make it possible to have an overview of all the stems so that we could make them all fit together, so we created a single *Pro Tools* (the program used to create our music) session with all the instruments that we decided to use. Then we created timestamps in the timeline of the session for each individual track. This made it possible to have the same instrumentation and sound mixing for all the musical pieces, and being able to easily see the time signatures and different volume changes for each individual piece. Then we could start the production of the music, one track at a time.

3.3.1 Focus Group

We realized early on that we needed some way to know if our mood music would correspond correctly with the feelings we wanted to portray. It was decided that a focus group would be held where people could come and listen to the music we had created, write down their opinions and have a discussion amongst themselves. We used a guide (Eliot & Associates, 2005) for reference but prepared a simpler, more condensed version.

When planning for the questions we had to keep in mind what feelings we were trying to establish in the music, mainly sad and happy. We wrote questions asking how the music made the person feel, but also what they thought our original idea with the piece was and if there was something we could change to better portray the feeling. The questions were structured, but very open for the participants to write down their opinions.

A total of eight people participated in the focus group, volunteers that responded to an event on *Facebook* (an online social network). We played music from the village and first forest zone in the game, in both sad/neutral/happy and dark/medium/bright variants. The outcome and discussion will be further written about in the Result and Discussion chapter.

3.4 Method for Production

3.4.1 Overview

The process of creating and designing sound effects and music for games is a creative one, which means that the creative flow must not be hindered in any means. To prevent this, a proper development model must be chosen.

The group decided to mix between two development models, *Scrum* and *Iterative and incremental development,* both will be described and explained below.

Scrum is a development pattern that makes it possible to share the goal of the product within the group. Scrum means that the teams work in so-called ‘sprints’, development phases that last for a set amount of time. The time span is set according to the size of the project - smaller projects require less time for every sprint and vice versa. This particular model also involves roles such as Managers and ScrumMasters, supported by team leaders that lead different topics and deals with it’s departments issues and tasks. (Scum Alliance, 2013)

We applied the essence from this model into our own; we used one week sprints supported by meetings in the first day of every sprint were we evaluated what had been done and what needs to be done for the next sprint in the form of a traditional priority list (fig.2).

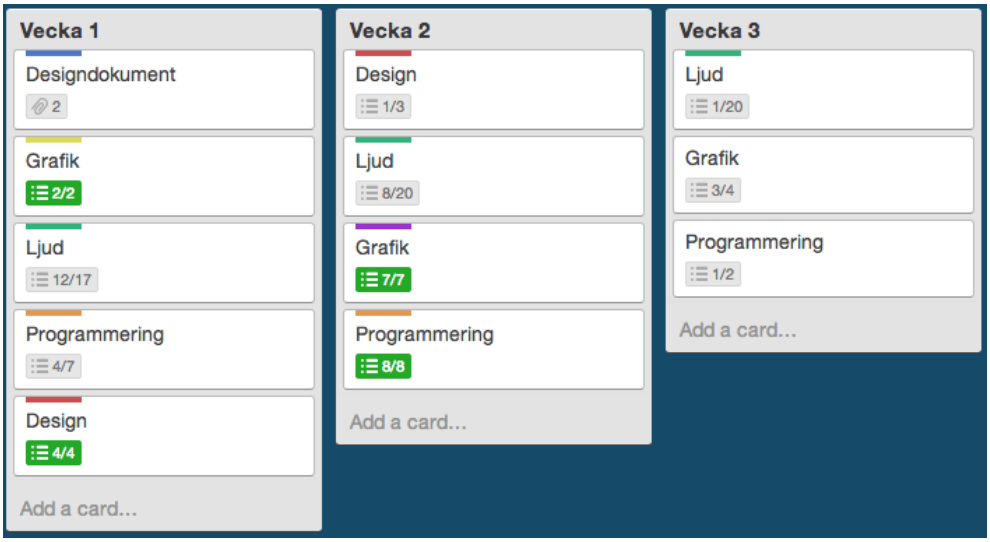

fig. 2

Relating to our creative needs this was the best way to go while also maintaining a sense of structure to the project as a whole (fig. 3).

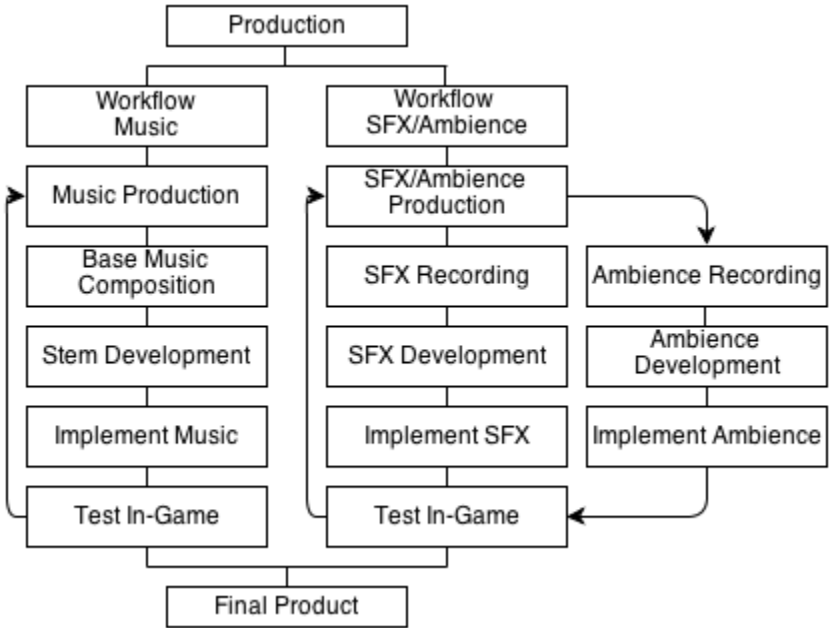

fig. 3

The other model, Iterative and incremental development, gave us the structure we needed for every sprint by outlining how every sprint would look like - every day during a sprint we would discuss what needed to be done to complete all the tasks for the deadline. This model made it possible to analyse and revise the work that had been done every day so that we could make adjustments and prevent further mistakes from happening. (Cauwenberghe, 2002)

3.4.2 Music Production

After planning how the music was going to be structured and setting up the Pro Tools session, the production of music could begin. Stems were created according to what zone they were going to be played in, and a transition was to be played when entering a new zone, which made it possible to use different time and key signatures for different zones. If no transition was to be played we would have to use the same time and key signatures for every zone, or else they would clash in the rhythm and cause dissonance in the music. It would, in our opinion, be repetitive and tedious to listen to the same key for all the zones.

Before starting on the stems for the zones however, we needed a main theme for our game. This was the first piece of music created for the game, and it had to set the tone for all the coming music. The result was a just under two minute long track, with all the instruments and themes we wanted to use in the rest of the tracks. This created several leitmotifs for us to use later on.

After our main theme had been completed we had the style and feel we were looking for in our music, and we could start on the actual stems for the zones. The process for every zone was very similar; establish the tempo and key signatures, start working on the neutral mood stem and then continuing on with the sad/happy stems.

To change the instrumentation of the track towards a brighter or darker feel we used our contrast parameter. We applied it to the distance from the starting village, and as you venture further from it the more dangerous and dark it gets. After all the mood stems and contrast were completed we started

working on the tension stems, adding more percussion for each step. It was important to get a suitably stressful feel for the highest tension, since it is played during combat in the game.

After tension came the final parameter to consider; tone. This parameter plays and switches between two stems that signify when the player is low on health. First comes caution, which tells the player that they should be careful not to receive more damage to its health, and is followed by danger which is played when the health is beginning to reach dangerously low levels.

3.4.3 Sound Effects and Ambience Production

As stated earlier we could not produce the sound effects and ambience in our preferred scrum method. This due to that all the work would be disproportional and almost all the sound that would be heard throughout the game would have to be finished in the first zone. Instead a priority list was created where effects and ambience with high priority included footsteps and sword swings with other interactions sounds that were predetermined.

Because the entire production phase entitled a combination of scrum and iterative production model a constant dialog had to be maintained with the rest of the group in order to make sure that the sound created was not in vain. In contrast to the music production this dialog was significant and had to be supported and not forgotten in order to make sure that the sound effects production was on the right track.

3.4.3.1 Sound Effects

To create adaptive sound effects was more of a challenge than we first anticipated, even though we quickly realized that not all sound effects in the game could be adaptive. Effects such as footsteps which would change depending on the surface of what the player is walking on is not adaptive[4] but rather interactive[5] due to the fact that the player is in direct control over which surface the player would walk on. We decided that we didn't have the time nor the programming knowledge to make all the effects

[4] See chapter 2.3.2
[5] See chapter 2.3.2

adaptive and to instead focus on making a portion of the effects adaptive.

First we had to choose which sound effects we could make adaptive and to what extent. We decided to make the combat a little more interesting. The idea of a combo system (attacks made by the player character that become stronger with each consecutive hit) was hatched, to make the sword hits sound harder and heavier the more times you hit an enemy. This method of creating adaptive sound effects produces a very satisfying way to reward a player for their performing well in the game.

3.4.3.2 Ambience

In order to produce an adaptive ambience a plan was devised how to make it sound believable. The plan (fig. 4) was to make three stems of ambience and to shift between them using a small ambience zone where the stems would crossfade and keep the new stem playing until a new zone was entered. I.e. ambience stem 1 would play when you enter the ambience zone but when you enter 'Zone 1' the parameter would change and ambience stem 2 would start playing masking the transition with a crossfade.

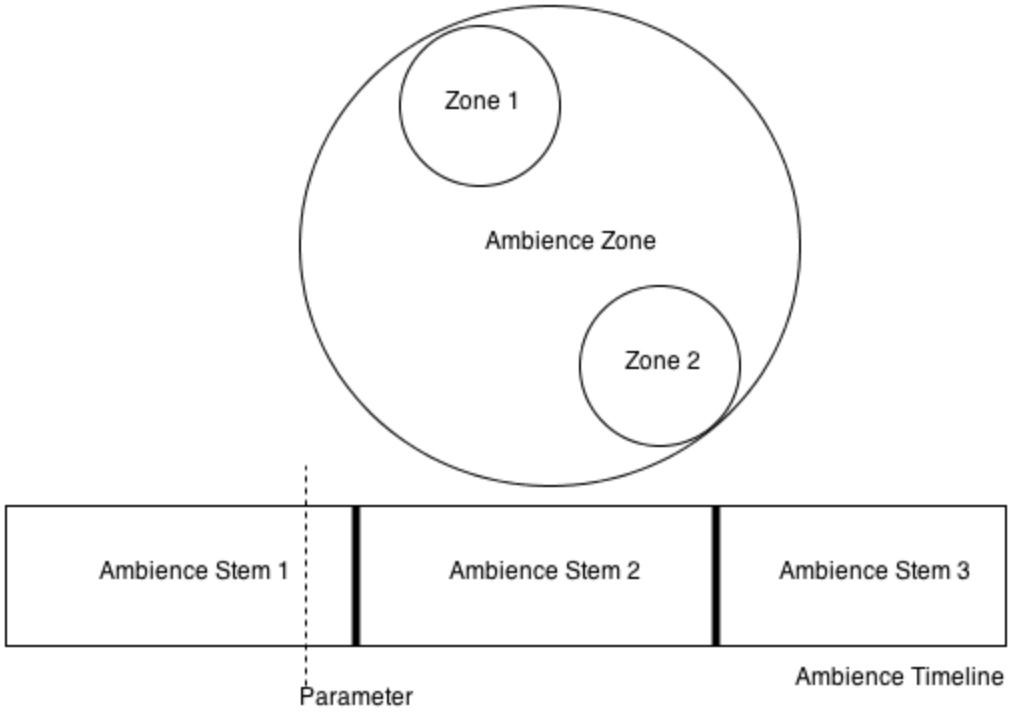

fig. 4

We also decided that in the center of the small zones a single bird would sound to make the environment even more living. The type of bird would also vary between zones, so the forest would seem to occupy different types of birds. It was an important step to make sure that the ambience stems and the various birds can mix to create a natural and realistic sounding ambience.

How could we make this system even more adaptive? We came up with the idea that if Eira was positioned inside one of the bird specific small zones during combat a sound effect would trigger alerting the player of danger and to prepare for combat, our plan was to make this alert sound into bird flaps and then the specific bird inside said zone would become mute giving the impression that the bird flew away at the sight of danger.

3.5 Software of Choice

While determining of how we would proceed with our adaptive audio system, we quickly established (along with the other groups) that the *Unity 4* (Unity Technologies, 2013) game engine would fit perfectly as it supports extensions and can be manipulated in ways many other engines cannot. The base reason to why we chose to work with Unity was that it is shipped for free and there are content provided that are ready to be used directly when starting the program. It also consists of the Unity Asset Store - a portal in the engine where users can upload content and functions for free or to sell to other users of Unity. This allowed us to find specialised tools for audio processing and implementation.

Another reason to why we chose to work with Unity was because of a piece of software in which we had previous experience with; *Fabric* (Tazman Audio, 2013). Fabric is a plug-in to Unity with provides visual editing and implementation of audio in a way that was not possible with the base version of Unity. Unity is also a very well-established tool for making games and applications, which means that there is an extensive community that can answer any questions or provide hints and tricks to enable us to produce exactly we what we have in mind.

While developing the game we had to split the project so that the groups could work on their corresponding content. For example, we needed to prototype and test the adaptive audio system while the programmers and designers worked on their content. This was made possible by a system called *Git,* which is an open-source decentralized version control system (DVCS). This system does not only support game development, but can also be applied to many other software development situations. Git offers a way to *branch* (creating a new version) and *merging* (unifying multiple versions) of a project, thus making it possible for us to combine our different areas into a working version of a project with all of our content.

To be able to utilize the Git system, we used a software called *Sourcetree* that functioned like a gateway to the Git, enabling us to easily download and upload our current versions of the project. It also provides an overview of all current versions that are being used and updated, so that one can know

whenever there are new functions implemented that another person might need to continue on his version. This system makes working in a group very easy, and hinders a lot of issues (like conflicted files, corruption and so forth) that might occur if not using a system like this.

3.6 Implementation

The implementation phase is very important and sometimes the most time consuming. Problems and conditions we'd never thought of arose and solutions had to be devised, This chapter will include problems and solutions that we've found significant.

3.6.1 Audio Listener

When we started to implement the sound we had produced, without thinking we stuck the audio listener (component in Unity that listens to all audio within the game) to the player character, since all sound would be heard from her perspective. But here's the problem: Because the audio listener rotated with the player characters movement all sound was rotated as well and panned in an instant resulting in the audio spinning around the speakers as the player changed direction.

Our solution was an invisible box containing the audio listener positioned just in front of the player character but instead of linking it to the character we linked it to the camera so that it always followed the players' movement but had the same position relative to the character regardless of which way the player was headed. This accomplished an audio environment that is relative to the players position but not to the players bearing. For example, if the player character is standing to the right of a campfire, the campfire sound would be heard in the left speaker regardless of which direction the character is facing.

3.6.2 Fabric Implementation

At first we thought that the implementation of music would be a rather easy task, seeing as we had done it before in various ways using other software. We quickly noticed how wrong we were when we actually had complete stems of music that was ready for implementation. Seeing as our system is quite complex in terms of how the music is going to be played back, the sound engine would have to be able to work with complex hierarchies and systems.

As Fabric provides a modular way of structuring (through Unity's built-in hierarchy system), there was much room to experiment on how we were supposed to structure the musical pieces. Fabric provides a function called 'timeline' (fig. 5), which makes it possible to fade the volume between different regions or audio clips.

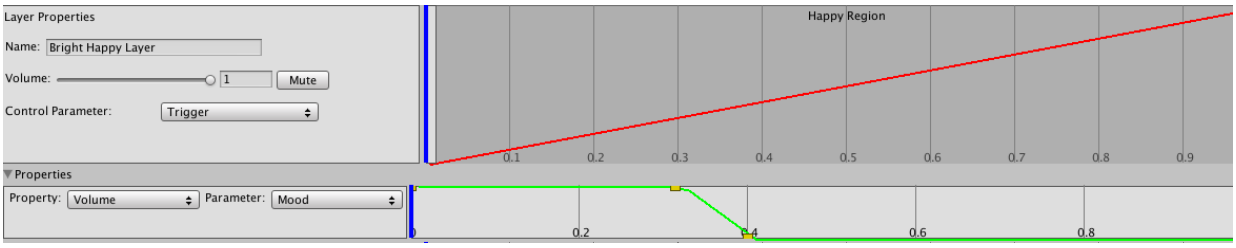

fig. 5

An issue we encountered while exploring the timeline was that while moving the timeline marker through different audio regions, the music would be retriggered, meaning that they would play from the beginning - which would defeat the purpose of our system. Luckily, this was overcome by contacting the author of Fabric; Tazman-Audio who discussed our issues with us via mail (March 11th, 2013).

The solution was not to put audio regions in a single timeline, but instead use multiple timelines that will contain an audio region controlled by the corresponding parameter. This made it possible to make

timeline within timelines, meaning that we could group a set of timelines into a new timeline that would be, for example, called “Bright Layer”.

This would then contain three separate timelines; Bright Happy, Bright Neutral and Bright Sad. The Bright Layer was then put into yet another timeline, the master timeline, so that we could control the volume of all sound in the current hierarchy (fig. 6). This made it possible for us to construct a complex hierarchy that could be controlled in every way that we wanted, e.g switch tonality, change instrumentation and add tension. This part is difficult to explain in pure text, but a screenshot of the final hierarchy in Unity might enlighten any uncertainties.

fig. 6

4. Result and Discussion

In this chapter we will present results and how we reached our conclusions. How we solved certain problems and discuss how the solutions will affect our idea of how sound design is used in the game industry. We will also discuss how our adaptive mood audio system ended up working and how it can be used to introduce different moods to the listener.

4.1 Result

In parallel to the research phase of this thesis we were planning on how to approach the production of the game to successfully be able to produce and implement the music and sound effects needed to reinforce the game experience. This was the part where we needed to ascertain where and how sound and music would be interacted by the player of the game in order to successfully bring out an immersive experience.

4.1.1 Why a Parameter Based System?

Music and sound play very large roles in our lives. We react to, interact with and feel with sound. There is a reason to why the old silent movies quickly adopted sound, or was accompanied by a piano for that matter. The reason to why sound play such a big role in games and other media is because of the feedback it provides while experiencing intense gameplay or watching a gripping movie. It all needs to 'click'. When translating this into why we use adaptive music and audio there are the factors about what we want the player to feel while playing and listening to the game.

> *"The changes within adaptive music can be a way of communicating with the listener. Because music acts instantly on such an emotional level inside our brains, we can use adaptive music to let listeners know that something has changed, and how to feel about this change."* (Claynote, 2005)

These were the fundamentals to why we chose to expand not only our knowledge, but to enhance how adaptive music and audio is used and experienced today. The system we developed ended up consisting of four parameters; Mood, Tension, Tone and Contrast (as planned).

- **Mood** - A parameter that controls the current 'mood'. E.g, it corresponds what feelings and vibe a current event or environment is currently representing. It is represented by changes in musical scale and can be changed in real time to provide the user with feedback on how the game wants you to feel. This parameter is being used in our game when the player character is approaching certain locations or entities that we want to enhance by switching the mood.

  An example of when this occurs is when leaving or entering the player characters home village. The closer it is, the 'happier' the music is, and farther means less happy. It is also used when in danger, like when encountering enemies or antagonists of any sort. We chose to represent this by music to reinforce the feelings the actual character would feel. A sense of home, a sense of adventure and uncertainty - and a sense of imminent danger.

- **Contrast** - The mood parameter is accompanied by another that we call 'Contrast'. It further enhances the mood parameter by changing the current instrumentation e.g what the music sounds like in terms of instruments used. We decided on three states for this parameter; Bright, Neutral and Dark. Bright consists of light strings, a guzheng (asian string instrument) and mild bells to provide a feeling of ease, Neutral consists of an Jubal flute and string staccato that represents what we would define as 'adventure'. The last state, Dark, consist of low key strings and brass to represent danger and 'evil'.

  This provides flexibility and allows for further variables to change how the user will interpret the current events of the game. We found that this is an excellent of way of 'reusing' music in a way that still provides a sense of change thus minimizing eventual tire of repetition in music. An example on how we used this in our game is when approaching the characters village where the

music is ‘brighter’ as the character was home and unburdened by the danger outside. Another example of how it is used is when the player health is starting to drop - this is represented by the music turning darker.

- **Tone** - This is where it gets interesting. The tone parameter can be used to expand on the tonality and feel of the current mood. It can be used to provide a sense of discontentment by adding tones that collide with the current scale and chord, but it can also be used to enhance and make already ‘happy’ music even happier. We, however, chose to use this parameter to provide a discord that would be played back when the player is low on health. A pulsating stab of dissonance against the current music track proves an effective way of telling the player that something is wrong. Much like the warning sound in a car when a seatbelt is forgotten. The Tone parameter is also affected by the mood parameter, which makes this even more versatile in forms of adaptivity.

- **Tension** - The last parameter to be incorporated into our system was ‘Tension’, a function that plays back percussion and/or musical layers to provide the player with a sense of, for example, impending or current danger. This method has been used in games for many years now and works very well in addition to our mood music. It is used in the game when the player is engaging in combat. The closer one gets to an enemy means that more tension layers are being blended into the music.

  Our tensions consisted of a silent layer and three layers with percussion in it. We called these layers, Silent, Calm, Medium and Stressed. In an early area of the game, Calm is represented by a bass drum, Medium by shakers and stressed by a jaw harp and a snare drum. The last layer contains all the earlier layers instrumentation as well, to add in to the tension level.

These four parameters in unison provide an extremely versatile music playback system that can be used fully represent the game designers intent of a scene or event. But, as with all music for movies and

games, it needs to be carefully tailored to fit the system as well as the game, which is very time demanding since it needs to be tested over and over again to prevent events of dissonance where there is not supposed to be. The system, however, can be increased - or decreased for that matter - in means of what is needed for the game, which makes it good for both entry-level musicians and established composers. This is the reason to why we wanted to develop a system like this - ease of use and much room for expansion.

4.1.2 Ambience

Due to limitations of time and knowledge we could not implement the adaptive ambience in the way that we first wanted. Instead a new approach was conceived. We needed the ambience to still be adaptive but without the use of advanced parameters and programming. We decided that we could get the same outcome but in a simpler way by using random generated zones where the different ambience stems could be played (fig. 7). The old system in contrast to this system allowed far more control and we as developers could adjust the ambience to make it sound just right. To the player this would make little difference though since they will still experience an adaptive and living ambience.

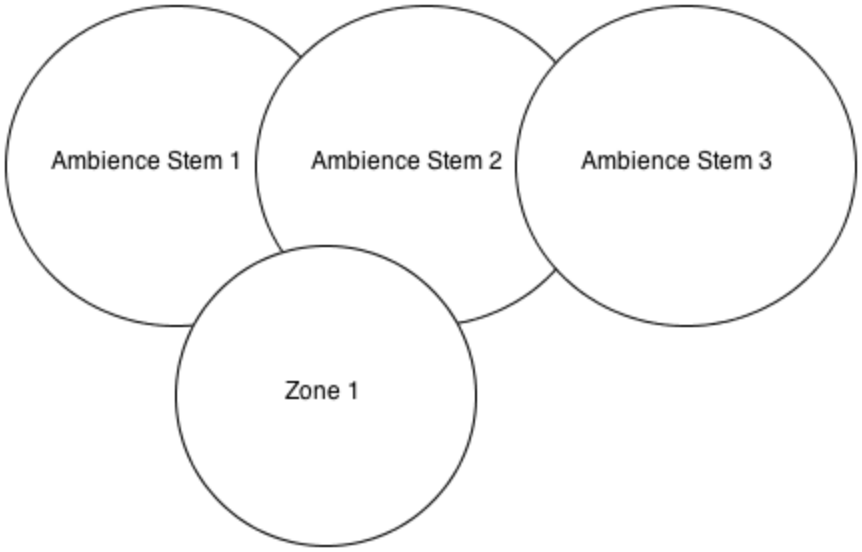

fig. 7

This system as stated before works similar to the old system but instead of using a parameter to control which ambience stem would play it generates a fixed number of zones (ambience stem zones) all over the playable area in the game and inside every stem zone, one of the three ambience stems is randomly generated, this produces a totally random and hence an adaptive experience. The small zones which contain the single tweeting bird were not forgotten, and to ensure a realistic and immersive experience these zones were also implemented alongside the stem zones.

The drawbacks of using this system instead of the old system[6] was that we could not control exactly how the ambience will sound and which stem would play where and when. Using the old system the crossfades between the stems just had to be made and adjusted once and then it was finished. Rather than doing this just once, we had to manually adjust the zones so they overlap and and also make sure the volume curve for the zones created a crossfade to mask the transition of the ambience stems.

The idea of the frightened bird that would fly away when Eira entered combat inside the small bird specific zones is not forgotten, but it could cause problems in contrast to the original system where the large ambience stems melt together and generates a solid carpet of ambience. Masking the specific birds make them harder to notice due to the fact that the small zones overlap a number of the larger stem zones. The result being the same as in the original form but the mixing had to be adjusted testing each bird specific zone, meaning even more time must be put down into the mixing.

To summarize, this method does not really have any impact on the player's experience but more on us as developers, the drawbacks are time consuming and generally annoying, not being able to control the ambience environment to that precise control we first wanted. In advantage of this system is that not even we as developers will know which stem would play where and this leaves the game with an even more adaptive and random ambience, that have been carefully plotted out and adjusted.

[6] See chapter 3.4.3.2 Ambience

4.1.3 Sound Effects

The sound effects ended up much different than we first thought. A lot of thought was put down into ideas and discussion how we could adopt the concept of adaptive sound into the general sound effects production.

We wanted to make most of the sound as adaptive as we could without breaking the illusion of this being a game. Sound effects could not vary too much because then the player would not recognize the sound of the action they are linked to, and as stated earlier in the text we focused on a small amount of sound effects that could be randomized and altered. One of these focus sounds was the various attack sounds and those related to the combat phase of the game. These sound effects include sword swings, sword hits and enemy wound sounds.

4.1.4 Results from the Focus Group

As expected, the focus group turned out to be a great way to get feedback for our mood music. A total of eight participants joined us in listening to two of our musical pieces with all the different moods and contrasts, and the general opinion about the music was good. In this chapter we will go through the different questions we asked and talk about the answers[7] in general, to see if what we were aiming for turned out right.

Question 1: What feeling did you get from listening to the music?

The answers were very pleasing, as they confirmed that we had went in the right direction and succeeded in portraying the feelings we wanted. Our listeners felt a sense of adventure and curiosity in the happy stems and many of them got a feeling of increased difficulty and danger when listening to the sad and dark versions of the music, which is a part of what they represent in-game; the music fades to the sad and dark stem once the player enters combat.

> *"The neutral one could be another stage with darker/harder content."* (Participant 1)

[7] Quotes are translated from Swedish to English.

Another popular answer was that the music sounded asian. This was also great to hear as the music was designed with this in mind. However no one mentioned that it sounded nordic, which was the second half of the cultures that our music was written for.

"Asian, open and light. Freedom, excitement and adventure." (Participant 2)

Question 2: What feeling did you think we wanted to portray?

This was an interesting question. We wanted to know if people could see beyond what they felt themselves and try to understand what we are trying to achieve by listening to the music. The answers were very similar to the first question, which was great since it confirmed that we had indeed portrayed our feelings correctly.

"The story could begin with a sad scene that gets happier." (Participant 3)

"Happiness that gets more epic, with a feeling of melancholy." (Participant 4)

Question 3: How can we enhance the feeling?

When creating music it is easy to miss and overlook things, and that is why we needed to ask a question like this. Everything from which instruments to use, volume and dynamics, we wanted to know if anything could be changed or reinforced to enhance the feelings of the piece. Many of the participants felt that the music needed more 'weight', or bass.

"It lacks a little 'weight'. At the moment the music tends to pass off as quite simple, give more 'punch'." (Participant 5)

We had anticipated this since we created the music alongside with the ambience and sound effects, and room had to be made for all of the sounds. It is hard balancing the three parts, and since the people in our focus group only listened to the music without the ambience it's understandable why it could have

sounded ‘empty’ in some parts.

Many answers also pointed out that the tempo in the songs could get repetitive, and that we should change it up sometimes. This, however, is pretty much impossible due to the way our parameters and stems work. We intentionally held back information about the way the music would be played in-game so that we could get as pure criticism like this as possible.

“The percussion loop in the first 3 pieces felt a little repetitive. You should maybe try to change it up to enhance the feelings you want to portray.” (Participant 6)

Question 4: Anything else you wish to point out?
With this question we wanted to know the general opinion of the music, and anything else our participants wanted to tell us. We got almost fully positive answers, with a few critiques.

“I like the cymbals och... everything! But I want <u>more</u>.” (Participant 1)

There were some more interesting inputs to, such as some of the pieces sounded like they belong in a 2D game, and others in a 3D one, however everyone thought the music would fit in an adventure game.

“The first pieces I think belong in a 2D game, while the others in a 3D one. They feel more expansive, while the first ones are more “forward”- (Participant 3)

All in all the reception and critique for the music was great, and we are all very happy with the results from this focus group. It was a great way to get critique and general feedback for our work.

4.2 Discussion and Conclusion

The following chapter concludes this thesis and will contain our thoughts and questions about what we think of the thesis and if something could be done differently. We will share our final thoughts reflecting this thesis and finally suggest further studies on this subject.

4.2.1 Problems with Adaptive Music and Sound Design

We started this project knowing what we were getting into, and that it was going to be difficult. Extensive planning and dedication is needed as the creation and implementation of adaptive music is a time consuming process, and a lot of things can go wrong. So, what are some of the problems that can arise working with adaptive music?

The most obvious problem for us is the way that tempo and key signatures work when making adaptive music. For every piece they have to remain the same for all the stems or else they will collide and cause dissonance. In many ways this is a restraint, but it doesn't have to be. Dissonance for example can be used in many ways to cause stress or discomfort. Changes in tempo however is very hard to pull off, except for when crossfading to another piece with the help of a transition. All in all adaptive music design is a very potent form of music in video games, with not a lot of side effects aside from the time it consumes and the technical and musical difficulties.

Moving away from the music production we can take a look at problems with adaptive sounds and ambience. The only real big problem for us was time, as the production of the sounds are pretty straight forward. There are a lot of interesting things that can be done and many ideas were planned for the sound effects and ambience that did not make it in the final version of the game, and these will be discussed more in the next chapter.

4.2.2 Unused Ideas

All of our ideas did not make it into the game. Some concepts were just too time consuming or too difficult to implement in time. In the following chapter we will share some of our ideas and concepts that

we did not manage to complete.

4.2.2.1 Creature Behaviour

We wanted to incorporate the essence of adaptive sound design into the sound effects where it could be heard and felt to such extent that it would properly represent adaptive sound design. One of these ideas was Goblins. At the beginning of this project when we brainstormed and generated ideas we came up with multiple types of enemies including goblins. The thought was that when the goblins appeared they would do so in a small group and would attack the player on sight.

Goblins are small dirty creatures that plunder and are generally creepy and gross. The sound design should reflect this and therefore the plan was to make the goblins sound cocky and superior in larger numbers but suddenly when Eira would defeat them one by one the sound would mirror a realistic behavior and start to sound frightened and pitiful. It's a shame that due to time limitations these sound effects didn't make it into the final game because the result would immerse the player even more into the fantasy world we've created.

4.2.2.2 Reversed Reverb zone

Another idea that was discarded was to use Unity's integrated reverb tools to make the audio environment even more realistic. Because of our knowledge in sound we know that sound behaves differently in different environments and the plan was to use a reverse reverb zone (a reverb zone is used to give all sound inside zone the same properties. for example: the 'bathroom' setting will incorporate a long reverb into all the sounds inside the zone). A reversed reverb zone is therefore a reverb zone that gives the predetermined settings to all the sound outside the zone instead of inside.

We wanted to use this to incorporate the distant sound such as ambiences with for example a dynamic echo that changes depending on how far away from the audio source the player character is located. This idea is possible in other game engines but we didn't know how or if you could create this in Unity. Unfortunately for us the solution was not available within Unity and thus the idea was scrapped.

4.2.3 Further Development

In order to further study this subject one must first understand that adaptive audio is time consuming and much of your work would only be heard for a short time but the idea is not to be heard, it is to create variations and changeable audio making the game an interesting and fun experience.

As mentioned earlier[8], the parameter Tone can be used in so many ways to enhance and/or change the overall feel of the music that is heard. Further development and tests in tonality using the parameter is key to producing truly adaptive music. Imagine if the music could correspond to 'all' feelings, or the absence of feelings for that matter - it would be able to immerse the player in a new fashion.

While defining the parameter, it can be used in so many ways to achieve this. We used it for simple feedback - health getting low - mainly because of issues with time. It is possible to make this parameter cooperate with the other two tonal parameters, Contrast and Mood, to achieve musical differentials by adding consonance or dissonance depending on what the composer want the player to feel. Consonance can be used with, for example heroic, powerful but also happy music to enhance the feelings of the gameplay in real-time. Dissonance can be used in a similar manner to produce deeper musical feedback for scary or dangerous situations, emphasizing stress and intensity.

This, in combination with recurring leitmotifs and mood music can, if composed and developed right, make the music directly correspond to every event in game - much like they do in movies during action, love or heroic scenes. There is no telling on how it would be perceived until a complete system is achieved - further development is required for this system to truly blossom. All the music might seem overwhelming at first, but one should never underestimate the power of silence. Silence could be inserted before big events - much like the expression 'the calm before the storm' - or to underline events where 'something is not right'.

[8] See chapter 4.1.1

It is noticeable that music can be used in an abundance of ways, and it is up to the composer and game designer to decide where and how to use music and silence. This is the essence of adaptive music - full control of music and feelings.

4.2.4 Conclusion

The idea of adaptive sound design is at first glance brilliant and if the execution is well done the end result can be amazing. There are a few drawbacks but overall we believe the end justifies the means. To resubmit our original research questions:

How can adaptive music and sound design be used to create a living audio environment?
- How can you create a parameter based system for music and sound handling in a game production?

Adaptive sound design can be used in a number of different ways to create an immersive and living audio environment, you just have to make sure that you have an appointed time frame and a detailed plan of how much realistic content could be implemented in time. A factor that cannot be overlooked is the fact that a fundamental knowledge of the software and programming is needed to be able to implement adaptive sound. There are many factors and parameters that have to be understood in the code in order to know how the sound will react in certain situations. This is the hardest part in implementing adaptive sound design in a game, especially if you don't possess the knowledge required to read and write code.

The creation of the parameter system was in a sense not created so much as used. We adopted the tools available to us within Fabric and Unity and subsequently developed our parameter system. Our system was hence not created from scratch even though we had plans in the beginning to develop a new system, but we didn't have near enough time to make that a reality. So we settled for a more commercial method with some modifications of our own.

In a world full of different video games with different genres, norms are bound to appear. But we did not want to be bound to these, instead we wanted to take what we think is good from it and adapt it into our own, yet refurbished vision.

5. Glossary

ADD - (Short for Audio Design Document) A document depicting how a game will sound like as well as a listing of assets and technical specifications.

Adaptive Audio - Music and audio that reacts and changes to certain conditions in the game.

Audio - Sounds that humans can perceive.

Audio Engine - A software with a set of tools that allow the audio designer to implement and design how music and sound effects will be played back in the game. An audio engine work in parallel to the game engine.

Crossfading: A way of using stems to fade between tracks that are individual and often not used together with one another.

Diegetic Sound - Sound that the characters hear in the scene.

Game Engine - Software with a set of tools for creating video games.

Health - a numeric value that defines if the character is alive or dead. It can also be displayed with visual representation such as bars or hearts.

Interactive Audio - Music and sound that reacts and changes to the players direct interactions.

Key: The key of a song is what defines its feel, mood and also which notes can be played in the song that will work together.

Leitmotif - A method of pairing instruments and musical pieces to characters and places in a game to create recognisability.

Non-Diegetic Sound - Sounds that only the audience hear.

NPC: Non Player Character; other people and creatures in the game that are not controlled by the player.

RTP - Real Time Parameter. A value that has been assigned to a certain condition, for example the distance from a player character to an enemy.

Sound - Vibrations that travel through liquids, gases or solids.

Static Audio - Music and audio that stays the same no matter how many times the medium is played.

Stem - A piece of music that, in collaboration with other pieces of music, can be used to alter the currently playing music into various fashions.

Stitching: Another way of using stems that focuses on stems that can be used together to create tracks that are appropriate to the situation in the game.

Tempo: Tempo defines how many BPM (beats per minute) there are in a song, which is often used to make it slower or faster.

Tension: A term used to describe how tense a situation in the game is and how music is reacting to it.

Time Signature: In a song, time signature specifies how many beats are in each measure and which note value constitutes one beat.

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