Berklee College of Music

Tales of the Lost Worlds:
An Immersive Audio Approach to Storytelling

Submitted in Partial Fulfillment of the Degree of

Master of Music in Music Production, Technology and Innovation

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Abstract

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The purpose of 'Tales of the Lost Worlds: An Immersive Audio Approach to Storytelling' is to compile an online immersive audio portfolio of three short stories made for YouTube and Facebook. The material is a mixture of pre-existing and new audio and visuals, each focused on an original story. The motivation behind this research is to consolidate a storytelling approach utilizing immersive audio to enrich the experience of a surrealistic world. A variety of techniques and plugins have been researched in order to mix ambisonics. The result is a diverse and coherent portfolio that displays competence in immersive mixing and a future of captivating storytelling.

Keywords: creative project, portfolio, immersive audio, binaural, storytelling.

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1. Introduction

Tales of the Lost Worlds: An Immersive Audio Approach to Storytelling is a research on utilizing ambisonic audio for storytelling in 360° virtual environments.[1] The aspiration for this research originated from a previous project by the author: Dutch virtual reality (VR) children's book, *Nirva en de Zonneboom* (Nirva and the Suntree) that started in 2018. This project displayed a need for an interdisciplinary approach in order to be able to realize a prototype product. During the development it came to light that the author (also the project leader) was missing skills in desired qualities such as knowledge about storytelling, immersive audio, VR development, 3D design, animation and marketing. These qualities were required to entirely be able to express their concept of a fully immersive surrealistic and fantasy world and share it with a young audience. With the help of a multidisciplinary team a VR prototype was constructed. However, when the prototype was tested in 2018 on 30 primary school children the results showed that the VR glasses caused considerable issues.[2] Therefore a different approach was explored.

The preferred result of this exploration consisted of: having a finished and marketable product; a portfolio filled with three different studies about storytelling; three binaural and immersive environments. This would overcome the considerable issues related to the use of the VR glasses while allowing the author to create as an interdisciplinary artist and to prepare material for potential clients.

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[1] Waves Audio Ltd., "Ambisonics Explained: A Guide for Sound Engineers | Waves," waves.com, October 10, 2017, https://www.waves.com/ambisonics-explained-guide-for-sound-engineers.

[2] Mirte de Vrieze, "Prototyping VR Children's Book in Primary Education" (Internal HUAS Report, 2018).

Missing knowledge and resources were identified to achieve the skills to be able to develop these immersive stories. The cause for some of the missing proficiencies could have been the background in the Dutch educational system, which focuses on specialization, rather than multipotentiality and missing resources about immersive audio in the undergraduate university.[3] Additionally, the lack of a directed plan for social media pointed to the lack of a missing community and following.

The aim of this project is to increase the knowledge and experience on mixing ambisonic audio, storytelling, 3D design and marketing to prepare the author to work in the music industry as an audiovisual composer, immersive audio mixing engineer and storyteller. To realize these goals, three cases are explored with different types of storytelling and virtual environments. Literature and media research have been performed to study the work of other professionals in this field. The available resources at Berklee have been utilized, such as attending an Immersive Audio course, collaborating with the Berklee community and faculty and communicating with the International Career Center. Information about 3D design, texturing, lighting and animation have been acquired through YouTube tutorials about Blender.[4,5] Tutorials and exercises on writing by Joyce Carol Oates and many others have been followed on the Masterclass platform.[6]

The problem statement considers that: due to missing interdisciplinary knowledge and experience the author is unable to fully express their artistic vision using 360˚ videos and

[3] Laurie Diane Shute, "An Investigation of Multipotentiality among University Honors Students," *Doctoral Dissertations*, January 1, 1999, 1–203, https://opencommons.uconn.edu/dissertations/AAI9942597/.

[4] Google LLC YouTube, "YouTube," *YouTube*, 2018, https://www.youtube.com/.

[5] Blender Foundation, "Blender.Org - Home of the Blender Project - Free and Open 3D Creation Software," blender.org, 2019, https://www.blender.org/.

[6] Masterclass, "Writing," Masterclass, 2020, https://www.masterclass.com/articles/categories/writing.

share this with an online community. The objective of this project was to research different techniques and approaches using three interconnected concepts to fulfill this gap. The three original concepts and implementation could result into an innovative product. Therefore, the main question is: 'How to approach storytelling with immersive audio and surrealistic 360˚ environments while building an engaged online community?'

To answer this question a literature and media research is described in the next chapter, Review of the State of the Art, which leads to the description of the project.

2. Review of the State of the Art

At first, a better understanding of VR was required. The definition of VR is stated hereby: "The computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors."[7]

Although different forms of VR have been developed over almost a century, the current technological developments allow it to be available for a large public.[8] Artists like Björk have worked with development teams to make 360˚ and 3D animated music videos. For example, the audio of the vocal track is connected to the location of Björk in this Stonemilker VR experience (see fig. 1).[9] When she moves around the 360˚ camera the listener is guided to follow her movement and sound.[10] The audio guidance technique will be utilized for this project as well, but without having an artist or character walking around the 360˚ video.

Figure 1: Screenshot of Stonemilker VR by Björk.
Source: https://www.indian.co.uk/pages/stonemilkervr

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[7] "Virtual Reality | Definition Of Virtual Reality By Lexico". 2019. *Lexico Dictionaries | English*. https://www.lexico.com/en/definition/virtual_reality.

[8] The Franklin Institue, "History of Virtual Reality," The Franklin Institute, October 21, 2016, https://www.fi.edu/virtual-reality/history-of-virtual-reality#:~:text=The%20use%20of%20the%20term.

[9] "ONE LITTLE INDIAN | Stonemilker VR". 2015. *Indian.Co.Uk*. https://www.indian.co.uk/pages/stonemilkervr.

[10] "Björk Digital". 2016. *Somerset House*. https://www.somersethouse.org.uk/whats-on/bjork-digital.

The Turning Forest, developed by the BBC, is a sound based real-time CGI VR fairytale made for the Samsung Gear VR and the Google Daydream.[11,12,13] This VR application makes use of immersive audio and head tracking. This experience was one of the inspirations for this portfolio because the narrator tells a story and the audio guides the listener.

Other sources of inspiration were the surrealism and fantasy art styles (see fig. 2).[14,15] The Dutch company Big Orange has made an surrealistic audio tour for the exposition 'Mad about Surrealism' (2017) in the museum Boijmans Van Beuningen.[16,17] For this audio tour the narrator was recorded with a binaural microphone to create a surrealistic feel. This has given inspiration to experiment with an ambisonic microphone for the voice over recording.
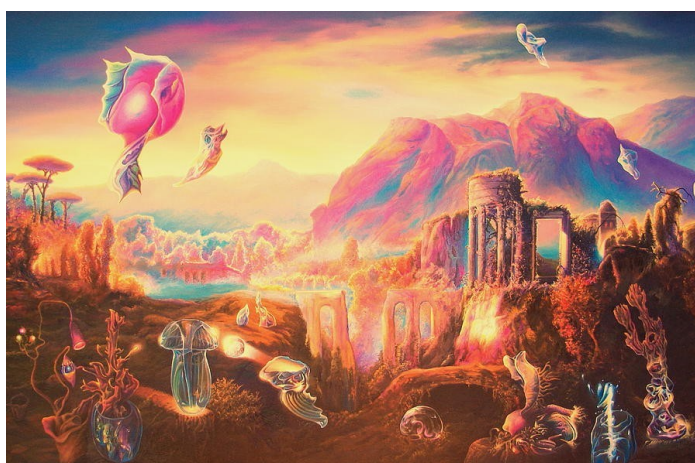
Figure 2. Holloween fantasy art landscape by James McCarthy
Source: https://fineartamerica.com/featured/holloween-james-mccarthy.html

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[11] BBC, "Turning Forest," BBC Taster, 2017, https://www.bbc.co.uk/taster/pilots/turning-forest.

[12] SAMSUNG ELECTRONICS CO., LTD., "Samsung Gear VR with Controller,"

[13] Google LLC, "Daydream," arvr.google.com, 2019, https://arvr.google.com/daydream/.

[14] The Editors of Encyclopedia Britannica, "Surrealism | Definition, Artists, & Facts," in *Encyclopædia Britannica*, November 5, 2018, https://www.britannica.com/art/Surrealism.

[15] Bitter Soup LLC, "Fantasy Art | ArtHistory.Net," Arthistory.net, 2017, http://www.arthistory.net/fantasy-art/.

[16] Big Orange, "Boijmans – Mad about Surrealism : Big Orange – Audio Experiences," experiences.big-orange.nl, accessed February 13, 2020, https://experiences.big-orange.nl/2017/09/29/boijmans-mad-about-surrealism/.

[17] Museum Boijmans Van Beuningen, "Mad About Surrealism," Museum Boijmans Van Beuningen, 2017, https://www.boijmans.nl/en/exhibitions/mad-about-surrealism.

To learn more about how stories are written professionally, the online resource 'Masterclass' has been consulted.[18] On this platform different writers, like Joyce Carol Oates, Neil Gaiman and many others, share their knowledge and perspectives about writing. It is accompanied with assignments in a workbook, which were used as a guideline or starting point for the portfolio pieces. Also Dan Harmon's Story Circle (see fig. 3) and the 'Once upon a time' formula or spine that was created by Kenn Adams, were used as guidelines.[19,20]
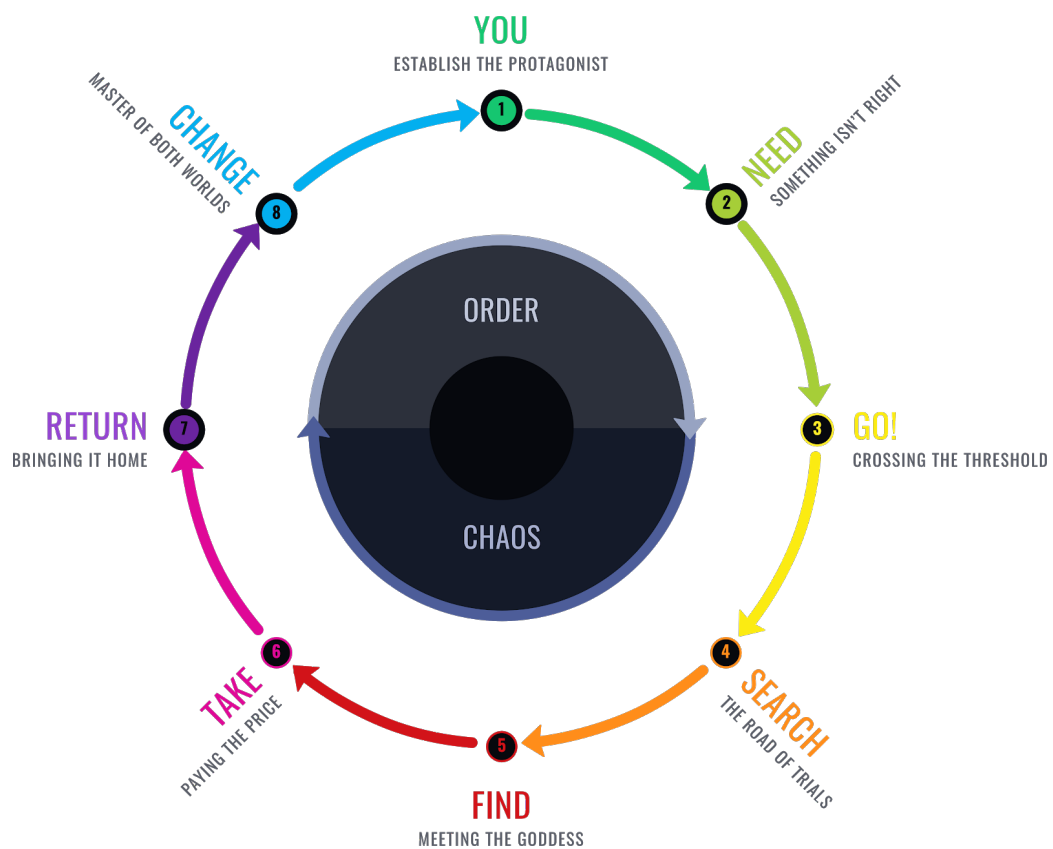

Fig. 3 Dan Harmon's Story Circle
Source: https://www.studiobinder.com/blog/downloads/story-circle-template/

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[18] Masterclass "Writing"

[19] Scott Myers, "Dan Harmon, the Hero's Journey, and the Circle Theory of Story," Medium, May 10, 2018, https://medium.com/@scottdistillery/dan-harmon-the-heros-journey-and-the-circle-theory-of-story-b64bb77d6976.

[20] Kenn Adams, "Back to the Story Spine," Aerogramme Writers' Studio, June 5, 2013, https://www.aerogrammestudio.com/2013/06/05/back-to-the-story-spine/.

To represent the audio in a realistic manner, a technique called ambisonics (B-format) has been utilized. This technique aims to resemble the sound direction like the real world, using a virtual sphere 3D audio technique (see fig. 4). There are different ways of using ambisonics. For example recording with an ambisonic microphone and for linear or interactive post-production. This paper will focus on mixing linear ambisonics and therefore the software Reaper will be utilized with the dearVR plugin and the Facebook Spatial workstation.[21,22,23]
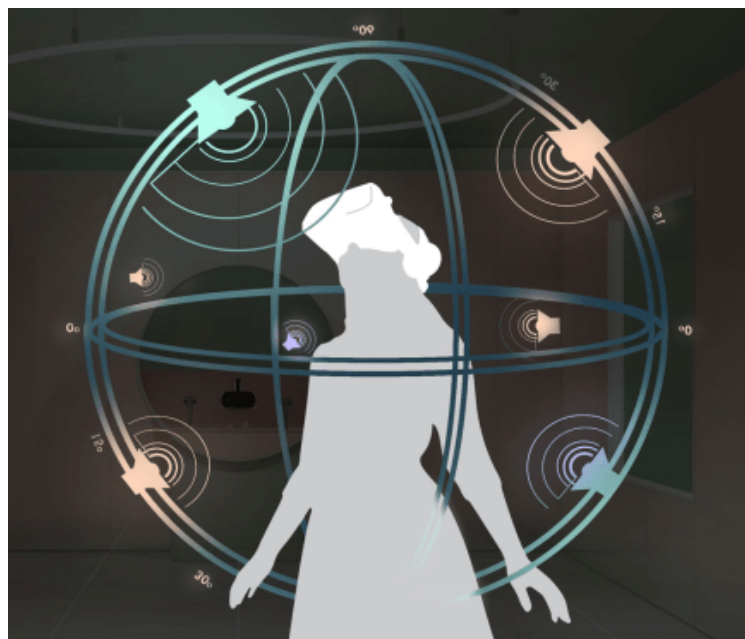

Figure 4: VR virtual header
Source: http://melodrive.com/blog/increase-user-immersion-with-audio/vr-visual-header/

[21] Cockos Incorporated, "REAPER | Audio Production Without Limits," www.reaper.fm, accessed February 12, 2020, https://www.reaper.fm/.

[22] Dear Reality, "THE EVOLUTION OF AUDIO MIXING," Dear Reality, accessed May 24, 2020, https://www.dearvr.com/.

[23] Facebook, "Spatial Workstation," Fb.com (Facebook 360 Video, 2019), https://facebook360.fb.com/spatial-workstation/.

The orders of ambisonics are connected to the number of channels used to represent the sound sphere. The 1st order has 4 channels, 2nd order 9 channels, 3rd order 16 channels and so on.[24] The quality of the sound representation increases using a higher order. Research has determined which order of ambisonics is suitable for this project. Currently YouTube supports the 1st order of ambisonics and Facebook the 2nd order. To have a consistent mix and quality, the decision was made to use the 1st order of ambisonics.

Binaural audio allows the virtual sphere with the speakers to be represented on headphones. Since music is nowadays often listened to through headphones and the computers are powerful enough to run the software to encode and decode ambisonics, immersive audio is becoming an increasingly popular manner to listen to music, also without VR.[25] At the time of writing this thesis, streaming services like Tidal have launched 360 Reality Audio playlists, which could indicate that there is an increasing interest in immersive, and more specifically, binaural audio. The process inside our brain differs between listening to stereo and immersive audio. This has to do with the recreation of the sound field, which happens inside our head with stereo audio and outside our head with immersive audio. This gives the music more space to blend between our ears and to place music in a virtual room with reflections that add ambience. Immersive audio could lead to a positive listening experience and it could give a better representation of the way the artist envisions their music and conveys emotion. Therefore immersive audio could be an innovative field to research. In the next chapter different approaches on mixing immersive audio will be presented.

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[24] "Ambisonics Explained: A Guide For Sound Engineers | Waves". 2017. *Waves.Com*. https://www.waves.com/ambisonics-explained-guide-for-sound-engineers.

[25] Abby Road Training Limited, "Spatial Audio - An Introduction to The Continuing Evolution," Abbey Road Institute Amsterdam, May 27, 2019, https://abbeyroadinstitute.nl/blog/spatial-audio-continuing-evolution/.

3. Project Description

'Tales of the Lost Worlds' is a portfolio of three different stories that take place inside a virtual environment, that are designed to fit the atmosphere and to research different types and approaches to storytelling. These stories are combined with music and sound effects and mixed into binaural audio. Together they form 360˚ immersive videos for YouTube and Facebook. These platforms support VR and ambisonics and are therefore suitable for this project. Since the products consist of different elements, it has been split into subtopics: story, environment, audio, final product and marketing. The topics are ordered in the way it was chronologically approached.

3.1 Stories

The children's book: *Nirva en de Zonneboom VR* (Nirva and the Suntree) has been written by the author in 2017-2018. The story is based on the moral: everyone should be included. Therefore, the main question of the story is about choosing to invite or exclude one of the fictional Ojos-Hojas creatures to celebrate the coming of spring. This choice, based on the preference of the child, has consequences for the end of the story. If the child chooses to exclude the Ojos-Hojas, there is a passage where the result of this choice is explained and the child is offered the possibility to loop back to the other option. In this way the child can learn about the result of their actions. This story has been written using the story cycle method by Dan Harmon and the 'Once upon a time' formula. [26,27] The manuscript can be found in Appendix A and, after collaborating with an editor, the plan is to release it as an E-book and a physical book.

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[26] Myers, "Dan Harmon, the Hero's Journey"

[27] Adams, "Back to the Story Spine"

The second project is the 'The Cave', a concept and story developed by the author using the Masterclass exercises by Joyce Carol Oates. This exercise was about picking one location, one person and one event to write a short story. This scenario presents the story of Colton, a 20-year-old man, inside a cave with a group of activists that should resemble his family. Eventhough the actions taken by the activist appear to work, Colton is still not sure if he has made the right decision. The full story can be found in Appendix B. The script was formatted using a screenplay example from the Screencraft website.[28]

'Clouds' is a poem inspired by the COVID-19 pandemic. It focusses on staying connected through love and moving forward in challenging times. This was combined with a reflection on the year at Berklee and how this affected the author in a positive manner. The poem can be found in Appendix C.

3.3 Audio

The audio for the three videos is a combination of pre-existent and new music, which is combined with sound effects and a voice over. The music for *Nirva en de Zonneboom* has been composed using the program Ableton Live 10.[29] The narrator is the Dutch actor and musician Fabian van der Dussen. The music for The Cave was created with Reaper and the music for Clouds with Ableton Live 10. The sound effects are from royalty free sample libraries and all the stems were added together in the Reaper digital audio workstation. This program was used because it has the capability of including multichannel audio, which is necessary for ambisonic processing.

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[28] Red Ampersand Company, "Elements of Screenplay Formatting," ScreenCraft, May 7, 2015, https://screencraft.org/2015/05/07/elements-of-screenplay-formatting/.

[29] Ableton, "New in Live: Discover the New Features Ableton Live 10 Has to Offer | Ableton," Ableton.com, 2019, https://www.ableton.com/en/live/.

The Facebook Spatial Workstation was used in Reaper starting from their provided template. Exporting the audio was the most challenging aspect, since there are very specific steps that need to be taken in order to get a multichannel file like the *.tbe* extension, which is used by the FB360 encoder to add the video and audio together. In order to share the progress with the advisors of this thesis, a binaural mix was made, which needed to sound as close as possible to the 2nd order ambisonic mix with the FB360 plugin. For this mix, the free Reaper ATK has been tested. The sound proved to be dissimilar due to the missing room reflections that the FB360 plugin provided. Therefore dearVR has been used, which proved to be similar, or even better sounding than the FB360 plugin due to the different reverberation room options.
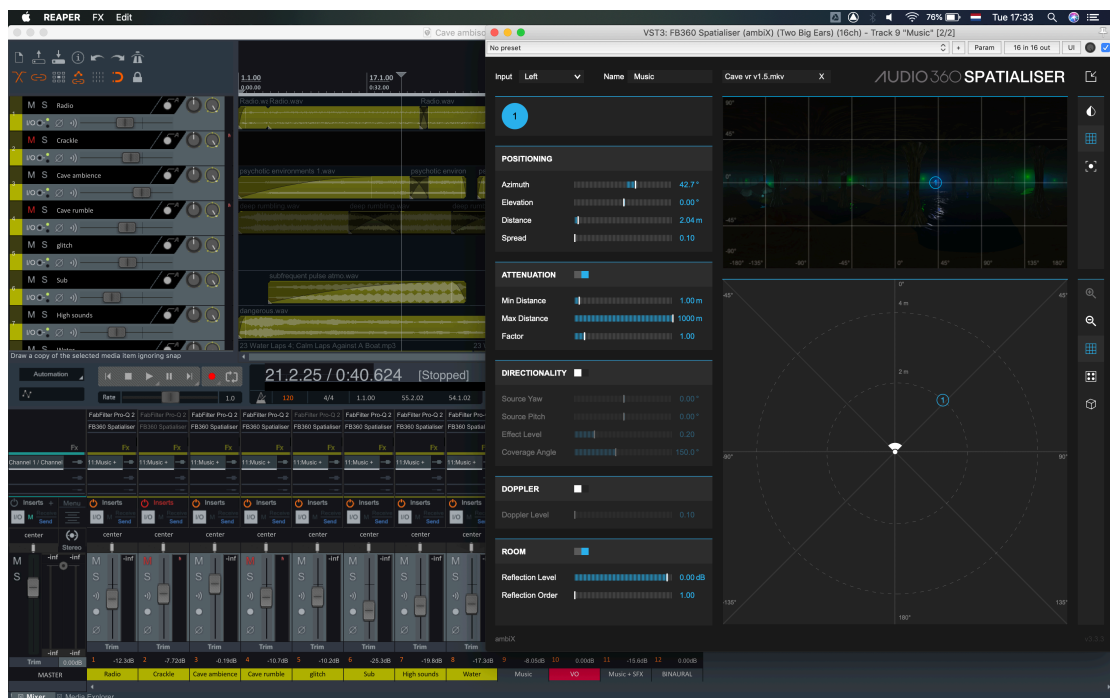

Fig. 5: FB360 Audio Spatialiser used within Reaper

As a final solution, a special template was built in order to route all the music and sound effects to one channel and apply a side-chain using the voice-over channel. In this way the music does not interfere with the narrator. After this, everything is routed into another

auxiliary channel that decodes the signal to binaural. This results in a *.wav* extension that can be played back without the need of any encoding and decoding. This shows the difference between the binaural file and the ambisonic file. The ambisonic file is multichannel and needs the encoder in order to be listened to on headphones, while the binaural does not. So, why not use only the binaural file and the dearVR plugin for the 360˚ videos? This is because the FB360 plugin has the option to import a video and to link sounds to a point in space, so that the location of the sound moves if the video is moved. This was useful for the placement of sound effects and to make the narrator guide the viewer. For the voice-over guidance in the video a 1st order ambisonic microphone by Sennheiser has been tested.[30] This recording was not useful since the flexibility and panning capability of a mono signal is preferred over a narrator that is walking around in space without the connection to the video events. The microphone could be useful if a 360˚ camera was used, which links the audio and video events, or if the actual location is not important, for example, in ambience recordings. However, these options are outside of the scope of this research.

3.2 Virtual Environment

All environments were built using the open-source 3D software Blender version 2.8.[31] This program has been chosen because it is free, just as powerful as any other 3D modeling program and there are many online tutorials to learn how to use it. The real-time renderer Eevee helped to achieve fast results in the created environments.[32] The YouTube tutorials of United Filmdom Ltd. were helpful to learn about equirectangular rendering and how to setup the camera rig for the 360˚ video in Eevee, since there did not appeared to be a function for

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[30] Sennheiser, "Sennheiser AMBEO VR MIC - Microphone 3D AUDIO Capture," nl-nl.sennheiser.com, accessed May 24, 2020, https://nl-nl.sennheiser.com/microphone-3d-audio-ambeo-vr-mic.
[31] Blender Foundation, "Blender.Org - Home of the Blender Project - Free and Open 3D Creation Software," blender.org, 2019, https://www.blender.org/.

[32] Grant Wilk, "Get Ready for Eevee, Blender's New Real-Time Rendering Engine," CG Cookie, February 14, 2018, https://cgcookie.com/articles/get-ready-for-eevee-blender-s-new-real-time-rendering-engine.

rendering.[33,34] Only the native Cycles rendering engine is currently capable of equirectanglar videos, but due to the high rendering times and major differences in final results the decision was made to use the alternative method build by United Filmdom Ltd.[35] In this method a six camera setup renders the scene with Eevee. After that the six separate videos were loaded on to blank planes in Blender with the Cycles renderer enabled and then the equirectangular camera renders the 360˚ video. This is a seems to be a faster method since the Cycles rendering engine only has to calculate the polygons of the 6 planes instead of the entire environment. However, more research still needs to be performed to make the rendering less intensive.

The prototype scenes of *Nirva en de Zonneboom* were built by Erik Schoonbeek (see fig. 7). This was the starting point of the further development of the scenes. The prototype scenes needed additional models, texturing and lighting. Therefore YouTube tutorials by Ducky 3D, CG Geek and DECODED have been followed to learn about low poly modeling, procedural texturing and natural lighting.[36,37,38] A normal map was used to give everything a paper resembling texture, this could be helpful to have a stronger connection between the

[33] United Filmdom Ltd., "Eevee Equirectangular Tutorial," YouTube Video, *YouTube*, December 5, 2018, https://www.youtube.com/watch?v=OcPeWJreP-4.

[34] Eric W. Weisstein, "Equirectangular Projection," mathworld.wolfram.com, accessed May 24, 2020, https://mathworld.wolfram.com/EquirectangularProjection.html.

[35] Blender Foundation, "Cycles," Cycles Open Source Production Rendering, 2018, https://www.cycles-renderer.org/.

[36] Nathan Duck, "Ducky 3D," YouTube, 2018, https://www.youtube.com/channel/UCuNhGhbemBkdflZ1FGJ0lUQ/about.

[37] Abby Crawford, "Meet the Tutorial Maker: Steve Lund (CG Geek)," BlenderNation, November 13, 2019, https://www.blendernation.com/2019/11/13/meet-the-tutorial-maker-steve-lund-cg-geek/.

[38] DECODED, "DECODED," DECODED YouTube, 2006, https://www.youtube.com/user/xpoc/about.

physical book and the video, although more research needs to be done to see if the children react to this.[39]
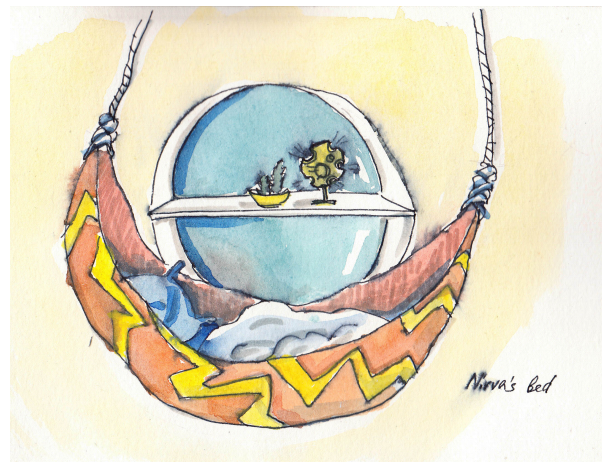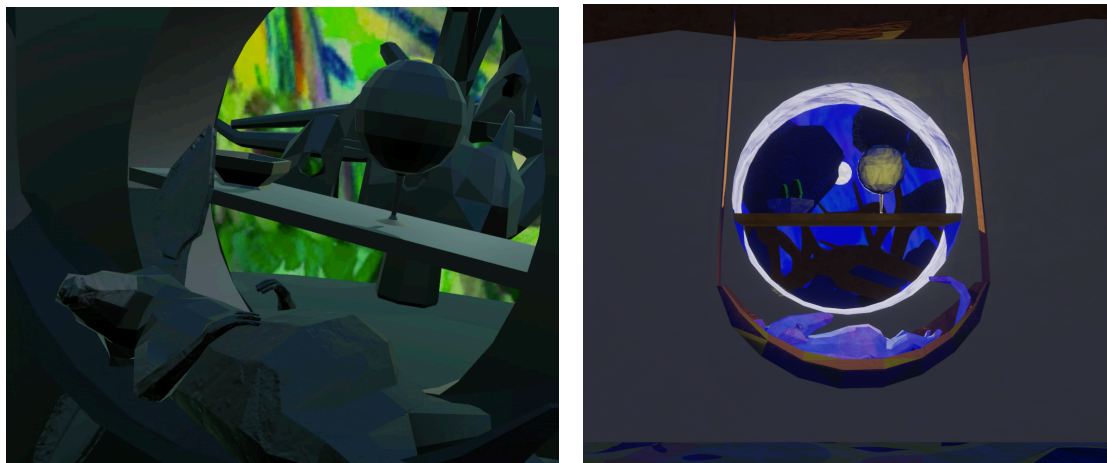

Fig. 6: Concept art by Nadezda Shvaikovsky

Fig. 7: Before (left) and after (right) applying the textures and lighting. The left image is from the VR

prototype built by Erik Schoonbeek.

The Cave has its origins as well in a YouTube tutorial from Ducky 3D about creating a Science-Fiction environment.[40] The texture of the columns and the ground were altered, plus elements like water and tents were added to match the story (see fig. 8).

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[39] Joey de Vries, "LearnOpenGL - Normal Mapping," learnopengl.com, accessed May 24, 2020, https://learnopengl.com/Advanced-Lighting/Normal-Mapping.

[40] Nathan Duck, "Blender - Easy Sci-Fi Environment in Eevee (Blender 2.8)," YouTube Video, *YouTube*, October 16, 2019, https://www.youtube.com/watch?v=3gjgCmj-b58.
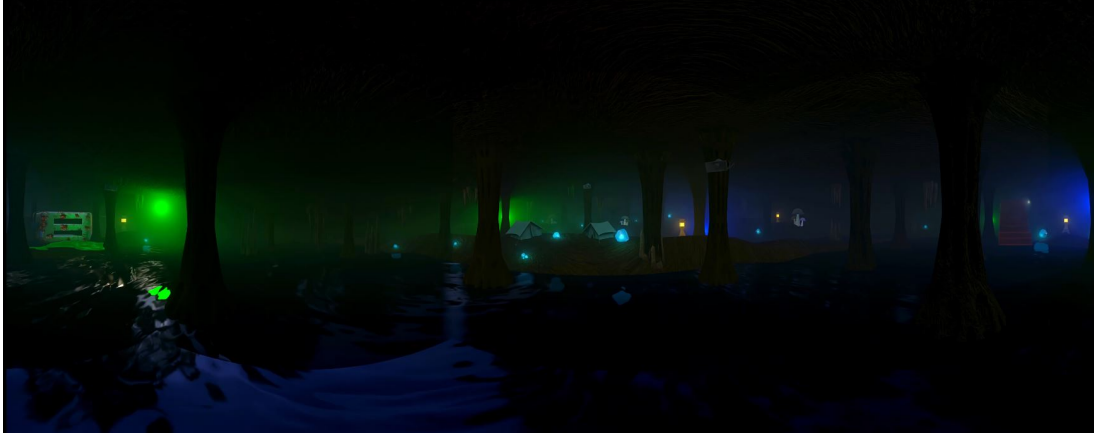
Fig. 8: The Cave environment

The Clouds scene consist of 3D modeled clouds, an audio reactive sphere and imported objects from the Turbosquid website.[41] The aim was to create a fantasy rich and surreal world and all the elements are animated to increase the sense of immersion (see fig. 9).

Fig. 9: Clouds scene within Blender 2.8

41 Turbosquid, "About TurboSquid | Behind the Largest 3D Model Library in the World," www.turbosquid.com, accessed May 24, 2020, https://www.turbosquid.com/AboutTurboSquid.

3.4 Final Product

When the videos were rendered out of Blender, they were imported in the video editing and color correction software DaVinci Resolve.[42] In here the scenes were edited together, a title, credits and the subtitles were added. The binaural audio was added for the video presentation and this was the final step of the process. The files were imported into the FB360 encoder for the final product, to combine them together and watch the end result in desktop mode and to upload the videos to Facebook and YouTube. The difference between them is the order of ambisonics. Facebook can handle 2nd order ambisonics and YouTube 1st order. Additionally, the difference between monoscopic and stereoscopic had to be considered.[43] The image is divided in two screens for stereoscopic visuals, one for each eye, which can be above or next to each other. VR glasses are required to see the video. Monoscopic can be seen with and without VR glasses, this has several advantages and disadvantages. The downside could be that monoscopic leads to a less immersed feeling since a VR headset helps to minimize distractions and improve the quality of the experience. However, for the presentation of the final products, video editing and ease of use on social media, monoscopic was used, as it can be more widely accessed. Stereoscopic is a feature that will be explored in further research.

3.5 Marketing

The title of this thesis: 'Tales of the Lost Worlds' is the name of the brand for all the products. The lost worlds represent different sources of inspiration that are being presented from the author's point of view using the tales to describe them. The logo for the website and social media has been designed by Valeria Piattelli (see fig. 10).

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[42] Blackmagic Design Pty. Ltd., "DaVinci Resolve 16 | Blackmagic Design," www.blackmagicdesign.com, 2020, https://www.blackmagicdesign.com/products/davinciresolve/.

[43] Immersion VR, "Monoscopic vs Stereoscopic VR | Everything You Need to Know," Immersion VR, accessed May 4, 2020, https://immersionvr.co.uk/blog/monoscopic-vs-stereoscopic-360-vr/.

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Fig. 10: Draft of the logo by Valeria Piattelli

The pre-existing website has been updated, making use of a new color scheme created through the website Coolors.[44] With the help of the International Career Center by Berklee, a strategy has been developed to publish the different videos and to plan the posts and content (see table 1).

Table 1: Planning of Social Media Post

Wk. 1	Tuesday	Thursday	Saturday	Wk. 2	Tuesday	Thursday	Saturday
Instagram	New video	Share theme	Inspiration		Picture or video of work	Road Blocks	Prepare launch
YouTube	New video	Share theme			Video of work		
Streaming	Upload music						
Pond 5	Upload music						

Source: Based on guidlines given by the International Career Center of Berklee Valencia

The children's story has a different approach. First the manuscript has been sent to an editor. After the editing process is completed the voice-over will be re-recorded and then the Dutch version of the audiobook will be ready. During the summer of 2020 the illustrator will finish the images and layout of the book, at the same moment the English translation will be finished. Inside the book a QR-code or code word will lead to a newly designed website that

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44 Fabrizio Bianchi, "Coolors," Coolors.co, 2018, https://coolors.co/.

includes the VR video as bonus content. A marketing strategy will be developed together with the illustrator. The goal is to publish the audiobook and E-book together in October 2020. This plan has been made after researching different book publishers and self-publishing options. Considering that the product consists of different audiovisual qualities the decision was made to self-publish using an online service like Smashwords and Bookora.[45,46]

[45] Mark Coker, "Smashwords – About Smashwords," www.smashwords.com, 2018, https://www.smashwords.com/about.

[46] Bookora, "Hi, Wij Zijn Bookora - Wij Geven Jouw Boek Uit Als Luisterboek!," Bookora, accessed May 24, 2020, https://bookora.nl/over-ons/.

4. Innovative Aspects

The innovative aspects of 'Tales of the Lost Worlds' are a combination of the product itself and the content of the videos.

For example, the three videos are compiled of binaural audio with storytelling in a 360˚ virtual environment. This combination is rare on platforms like YouTube and Facebook and is usually found on gaming platforms like the Samsung Gear VR.[47] Bringing the videos to social media allows the content to be more accessible and it does not have the limitations of requiring an additional VR headset.

The content has innovative aspects because one of the virtual stories is especially written and designed for children. The creatures, named Ojos-Hojas, are a fantasy tribe that plays instruments based mostly on western instruments, with a few originally designed for the story. This story has two different paths, so the child can decide how the story ends. The Cave is also an original story by the author and it is a mystical perspective of an underground resistance group. Clouds uses a poetic structure to tell a story. Together they form three different types of original stories with audio and visual content that create an immersive experience. This is how the innovative content is applied into a virtual immersive world.

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[47] SAMSUNG ELECTRONICS CO., LTD., "Samsung Gear VR with Controller," The Official Samsung Galaxy Site, 2019, https://www.samsung.com/global/galaxy/gear-vr/.

5. New Skills Acquired

During the research and development of this project new skills were acquired. The distinction can be made between hard skills, for example the gained technical abilities, and the non-technical skills, which are the personal, emotional, social and intellectual abilities.

The interdisciplinary skillset has been developed by gaining more knowledge and experience in writing, by practicing exercises given by the Masterclass authors and by researching of different writing methods. On the software side, programs like Reaper and Blender were introduced and adapted to a personalized workflow. This has been achieved by changing keyboard shortcuts to make them uniform, creating templates and reading the documentation about different functions and how to apply them. This was especially important to increase the speed of mixing immersive audio, which is on itself a gained competence. The skillset has improved by learning and applying 3D design terminology (e.g. polygon count, procedural texturing and lighting types).[48,49,50] Finally, the ability to edit and create 360˚ videos using DaVinci Resolve and FB360 to share and express an artistic vision has been realized.

[48] Arm Ltd, "Graphics and Gaming Development | Triangle and Polygon Usage," ARM Developer, accessed May 2, 2020, https://developer.arm.com/solutions/graphics-and-gaming/developer-guides/game-artist-guides/geometry-best-practices/triangles-and-polygons-usage.

[49] Shea McCombs, "Intro to Procedural Textures," Upvector.com, 2020, http://www.upvector.com/?section=Tutorials&subsection=Intro%20to%20Procedural%20Textures.

[50] All3DP, "Blender 2.8: Lighting – Simply Explained," All3DP, April 21, 2020, https://all3dp.com/2/blender-lighting-simply-explained/.

This research and the Berklee International Career Center lectures have helped to learn about branding, publishing and social media, which led to a release plan of the products. The Berklee course Principles of Music Research has supported the path of writing a thesis, that has resulted in a better document overview and the enthusiasm for the possibility of pursuing a Ph.D.

On a personal level the intrinsic motivation and creative thinking has deepened by having little external stimulus at Berklee due to the circumstances of the COVID-19 pandemic and finding activities like binaural mixing and 3D modeling. These have generated a sense of loss of time. The year at Berklee has also given a refreshed insight on the importance of emotion and connection through music. In the previous years, the focus of the author was on the theoretical and logical significance of music instead of feeling joy while composing. Although there are still steps that need to be taken in order to be able to create musical drafts without personal criticism, the pleasure in creating music is slowly returning. This insight will be a guideline for future projects. Additionally, the current world circumstances and the strong Berklee community have increased the level of social awareness. This has raised the interest in artivism, which will be explored in future work.[51]

The development of the hard and soft skills are a result of getting through challenges both expected and unexpected. In the next chapter this will be explained in more detail.

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[51] Erasmus+, "What Is Artivism For?," Artivism Online, 2017, https://artivism.online/what-is-artivism/.

6. Challenges

During this research several challenges occurred. The biggest unforeseen challenge was the outbreak of the COVID-19 pandemic in March 2020, which led to an international lockdown and therefore Berklee was closed. After consideration the choice was made to relocate to the Netherlands and continue the research from there.

This has affected the research in many different ways. For example the delivery format of the prototype presentation had been altered into video presentations, which did not work for the 360˚ videos and ambisonics this project was centered on. Therefore research had to be done into binaural audio using dearVR instead of Facebook360 and a consideration had to be made between rendering one camera perspective and making a screen capture of the 360˚ environment. In the end, this issue was helpful to develop new skills. The virus has also affected the collaboration with a singer-songwriter, which was intended to replace The Cave story, but was cancelled at the last moment due to private matters. Therefore, the story about The Cave was restored and updated into the final version of this research.

The approach was an expected challenge. Adding different elements to the starting point was a process of trial and error. Although it comes to personal preference, if the music is written to image or vice versa, this project has displayed that having the audio ready before the visuals is helpful to plan the animation timeline (see fig. 11).
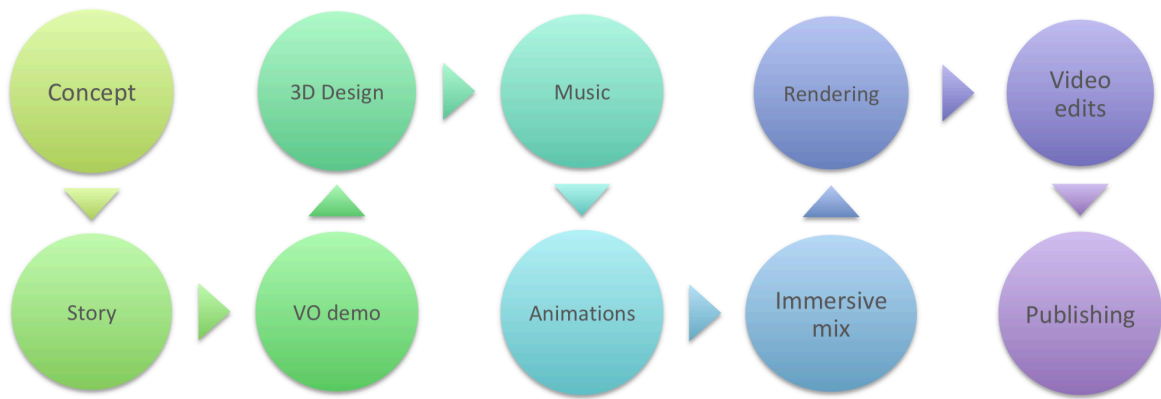
Fig. 11: Process overview

The schedule was severely affected by the relocation, adaptation to the new situation and resolving issues with the binaural audio export. The latter has been resolved with the help of classmates that ran into similar issues and by purchasing the dearVR plugin, but the schedule has been hard to catch up with. Additionally, the steep learning curve of Blender using 360˚ rendering was unexpected. This resulted in using a different method to reach the desired product. In the next chapter, Future Ramifications, a perspective is given on how this project might continue.

7. Future Ramifications

The publication of the three products, as presented in chapter 3.5, will take place in the future. This decision has been made since more content will be completed before starting to post and to ensure a regular update of new content, which could otherwise break the audience engagement. The acquired skills will assist the future products to be developed faster, therefore the publications will take place in the near future and indicate a growing portfolio. This portfolio might lead to create content for other artists and musicians. For the video development of *Nirva en de Zonneboom* research will be completed to see if the created environments need any adaptations. Currently one of the ten 360 scenes are completed and they will be finalized during the summer of 2020. The final video will be send to Berklee College of Music as an addendum of this work.

There is the possibility that this research might be continued in the form of a Ph.D. research project. Otherwise, it will be completed out of personal interest.

8. Conclusion

'Tales of the Lost Worlds' has become a portfolio with three diverse interconnected immersive virtual environments that display the gained interdisciplinary knowledge and experience on storytelling, immersive audio, 3D design and marketing. It shows the undertaken steps that were necessary to reach the final results and how to approach future immersive stories. Eventhough the circumstances of this research were challenging, it led to new insights, skills and most importantly: a loving community. By utilizing new technologies and collaborating with various artists, 'Tales of the Lost Worlds' hopes to become a recognizable brand which innovates, inspires and contributes to the multimedia industry.

Appendix A: Story of '*Nirva en de Zonneboom*'

Diep in de bossen, ver weg van hier, leven Nirva en de andere Ojos-Hojas, de ogen van de bladeren.
Ze leven al honderden jaren hoog in de bomen. Zie je ze zitten?

Één keer per jaar klimmen de Ojos-Hojas naar beneden om de komst van de lente te vieren. Dit gebeurt met muziek, lichtjes en verhalen.
Het feest is bij de zonneboom, middenin het bos. De wortels van de zonneboom geven energie om het bos te laten bloeien. De struiken en planten geven lekkere vruchten, maar er is helaas niet genoeg voor iedereen. Als iedereen samen de muziek speelt, die alleen de Ojos-Hojas kunnen maken, geeft de boom net genoeg energie om een paar planten te laten bloeien. Hierdoor is er niet veel eten en hebben de Ojos-Hojas weinig energie. De kleine Ojos-Hojas zijn te moe om na school in de bomen te spelen en dat maakt ze erg verdrietig. Ook komen ze moeilijk in slaap door het gerommel van een lege buik. Wat zou het fijn zijn als de zonneboom écht zou bloeien! Maar hoe krijgen ze dat voor elkaar?

Het oefenen voor het lentefeest is in volle gang wanneer Fey binnenkomt. Nirva en haar vriendjes kijken verstoord op. Waarom is hij altijd te laat? Zijn wilde haar staat alle kanten op en hij kan zijn rare instrument, het contrablad, maar nauwelijks tillen.
De dirigent zegt dat Fey gauw moet gaan zitten en iedereen moet weer vanaf het begin starten. Nirva's vriendje Doorn zucht verveeld.
Nirva ziet dat Fey z'n best doet, maar het klinkt nog niet zo goed.. Luister maar..

Als Fey na het oefenen zijn contrablad pakt zegt Doorn: "Zo mooi als wij kun jij niet spelen, waarom doe je eigenlijk mee?"
Zijn vriendje Stekel zegt: "Met jou erbij zal de boom nooit gaan bloeien!"

Deep in the forest, far away from here, live Nirva and the other Ojos-Hojas, the eyes of the leaves.
They have lived for over one hundered years up in the tree. Can you see them?

Once per year the Ojos-Hojas climb down to celebrate the come of spring. They use music, lights and stories.

The celebration is around the suntree, in the middle of the forest. The roots of the suntree give the energy to make the forest bloom. The shrubs and plants give tasty fruits, but unfortunately there's not enough for everyone. If everyone plays the music, that only the Ojos-Hojas can make, the tree gives just enough energy to let only a few plants blossom. Because of this there is not enough food and the Ojos-Hojas have very little energy. The small Ojos-Hojas are too tired to play in the trees after school and this makes them very sad. They also can't fall asleep because of the sound of their empty stomaches. It would be so nice if the suntree would blossom for real! But how are they going to do this?

Spring party practice is in full swing when Fey enters. Nirva and her friends look upset. Why is he always late? His wild hair peaks in all directions and he can barely lift his strange instrument, the upright leaf.

The conductor says that Fey should sit down soon and everyone should start again from the beginning.
Nirva's friend Doorn gives a bored sight.

Nirva sees that Fey is doing his best, but it doesn't sound good... Have a listen...

When Fey grabs his upright leaf after practice, Doorn comes to him and says: "You can't play as beautiful as we do, why are you actually participating?" And his friend Stekel adds: "The tree will never bloomhaving you there!"

Fey kleurt rood en pakt stilletjes zijn spullen.
Nirva voelt zich rot maar ze zegt niets, straks vinden ze haar nog stom!

's Avonds zit iedereen warm bij elkaar in de boomhut van grootmoeder Avi.
"50 jaar geleden heeft de zonneboom voor het laatst gebloeid" vertelt ze. "De wortels hadden de mooiste kleuren die ik ooit heb gezien. De dirigent Safwa heeft iedereen laten spelen en het klonk geweldig. De hoge fluiten, de lage trommels en de sprankelende licht-harp. Het evenwicht tussen hoog en laag was precies goed. Iedereen was zo blij, zo vrolijk! De wortels van de zonneboom hadden de kleur van de regenboog en er was genoeg eten voor iedereen.
Een heel jaar waren er geen zorgen over honger en energie. Dat is nu zo moeilijk voor te stellen... Ik hoop dat ik dit nog eens mee mag maken..."
"Maar onthoud goed" fluistert ze zachtjes. "De tak houdt de bladeren van de boom bij elkaar omdat ieder blad voor de boom waarde heeft."

Nirva kan die nacht moeilijk slapen. Het lukt nog niet om de muziek samen zonder fouten te spelen en morgen is de grote dag al! Ze valt langzaam in een onrustige slaap.

De volgende ochtend stelt Doorn voor om Fey niet te vragen voor de uitvoering. Zonder hem ging het tenslotte veel beter!

Nirva twijfelt, zullen ze Fey uitnodigen?

-> Ja!   -> Nee!

- Nee! -
Doorn heeft gelijk, denkt Nirva na de laatste repetitie.
Ze loopt samen met Stekel naar Fey toe. Stekel zegt: "Heb je het al gehoord? Het feest begint vanavond een uur later." Nirva knikt: "De versiering is nog niet af."

Fey turns red and quietly packs his things. Nirva feels bad, but she doesn't say anything, what if they think that she's stupid?

In the evening everyone sits cozy together in the treehouse of grandmother Avi.
"The last time the suntree bloomed was 50 years ago" she says. "The roots had the most beautiful colors I have ever seen. The conductor Safwa made everyone sound fantastic. The high flutes, the low drums and the sparkling lightharp.
The balance between high and low was just right. Everyone was so happy, so happy!
The roots of the suntree were the color of the rainbow and there was enough food for everyone.
For one entire year there were no concerns about hunger and energy.
That is so hard to imagine now... I hope that I can experience this once again..."
"Remember," she whispers softly. "the branch holds the leaves of the tree together, because every leaf is valuable for the tree."

Nirva has trouble sleeping that night. They can't play the music yet without making any errors and tomorrow is the big day! Nervously she falls asleep.

The next morning, Doorn suggests not to ask Fey for the performance. After all, things went much better without him!

Nirva is in doubt, will they invite Fey?

-> Yes!   -> No!

- No! -
Nirva thinks that Doorn is right, after they finish the rehearsal.
Together with Stekel she walks up to Fey and says: "Have you heard? The party starts one hour later." Nirva nods: "The decoration is not done yet."

"Fijn dat jullie het zeggen! Kunnen we helpen met versieren?" vraagt Fey.
Nirva bloost en kijkt gauw weg. Stekel zegt: "Nee het is beter als we thuis het muziekstuk gaan oefenen, dan gaat het optreden beter."
"Dat is waar" zegt Fey. "Tot vanavond!"

Als Fey 's avonds bij het feest aankomt is iedereen al aan het spelen! Hoe kan dat nou! Fey kijkt toe en voelt zich heel verdrietig.

Als de Ojos-Hojas klaar zijn met spelen kijken ze vol verwachting naar de zonneboom. Maar er gebeurt niets! De zonneboom begint niet te bloeien.
Dat betekent dat er geen eten is!
De Ojos-Hojas kijken elkaar geschrokken aan. "Dit is een ramp" fluistert grootmoeder Avi. "Hoe.. Hoe kan dit?"
Nirva, Stekel en Doorn durven elkaar niet aan te kijken.
Iedere Ojos-Hojas is voor de zonneboom belangrijk.. Dat begrijpen ze nu.
Dan zakt de zonneboom krakend in elkaar.

De keuze van Nirva had grote gevolgen, want het leven van de Ojos-Hojas zal nooit meer hetzelfde zijn... Wat als ze Fey wel had gevraagd?
Zullen we gaan kijken?

-Ja -
Nirva denk terug aan wat grootmoeder Avi gister zei en ze heeft een idee.
Nirva zegt tegen Doorn: "Ik ga thuis nog even oefenen, tot vanavond!"
Gauw rent ze weg. Maar ze gaat niet naar huis. Ze kijkt even achterom en klimt dan naar de hut van Fey.
Door het raam ziet ze dat hij druk bezig is met zijn contrablad. Ze klopt zachtjes aan en Fey kijkt verschrikt op. Zijn wangen kleuren rood.
"Wat ben je aan het doen?" vraagt Nirva.

"Thank you for letting me know! Can we help to decorate?" Fey offers.
Nirva blushes and looks away. Stekel says: "No, it is better if we practice the song at home, so we can perform better tonight."
"That is a good point." Says Fey. "See you tonight!"

When Fey arrives at the party that evening, everyone is already playing! How is this possible! Fey watches and feels very sad.

When the Ojos-Hojas finished playing, they look expectantly at the suntree. But nothing happens! The suntree does not start to bloom.
This means that there will be no food!
The Ojos-Hojas look at each other with panick in their eyes. "This is a disaster..." Grandmother Avi whispers. "How ... how is this possible?
Nirva, Stekel and Doorn dare not to look at each other. Every Ojos-Hojas is important for the suntree... They understand it now.
Then the suntree collapses.

Nirva's choice had major consequences. Because of this the life of the Ojos-Hojas will never be the same again...
What if she had asked Fey?
Shall we have a look?

- Yes! -
Nirva remembers what Grandmother Avi told them yesterday and she has an idea.
Nirva says to Doorn: "I'm going to practice at home, I'll see you tonight!"
She quickly runs out, but she is not going home. Nirva looks back and then climbs into Fey's hut.
Through the window she sees that he's working on his upright leaf. She softly knocks and Fey is startled. His cheeks turn red. "What are you doing?" asks Nirva.

Verrast door haar vraag begint Fey te vertellen.

"Mijn grootvader heeft 50 jaar geleden het contrablad bespeeld. Het was het grootste instrument van het orkest en mijn grootmoeder vertelde dat hij heel mooi kon spelen. Helaas is hij op een regenachtige zomerdag met zijn contrablad op een glibberige tak gaan staan. Hij is helemaal naar beneden gegleden." Fey kijkt verdrietig. Hij heeft zijn grootvader nooit gekend, maar hij had zo graag van hem willen leren!

"Het contrablad is nu weer gemaakt, alleen ik kan er nog niet zo goed op spelen" zucht Fey. Nirva pakt haar fluit. "Zullen we gaan oefenen?" Fey glimlacht en knikt opgelucht.

's Avonds zitten alle Ojos-Hojas in een grote kring om de versierde zonneboom. De maan schijnt door de bladeren en de licht-harp wordt gestemd. Nirva glimlacht naar Fey. Hij mag de eerste klanken spelen van het stuk en hij is best zenuwachtig. Zodra de dirigent opstaat wordt iedereen stil.

Hij geeft het teken en Fey begint te spelen.
- Luister je mee?

Wat een prachtige kleuren!
De boom is gaan bloeien! Iedereen juicht!
Het is gelukt!
Er is genoeg eten voor iedereen!

Doorn fluistert tegen Fey: "Je hebt heel mooi gespeeld. Zou je mij dit kunnen leren?" Fey lacht zachtjes en denkt: "Vanaf nu wordt alles beter."

Surprised by her question, Fey starts to explain.

"My grandfather played the upright leaf 50 years ago. It was the largest instrument of the orchestra and my grandmother said that he could play it very well. Unfortunately, on a rainy day he stood on a slippery branch with his upright leaf. He slid all the way down." Fey looks sad. He has never known his grandfather; he would've loved to learn from him!

"The upright leaf has now been repaired, only I can't play so well" sights Fey. Nirva takes her flute. "Shall we practice?" Fey smiles and nods relieved.

At night all the Ojos-Hojas gather around the decorated Suntree, they stand in a large circle. The moon shines through the leaves and the lightharp has been tuned. Nirva smiles at Fey. He can play the first notes of the song and he looks quite nervous. As soon as the conductor gets up, everyone is silent.

He gives the sign and Fey starts to play.
Are you listening?

What a beautiful colors! The tree started to bloom! Everyone cheered, it worked!
There is enough food for everyone!

Doorn whispers to Fey: "You played very well, could you teach me how to play upright leaf?"
Fey smiles and thinks: "From now on everything will be better."

Appendix B: Story of 'The Cave'

IN A CAVE, CAMERA POINT OF VIEW — EARLY MORNING

It is a mysterious place where an unspecified group of people
set up a camp. They protest against the propaganda coming from
an upper level of earth.

COLTON quietly walks away from the tents and looks around. He
feels cold, but it is nice to breath in some fresh air. His
slow steps emphasize the silence and he is in deep thoughts.
He is slowly getting enthusiastic.

                    COLTON (V.O.)
  Something changed. The propaganda has ended, I seem the
  first one to notice, the actions appear to work!
  The noise from the speakers seems to be twice as loud,
  but the hiss calms me down.

COLTON listens to the hiss and takes a deep breath. The cloud
of his breath drifts away towards the green substance on the
ground. He feels a bit wary.

                    COLTON (V.O.)
  What is this? Is this from last night? I could barely
  sleep with all the commotion of the new descendant
  ceremony. I decided not to join them, but maybe I
  should've kept watch.

COLTON has a flashback of her ceremony and he shivers.

                    COLTON (V.O.)
  It has been 2 years since I had my ceremony, but it feels
  like yesterday. I had to be strong for my brother, but I
  never felt so humiliated. Am I happy to be reborn into my
  new family?
  I don't know if I'm more shocked about questioning this
  or my answer...

COLTON tries to get himself together.

                    COLTON (V.O.)
  I'm one of them and I should support my family. We are on
  a mission after all. So we should stick together, stay
  strong and follow my lead to awaken everyone.

THE FEELING of leadership fades away when he thinks about his brother. He feels quite worried.

> COLTON (V.O.)
> My brother seemed so happy and carefree before, I barely see him playing now. He takes every order so seriously -- why don't I?

AS A last effort he tries to convince himself to be strong and proud and that he has made the right decision. He thinks this quite powerful.

> COLTON (V.O.)
> Didn't I felt the pleasure of breaking the hands of the traitor in our family? The power of the hammer, the snapping of the bones and the screams?
> I felt respected, accepted among my friends and family--

COLTON feels sad

> COLTON (V.O.)
> --yet, I have never felt so alone.

COLTON hears a sound that changes his sadness into fear.

> COLTON (V.O.)
> Who is there? -- Was I ever alone?

Appendix C: Poem of 'Clouds'

On the clouds we walk
Softly and swiftly
The step stones of love
That connects us so deeply

As we enter lost worlds
In our unconscious being
We absorb the flavors
Of abstract dreaming

On the clouds we walk
In the land of possibilities
Let us get closer
Let us all breathe art

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