Tampereen ammattikorkeakoulu

2D Animation in the World of Augmented Reality

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Bachelor's thesis
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Degree Programme in Media and Arts
Interactive Media

ABSTRACT

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The purpose of this thesis was to explore how 2D animation can be linked and used with augmented reality on mobile devices. When thinking about augmented reality, the first association is usually with animated 3D objects. 2D animation is often considered as more traditional technique and it seems 2D is not used as frequently in the field of augmented reality as 3D.

This study was carried out with two sections: theoretical and practical. In the theoretical part, the thesis briefly introduces the history of augmented reality and discusses on mobile augmented reality. Also, benefits and limitations of 2D animation as well as professionals' views of 2D's future in the field of AR are covered.

In the practical section this thesis looks into the production process, methods of execution and technical developments of Arilyn's AR Christmas Adventure at Stockmann in 2017 and 2018. The aim is to provide insight into how this case developed from a pilot project in one Stockmann department store to a solid part of Stockmann's Christmas campaign in the following year. The improvements and developments from 2017 to 2018 are described and discussed. The technique used to put the final AR pieces together was created specifically for this case. The final AR pieces indicate how 2D animation can be used creatively with augmented reality and demonstrate the technical solutions in use.

Key words: augmented reality, mobile augmented reality, 2D, animation

CONTENTS

ABBREVIATIONS AND TERMS

2D	Two dimensional
3D	Three dimensional
AR	Augmented reality
AR Application	Augmented reality application is a software able to arrange and control different features of an augmented reality experience.
AR Content	AR content can be for example video, animation, sound, 3D objects or 3D animation.
ARCore	Android's version of AR tools which enable the phone to estimate effectively the size and position of, for example, tables and chairs in our surroundings. 3D models can then be placed on these objects in our reality through an AR device's screen.
Arilyn Manager	Arilyn's content management system through which targets and contents are also paired together.
ARKit	ARKit is the same thing for iOS than ARCore is for Android.
Computer Vision	When AR application accesses an AR device's camera, the camera sends a live video feed on what the camera 'sees', to an AR device's display.
Duik	A set of tools used for animation and rigging.

Image Target	An image target is usually an image linked with a certain content. When the target is scanned with a mobile device using an AR application, this specific linked content will become visible.
Parallax Effect	A technique enabling the images on the foreground move past the camera faster than the background images. When background images move slower than the foreground images, it creates the illusion of depth and immersion.
Polygon	A flat shape with three or more straight sides. In 3D computer graphics polygons are used for creating a polygon mesh from which a 3D model is built.
Rigging	An animation technique for creating interconnected digital bones.
Scanning	The process of reading an image target.
Screen Real Estate	The space available on a screen for an application to display content.
Tracking	When talking about augmented reality, tracking means technology enabling a device to calculate an AR object's position in relation to its surroundings. This means the AR object is not stationary on the mobile device's screen but can be explored freely from different angles similarly to real life objects.
VR	Virtual reality
XR	Cross reality or extended reality. XR is the umbrella term used for all AR, VR and mixed reality along with the realities technology might bring in the future.

1 INTRODUCTION

Today AR is a field which is strongly developing and somewhat searching for its form. Augmented reality has quickly adapted 3D for its purposes and today it seems that 3D is used more often with AR than 2D. As a result, it feels 3D has left 2D largely in its shadow. This raises the question whether 2D animation has reached its limits in this specific field and does it have a place in the world of augmented reality.

This thesis focuses on mobile augmented reality and 2D, especially 2D animation. The use of the term 'mobile augmented reality' is limited to describe handheld AR devices. The scope around the technical side of mobile augmented reality is narrowed to the basics of image recognition.

The motivation behind this paper was to explore how 2D, especially 2D animation, is used in the world of augmented reality. What are 2D's strengths and weaknesses in a world that currently seems to strongly lean towards 3D. Features of 2D and 3D are compared and discussed. Also, the current state of 2D animation and what are its future prospects are explored. The materials used for answering these questions were gathered by interviewing experts currently or previously working in the field of augmented reality.

The theoretical and practical parts of this thesis are linked together as the theoretical part explores mobile augmented reality in general, and how 2D animation can be used in the field of augmented reality. Then the practical part puts these methods in use in a creative manner.

The practical part studies how the AR Christmas Adventure at Stockmann evolved from a pilot project at one of Stockmann's department stores in 2017 to a solid part of Stockmann's Christmas campaign at all Stockmann's department stores in Finland as well as Tallinn and Riga in 2018. The starting points and challenges are investigated and explored. Furthermore, this thesis will introduce the technique how 2D and 3D elements were put together in the final AR pieces. The technical discussion will be built around how the technique behind the AR

Christmas Adventure was created in 2017, and how it was improved in 2018. One image target from both AR Christmas Adventures with linked AR content are included in this paper.

Information for the practical section was partly gathered while I was working as a part of Arilyn's team creating this AR adventure for Stockmann, and partly by interviewing other members of Arilyn's group participating in this case. In addition, Stockmann's experience producer, Timo Suomalainen, was interviewed in order to gain more insight to this project from Stockmann's perspective.

2 AUGMENTED REALITY

2.1 What is Augmented Reality?

Augmented reality, also known as AR, creates a space where the world as we perceive it and virtual elements appear to coexist. In AR, the user can see the real world, but there are virtual objects added into it. (Azuma 1997, 2) Augmented reality can, for example, add graphics, video, 3D elements and sound into our experience. Usually a user accesses augmented reality by using specific AR apps on display devices, for example on smart phones, glasses and tablets. (Augmented Reality Games 2018) Then the display device becomes a magical window through which a user can explore the world.

According to Ronald T. Azuma (1997, 2) AR can be defined by three main rules. 1. It is something that combines real and virtual information. 2. It is interactive in real time. 3. It is three-dimensional. Nevertheless, in this case three-dimensional does not necessarily mean everything in AR has to be 3D modelled. AR can contain 2D elements which are placed in 3D space and the user can explore the elements three-dimensionally, whether they are 2D or 3D.

Gene Becker, however, points out that AR is not just one technology, but a blend of multiple technologies. When these technologies are put together, it is possible to produce digital information into visual perception in our reality. (Kipper & Rampolla 2012, 4) Becker states that augmented reality is: “a technology, field of research, a vision of future computing, an emerging commercial industry and a new medium for creative industry”. (Becker 2010) AR is indeed all this.

2.2 Historical Overview

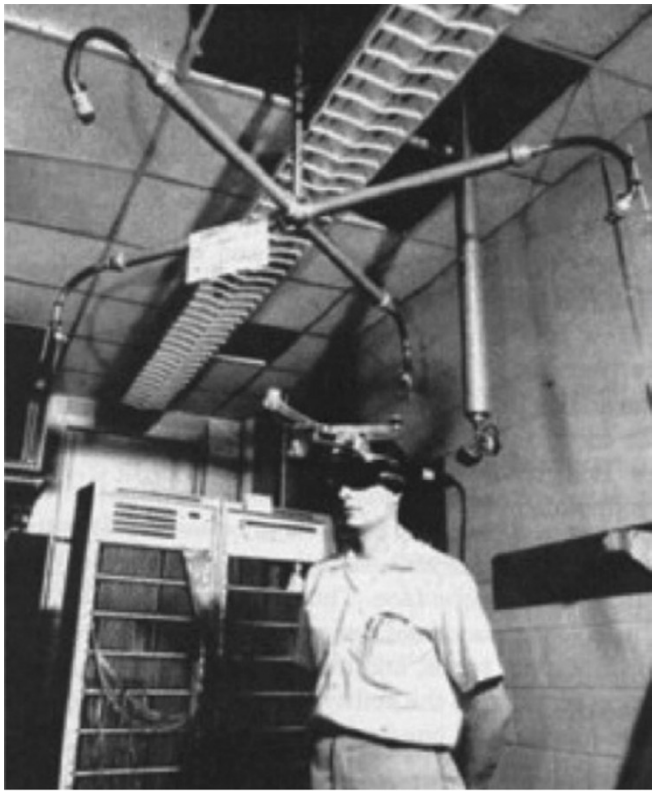
The term ‘augmented reality’ has existed since the 1990s, however, the history of augmented reality started long before the term itself was acknowledged (Augmented Reality Games 2018). The very starting point of the history of augmented

reality is debatable, however, the importance of Morton Heilig in augmented reality's early days cannot be undermined. As early as 1962 Morton Heilig, a cinematographer, designed a motorcycle simulator which he named as Sensorama (PICTURE 1). The Sensorama utilised multi-sensory technology which allowed the user to experience not only sound and 3D film but also vibration and smell. (Kipper & Rampolla 2012, 7) Commercially the Sensorama did not reach success, yet, today it is considered that Heilig's multi-layered sensory stimuli approach to a cinema experience opened the door for further developments towards augmented reality and virtual reality known today. (Turi 2014)

PICTURE 1 Morton Heilig's Sensorama (Kipper & Rampolla 2012, 8)

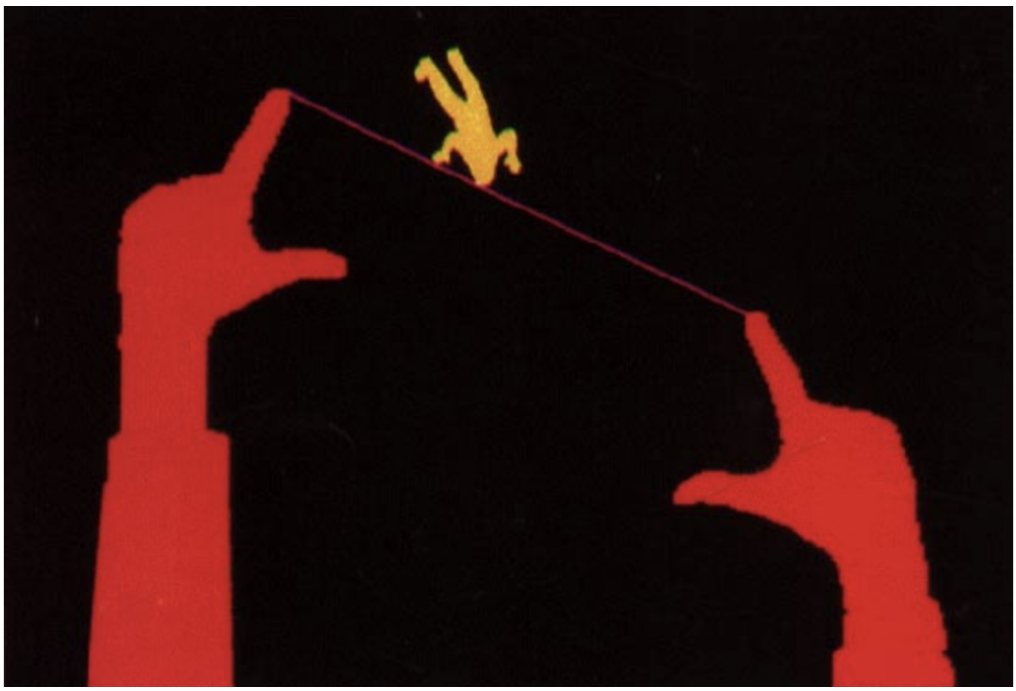
Next significant step towards augmented reality as we know it today was in 1968, when Ivan Sutherland, a computer scientist, created the first augmented reality system. It was called the Sword of Damocles (PICTURE 2). (Kipper & Rampolla 2012, 8) The Sword of Damocles utilised a head-mounted see-through display, through which the user was able to see computer generated vector-based images (Sirén 2016). Since the screen was see-through, these images were mixed with the user's physical surroundings and created an illusion of adding a new layer into the reality. (Höllerer, T & Feiner, S 2004, 2) However, Sutherland himself stated that the most important feature of The Sword of Damocles was its ability

to adapt to the natural head movements of its user (Sirén 2016). Yet, it is worth noting that the Sword of Damocles was a very heavy device and as such it had to be suspended from the ceiling by an adjustable pole. (Simpublica staff 2014).



PICTURE 2 Ivan Sutherland's The Sword of Damocles (Kipper & Rampolla 2012, 9)

In 1975 Myron Krueger, one of the first-generation pioneers of virtual reality and augmented reality, created an interactive art piece called the Videoplace (PICTURE 3). It was the first augmented reality system which enabled users to interact with virtual objects and other users. (Kipper & Rampolla 2012, 8) The Videoplace allowed two people in different rooms to have their silhouettes projected onto a screen. Through their projected silhouettes the users entered into a shared space, where they could interact with each other by physically moving themselves. In addition, the users could change their colour, resize their silhouette image or rotate it. Interaction with completely virtual objects was also possible. (Aboutmyronkrueger.weebly.com n.d.) The original Videoplace piece relied on analogue video technology instead of a computer (Seevinck, J. 2017, 33).



PICTURE 3 Myron Krueger's Videoplace (Inventing Interactive 2010)

During the early 90s Tom Caudell and David Mizell were involved at Boeing's Computer Services' Adaptive Neural Systems Research and Development project. The aim of this project was to find a new way to help Boeing's manufacturing and engineering process. Caudell and Mizell ended up designing a software which had the ability to overlay the positions of where certain cables were intended to be placed during the building process. Because of their project, they are also credited for introducing the term 'augmented reality' for the first time. (Kipper & Rampolla 2012, 8)

Regardless of many technological advances developed during the 90s, augmented reality remained generally unknown. (Augmented Reality Games, 2018). Nevertheless, in 1999 Hirokazu Kato made a difference to this when he released ARToolKit to the open source community (Kipper & Rampolla 2012, 11). Until then creating an augmented reality experience required tricky software programs and large equipment. ARToolKit made it possible to incorporate virtual objects with video capture in the real world. Moreover, the user only needed an internet connection and a handheld device, such as a camera, for the experience. (Augmented Reality Games, 2018).

The first AR applications were released on smart phones in 2008. (Augmented Reality Games 2018) However, it was 2016 when Pokémon Go brought augmented reality to a wider awareness. At its prime, Pokémon Go reached 45 million daily users. Since the enormous popularity after its releasing, the number of daily users has greatly decreased. (Anthony, S. 2017) Yet, Pokémon Go left its mark in the history of augmented reality and brought the basic idea of AR to a wider audience. Having said that, whether Pokémon Go is more an AR game, or a location-based game is debatable.

3 MOBILE AUGMENTED REALITY

The definition of ‘mobile augmented reality’ is not necessarily as straightforward as it may seem at first. There are two possible meanings for this particular term. Sometimes mobile augmented reality is used to describe any transportable AR system which allow users to move freely while occupied with the AR system. However, usually mobile augmented reality is used to describe solely handheld mobile devices, such as smartphones and tablets which can be used to access AR content. The latter definition is the one this thesis refers to when using the term ‘mobile augmented reality’.

3.1. A Quick Overview of How Image Recognition Works in AR

As depicted in the picture 4, before anything can happen through an AR application, someone needs to create content for it. Content can be, for example, 2D or 3D objects, animation, video, images, sound or a combination of these. After content has been created with 2D or 3D software, it is uploaded to a server or a cloud service, where it is linked with a chosen image target. From there the augmented reality content can be accessed with an AR application.

An augmented reality experience starts after a user downloads an AR application and opens it on their smartphone or other AR device. The application accesses AR device’s camera which enables computer vision. The AR device’s display shows a live video feed from the user’s physical world. (Kipper & Rampolla 2012, 43).

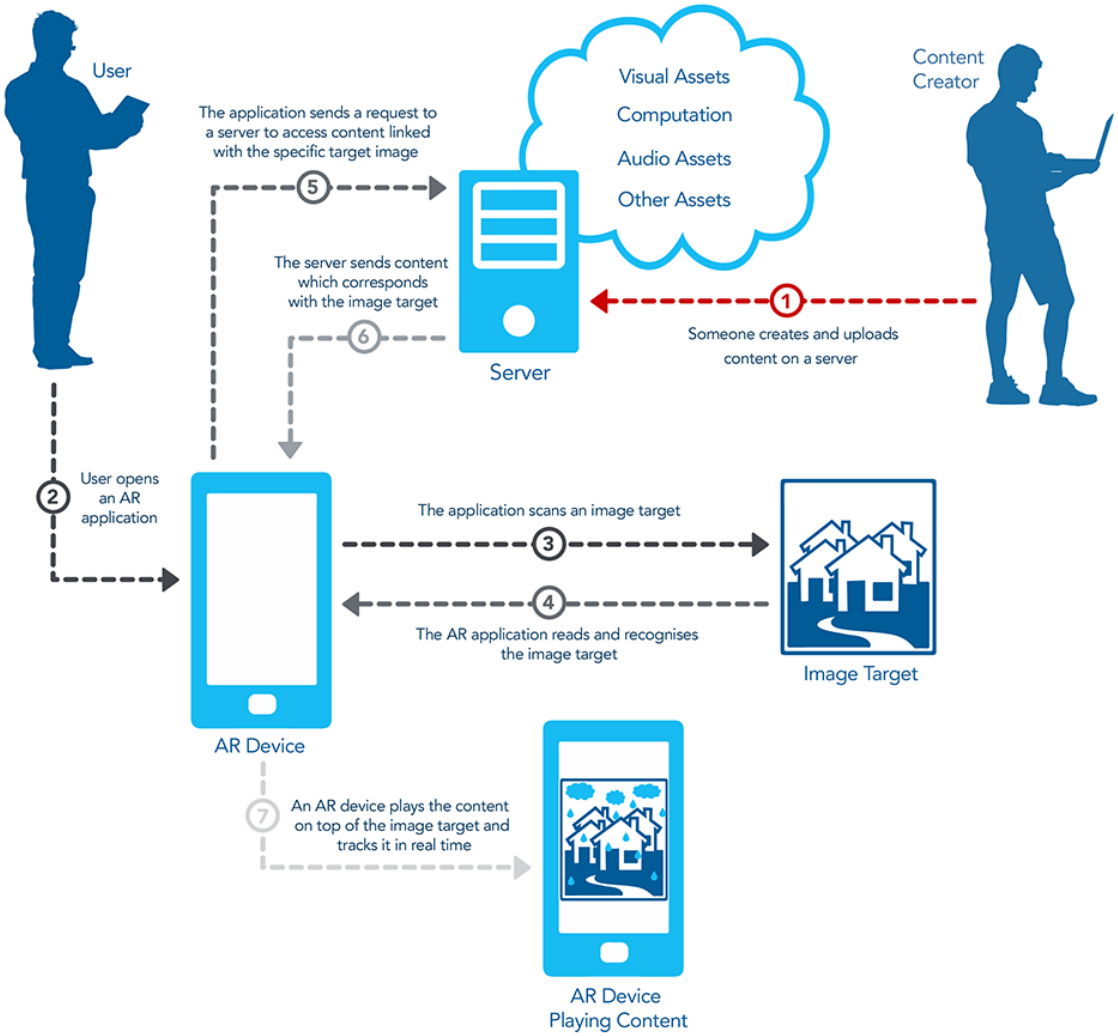
In an image recognition-based augmented reality application the user points a smartphone at an image target. This action can also be referred as ‘scanning’. The AR application catches an image of the image target (Turk & Fragoso 2015, 24). Then, computer vision algorithms aim at finding recognisable feature points from the image. Feature points are usually sharp, high contrast edges which form distinctive asymmetrical patterns. (Grubert, J & Grasset, R 2013,76-77)

The image data is processed and sent to a server or a cloud service where feature indexing and confirmation of the recognised image target are carried out. The recognition happens by matching the most relevant image available on the database with the image data provided in an earlier stage. (Turk & Fragoso 2015, 24). Next, the recognised image target is paired with a specific content which is sent back to the AR device. This chain of actions requires an internet connection. (Yang & Cheng 2015, 245-246, 247)

For an AR application to be able to create an illusion of adding something into our reality, the augmented content needs to have the right perspective regardless from which angle the user looks at it. Therefore, the application needs information about the current state of the user's physical surroundings in real time as well as the current state of the virtual components. (Craig 2013, 39-40) This kind of action is called tracking, and this is when the computer vision steps in again. The computer vision system calculates and analyses where the camera is positioned in terms of location and perspective to have the particular view. (Kipper & Rampolla 2012, 43).

Camera parameters are matched between the physical and virtual cameras, the virtual camera being the one rendering the augmented content. (Grubert, J & Grasset, R 2013,13) At this point, the user sees on their AR device display the augmented reality content merged with the physical information, such as the surroundings of the user. (Grubert, J and Grasset, R 2013, 7)

Augmented reality aims at adding something into the user's physical world, not making the user believe they are somewhere or someone they are not in the real world. Hence, the stream of information must be responsive and look seamless. This requires some computational ability of the AR device as every time the orientation of the device changes, the system must update the view on the display in real time. If the system fails to do tracking in real time, the illusion of augmented reality being part of the user's physical world is broken by lag or hesitation. (Craig 2013, 51)



PICTURE 4 Simplified image of how image recognition-based AR works with a mobile phone (writer's own image)

3.2. Benefits and Disadvantages of Mobile Augmented Reality

Similar to any other media, mobile augmented reality has its own benefits and disadvantages. Furthermore, both strengths and weaknesses are mainly built around the mobility aspect. As mobility brings freedom to experience augmented reality anywhere at any time, it also brings technological and environmental constraints. (Craig 2013, 212)

3.2.1 Benefits

The most important feature of mobile augmented reality is that it can be experienced anywhere in the real world. Not having to build or set up a specific facility for the experience, unlike with virtual reality, creates freedom to experience augmented reality where it makes the most sense. (Craig 2013, 212) However, experiencing something where it makes the most sense does not necessarily mean every augmented reality experience is or should be available everywhere regardless of the location. Sometimes the geological location is part of the experience. For example, tourist attractions may have augmented reality content which loses its meaning if taken out of its scenery.

Another essential attribute for mobile augmented reality is that many people carry the necessary hardware with them practically all the time (Craig 2013, 213). Smartphones and tablets are a large part of our everyday-lives which makes it more of a rule than an exception to keep them with us. Today these devices are built with sensors, processors and displays which are required for mobile AR applications. This means there is virtually a considerable number of potential users for mobile augmented reality with an easy access to it. (Craig 2013, 213)

A less obvious advantage for mobile augmented reality is that the hardware, mobiles and tablets, usually cost significantly less than more special-purpose or permanent technologies. Further, mobiles' and tablets' prices are coming down while at the same time the technology behind the devices is getting more advanced. This means these devices are gaining more power and features. (Craig 2013, 212) In addition, these devices are provided by the users themselves, not whoever created the AR experience.

3.2.2 Disadvantages

According to Craig, the disadvantages of mobile augmented reality can be divided into two broad categories: technological and environmental. These categories are also closely linked with each other. (Craig 2013, 214) This chapter will discuss on

the technological disadvantages and briefly introduce some of the environmental constraints.

The capabilities for mobile augmented reality applications are dependable on the devices' resources. This falls into the technological constraint category. Memory, computational and graphics capability as well as input and output options are all limited. Also, even if the screens have been getting bigger and bigger in smartphones, still the question of limited screen real estate remain. Moreover, the resolution and field of view are restricted by the display. (Craig 2013, 215)

Memory is a substantial technological limitation on its own as it directly effects on what kind of content can be ran or kept on a mobile device at any point. In other words, the available memory restricts how sophisticated elements, such as sound and graphics, the AR content can have as well as the number of these elements. However, there are ways to go around this problem. For example, 3D content can be optimised by limiting the number of polygons, 2D content can be compressed in a smaller size, and the number of objects or other elements can be limited. All these actions decrease the memory capacity the content requires to run on a device.
Another approach to bypass this problem is within the AR application itself. AR application can be built up in a way that it only downloads content temporarily and off-loads it when the content is no longer in use. Nevertheless, it is worth noting that even when this approach is in use, it does not solve the problem of how much memory the content can occupy while it is played on a device. (Craig 2013, 215)

In his book Craig categorised network as an environmental constraint which it is in a sense, since network may or may not be available in a certain area. Nonetheless, here it is categorised as a technological matter since the environment as such is not a problem but lack of technology available in that area is.
Yet, Craig has hit the nail on the head by stating: "- - *the presence or absence of a network can make or break the success of an AR application if a network is required."* (Craig 2013, 215) If an AR application relies on a server system to access and display its content, the AR experience cannot be seen without a proper network (Craig 2013, 215).

When referring to the environmental constraints, the key challenges effecting on the AR experience are light and noise. Particularly for applications which occupy computer vision for tracking, light and shadows play an essential role. Harsh shadows or bad lighting can make it difficult for the computer vision to recognise an image target. Sound, on the other hand, can be lost in noisy areas. (Craig 2013, 216)

3.3. Some Mobile Augmented Reality Applications

Today there are over one hundred different AR applications available on Google Play. Some of them are using augmented reality's features only for a very specific purpose. For example, placing 3D furniture in real scale into the user's room or creating digital graffiti.
However, this chapter will concentrate on three augmented reality applications: Arilyn, EyeJack and Zappar. The reason for choosing these three is, that they all utilize image recognition and playing content linked with the image target for multiple potential usages which makes them comparable with each other. Furthermore, behind every application introduced, there is a company both maintaining and creating content for their application. For choosing the applications, Arilyn was a natural choice being the application used for the practical work in this thesis. EyeJack was included due to being a smaller company focused mostly in 2D which has a good correspondence with the title of the thesis. Zappar was chosen being widely known and a big contender in the AR industry.

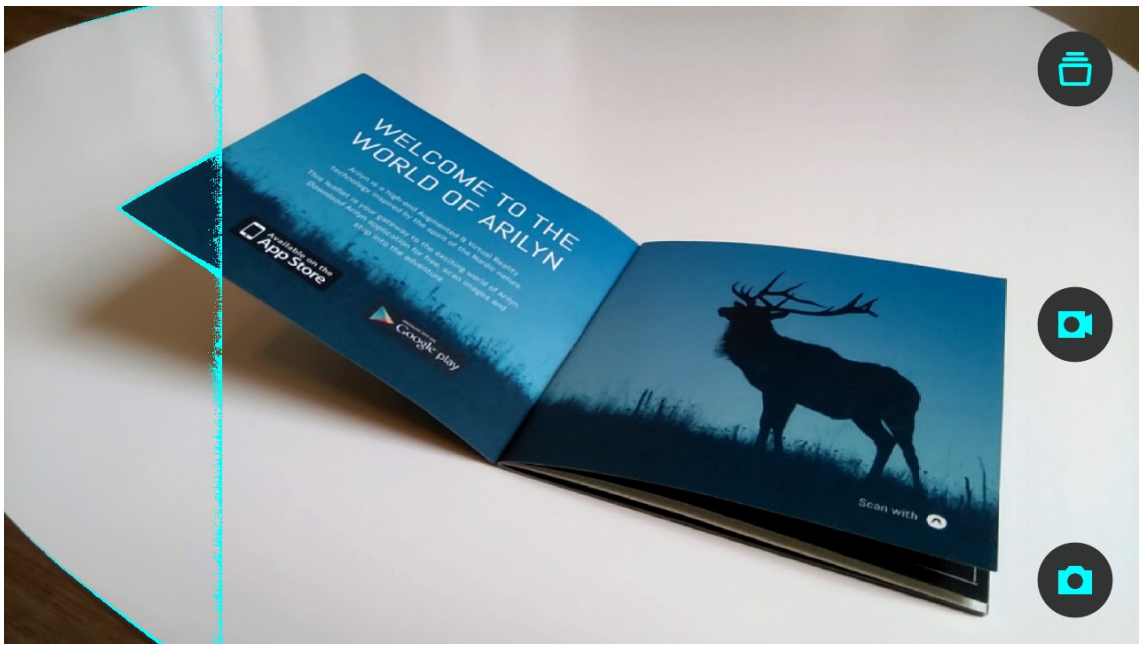
3.3.1 Arilyn

Arilyn is an AR application created by a Finnish company which is widely known by the same name as the application. However, the official name of this company is Robust North. The Arilyn application is available for Android and iOS and it is completely free for the user.

When using the scanning feature, the overall look of the Arilyn application is minimal. There are three buttons either on the side or bottom of the screen depending

on the phone's position. The icons re-position themselves relative to the phone's movements, so they are never, for example, upside down. The buttons enable camera or video camera functions and accessing the main selection. The direct camera buttons on the scanning and viewing the content view are handy, as with some phones it is very difficult to take a screenshot with controlled point of view. Furthermore, when taking a picture with the direct camera button, the icons do not show in the picture that was taken. Also, as there is a possibility to take pictures directly with Arilyn application, there is an in-built photo gallery for the pictures as well.

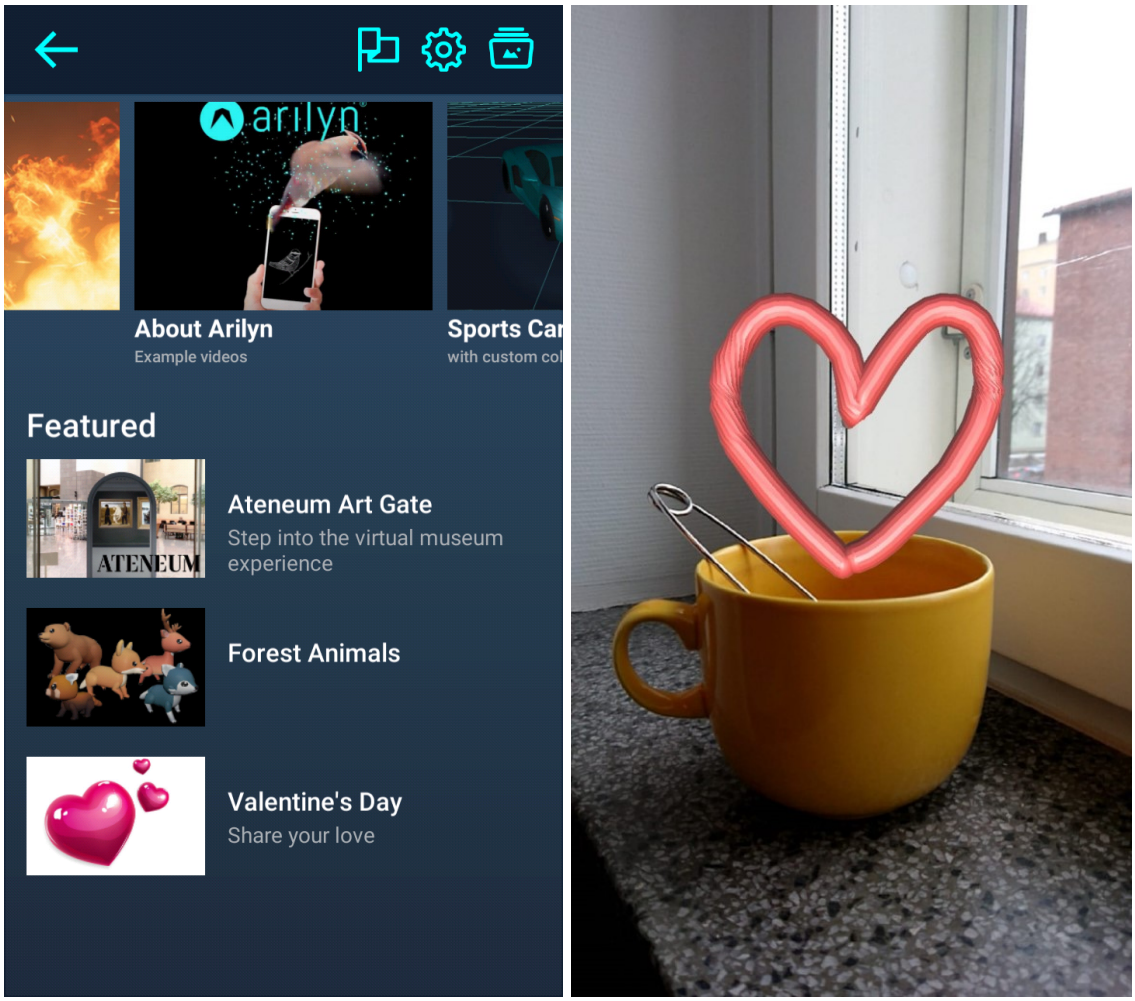
With Arilyn it is very obvious what the application is doing at various times. Visually, when Arilyn is scanning an image target, the view simulates the visual appearance of any scanning (PICTURE 5). There is a cyan line moving across the screen and looking for detectable features similar to radar. When Arilyn recognises an image target, it shows a downloading bar before the content is revealed.



PICTURE 5 Screenshot from the Arilyn application scanning a target

The Arilyn application supports both 2D and 3D content. Moreover, there is a lot of in-built material in the current version of Arilyn. For example, a 3D library lets the user to place 3D objects and effects into their surroundings, and a float brush enables drawing 3D doodles at a fixed distance (PICTURE 6).

When referring to 2D content accessed via the Arilyn application, usually it is set to be tracked in relation to the viewer's point of view. Visually this means that the content plays on the image target, but its perspective changes when moving the AR device to different angles of view. If the camera turns away from the target, the content disappears from sight as well. Tracking like this strengthens the illusion of the content being part of our world.



PICTURE 6 Arilyn's main selection with special features on the left and a screenshot from using Arilyn's float brush on the right

3.3.2 EyeJack

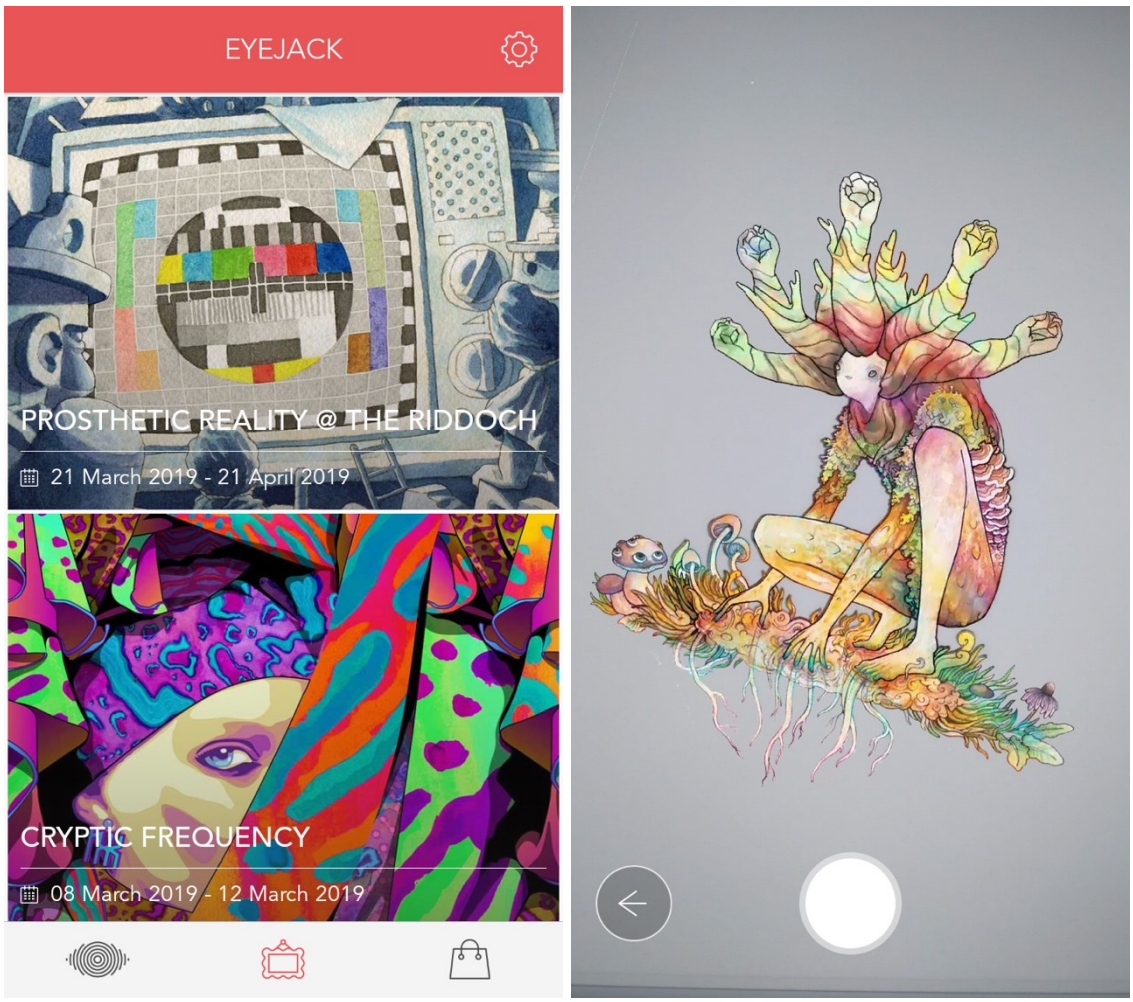
EyeJack is an augmented reality application with a mission to curate and distribute augmented reality art. (EyeJack, EyeJack n.d.) It was launched in 2016 together with an AR art book project, Prosthetic Reality, and since then it has

curated AR art prints, pins and comic book issues. (Sutueatsflies, EyeJack App n.d.) The founders of EyeJack are Stuart Campbell and Lukasz Karluk (Sutueatsflies, EyeJack AR Company n.d.). EyeJack is available for Android and iOS and downloading the application is free.

The EyeJack application opens up with a view of augmented reality content packages (PICTURE 7). In this first view, these packages are free of charge. Before accessing the AR content, the AR content package needs to be uploaded into an AR device. If the content package is not downloaded, EyeJack does not recognise any targets automatically. Moreover, downloading content packages does not directly guarantee access to all the AR art available from a specific content package. The user needs to be able to scan the individual image targets as well in order to access the augmented content.

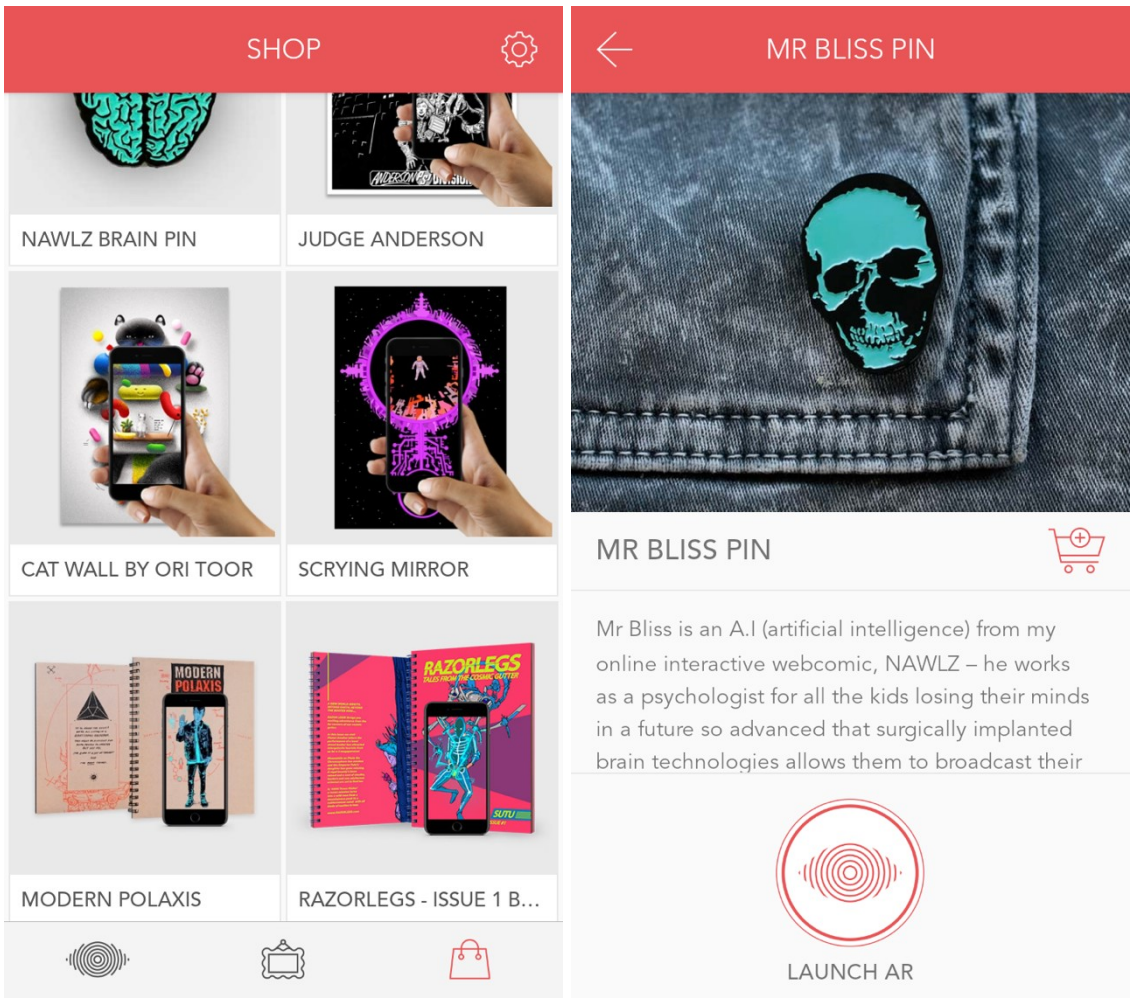
The scanning view is very simple (PICTURE 7). There are only two buttons: back to main view and record. The record button did not work on my phone, so it is unclear what the record button specifically does.
When scanning the image target, EyeJack does not have a download bar or other indicators suggesting whether AR content is recognised or scanned by EyeJack. Therefore, from the user's perspective, it is difficult to know when EyeJack is processing data or when it does not recognise a target at all.

EyeJack tracks the AR content in a way that the viewer can explore the content from different angles. In other words, 2D content stays on the image target, however, the perspective changes when the AR device faces the image target from different views.



PICTURE 7 Screenshots from the EyeJack application. Main view's AR content packages available for download on the left. On the right EyeJack's scanning view.

From the main view, it is possible to access directly to an online shop inside the application (PICTURE 8). A user can purchase, for example, physical art prints, cartoon issues and books which can be viewed via the EyeJack application. The shop works like any other online shop with an option to add products into a shopping cart and then ordering them. Launching the relevant AR content can be done from the product view.



PICTURE 8 EyeJack's online store on the left. Product view on the right.

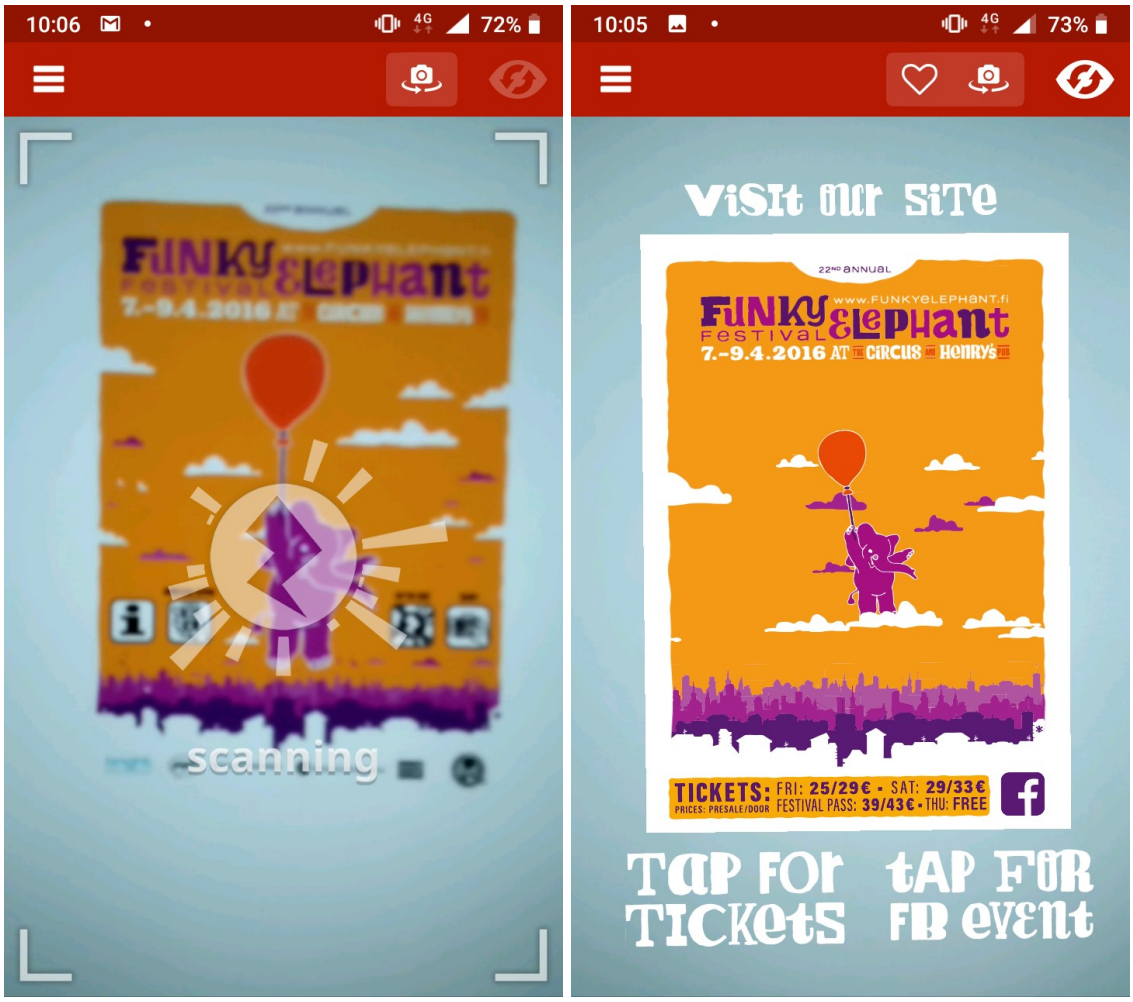
3.3.3 Zappar

The technology behind Zappar was created at the University of Cambridge in England. (Zappar n.d.) Zappar is available for iOS and Android. Along with developing their application and creating AR content, Zappar offers other companies, or individuals, power to create content for the Zappar application. For the end user Zappar is a free of charge application. However, creating content for Zappar is not a free feature.

Zappar feels user friendly as its outlook is easy to understand and use. The application has a clear scanning view, so it is obvious for the user when Zappar is

scanning (PICTURE 9) or unlocking content and when Zappar does not recognise a target. The application opens directly to the view for scanning, and it immediately starts to look for an image target.

Before Zappar recognises an image target, there are two available buttons on the top bar: main menu and using phone's front camera instead of the camera on the back (PICTURE 9). After the AR target is recognised, two more buttons become available. Those buttons are for adding the AR content as a favourite and replaying the content from the beginning.

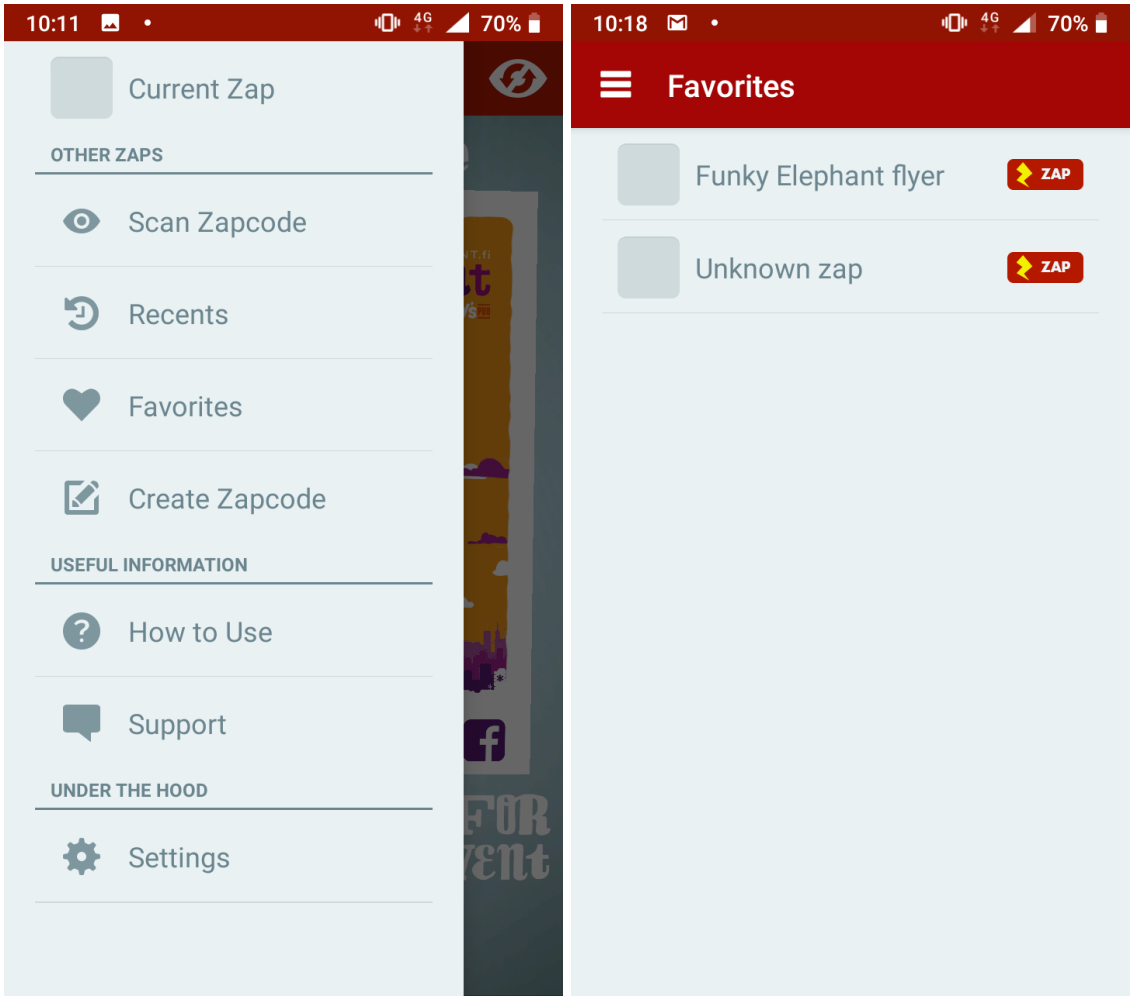


PICTURE 9 Zappar's scanning view on the left and Flyar's Funky Elephant poster scanned with Zappar on the right

With Zappar, as well, it is possible to view the AR content in relation to the viewer's perspective. When the camera is turned away from the image target, there are two options that can happen. Sometimes the content simply stays

where it physically is. In other words, when the target is in sight, the content is played and when the camera is facing the other direction, the content is not visible as the camera does not see the target. However, in some cases the AR content sticks on the AR device's screen, even if the camera is moved away and does not see the target.

In the main menu there are direct buttons for accessing support and, for example, settings including privacy policy, software licences and age group (PICTURE 10). Moreover, there is button for creating zapcode. Zapcode is Zappar's own term for image targets. This button takes the user into ZapWorks site which is Zappar's content management and creation system. There it is possible to registrate and start to create AR content. Nevertheless, this feature requires registration on the site and using it is chargeable.



PICTURE 10 Zappar's menu bar and favourites selection

3.4. Mobile AR and 2D

This chapter will briefly introduce some surfaces, cases and purposes in which AR and 2D have been combined. I will concentrate on moving images, however, a couple of cases without motion are presented as well.

3.4.1 Art

Prosthetic Reality is an augmented reality art book (PICTURE 11). It includes work from 45 artists and sound designers from around the world. The book was created by an artist under the name of Sutu, Code on Canvas and all the artists contributing in the book. (EyeJack, Prosthetic Reality Book n.d.) The work featured in the book have also been exhibited in art galleries. Furthermore, Prosthetic Reality won an AR & VR industry award with the title of 'Best in Show' in 2017 Auggie Award (Awe USA n.d.).

When the EyeJack application is running and the viewer waves their AR device over the pages of Prosthetic Reality book, the animations appear. As there are several different artists contributing in this book, it is very interesting to see the different styles, ideas and solutions with their AR content.
The animations differ from each other depending on the artist and the artwork itself. Some are more subtle and some quite intensive. The animation techniques also vary from hand-drawn 2D animations to computer animations and 3D.

In a sense, there is an artwork within an artwork, and the complete piece of art can only be revealed with AR technology. The ability to choose when to explore the AR content and when to look at the art piece, which also works as an image target, makes AR art quite personal. Furthermore, unlike regular videos, if there are several viewers scanning the same image target with their own AR devices, the viewers are looking at the same scene but not in sync. In other words, the content starts playing from the beginning when it is scanned. Therefore, the timing is always relative to the viewer's own actions.

PICTURE 11 Screenshot from Sean Edward Whelan's art work scanned with the EyeJack application (Auggie Awards n.d.)

3.4.2 Street Art

This chapter introduces two examples of AR and street art.

The image below presents an augmented reality mural in the city centre of Budapest, Hungary (PICTURE 12). After scanning the mural with the LARA application, 2D animation of the same scenery as pictured in the artwork is revealed. In the animation, the weather changes and there are characters entering and leaving the scene.
The difference between a traditional mural and an AR mural is that an animated AR mural can change moods and bring forth something that is not visible at first. In this sense, there is an element of surprise. Moreover, animation can break the limitations of a still image. This means the experience of an artwork can be intensified and even changed.

In an increasingly technologized society, it is no surprise that AR technology has found its way to urban arts. Today AR can create an intersection between a personal and shared experience of an artwork, as well as between digital and first-hand experience of space (Gwilt 2014, 189, 190).

PICTURE 12 Screenshot from LARA Augmented Reality Mural (Lara AR 2017)

Another way to utilize AR's possibilities in street art is, in a way, preserving or returning it. Often murals are temporary pieces of art which means that they can be experienced in their original environments only for a period of time. After murals are removed, they no longer exist in the space they were created for. With the use of AR technology, it is possible to digitally resurrect the past murals on the walls where they were once created for (PICTURE 13).

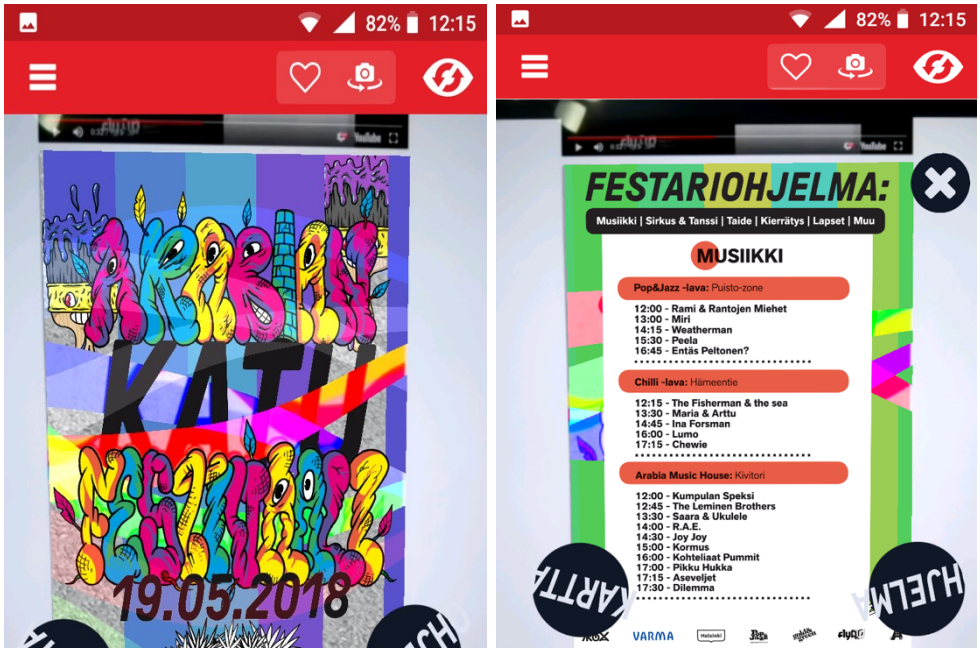
PICTURE 13 Screenshot from digitally resurrected mural (Heavy 2012)

3.4.3 Posters

Arabian Street Festival was a family-friendly event in Helsinki's Arabianranta presenting art and music. The poster (PICTURE 14) promoting this event in 2018 had AR content embedded in it. The AR content was created by Flyar, a Finnish AR production company.

2D animations appear after scanning the poster with Zappar. On the background there are paint brushes painting stripes in different colours. The letters that have eyes blink while the buttons for the map, programme and social media shake encouraging the viewer to press them. When pressing the buttons, they open the appropriate content similar to web pages. For example, if the map button is pressed, it reveals a new view with a 3D map of the area. Moreover, the 2D content is not completely flat, but they are layered in order to create a sense of depth.

The advantage of AR posters is that they are visually effective, they can include music and sounds, but they also have interactive side to them. In other words, the poster stimulates more senses than one as well as allows the viewer an easy access for additional information.



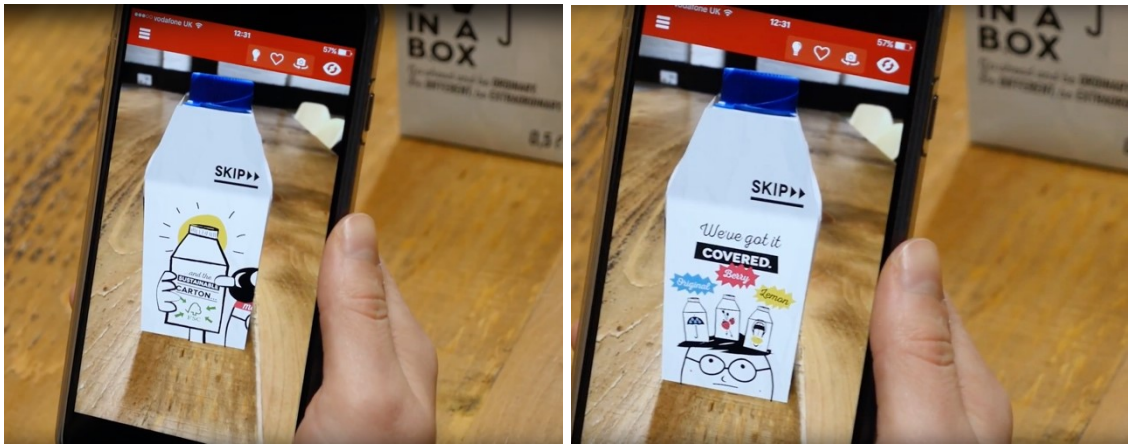
PICTURE 14 Screenshots from scanned Flyar's Augmented Reality poster for Arabia Street Festival in 2018

3.4.4 Interactive Product Packaging

Sometimes product packages with AR content are called smart packages or intelligent packages. These terms refer to the digital content linked with the specific product that can be accessed with an AR application.

W-in-a-Box was an example of a promotional water product with eco-friendly packaging (PICTURE 15) (Zappar, Augmented Reality for Packaging 2018). Thus, this product is not available for consumers as it is in the screenshots below. Zappar enables a 2D animation to appear on the side of the package. The animation playfully introduces the water product and the eco credentials. Also, there are some interactive elements in the animation. For example, it is possible to press the names of different flavours of water. Behind each flavour button there is an animation presenting what kind of personality might like this drink with an encouraging text to embrace their personalities.

From a brand's point of view, interactive packages can be useful in bringing forth the brand's values, vision or mission to the consumer as well as to reach the brand's target audience with additional information. For the consumer, AR content can be fun and also provide useful information about the brand, product, or relevant product families.



PICTURE 15 Screenshots from SIG's interactive packaging scanned with Zappar (Zappar 2018)

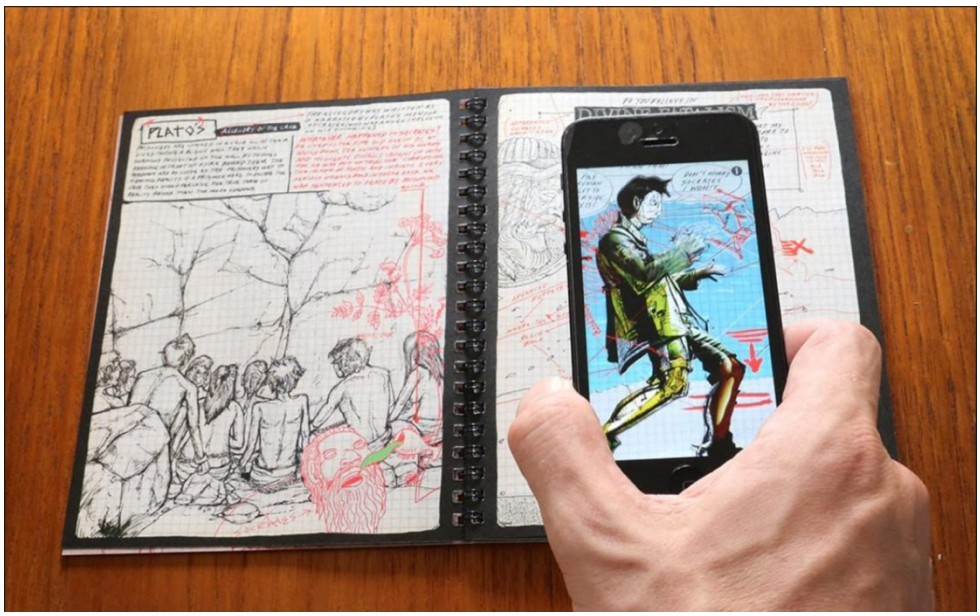
3.4.5 Comics

In this chapter there are three examples of different approaches to AR and comics.

Modern Polaxis is an augmented reality comic book created by Stuart Campbell, also known as Sutu. The comic book is named after its main character, Modern Polaxis, who is a paranoid time traveller. In Charles Singletary's interview with Sutu, Sutu sheds light on Polaxis' way of thinking: "*He believes our reality is a projection from another plane in the universe and his mission is to find the projectionist*". (Singletary 2016)

The book is made to feel like Polaxis' private notebook in which Polaxis reflects his daily life (PICTURE 16). However, there is more to his notebook than meets the eye at first glance as Polaxis hides all his secret information, conspiracy theories and paranoid delusions in the augmented reality layer. (EyeJack, Modern Polaxis n.d.)

In Modern Polaxis the augmented reality aspect is not only adding up to the appearance and impact of the comic but also giving details which are otherwise invisible. (Singletary 2016) Unless the reader looks at the AR content as well, the story is not complete which gives the AR feature a new layer of meaning. The AR layer is not only adding into the story but changing it as well.



PICTURE 16 Sutu's augmented reality comic book Modern Polaxis (UploadVR 2016)

Second example of AR and comics is Priya's Mirror which is a second volume of modern-day superhero Priya's adventures. Priya is the first female Indian superhero and a rape survivor. (Mahedra Singh foundation n.d.) The first volume, Priya's Shakti, deals with themes of rape and violence against women. Priya's Mirror continues with the theme of violence against women, but this time the story brings forward societal exclusion of acid-attack victims and their internal conflicts. Both Priya's Shakti and Priya's Mirror are created by Ram Devineni, Paromita Vohra, and Dan Goldman.
The idea behind Priya comic books evolved after a brutal gang rape was committed on a bus in New Delhi in 2012. This crime triggered extensive movement against deep-rooted patriarchal views towards women. (Screendiver n.d.)

The aim of the comic books is to break taboos concerning violence against women. The comic series is especially targeted at teenagers and young adults with a purpose of educating them about gender-based violence and gender equality (Screendiver n.d.). Furthermore, there is another important motive behind the comic book: to create empathy towards the survivors of violence. (Ians 2018)

The new technology, augmented reality, was harnessed in order to increase the attraction of the comic book's target group, teens and young adults. (Screendiver

n.d.) Every page of the comic book can be scanned with Blippar, an augmented reality application. The augmented reality content varies from adding visual effects to comic's frames, additional info bars, photos of real victims of acid-attacks to links to videos addressing the same issues as the comic book (PICTURE 17).

PICTURE 17 Screenshot from online comic Priya's Mirror after scanning it with Blippar

In the third example comics and AR are be put together in marketing purposes. For example, in order to promote Finnish pop singer Sanni's concert, she was layered into a comic magazine using AR technology (PICTURE 18). The comic magazine in question was Aku Ankka, the Finnish equivalent to Donald Duck.

Using the Arilyn application for scanning the pages of Aku Ankka's story including Sanni's cartoon look-alike, the viewer could find cartoon frames which revealed augmented videos of real life Sanni. Some of these videos were spiced up with 2D animations as well. The aim was to find a frame revealing a raffle for winning tickets for Sanni's concert. If the viewer did not win the tickets, a button linked to the site from which the tickets could be bought appeared instead.

PICTURE 18 A Finnish pop star Sanni appeared in the pages of Aku Ankka, the Finnish equivalent to Donald Duck comics (Arilyn 2018)

3.4.6 Activism

Some activists have also deployed augmented reality as a tool for social change. From an activist's perspective, AR is a relatively low-cost platform, easy to access and it enables adding layers onto physical prints. (Skwarek 2014, 3, 11) In other words, this means that technically it is possible to hijack an advertisement, for example, and overlay its content with an augmented reality layer. According to Skwarek, this kind of AR activism is originally inspired by graffiti artists and culture jammers who executed works of art in public spaces with no authorization (Skwarek 2014, 8). However, different AR applications do not share their databases with each other. In other words, to be able to see the content requires scanning an image target with the specific AR application which has access to the same database the content has been uploaded into.

AR AD Takeover (PICTURE 19) was literally a digital ad takeover in public space. The idea behind this was to explore the autonomy of an individual in public space where commercials constantly surround us. The project was executed by Public Ad Campaign in collaboration with Heavy projects. (Heavy 2011)

PICTURE 19 Screenshot from AR AD Takeover (Heavy 2011)

4 2D ANIMATION AND AUGMENTED REALITY

This chapter discusses on the current status of 2D, especially 2D animation, in the world of augmented reality and explores how the professionals working in the AR industry see 2D's future. Moreover, 2D animation will be compared with 3D animation, and their advantages and disadvantages are studied.

The information presented in this section is based on interviews with the experts. The experts who were interviewed are currently or have formerly worked at Arilyn or Flyar which both are Finnish companies creating AR content.
Arilyn is considered as one of the pioneers in the Nordic field of augmented reality. They are focusing on both developing AR technology and creating AR content. Arilyn has its own mobile application under the same name. (Business Finland 2018)
Flyar is a company specialising in creating AR content. Three dimensional and interactive AR experiences are especially their forte. Flyar's AR content can be accessed with the Zappar application. (Flyar 2018)

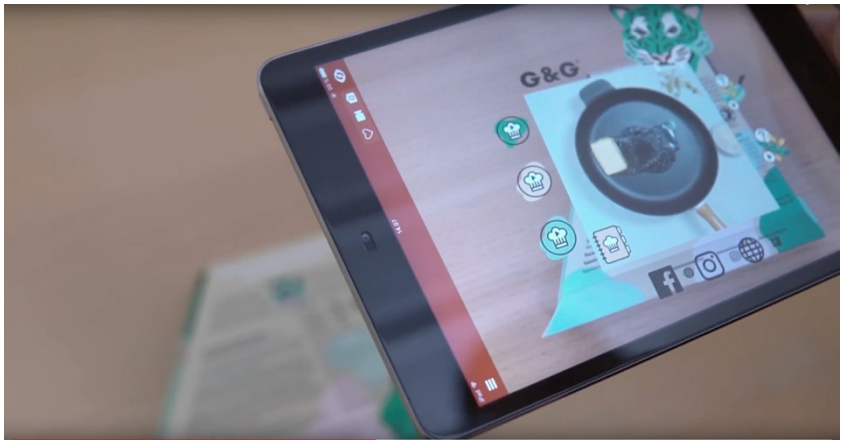
4.1. Current State of 2D in the World of AR

Otso Kähönen, Creative Director and Co-founder of Arilyn, estimates that about half of the content produced for client projects are currently done using 3D and the other half, or possibly slightly less than that, using 2D. However, it is possible that the current situation is just a coincidence. (Kähönen 2019) Frans Tihveräinen, Chief Executive Officer and AR Designer at Flyar, states that from Flyar's AR productions 3D is considerably more popular than 2D. (Tihveräinen 2018)
Nevertheless, both Kähönen and Tihveräinen strongly underline that the technique itself, whether it is 2D or 3D, is not the key. Finding the best possible solution from the client's perspective is. (Kähönen 2019, Tihveräinen 2018)

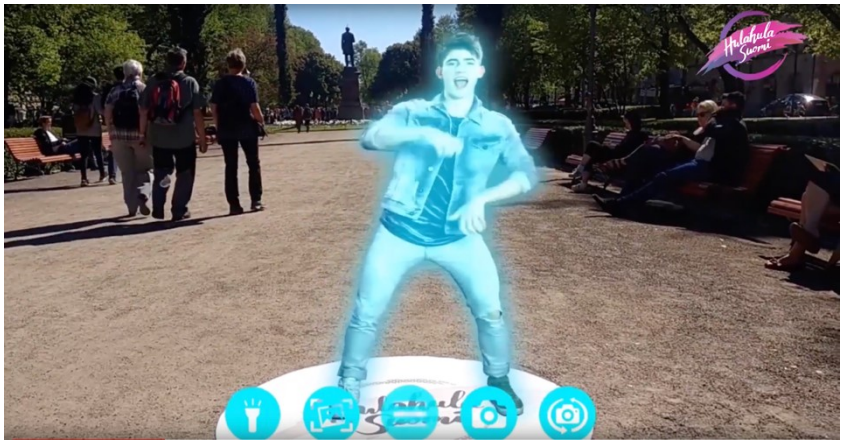
Kähönen, Tihveräinen and Mats Havia, Motion Designer and Content Specialist at Arilyn, all agree on the most typical case to use 2D with AR is when a video

file is placed over an image target (Kähönen 2019, Tihveräinen 2018, Havia 2018). Linda Loukonen, formerly Junior Content Specialist at Arilyn today 3D artist at Reworks, adds that often a client already has their own video which they want to transform into augmented reality content (Loukonen 2018).

The video can be a regular type of video (PICTURE 20) or a green screen video (PICTURE 21) from which the background has been removed with alpha channel. Green screen videos are usually videos in which a person is making a presentation about something or welcoming the viewer to somewhere. Green screen videos are then placed in a way that it seems like this person is standing on a target. (Havia 2018)



PICTURE 20 Pulled Oats package with AR recipe videos. This video content is placed over an image target. The video plays like a regular video while it floats in the viewer's surroundings. (Flyar Augmented Reality Studio Oy 2017)



PICTURE 21 A Finnish pop star Robin dancing to his song Hula hula. This is an example of a green screen video from which the background has been removed and the person in the video looks like he is standing on a target. (Arilyn 2017)

It seems 2D animation is not common enough today to have formed a case considered as typical. However, Havia points out that it is quite straightforward when 2D animation may be used in a project: in flat formats not requiring 3D depth. The flat surface can be, for example, postcards, paintings or newspapers. (Havia 2018) Tihveräinen has a similar approach to 2D animation. He notes that so far at Flyar there have not been many projects containing 2D animation. Nonetheless, the ones they have executed have been related to posters or are somewhat more artistic cases. (Tihveräinen 2018)

4.2. 2D Animation or 3D Animation, Is One Better than the Other?

Today in the field of AR 2D animation may not be seen as often as 3D animation. However, does it signify that one technique has more potential or places of use than the other? Does one method overshadow the other one?

Havia states that he does not think either 2D or 3D is better than the other. The magic in AR, created with animations, depends on the artists for the most part, not the method. The key is how the animation is done, how the characters move and look like as well as the overall visual style. Nevertheless, Havia considers these two techniques do have their differences. (Havia 2018)

3D is closer to our reality than 2D. The reason for this is the sense of depth and the ability for the viewer to walk around a 3D character or a model. Nonetheless, Havia reminds that 3D is also very far from the real world since the viewer cannot really touch or interact with the 3D character. Having said that, a 2D character can only be viewed from one angle. If the viewer tries to walk around the 2D character, they can immediately see it is flat which breaks the illusion of the character being part of our reality. (Havia 2018)

2D's strong points, according to Havia, are that it can be done faster in a lot of cases and with a lower budget which is usually where the projects come down to. Regardless of creating 2D animation can be done with less of a budget, Havia does not want to present 2D animation simply as a budget solution. Instead he

clarifies why 2D animation can generally be done quicker and with a lower budget.
Especially with AR often it is very important that 3D objects and characters can be looked at any angle and direction. This has a direct effect on the amount of time it takes to create 3D animation. Also, rendering 3D animation takes a long time. When working with one dimension less and a predefined angle of view, there are not as many details to take into an account. In this sense the working process is more straightforward with 2D. (Havia 2018)

As an example, Havia presents how different the approach is to the same scene, if done with different techniques. For instance, if there is a scene in which a character takes something out of their pocket. In 2D the viewer does not necessarily see much detail of this action (Havia 2018). By this Havia means that the pocket can be on the side of the character that the viewer cannot see, or the item can just magically appear. In 3D, when specifically referring to AR, hiding things is not as easy and there are not as many tricks to be used for that. Therefore, when animating 3D, the artist really has to think about the flow of actions thoroughly. (Havia 2018)

Havia also presents another scenario in which 3D animated characters or models are better. This is when ARKit or ARCore is used (PICTURE 22). Havia specifies the idea behind ARKit and ARCore is to place a 3D model, or a character, into the real world using AR. This means the 3D content can be placed on objects that exist in our surroundings, for example tables or sofas. With these particular tools 3D works better as it is more realistic with all its dimensions. Again, 2D would break the illusion. (Havia 2018)

PICTURE 22 ARCore in use (AndroidGuys)

Eeva Jäntti, Executive Producer at Arilyn, has very similar ideas to Havia as she believes the value of a certain technique depends on a specific case in question. For example, for architectural purposes 3D is better than 2D. However, if looking at a model or a character from multiple angles does not add any extra value, 2D is then better. Jäntti also highlights budget as an important matter. She thinks the choice between 2D and 3D have to be carefully weighted. After rationalising, this question needs to be asked: "*Is there a reason to do a specific project in 3D since it is possible to do captivating executions with 2D as well?"* (Jäntti 2018)

From Loukonen's point of view 3D is a very good match for AR. Loukonen bases this reasoning on the same thought as Havia: a viewer can look at the model or a character from any angle. She thinks this can be considered as 3D's best feature when combined with AR. However, Loukonen recognises a problem with 3D. (Loukonen 2018)

As discussed in the chapter 3.2.2, currently all the 3D models must be optimised since mobile phones are not powerful enough to run large files. Mobile technology is not yet advanced enough for that. As a result, these 3D models have a rubbery and plastic feel to them. Therefore, it is possible to have more unique style with 2D and, in some cases, it can be executed faster than 3D. (Loukonen 2018)

Nevertheless, Loukonen feels AR is a hybrid of 2D and 3D and both of these techniques are important. Moreover, these two methods can be combined in creative ways. The problem of 3D being more difficult to style, since the current technical constraints of mobile phones, can be somewhat solved with 2D. For example, an animated 2D texture can be placed over a 3D character which can create an illusion of a drawn texture. (Loukonen 2018)

Nonetheless, according to Loukonen as a stand-alone technique 2D may need compensation in the lack of physical depth. With this Loukonen refers to layering 2D elements similarly to pop-up books. In her view, a flat video on top of a target is not enough of a reason for someone to upload an AR application on their phones. A viewer can easily look at flat videos from YouTube. Consequently, in AR the 2D content has to have something more than just a video. (Loukonen 2018)

From Kähönen's point of view, there does not have to be a line drawn between 2D and 3D. He also points out that currently there is a substantial tendency towards XR, cross media, which combines both 3D and 2D elements. (Kähönen 2019)

Tihveräinen is on the same track as the other experts with the idea that both 2D and 3D have their strengths and weaknesses. However, he considers 3D as generally more diverse and exciting in some ways. Although, Tihveräinen does not deny that it is possible to create impressive AR experiences with 2D as well. Sometimes technically simple ideas and straightforward execution with clever thinking can create excellent results in 2D. Furthermore, Tihveräinen emphasises that the technique which is chosen to be used in a specific project really depends on what serves the purpose in the best way. (Tihveräinen 2018)

Overall, after interviewing the experts it feels that making statements about whether one technique or the other is a better one for AR would be careless. Both 2D and 3D have their benefits and drawbacks.
Nevertheless, 3D's disadvantages seem to be more related to the current constraints of mobile phones as well as time and budget matters than the 3D technique itself. As the current mobile phones are not powerful enough to run

large files, 3D's potential needs to be restricted. On the other hand, optimising 3D models as discussed in the chapter 3.2.2, can cause the models to have a rubbery feel to them and make them look generic. Also, the diversity and excitement of 3D seems to rely on the same feature that makes it generally more expensive to produce: the viewer's ability to explore it from different points of view.

2D appears to have more of a margin where and how it can be used successfully because of the qualities the technique itself possesses. The predefined angle of view seems to be both 2D's strong and weak point at the same time. On one hand, working with two dimensions saves time and is generally easier on the budget than working with three dimensions. On the other hand, the viewer cannot explore the content from as many angles of view than 3D without breaking the illusion AR usually intends to strive for. Furthermore, it can be concluded that a flat surface is a safe place to use 2D content, but a flat content is not necessarily enough of a reason for the user to upload an AR application. As a result, 2D may need more tricks to be a captivating AR piece than 3D.

Some of the experts also suggested that it is possible to create AR solutions with combining 2D and 3D together. Perhaps neither 2D nor 3D are at their best as stand-alone techniques. Considering 3D cannot be fully utilized as a technique since the current technological constraints, and 2D does not provide the possibility for the viewer to explore it from multiple angles of view without compromising the illusion of something being part of our reality. Possibly, finding new ways of combining these methods to compensate the other one's shortages should be the main interest instead of putting these techniques against each other. Maybe the real question is not whether 2D or 3D is better in an AR project, but is one technique enough as it is?

4.3. 2D Animation's potential and Views of the Future

It seems that 2D animation is currently not an everyday product in the world of AR, but it is not abnormal either. Moreover, even if the experts see a fair amount

of potential with 2D, it still feels a little of an underdog technique in this specific field of expertise. This raises the question: what are 2D's future prospects in AR?

From Havia's point of view 2D animation will still be needed in the future and 2D is not going to disappear from the world of AR. Further, Havia refers back to the question of time and budget as relevant matters in this context. From the budget standpoint, 2D can be executed with lower costs more often than 3D. Often a client asks, if something can be done with a certain amount of funds and quite a rapid schedule which is when 2D is usually recommended as a technique. Havia concludes: "*As long as this aspect remains in this business, 2D will exist.*" Also, Havia has noticed that 2D is an easy gateway to AR from the client's perspective. He adds that as long as clients are a little unsure about AR, they will most likely start with a 2D-based project and later the same client will come back to try 3D. (Havia 2018)

Kähönen agrees with Havia on the financial side having a substantial effect on the projects. The costs for producing 2D animation are generally lower than for 3D animation. Further, Kähönen thinks there will always be demand for high quality 2D animation in the field of AR. He also strongly believes 2D and 3D will merge together more and more. Kähönen feels that finding new creative ways of combining these two methods is currently the most interesting way of execution in AR and possesses the most potential for the future. (Kähönen 2019)

Loukonen expects 2D animation to have a rocky road ahead. According to her, it seems it is often thought that creating something with 3D has more of a wow factor. However, she hopes people would start using 2D animation in creative ways with AR. Moreover, similarly to Kähönen's ideas, Loukonen feels that the most brilliant AR executions are combinations of 2D and 3D, and she would like to see more of these types of executions in the future. Yet, it may require several good examples from 2D to push itself through. (Loukonen 2018)

One of the experts sees the future a little differently. Tihveräinen predicts that in the future of AR the main content may largely concentrate on 3D. He sees 2D's

potential especially with illustrative materials and graphical user interface elements. Yet, Tihveräinen highlights that the future depends on what kind of content people will start to produce as it is difficult to foresee. (Tihveräinen 2018)
Nevertheless, Tihveräinen hopes that creating 2D animation with layering several 2D elements, like pop-up books Loukonen referred earlier, would become its own AR genre. Tihveräinen says he could imagine this as a new way of visualising bedtime stories, for example. (Tihveräinen 2018)

The future of 2D animation when combined with AR feels quite open at this point. AR itself is a fairly new technology for the public, and companies focusing on AR and entertainment are relatively new as well. Therefore, it is difficult to forecast how the content created for AR will evolve in the future.
However, it appears to be unlikely 2D would disappear in the future of AR. At the very least, 2D may have value as an easy gateway to the world of AR for someone who wants to test whether AR fits for their purposes or is otherwise unsure about it, as Havia suggested earlier. In addition, it is possible that 2D will become more commonly used as graphical user interface elements or other illustrative materials, as Tihveräinen presumed.

All that said, it is worth noting that there are places of use for 2D animation, where 2D can be a more suitable and justifiable solution. Cases with a rapid schedule or when the budget is on the lower side, 2D may more often than 3D be the better option. Further, flat surfaces such as product packaging, murals, comics, books and posters can all gain more insight from added augmented 2D animation layer as demonstrated in the chapter 3.4. Still, it seems likely that the form of 2D animation will transform from traditional flat video to something else. Time will tell, if we will see more AR projects combining 2D animation and 3D in one way or another.

5 THE AR CHRISTMAS ADVENTURE AT STOCKMANN IN 2017 AND 2018

The AR Christmas Adventure at Stockmann in 2017 and 2018 consisted of two parts: finding 'hidden doors' which have been placed across Stockmann's department stores and colouring cards.

The hidden doors were image targets which unveiled a scene from the adventure after scanning it with the Arilyn application. The scenes were combinations of 3D space and 2D animation. The colouring cards, on the other hand, revealed an animated 3D figure of the main character of the adventure with the exact colours and strokes the drawer made on the card. Consequently, as the 3D colouring card is out of scope for this thesis, this chapter will concentrate on the hidden doors instead of the 3D colouring cards.

5.1 Concept

Otso Kähönen, Creative Director and Co-founder of Arilyn, introduces the AR Adventure at Stockmann as a combination of AR and a real-life treasure hunt game. The adventure started from the traditional Stockmann Christmas window (PICTURE 23), where the felted creatures created by Ulla Mertalehto were on display. (Kähönen 2019)

PICTURE 23 Christmas window in the Stockmann department store in central Helsinki in 2017 (Stockmann 2019)

Some of Mertalehto's felted creatures were turned into 2D characters and animated. A viewer could find these characters behind 'hidden doors' across Stockmann department store. Finding the hidden doors represented the treasure hunt game. Each animation presented a scene from a theme behind the adventure which was a little different in 2017 and 2018. The 2D animations were placed in 3D space to create an illusion of looking inside the walls.

According to Eeva Jäntti, Executive Producer at Arilyn, the AR Christmas Adventure at Stockmann was created to enrich the visitor experience and to showcase that it is possible to create experiences at department stores. The AR Christmas Adventure was a concept that was especially targeted at families with children. (Jäntti 2018)

Timo Suomalainen, Experience Producer at Stockmann, sees AR Christmas Adventure at Stockmann as a way to create enjoyable experiences for the customers both in the department stores and at home (Suomalainen 2019). With this statement Suomalainen refers that the treasure hunt game was designed for the department stores, but the 3D colouring cards were something that could have been taken home as well. In addition to enjoyable experiences, Suomalainen adds, the adventure was a new way to reach customers and invite them to the department stores. Furthermore, Stockmann desires to be in a vanguard position when it comes to new technologies. For many of the customers this was a new way to get acquainted with AR technology. (Suomalainen 2019)
In this context, it is noteworthy that the Christmas window display at Stockmann has been unveiled since 1949, and it is probably the most famous Christmas window in Finland. Unveiling it is awaited event for many. (Myhelsinki.fi) Therefore, the customers know to find their way to admire Stockmann's Christmas window display year after year.

The Christmas adventure was designed in a way that it was available for everyone, regardless of their language. The animated characters do not have a human language, but they have their language. This expressive language as well as other sounds were created by Jani Hietanen.

5.2 The AR Christmas Adventure at Stockmann in 2017

In 2017 the adventure was a pilot project which was only displayed at Stockmann's flagship store at Helsinki city centre. The concept was designed from a blank sheet and everything was built from scratch. This was the first time the AR Christmas Adventure was executed at Stockmann. Moreover, it was the first time Stockmann had AR technology in their department store. (Suomalainen 2019)

The story behind the adventure was that there is a secret inside the Stockmann department store. A group of little creatures is living inside almost 100 years old walls of Stockmann. The creatures have been taking care of the building and they are the ones that really keep the lights on. (Kähönen 2019)
Onni the Elf was the leading character of the first AR Christmas Adventure. Onni was in a rush to find Father Christmas but did not know which way Father Christmas had gone. The viewer is invited to find hidden doors through which it is possible to see what happens when Onni gets hints about where Father Christmas is. The adventure enabled the viewers to peek through the walls into this secret world (Kähönen 2019). The story for the adventure was created by Vilja Roihu, scriptwriter and director.

This adventure started at the Stockmann's Christmas window as there were the first targets to scan (PICTURE 24). The hidden doors were spread across the Stockmann department store and each of the doors was unique. The adventure ended at the top floor near Father Christmas' seat. If Father Christmas was not currently present at his seat, it was possible to scan an image target with the Arilyn application to see a hologram of him. Furthermore, there was an area following the theme, where it was possible to draw on the 3D colouring cards (Kähönen 2019).

PICTURE 24 The first hidden door on one of Stockmann's windows (Arilyn 2018)

5.2.1 How the Production Started

According to Kähönen the starting point for the adventure in 2017 was Stockmann's interest in offering an unprecedented experience for children (Kähönen 2019). Arilyn was widely trusted to provide its expertise with the design process and execution (Suomalainen 2019). As a result, Arilyn had quite free hands with this adventure from the start (Kähönen 2019).

When developing the concept, Kähönen wanted the adventure to suit with Stockmann's almost 100 years old building. Consequently, the execution was aspired to mimic mechanical toys around the time when Stockmann's main department store was built. This is how the felted puppets by Ulla Mertalehto came into the picture (PICTURE 25). In addition, the choice to use the same characters as in the Christmas window also supported the overall Christmas theme at Stockmann. (Kähönen 2019)

PICTURE 25 Some felted creatures by Ulla Mertalehto (writer's own image)

Before the actual production started, Linda Loukonen did a proof of concept. It was for combining 3D space and 2D characters. Previously Loukonen had worked on the Arla AR Kitten project which had a similar idea about 3D space appearing inside of an object in our reality (PICTURE 26). Nonetheless, this project had been done completely in 3D form. Yet, very similar mechanics proved to work with the idea of combining 3D space and 2D animated characters as well. As a result, the concept was given a green light. (Loukonen 2018)

PICTURE 26 Arla AR Kitten jumps out of the milk cardboard and there is a 3D space seen inside the milk cardboard (Robust North n.d.)

From the technical perspective the method of execution was something that had not been done before, not to our knowledge at least. Kähönen brings forward that easier ways of executions were available, nevertheless, this specific approach felt right from the start and there was no need to explore other options further. (Kähönen 2019)

My role in this project was to create 2D animated scenes, do supportive work stages relating to animating and exporting the animations as well as to create some graphics. I started with creating a concept book in order to give a visual impression for Stockmann about the feel of the adventure before it was executed. This concept book was then sent to Stockmann for them to see and comment on. Later, the visual look of this concept book was used in the department store in some of the printed media relating to this adventure.

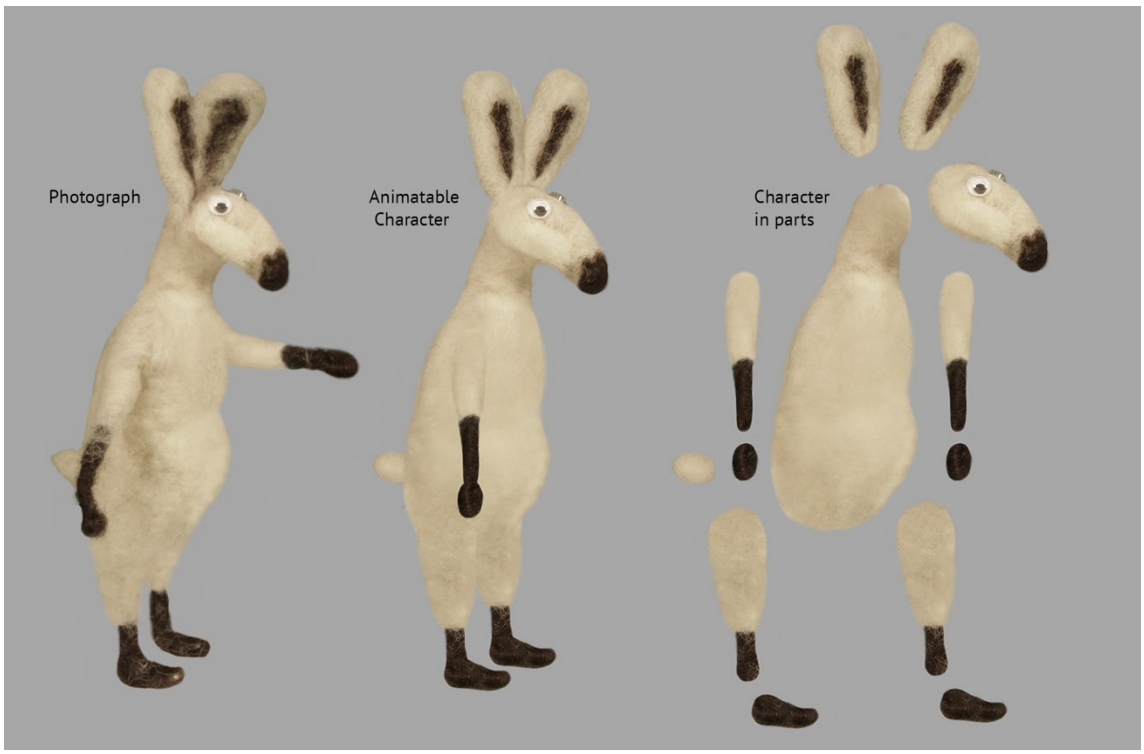
Vilja Roihu, scriptwriter and director, wrote a magical story behind the AR adventure. She also had captivating ideas about what could happen behind every

hidden door. Unfortunately, the schedule was very tight. Therefore, a lot of the ideas of the characters' actions in the animated scenes had to be quite harshly stripped down.

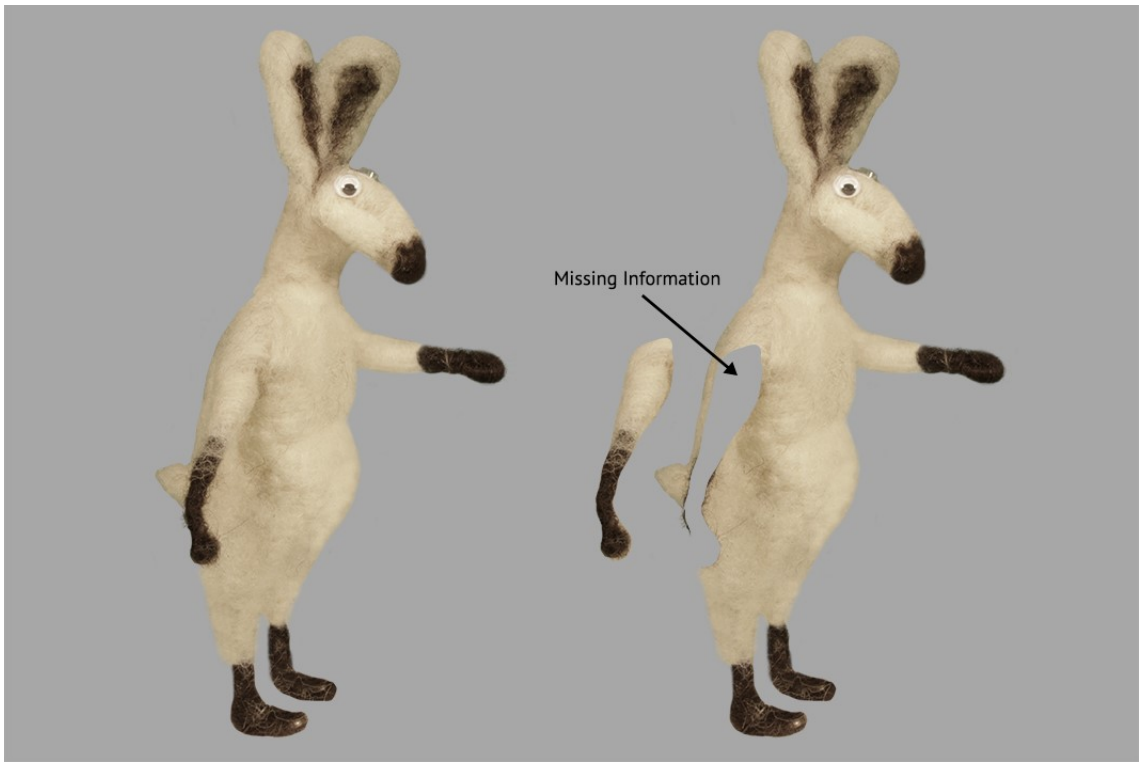
5.2.2 Technical Execution

At first all the felted characters were photographed from a variety of angles against a green screen. The photographs were arranged, named and filed. At this point the scripts for the scenes were not written yet. Furthermore, it was unclear which characters were to be used in the actual adventure and in which angle of view a specific character would appear in. As a result, it was mandatory to photograph all the characters from several angles. In addition, Stockmann needed the felted creatures for their Christmas window, so none of the characters could be re-photographed later on.

After receiving the scripts for each scene, suitable characters for the animation were selected and turned in a form in which they could be animated in 2D. This meant that the background had to be removed from the photos, all the parts of the characters separated and colour adjusted (PICTURE 27). After separating the parts, if there was any missing information, this information was created in Adobe Photoshop. In this case, missing information means information that does not exist in the picture itself. For example, if the character's arm was separated from the body, it left a hole in the character's side (*PICTURE 28*). This hole needs to be filled, so the character would look nice when animated. I did some of the work for this step and Topias Hirvonen, graphic designer, did the rest.



PICTURE 27 Example of turning a photographed character into an animatable character with separate parts (writer's own image)



PICTURE 28 Missing information after separating character's arm from the body (writer's own image)

One of the charms of the felted characters was that they were handmade, and their execution was intentionally done in a way that they were asymmetrical or a little wonky. It was desirable to maintain the original feel of the felted characters. However, the crookedness had to be toned down a little, so the character would work in an animation. The characters were rigged and animated in Adobe After Effects using the current version of Duik plug-in. I did the rigging for the main character and all of the characters I personally used in my animations. Other animators did their own rigging as well.
Altogether, there were four animators working for this project in 2017. Karissa Laine created one of the animated scenes and two animators from Animaatiokopla also created one animation each. I created four animated scenes for this adventure.

Since the scenes had to be stripped down for time management reasons, I felt there had to be another reason for the viewer to want to look at the animations. My solution was to create every character I animated a strong personality through their movements. As the director and scriptwriter Roihu gave the animators a fair amount of freedom to do so.

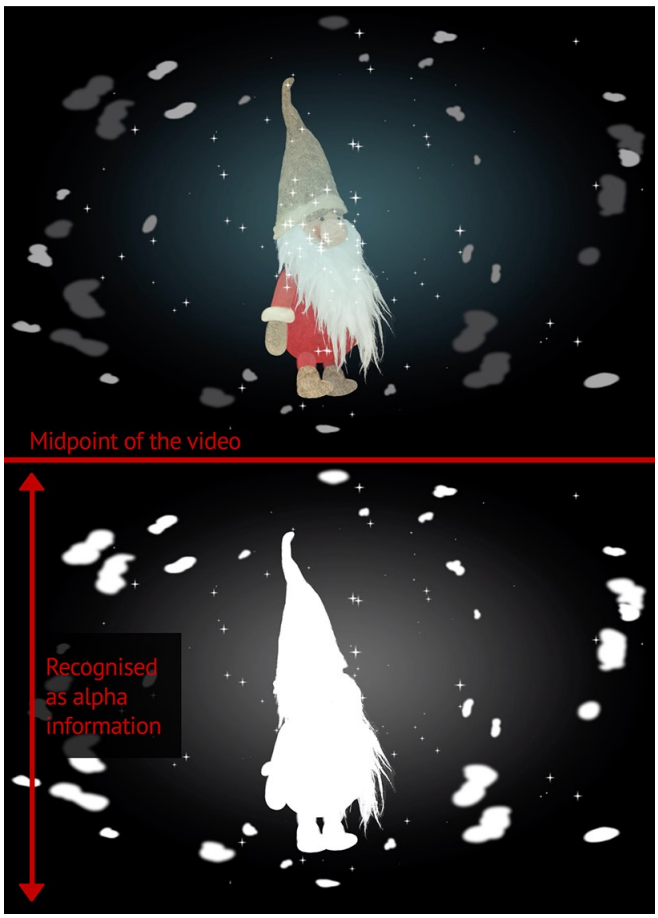
Before I started to animate any of the scenes or characters, I sat down and planned personalities for each of the characters. After the personalities were clear to me, I planned the interactions and reactions between the characters accordingly. I tried to add as many personal details to the movements as the schedule allowed.

The animated scenes were done in Full HD size, so everything had to fit in Full HD after putting together. Sometimes the characters in the same scene were placed on their own separate video layers and sometimes characters were on the same video layer with each other. The rule was that if there were any direct transactions between characters, they were placed on the same video layer. On the other hand, if the parallax effect was preferred between the characters, then the characters were placed on separate video files. The video files were then turned into an alpha channel supporting format and exported. Every video layer file had its own sounds exported with it.

For Arilyn Manager alphas are exported in a specific method which is similar to green screen. The animated video files are exported in a way that there are two video files of the same video on top of each other (PICTURE 29). On top there is a regular video which has a black background and the characters as they will be seen in the final output. Below there is the same video, but in black and white. The black and white video is a shader, the alpha information. White defines all the opaque parts of the video and black everything that is transparent. (Havia 2018)

PICTURE 29 Two-character video files from the same scene with alpha channels (writer's own image)

The exported videos with the alpha information were uploaded into Arilyn Manager. In Arilyn Manager there is a switch for enabling alpha channels. This switch was then activated in order to transform the black background into a transparent one. After activating 'enable alpha channel' switch, the code behind the switch cuts the pixel size in half and counts it. Everything that counts under the midpoint of the video is recognised as alpha info (PICTURE 30). (Havia 2018)



PICTURE 30 Demonstration of what is recognised as alpha information (writer's own image)

Developers created this alpha method for Arilyn Manager, since otherwise the only file format for rendering out alphas would have been .mov. Moreover, videos exported as alphas in .mov form are usually very large in file size. A large file size becomes a problem when the content is downloaded into Arilyn Manager and someone is playing the content on their AR device. A large content file is slow to download and upload. The alpha solution, which was explained earlier, reduces the file size significantly by decreasing the downloading and uploading times. (Havia 2018)

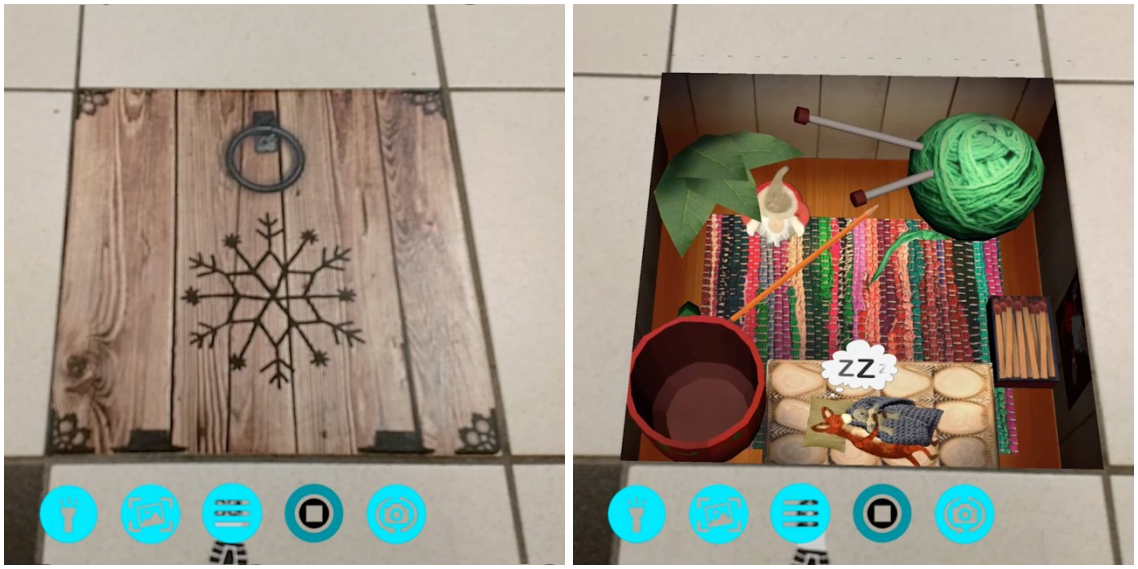
Even though the animation scenes were done in Full HD screen size, the separate character video compositions were cropped as small as the character's movements allowed. The reason for this was that the alphas enabled the background to be transparent, however, if several alpha video layers were placed on top of each other in Arilyn Manager, they cut one another. (Loukonen 2018) The result for this was that the edges became visible. Before we managed to get the

videos in the right sizes to prevent them from cutting each other, I had to export the videos a few times.

According to Linda Loukonen, who was in charge of creating the 3D rooms for this adventure, the 3D spaces were first done using Maya. Yet, the textures for the walls were created from photo collages, so the characters and the rooms would look like they are part of the same world. These photo collages were then added on the surface of 3D planes. (Loukonen 2018)

The 3D rooms were exported to Unity, where Loukonen did a few more fixes to the textures. Next the rooms were exported with Unity's asset bundle. Using Unity at this stage was mandatory as Arilyn Manager requires 3D to be exported with this specific method. (Loukonen 2018)

The 3D content and the target doors were uploaded into Arilyn Manager. Then the targets and the 3D rooms were linked and arranged with each other. In other words, this means that the 3D space's peephole which appears after scanning, had to have the exact same shape from the side facing the viewer as the target door (PICTURE 31). The reason for this was that the illusion of a kind of peephole inside a wall would break otherwise. If the 3D room's peephole was smaller or otherwise in different shape than the target door, it would have looked like the content is just glued on an image target.



PICTURE 31 Target door and the 3D room's peephole are exactly the same size and placed precisely on top of each other (Arilyn 2018)

The targets were mainly images of facades or doors. However, there were a couple of exceptions as there were a picture of a radio and a round vent as well. All of these targets had a specific theme which continued when the target was scanned. For example, when a picture of a radio was scanned, the 3D room looked like a jazz club and there was a band playing on a stage.

The next step was to combine 2D animations with the 3D rooms. As mentioned earlier, the characters were exported in separate video compositions and moved to Arilyn Manager. These video compositions were then added into the same campaign as a specific 3D room and its image target. Arilyn Manager allows the user to arrange video layers in three-dimensional space which means the user must determine values for an x-axis, a y-axis and a z-axis.

In this project, determining the z-axis was a little tricky. The video layers were placed on the z-axis by a rough estimation. Then the estimated placing was tested by scanning the actual target with a mobile phone. After testing, the placing was fixed on Arilyn Manager and tested again. This part of the project took quite a lot of time, since the outcome could only be seen when scanning the target with a phone and not while arranging the video layers on Arilyn Manager. (Loukonen 2018) Moreover, if animations needed to be changed somehow, this step of adjusting the placing of the animation layer, or layers, had to be done again from scratch.

5.2.3 Challenges

One of the biggest challenges, according to Havia, was to obtain all the layers of information to play at the same time (Havia 2018). In this case the layers of information were animations, sounds and 3D. The Arilyn application’s ability to perform its actions relies on the internet connection. Therefore, if the internet connection is poor, it takes longer for the AR content to appear on a device’s screen. Havia adds that there were not a lot of delays, however, depending on the internet connection there could have been a big lag between the animation layers. (Havia 2018) In other words, if the internet connection was bad, the animation layers

may not have appeared exactly on the right timing which would somewhat break the flow of actions.

Determining how everything would appear on the AR device's screen was also one of the challenges that occurred. The downloading time of each information layer regulated in which order all the elements appeared on the screen. In this case the room appeared first and then the characters. This was a problem for which several solutions to solve it were tried. Nevertheless, solving this difficulty only brought more issues. The seriousness of this problem was weighted, and it was decided that it was not a huge issue at this stage. The problem was accepted as part of the learning curve and it was solved in the following year's AR Christmas Adventure. (Havia 2018)

Kähönen states that the presentation at the department store also had its own obstacles in 2017. The schedule and the contract the client had with their subcontractor regarding the presentation at the department store created some challenges. As a result, the display of the image targets across the department store at the opening day of the adventure was not as desired. Nonetheless, this challenge was faced with an understanding from both sides and the display was improved soon after the opening day. (Kähönen 2019)

From Stockmann's perspective there were some difficulties concerning Wi-Fi sufficiency. Moreover, some of Stockmann's clients felt Arilyn application drained their AR device's battery quite quickly. (Suomalainen 2019)

This project was challenging in more ways than one. However, Kähönen brings out that all the challenges that occurred during the AR Christmas Adventure in 2017 were overcome and turned to its advantages. In addition, this case with all of its twists and turns brought a great deal of expert knowledge into Arilyn. (Kähönen 2019)
Suomalainen confirms the positive outcome by stating that a typical customer's response concerning the AR Christmas Adventure was excited. Furthermore, Stockmann received praises from keeping up with the times and trying out new things. In fact, the pilot adventure was so successful it was decided to be executed next year as well but this time in larger scale. (Suomalainen 2019)

5.2.4 The Final Outcome

The final product was the AR Christmas Adventure which guided the viewer from Stockmann's traditional Christmas window inside the department store and encouraged the customers to take part in a treasure hunting game. The treasure hunting game was based on an idea about finding hidden doors and in that way, taking part of Onni the Elf's mission to find Father Christmas. Altogether, there were seven hidden doors. One of the hidden doors can be seen in a picture below (PICTURE 32). Scanning the hidden door with Arilyn application (PICTURE 33) reveals the AR content.

Behind every hidden door Onni the Elf met creatures living inside Stockmann's walls. Those creatures gave Onni the Elf hints about where Father Christmas had gone, while performing their duties at the store. The adventure ended on Stockmann's 6th floor near Father Christmas' chair and where there was a dedicated place for colouring 3D AR cards.

In the final product, there were a few things that needed to be compromised in order to stay on schedule. For example, although Vilja Roihu wrote a heart-warming story for this adventure, the scenes had to be simplified. As a result, the animated scenes are fun and cheerful, but perhaps some of the scenes could have been a little more immersive.

Some of the hidden doors did not disappear completely from the AR device's view after scanning. For example, some target doors depicted a window and a door. Then it was the window and the door that transformed into a peephole and not the complete wall.
This solution was presumably made to strengthen the idea of looking inside a secret room as well as to encourage the viewer to explore the animated scene from different angles. From that perspective, the solution is clever. Nevertheless, not being able to see the animated scenes completely without the walls may have felt a little frustrating at times.

Overall, especially when taking into the account that this was a pioneering case from the technical perspective, the outcome is quite impressive. 2D animation

and 3D space are combined quite seamlessly and all the elements look like they belong in the same world. This aspect alone is not easy to achieve.

The viewer can explore the content from multiple angles of view. Nonetheless, the viewer cannot walk behind the target or the characters as the rooms are ‘embedded’ into the wall. For this reason, the illusion of peeking into a secret world does not break, even if the characters may feel a little like paper dolls when explored from a certain angle.

PICTURE 32 One of 'the hidden door' targets (Arilyn 2017) If the target does not play visit: https://youtu.be/htg_9_Bll2g

PICTURE 33 Instructions on how to see the AR content. 1. Download the Arilyn app for free 2. Scan the image. 3. Step into the adventure. (Arilyn 2017)

5.3 The AR Christmas Adventure at Stockmann in 2018

2018 was the second time AR Christmas Adventure was executed at Stockmann. This time the adventure was displayed in all the Stockmann's department stores in Finland as well as the stores in Tallinn and Riga. (Jäntti 2018)

The adventure's main idea stayed the same as in the previous year: there are little creatures living inside Stockmann's walls and the leading character visits them. Nevertheless, in 2018 the AR Christmas Adventure did not have as much of a backstory than in 2017. Instead, the game aspect of the adventure was re-designed and developed further. In addition, the story about the creatures living inside of the Stockmann's walls was not executed as literally.

In 2018 the AR Christmas Adventure followed the same theme as Stockmann's overall Christmas campaign: 'Give Time for Christmas'. (Jäntti 2018) This theme was seen throughout the AR Christmas Adventure. The adventure also had the same leading character, flying squirrel Manteli, as in the main campaign. Manteli visited and helped the little creatures inside the walls while they were doing their Christmas preparations in a hurry.

A 3D drawing card was also part of the adventure. This time it was Manteli the flying squirrel, who was available for colouring. After scanning, Manteli transformed into a 3D character which flew around the room. There was a designated place at Stockmann for colouring these 3D cards, however, these cards could have been taken home as well. Furthermore, as in the previous year, a hologram Father Christmas was part of the adventure as well.

5.3.1 How the Production Started

According to Mats Havia, Motion Designer and Content Specialist at Arilyn, the production for the next AR Christmas Adventure already started when Stockmann's Christmas windows for 2017 were taken down. Plans and ideas for the next year's adventure were already made on some level. However, the ideas

were left to grow at that time, and after the summer Arilyn and Stockmann started to plan the actual adventure further. (Havia 2018)

From the start it was clear that the AR Christmas Adventure 2018 would continue with the idea about hidden doors. Yet, it was important to determine what can be improved from the previous year, when talking about the technical side, experience and the methods of display. From there the production started to develop. (Havia 2018)

In 2018 the start of the production was more efficient. In the previous year a lot of the technical aspects of the AR Christmas Adventure were new for the production team. This meant a lot of testing and learning along the way. Consequently, this year the research had already been done and the knowledge was laid down. It was easier to start working on something, when the information already existed. (Havia 2018)

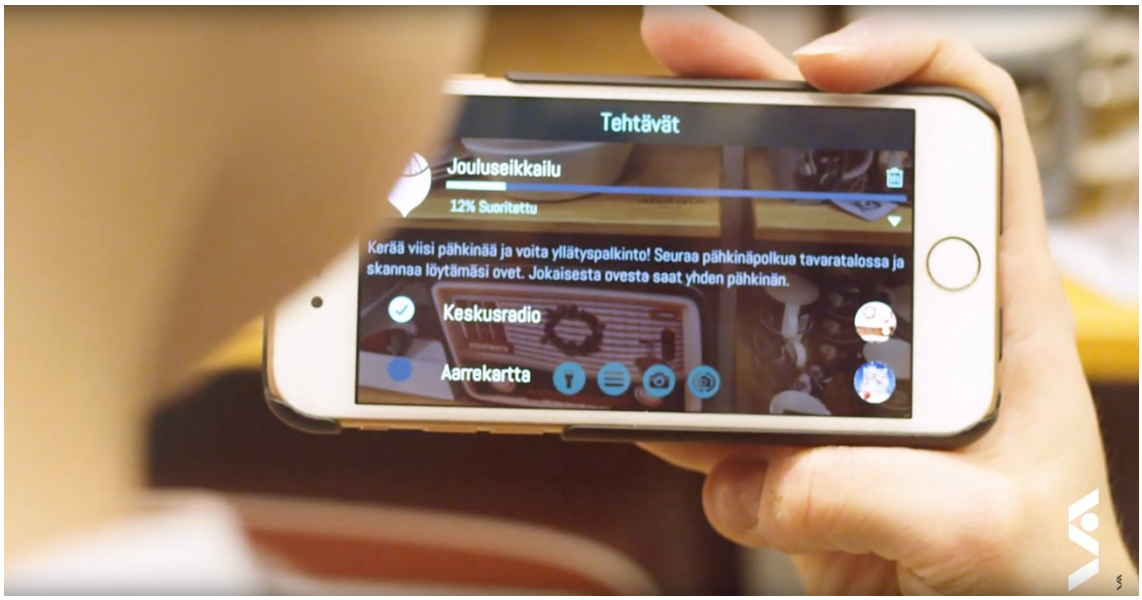
This time my role was to create one of the animations for the AR adventure. The other 2D animators were Elli Mäenpää and Animaatiokopla. I received a storyboard, rigged characters and all the elements that were desired to be part of the animation. As a result, my role was not as hands-on than during the previous year's production. However, this made creating the animations a lot quicker. The storyboard had the main actions depicted. Yet, the reactions and the overall flow of actions were left for the animator to decide.

5.3.2 What is Different Compared with the Previous Year's Adventure

The biggest difference compared to the adventure executed in the previous year was that this time there was a more obvious game aspect. Furthermore, it was possible for the viewer to get an award after completing tasks (PICTURE 34). The awards could have been, for example, mugs, pedestrian safety reflectors or soft toys (Jäntti 2018).

The game had four different stages:
1. Finding a 'hidden door'.

2. Scanning the hidden door and watching the animation.
3. At the end of the animation a user gets a hazelnut in their inventory. The user can collect one hazelnut per hidden door. If the same hidden door is re-scanned multiple times with the same device, it is possible to watch the animation but new hazelnuts are not added into the inventory.
4. After collecting five or more hazelnuts the user was eligible for collecting an award from a toyshop called XS Lelut.



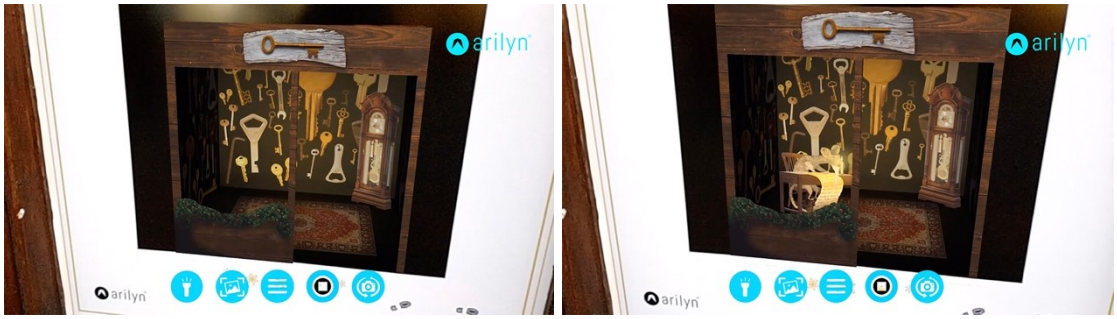
PICTURE 34 A picture from a Finnish language version of the AR Christmas Adventure's game view for accomplished tasks (StockmannCOM 2018)

The way the adventure was displayed at Stockmann was changed as well. In 2017 all the hidden doors were literally on the walls and each of them were unique. This time around there were several prints of the same hidden door set in different places. Also, the hidden doors were not necessarily placed directly onto a wall, but they had small freestanding temporary walls build for them (PICTURE 35). This was done differently, so it would be easier for the user to find the targets (Havia 2018).

PICTURE 35 One of the hidden doors at Stockmann in 2018 (Arilyn 2019)

According to Suomalainen, Stockmann ordered larger elements regarding this adventure than in the previous year. These elements were, for example, floor stickers and printed components guiding the viewer towards the magical doors. (Suomalainen 2019) The aim was to make it more straightforward for the player to find the doors.

Visually there was a difference with how the secret world appeared after scanning. In the earlier version of the adventure, a 3D room with its 2D characters simply popped up into sight (PICTURE 36). This time the doors literally opened into the secret world (PICTURE 37). An animation of the doors opening created an illusion that the secret world was already there before scanning, and scanning the target only created a gateway to see into this magical world.



PICTURE 36 In 2017 the characters simply popped into the sight after scanning the image target (Arilyn 2018)

PICTURE 37 In 2018 animated doors opened and revealed the characters in a hidden world (Arilyn 2019)

As the opening doors also strengthened the feeling of looking into another world, there was no reason not to reveal the doorway completely. By stating this I refer to the pilot version of the adventure in which some of the hidden doors did not disappear completely. Instead, in some image targets only parts of the image became peepholes. This can also be seen in the picture presented earlier (PICTURE 36) where doorframes and the little piece of wall under the window remain in sight after scanning.

In 2017 there was a clear starting and ending point for the adventure. This was changed in 2018, so the order from which the player found the hidden doors would not affect the functionality or the excitement of the adventure.

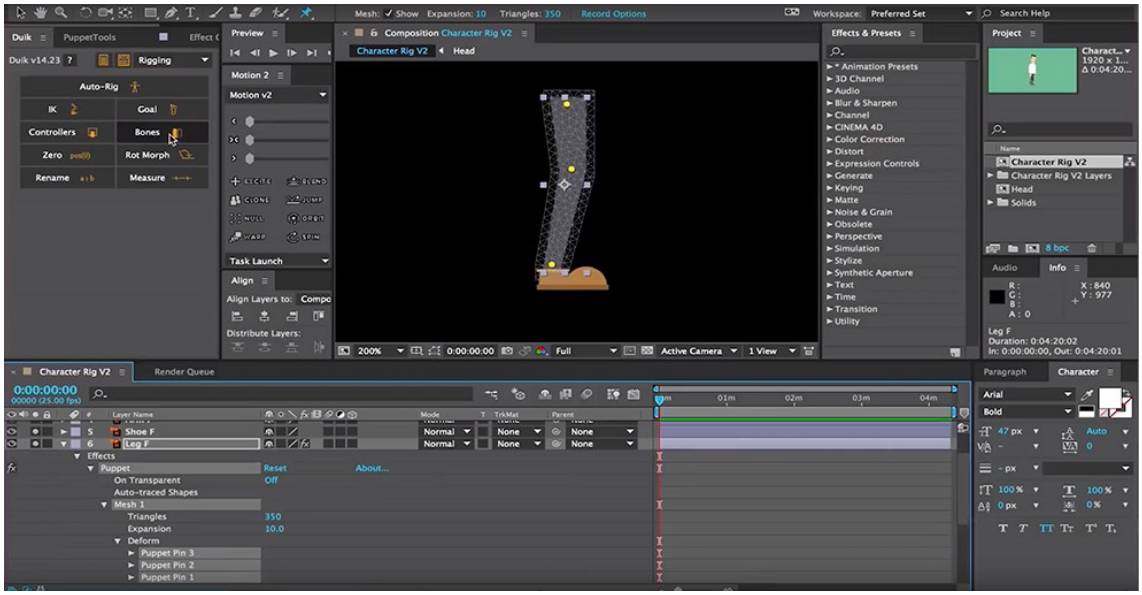
5.3.3 Technical Execution

Havia reminds that in the previous year there was a problem with the 3D rooms and 2D animations appearing at different times when scanned with an AR device. As a result, there was some lag between the elements and everything did not happen in sync. Since then, Arilyn made some technical developments. One of these improvements was to enable streaming videos directly onto the 3D space, and not adding everything together at Arilyn Manager. (Havia 2018)

From the animator's perspective, there were not many changes compared with the pilot version executed a year earlier. The animations were completed again with Full HD screen size. In the final exported animation, the background was black, and alphas were used as in the previous year. Duik, on the other hand,

had a new version which made the animation process a little different. The version used in 2018 is called Duik Bassel.

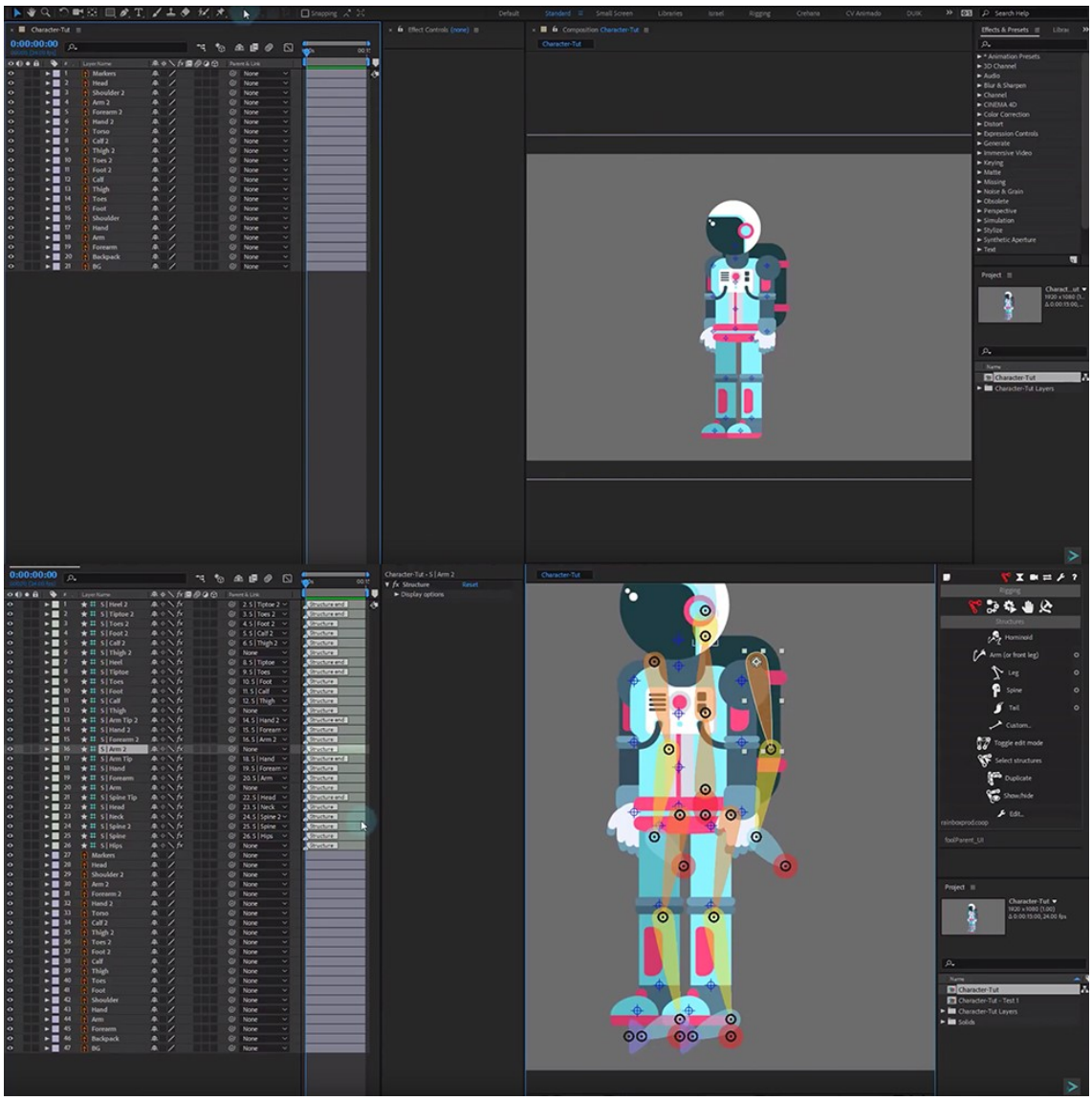
In the previous version of Duik, the rigging started with creating joints with the puppet tool (PICTURE 38), forming bones and then determining a hierarchy for the joints. Determining hierarchy means creating an order in which different parts of the body follow each other, when creating an animation. For example, if an arm joint is rotated, also the forearm and wrist rotate in relation to the arm's rotation. This creates a movement in which the hand moves either up or down. Yet, if the wrist joint is rotated, the hand is the only part that moves.



PICTURE 38 Creating joints with a puppet tool using older version of Duik (Matt Wilson 2015)

Duik Bassel had a new system for creating structures. In this version it is possible to create a ready-made skeleton which has joints and most of the hierarchy is already defined. This skeleton, however, does not automatically fit on a character that is being rigged. Therefore, the rigger needs to place joints in the right places, set out the links between the image layers and the skeleton, and possibly adjust some of the parts of the skeleton with creating bones. For example, bones are often created for the spine in order for it to move more naturally.

Altogether, Duik Bassel saved a lot of time from the rigging compared with its previous version.



PICTURE 39 A character before and after creating an automatic skeleton with Duik Bassel. The skeleton does not automatically fit on the character. (D.Israel P. 2018)

Another difference with the animation was that there were less layers to be exported. In 2018 the scripts and storyboards were designed in a way that there were only two layers of 2D animation. All the characters were on one video layer and the other video layer was for a clock.

Since this year I was not working as hands-on with the overall AR Christmas Adventure campaign, before I started to animate anything, I asked Vilja Roihu for a short description of Manteli's personality. For me this was important, for when a character has completely different body language in different animation scenes, the character cannot be very believable. Movement is a strong way to represent

a personality. After receiving Manteli's characterisation, it was easier to maintain a cohesive style with this specific character. With the other character I animated I had quite free hands with its personality.

With 3D, also, the process started very similarly to last year. Maya was used for creating the 3D rooms. (Havia 2018) Moreover, some visual elements seen in the previous AR adventure were used again this year. Then the 3D rooms were exported into Unity (Havia 2018).

The next step was to download all the animations into Arilyn Manager. Also, instead of the final image targets which were depicting the hidden doors, dummy targets were uploaded. (Havia 2018) Dummy targets are targets which are not going to be seen in the end product in any form. Instead, dummy targets are added for technical reasons.

In Arilyn Manager each animation had an individual campaign created for them (Havia 2018). The term 'campaign' is used in Arilyn Manager and it means creating an AR project. Usually a campaign can consist of many videos and targets linked with each other. For example, if a client has two image targets and one video for each of the targets, they can be under the same campaign. This makes managing the content systematic. However, in this case every animation with its dummy target had their own campaign. The reason for this solution was that every campaign gets its own ID number after it is created in Arilyn Manager. This ID number was the key in this process. (Havia 2018)

Arilyn's developer Marko Varsila created a script for linking video components directly onto a 3D plane in Unity. This is where the target ID was needed. (Loukonen 2018) The script with the target ID tells Unity to read that specific animation with this target ID in this particular 3D object. In other words, the script enables streaming of a 2D animation onto a 3D plane (Loukonen 2018). This basically means that all the elements of a scene are put together in one place. Consequently, every element in the content will upload at the same time which solves the problem with lag that occurred in the previous year. (Havia 2018)

Technically it would have been possible to add animations directly in Unity. However, the 2D animations did not transfer with the 3D elements when exporting an asset bundle into Arilyn Manager. (Loukonen 2018) Furthermore, solving the problem in this way would have produced files which were too large. (Havia 2018) The solution of a script streaming the 2D animations into 3D planes was a way to go around these issues.

5.3.4 Challenges

This time the challenges were very different from the last year, as they did not relate to the production but the application. For example, Havia brings out that iOS had updates done just four days before launching the AR Christmas Adventure. This turned out to be problematic as iOS changed their video component which the Arilyn application used when playing the AR content. As a result, this created a bug in Arilyn's entire app system. Luckily, this problem got fixed before the launch. (Havia 2018)

5.3.5 The Final Outcome

The final product was an interactive story experience closely linked with the main theme of Stockmann's Christmas campaign: 'Give Time for Christmas'. Again, in a way, the adventure started from Stockmann's Christmas window, where the felted creatures, later seen in the AR adventure, were first introduced. There were seven magical hidden doors which opened up after scanning them with Arilyn application. Each door uncovered a 2D animated scene in 3D space. These animations showed how Manteli, the flying squirrel, helped other creatures who were in a hurry or otherwise in trouble with their Christmas preparations. One of the hidden doors can be seen in the picture below (PICTURE 40). Scanning the hidden doors gave a player a virtual hazelnut from every new door. After five hazelnuts the player was eligible to collect an award from a toyshop called XS Lelut.

Visually there were not many changes done to the overall style of the 3D rooms and 2D characters compared with the previous year's adventure. Most of the characters in the animated scenes were the same as in 2017. Yet, this was quite easy to justify as some of the 3D rooms had the same scenarios as well. For example, the same characters were still employed at the bakery checkpoint.

As a lag between the characters' interactions was no longer a problem, timings were more precise. From the animation perspective, this makes a huge difference. Often if the timing is even little off between two animated characters, the scene loses a lot of its surprise element as well as the natural flow of actions. As a result, the scene may not feel as exciting. Therefore, fixing the problem with lag made the animations look and feel more appealing.

The work that went into improving and developing the AR Christmas Adventure can most definitely be seen in the final product. The illusion of a secret world is much stronger than in the pilot version. Furthermore, the story feels more cohesive and perhaps easier to get into. Every scene has their own catch which captivates the viewer.

According to Timo Suomalainen, by mid-December there were over 72 000 scans done with the Arilyn application regarding the AR Christmas Adventure (Suomalainen 2019). This number of scans includes all the scanning of the AR Christmas Adventure counting the scans of the 3D colouring cards as well. It feels it can be safely said that the adventure was a success.

According to Suomalainen, the preparations for the Christmas campaign in 2019 have already started. Suomalainen reveals that a new AR Christmas Adventure at Stockmann is one option for the campaign. (Suomalainen 2019) However, the question of whether we will see a new AR Christmas Adventure at Stockmann is left open.

PICTURE 40 One of the targets in AR Adventure in 2018. Instructions on how to see the AR content: 1. Download the Arilyn app for free 2. Scan the image. 3. Step into the adventure. (Arilyn 2018) If the content does not play visit: https://youtu.be/Yk4DuI06GjE

6 CONCLUSION

This thesis had two aims. The theoretical part of this thesis aimed at exploring how 2D, especially 2D animation, fits in the world of augmented reality. Does 2D animation have a place in this field today and in the future, or is it overshadowed by 3D? The practical part, on the other hand, studied how Arilyn's pilot project of the AR Christmas Adventure at Stockmann in 2017 utilising 2D animation and 3D space evolved into a part of Stockmann's overall Christmas campaign in 2018.

The interviews with the professionals working in the field of AR imply that the right question regarding 3D and 2D animation is not whether one is better than the other. Instead, the question should be which technique serves a specific purpose the best. Therefore, even if 3D may be used more often with AR today than 2D, it does not mean 3D would render 2D animation superfluous.

While writing this thesis, it emerged that neither 2D nor 3D is a seamless solution for every AR case. For example, schedule, budget, intended purpose as well as the technical side and technological constraints are all factors having an impact on the AR experience. Furthermore, it became clear that both 2D and 3D have their own pros and cons.

When combining 2D animation with AR, there is a high risk that the illusion of something being part of our reality will break. The reason for this is that the viewer is usually likely to explore the content in multiple angles of view. Then the viewer is able to see the content has no physical depth. This 2D's feature has to be taken into a consideration when planning how to use this technique with AR. Nonetheless, having one dimension less than 3D is also the feature that makes 2D animation generally faster to produce and then easier on the budget. In other words, there are not as many work stages as with 3D. Therefore, a predefined angle of view is both 2D's weak and strong point at the same time.

On the other hand, mobile phones today are not powerful enough to harness all the possibilities with 3D, as 3D models must be optimised in order to run on AR devices. This can leave 3D content's appearance having somewhat a rubbery

feel to them, and the 3D models cannot have too many details on them. In addition, creating 3D content is usually more expensive than 2D and generally it takes longer to create.

However, 2D animation and 3D can also be combined. Then it is possible that these two techniques can compliment and compensate each other's advantages and shortages. Moreover, there may be many possibilities to do so in creative ways yet to be seen.

The case study of Arilyn's AR Christmas Adventure at Stockmann presented in this thesis put the best features of 2D animation and 3D in use. 2D animation enabled efficient production as well as staying relatively true to the original felted characters at Stockmann's Christmas windows. In addition, in this case 2D animation may have been a better choice for expressing the idea of mechanical toys and the feeling of an old Christmas. Arguably, that is because 2D may visually feel more traditional than 3D as a technique.
3D, on the other hand, provided a sense of physical depth which made the idea of looking inside of a wall possible as well as enabled a parallax effect which in turn strengthened the feel of depth. When all the elements were put together, 3D made it possible for the viewers to explore the room from multiple angles. Furthermore, as the 3D room appeared inside of a wall and not on top of it, this 3D room also somewhat prevented the viewer from looking at the 2D content from angles that would have revealed the characters' flatness. This aspect upheld the illusion of the characters being part of our reality.

Based on my research I feel quite assured that there is and will be a place in the future for 2D animation in the world of augmented reality. However, it is worth noting that the number of interviewees for this thesis is limited. Also, all the experts who were interviewed are living in the same geological area. It is possible a more extensive investigation with an international point of view would provide differing results.

Presuming 2D animation is to stay in the world of AR, it is unclear whether 2D will become as mainstream as 3D. Also, it is uncertain in which form 2D animation

or 2D in general will be present in the field of AR. Will it remain clearly recognisable as 2D animation or will it merge more together with 3D? Furthermore, have we seen 2D animation’s full potential in this field or is there more to come? Time will tell which direction 2D will take in the future of AR.

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APPENDICES

1(2)

Appendix 1. Interview Sheet for Otso Kähönen, Creative Director & Co-founder of Arilyn

General Questions about 2D and Augmented Reality

What is a typical case for Arilyn when 2D, especially 2D animation, is used in an AR project?

What is a typical case for Arilyn when 3D is used in an AR project?

Do customers order more 3D-based or 2D-based augmented reality productions from Arilyn? Do you have an idea why?

Is there a difference between 2D and 3D on what kind of impact they have on a viewer when these techniques are combined with AR technology?

Can you see 2D being used in AR projects or campaigns in the future, or is everything turning more towards 3D?

Do you feel 2D and 3D are equally needed in the world of AR or does one have more potential places of use than the other?

How do you see the future of 2D animation in the world of augmented reality?

Do you have a favourite project in 2D or 2D animation you have been working on? What makes it your favourite 2D project?

AR Christmas Adventure at Stockmann in 2017

How would you generally describe AR Christmas Adventure at Stockmann? What is it about?

What was the starting point from which the Christmas Adventure started to take shape?

What was the story behind the AR Christmas Adventure at Stockmann in 2017?

What where the main reasons why the execution was decided to do with animated 2D felt characters?

Is there a specific reason, why the adventure was executed with a combination of both 2D and 3D, and not just with one of these techniques?

What where the optional ways of approaching the AR Christmas Adventure concept besides creating 2D animated characters from the photographs of original felted animal characters displayed at Stockmann Christmas window?

What was the emotional impact that 2D animated characters were desired to have on a viewer? Do you think it would have been possible to achieve the same emotional impact with 3D characters?

Was the desired emotional impact succeeded or were there any unexpected surprises?

Did this project teach you anything new?

What was best about the AR Christmas Adventure in 2017 and why?

Is there anything you would like to tell about the Christmas Adventure, but I have not asked?

Appendix 2. Interview Sheet for Frans Tihveräinen, Chief Executive Officer & AR Designer at Flyar

What is a typical case for Flyar when 2D, especially 2D animation, is used in an AR project?

Do customers order more 3D-based or 2D-based augmented reality productions from Flyar? Do you have an idea why?

What are the major technical differences between 2D and 3D when used with AR?

Do you think there are any benefits when using 2D media with AR instead of 3D?

What is a typical case for Flyar, when 3D media is used in an AR project?

In your opinion, when does using 3D on a project serve the purpose better than using 2D?

In your opinion, what are the benefits and downsides of using 3D with AR?

Is there a difference between 2D and 3D on what kind of impact they have on a viewer when these techniques are combined with AR technology?

Can you see 2D being used in AR projects or campaigns in the future, or is everything turning more towards 3D?

Do you think there are unique features 2D beholds but 3D does not? For example, a different kind of emotional impact on a viewer, or can it be used somewhere where 3D does not work as well?

2(2)

Do you feel 2D and 3D are equally needed in the world of AR or does one have more potential places of use than the other?

How do you see the future of 2D animation in the world of augmented reality?

Do you have a favourite project in 2D or 2D animation you have been working on? What makes it your favourite 2D project?

Do you have any additional comments you would like to make relating to 2D animation or 2D media in the world of augmented reality or in general?

Appendix 3. Interview Sheet for Mats Havia, Motion Designer and Content Specialist at Arilyn

General Questions about the AR Christmas Adventure at Stockmann

What where the main reasons why the execution was decided to do with animated 2D felt characters?

Is there a specific reason, why the adventure was executed with a combination of both 2D and 3D, and not just with one of these techniques?

What where the optional ways of approaching this AR Christmas Adventure concept besides creating 2D animated characters from the photographs of original felted animal characters displayed at Stockmann's Christmas window?

AR Christmas Adventure at Stockmann in 2017

How did the project begin?

How was the Christmas Adventure technically executed in 2017?

Did any unique or unexpected challenges occur when creating this project?

How did you overcome the challenges?

Did this project teach you anything new?

Did anything surprise you during this project?

What was best about AR Christmas Adventure in 2017 and why?

AR Christmas Adventure at Stockmann in 2018

How did the project begin?

What is different from the AR Christmas Adventure in 2017 and why?

When talking about the technical execution, what was done differently in 2018 than in 2017?

In 2017 Arilyn Manager was a vital tool for this project. I understood this year Arilyn Manager is not used at all with the execution. How was the usage of Arilyn Manager replaced in 2018?

In 2017 there was a limit on this specific project on how many different layers could be put together in Arilyn Manager in order to keep the content available for the older phones as well and keeping the download time reasonable. Is there a similar limit this year?

How was the Christmas Adventure technically executed in 2018?

In what form are the 2D videos exported? Are alphas used?

Did any technical challenges or difficulties occur with the execution this year?

Did this project teach you anything new?

Did anything surprise you during this project?

What was best about AR Christmas Adventure in 2018 and why?

Is there anything you would like to tell about the Christmas Adventure, but I have not asked?

General Technical Questions

What is a typical case, when 2D, especially 2D animation is used in an AR project?

What is a typical case, when 3D is used in an AR project?

Do you have a favourite project in 2D or 2D animation you have been working on? What makes it your favourite 2D project?

What are the major technical differences between 2D and 3D when used with AR?

In your opinion, what are the benefits and downsides of using 3D with AR?

In your opinion, when does using 3D on a project serve the purpose better than using 2D media?

Are there any benefits when using 2D media with AR instead of 3D?

When does 2D fall short when compared with 3D?

Can you see 2D been used in AR campaigns in the future or is everything turning more and more towards 3D?

Is there any unique features 2D beholds but 3D does not? For example, a different kind of emotional impact on a viewer, or can it be used somewhere where 3D does not work as well?

Do you feel 2D and 3D are equally needed in the world of AR or does one have more potential places of use than the other?

How do you see the future of 2D animation in the world of augmented reality?

4(4)

Do you have any additional comments you would like to make relating to 2D animation or 2D in the world of augmented reality?

Appendix 4. Interview Sheet for Linda Loukonen, Former Junior Content Specialist at Arilyn, currently working as 3D Artist at Reworks

AR Christmas Adventure at Stockmann in 2017

How did the project begin?

How was the AR Christmas Adventure technically executed in 2017?

Did any unique or unexpected challenges occur when creating this project?

How did you overcome the challenges?

Did this project teach you anything new?

Did anything surprise you during this project?

What was best about the AR Christmas Adventure in 2017 and why?

AR Christmas Adventure at Stockmann in 2018

How did the project begin?

What is different from the AR Christmas Adventure in 2017 and why?

When talking about the technical execution, what was done differently in 2018 than in 2017?

In 2017 Arilyn Manager was a vital tool for this project. I understood this year Arilyn Manager is not used at all with the execution. How was the usage of Arilyn Manager replaced in 2018?

In 2017 there was a limit on this specific project on how many different layers could be put together in Arilyn Manager in order to keep the content available for the older phones as well and keeping the download time reasonable. Is there a similar limit this year?

How was the Christmas Adventure technically executed in 2018?

In what form are the 2D videos exported? Are alphas used?

Did any technical challenges or difficulties occur with the execution this year?

Did this project teach you anything new?

Did anything surprise you during this project?

What was best about AR Christmas Adventure in 2018 and why?

Is there anything you would like to tell about the Christmas Adventure but I have not asked?

General Technical Questions

What is a typical case for Arilyn, when 2D, especially 2D animation is used in an AR project?

What are the major technical differences between 2D and 3D when used with AR?

Do you think there are any benefits when using 2D with AR instead of 3D?

What is a typical case for Arilyn, when 3D is used in an AR project?

In your opinion when does using 3D on a project serve the purpose better than using 2D?

In your opinion, what are the benefits and downsides of using 3D with AR?

Is there any unique features 2D beholds but 3D does not? For example, a different kind of emotional impact on a viewer, or can it be used somewhere where 3D does not work as well?

Do you feel 2D and 3D are equally needed in the world of AR or does one have more potential places of use than the other?

How do you see the future of 2D animation in the world of augmented reality?

Do you have a favourite project in 2D or 2D animation you have been working on? What makes it your favourite 2D project?

Do you have any additional comments you would like to make relating to 2D animation or 2D in the world of augmented reality?

Appendix 5. Interview Sheet for Eeva Jäntti, Executive Producer at Arilyn

General Questions about the AR Christmas Adventure at Stockmann

How would you generally describe AR Christmas Adventure at Stockmann? What is it about?

What was the emotional impact that 2D animated characters were desired to have on a viewer?

Was the desired emotional impact succeeded or where there any unexpected surprises?

Is there a difference between the emotional impact on a viewer when using animated 3D characters in an AR project compared with using animated 2D characters?

AR Christmas Adventure at Stockmann in 2017

What was the story behind AR Christmas Adventure at Stockmann in 2017?

Was this the first time Stockmann used AR technology at their department store?

Did this create any unique or unexpected challenges?

Did any other challenges occur during this project?

How did you overcome the challenges?

Did the customers at Stockmann find the campaign?

The customers needed to have a smart phone and Arilyn application on their phone in order to access the campaign. Where there any challenges with introducing the technology customers needed in order to access the campaign?

What was the response the customers had towards the campaign?

Did this project teach anything new?

Did anything surprise you during this project?

What was best about AR Christmas Adventure in 2017 and why?

AR Christmas Adventure at Stockmann in 2018

What is the story behind AR Christmas Adventure at Stockmann in 2018?

What is different from the AR Christmas Adventure in 2017 and why?

What was done differently in production this year?

What kind of challenges did you face this year?

Did the customers find their way to the campaign?

Where there any challenges with introducing the technology customers needed in order to access the campaign this year?

How did the customers respond to the AR Christmas Adventure in 2018?

Did this project teach anything new?

Did anything surprise you during this project in 2018?

3(3)

What was best about AR Christmas Adventure in 2018 and why?

Is there anything you would like to tell about the Christmas Adventure, but I have not asked?

Appendix 6. Interview Sheet for Timo Suomalainen, Experience Producer at Stockmann

General Questions about the AR Christmas Adventure at Stockmann

How would you generally describe the AR Christmas Adventure at Stockmann? What is it about?

What did Stockmann want offer to the customers through the AR Christmas Adventure?

What was the impact that the adventure was desired to have on a viewer?

Was the desired impact succeeded or were there any unexpected surprises?

Does Stockmann plan to organize the AR Christmas Adventure in the future as well?

AR Christmas Adventure at Stockmann in 2017

How did the Christmas Adventure project begin in 2017?

How did Onni elf end up as a main character of the Christmas adventure in 2017?

Were there any other candidates for the main character than Onni the elf?

Was this the first time Stockmann used AR technology in their department store?

Did this create any unique or unexpected challenges?

Did the customers at Stockmann find the campaign?

What was the response the customers had towards the campaign?

What was a typical customer feedback like concerning the Christmas Adventure in 2017?

Did this project teach you anything new?

Did anything surprise you during this project?

What was best about AR Christmas Adventure in 2017 and why?

AR Christmas Adventure at Stockmann in 2018

How did the Christmas Adventure project begin in 2018?

Were there any changes to the Christmas Adventure from Stockmann's point of view in 2018 when compared with the Adventure in 2017?

How did Manteli the flying squirrel end up as the main character of the Christmas adventure in 2018?

Were there any other candidates for the main character than Manteli the flying squirrel?

What kind of challenges did you face this year?

Did the customers find their way to the campaign?

How did the customers respond to the AR Christmas Adventure in 2018?

What was a typical customer feedback like concerning Christmas Adventure in 2018?

3(3)

Did this project teach you anything new?

Did anything surprise you during this project in 2018?

What was best about AR Christmas Adventure in 2018 and why?

Is there anything you would like to tell about the Christmas Adventure, but I have not asked?