Anno Pipervika

A Situated Simulation

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Abstract

The visualization or illustration of different types of information in today's society are in many ways increasing in line with the digitalization of conventional activities. The growth in the digital interfaces that are connected to our physical surroundings are unlikely to be reduced, and one of the most associated and applicable devices to this expansion within the digital is the smartphone. In my studies I have created a prototype for an indirect augmented reality application known as a Situated simulation, or *Sitsim.* These simulations enable the integral features of the smartphone or tablets to create a virtual environment which is restricted to a specific location. The application is to be tested through observation of field study and a user survey. This method of design is used to study the connection between a past, absent environment and the urban landscape of today.

Preface

I chose to do this project because of my love for computing and anything which is digital. Before this project I was overly confident in my ability to handle different types of software in relation to computers. But the introduction to 3D-modelling was the manifestation of how little I really knew. With no prior experience in the field of 3D-modelling, interaction design or field studies I was immediately taken back by the full scope of what I was in for. Still, this has been the most interesting project I have done as a student at the University of Oslo. Even though I wished I had some previous experience in the field beforehand; this just made for a much more interesting learning curve. While I now know a thing or two about 3D-modelling, I would not have managed to continually progress without the help of a special few.

I would really like to thank Gunnar Liestøl (Fall 2019/Fall 2022) for guiding me through this entire process, the knowledge you possess within this field of study is astounding. You always have multiple answers if a question arises. I would also like to thank Espen Johnsen Bøe for letting me spend some time with him at HF Studio and teaching me how to model properly in Blender. Thank you Šarūnas Ledas and the *Tag of Joy* team for helping and guiding me on how to implement my design into Unity.

I would also like to thank my partner Ingeborg Nesbø for helping me with the text in the form of discussion and fixing my grammatical mistakes, and the overall structure of my thesis. I would also like to thank you for walking our dog (Mikkel) when I was zoned in and couldn't let myself go from the computer.

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1 Introduction

There is no denying that the world is becoming more digital, and that the term digital media now in fact applies to all media. As a choice of medium, the smartphone has proved to be applicable to almost all forms of media. While there are some concerns regarding the high-choice media market and its user-centric position; innovations within interactive design now have the ability to produce prototypes that acclimate place-specific solutions within location-aware systems such as smartphones or tablets. The specific form of interactive design I will present in this paper is known as a *sitsim*, short for situated simulation. These simulations are a form of indirect mobile augmented reality, which is used to illustrate and modify different types of information. It is a solution that could function as an educational tool and is often used to contextualize information of historical importance related to a geo-positional location. These simulations are constructed through several stages of development in order to define and improve on their qualities. The iterations are powered by the synthetic-analytical approach to design and these representations are continually improving on their functionality through the course of production and evaluation.

1.1 General description of the thesis

This thesis describes the development of the situated simulation *Anno Pipervika*, which is a mobile augmented reality application made for the iPhone and iPad. The application is a representation of a simple reconstruction of old structures that used to occupy the area in which the new town hall square of Oslo now resides.

The application is to be tested by other students through ethnographic research, where I observe their physical interaction with the prototype which is followed by a user survey. I have tried to accumulate students with a diverse field of study in order to capture multiple understandings and different focus points when conducting the user survey. I wish to examine the value of presenting the past in an intertextual manner through a device such as the smartphone, and to analyze the experience in the difference between the physical urban landscape and the virtual elements provided by the simulation. I also wish to examine the concept of situated simulation at its core by highlighting the indifference in the graphical solutions within the application, where some objects are more detailed than others.

I wish to investigate these qualities through the theoretical perspectives on interactive design; augmented reality; location-based services; and place specific computing. I have used the methods found in interactive design theories to create a prototype to evaluate my product through field studies and user testing.

1.2 Motivation

While my previous academic work almost solely consisted of papers describing the sociocultural relations between producers and consumers, I wanted to do something different for my master thesis. In the first week of the beginning of my studies, my class was presented with the different options of guidance teachers, where they each had a five-minute introduction on what their projects were, and the last teacher that presented was Gunnar Liestøl. I remember he said that "if you choose me, you will do something hands-on." I had never had an option to work with something practical at my time at the university, so I went with Gunnar. In my first meeting with Gunnar, I was presented with the *sitsim* project through the thesis of Vegard Fleischer Orkelbog in which he created the application *Holmenkollen Time Travel* (HTT). This is a situated simulation created ten years ago that tried to add more functionalities within the *sitsim* itself, such as hyperlinks with additional information about objects or the area, and different views in a constructed timeline that shows the evolution and development of Holmenkollen through digital solutions (Orkelbog, 2012).

I was asked to find a designated or interesting area which may showcase certain developments that could be depicted and recreated. When I looked at old photographs of certain areas around Oslo, the development of the area around the town hall square of Oslo is what I found to be most interesting. The old photographs were found through websites such as oslobilder.no and digitalmuseum.no, and I tried to find an era that had enough pictures of the environment so that I could construct more detailed and natural objects. The pictures were dated from the early 1800s to the present date. The project originally started out as Orkelbog´s, where I wanted to depict the area over the course of three different timelines, showcasing the construction of the town hall and the destruction of the old neighborhood at the same time. This proved to be a much larger project than I first predicted, so I had to choose one era to represent and compromise on the size of the area. My application portrays the original constructions of the road known as Søgaden in the early 1900s; right before it was demolished to be replaced with the new town hall of Oslo.

1.3 Background

When it comes to urban development, there are many ways to illustrate proposals for changes; through architectural drawings or through handcrafted prototypes such as miniature representations. There is also an indication that these types of representations are becoming more digital as well (Mohammad, Mizi & Chuck, 2014). The new Obos project called "Middeltunet", which is being built on Majorstuen, has created a virtual environment that is

both informative and speculative in its form. They present a digital interactive design which allows the users to examine different details of the exterior and interior of the construction, even though it's not yet installed (Obos, n.d.). These solutions are increasing in line with the possibilities provided by the development and convergence of different technologies. The rapid increase in digital services provided by devices such as the smartphone has created new possibilities within the visual representation of information through solutions such as mobile augmented reality. The smartphone is perhaps the most commonly used device by the human population, and its features are becoming more applicable than ever. Its connectivity with the internet makes it a tool that is more personal than the personal computer. We use the smartphone for consumption and generating content; we use it for navigation; we use it as a payment form; we use it for communication; and we use it for the storage and capturing of memories. The increase in the efficient computing power these devices provide also makes it possible for external applications to run on its platforms. This, in combination with the higher resolution displays available through the smartphones, creates the possibility of engaging with the users of a smartphone in a different manner (Baker, 2018). This convergence of technologies that once used to be seen as individual accomplishments on their own, are now enabling the convergence of more such technologies to adjust and coexist in a symbiotic way. Sharp, Rogers & Preece describe the user-product relationship in this way:

> Interface metaphors combine familiar knowledge with new knowledge in a way that will help the user understand the product. Choosing suitable metaphors and combining new and familiar concepts requires a careful balance between utility and fun and is based on a sound understanding of the users and their context. (Sharp et al., 2011, chap. 11.3.1, para. 4)

1.3.1 The modern Swiss army knife

The phone was stationary before it became mobile, and it was mobile before it became smart. The mobility of the smartphone is both key in its enrichment in human digital culture, and a vital factor when constructing the prototype for my thesis. It could be argued that the smartphone is the ultimate option of choice when it comes to widespread communication and consumption of entertainment and news (Panek, 2016; Prior, 2005). And with the development within cybersecurity, it can now be used as a payment form either through the unlocking of objects like e-scooters, bikes, or cars; or it can be used as a virtual payment card

on its own or through applications like Vipps, which uses the smartphone as a personal id; connected and verified through the bank by the owner. One could argue that the smartphone is becoming the most vital personal belonging, either when out in public or in the privacy of our own home. This speaks on the importance this device has over the civic and points to a new direction in which the smartphone has become the modern Swiss army knife.

While there are some obvious negative elements to such developments, there are also many positive features. The rapidly increasing inherent functions of the smartphone, such as its graphical-resolution, GPS-positioning, gyroscope, 5G, computing power etc. is opening the space for different ubiquitous computing designs, where the smartphones may generate more interactivity with our real-life surroundings based on contextualization, navigation and movement. Through these new advancements of the features of the smartphone, it has become a collaborating device, which by its very nature is already engaging with the user. In some ways you could argue that the smartphone is the ultimate "extension of man" in McLuhan's terms (McLuhan, 1967), and one where this evolution of functionality sets the groundwork for a space where new ideas could flourish. Liestøl calls this the "emergence of sensory media" (Liestøl, Doksrød, Ledas & Rasmussen, 2012).

1.3.2 Situated Simulations

This emergency has enabled projects such as the situated simulation (*sitsim*) projects to engage with the developments in the features of handheld devices to produce prototypes and practice certain theories on education and learning, textualization, and interaction design. The sitsim is a form of indirect augmented reality, which exists in the space between augmented reality and virtual reality; whereas "AR allows us to extend our physical reality; VR creates for us a different reality" (Bolter, Engberg & MacIntyre, 2021, p. xix). These terms are being implemented into the field of ubiquitous computing which enables the integral qualities of devices such as, the iPhone or the iPad in combination with other software to create visual representations, such as the recreation of lost architectural structures on location.

The situated simulation was first introduced by Gunnar Liestøl in the INVENTIO-project (Liestøl, 2009b). The situated simulation is one of the emerging forms of expression that exploits these new improvements in the smartphone's sensory capabilities. These sensory capabilities are often related to the Global Positioning System (GPS) in combination with the gyroscope and accelerometer, which provides for the device's accuracy when it comes to navigation and positioning. Devices such as the smartphone are now categorized as a location-aware system, and with the continual improvements being made on these devices,

their computing power and graphical resolutions are making smartphones much more applicable to location-based services. While previous depictions of historical information are mainly sourced through text or pictures related to museums, libraries, the internet, or city guides; applications like the situated simulation have spawned out of the convergence of different multiple technologies and are combining these technologies to create and contextualize information in a new manner.

> Imagine you're exploring the historic center of a city with its impressive town houses, churches and monuments. What if you could just use your mobile device to find out about the historic buildings around you, with detailed visual information about how they were built and the story behind them, making history come alive before your eyes? (Münster et al., 2020, p. 65)

1.4 Research Question

In this thesis I wish to study the smartphone's applicability as a tool for learning through interaction with information based on a current location. While smartphones are primarily used for communication or consumption of different media, the situated simulations generated through these devices are more interactive and more demanding of the user. Does it come off as an easy-to-use application that has valuable information and exciting features? What is the value of presenting the past in an intertextual manner through a device such as the smartphone? How do the different solutions in the design of each object interfere with the application as a whole? How simple may a simulation graphically be in order to augment the experience of the past urban structures?

This application does not add any new functionality or design elements which would be found in the newer iterations of sitsim´s created by Liestøl and the INVENTIO team or such as in Orkelbog´s project. I merely want to examine the *here-and-now* connection with the past. How far have we come in our acceptance of digital representations? Does one need additional information in the form of hyperlinks in order for the application to be experienced as something which may enhance the perspective? How simple may the interaction design be in its functionalities to be a viable representation of a concept?

Anno Pipervika is an application that represents an alternative version of the area around the town hall square of Oslo. The application represents a specific time and place in

the old town of Christiania around the early 1900s. The area that is chosen was previously known as Søgada, or Sjøgata; but was demolished in the 1930s to be replaced by the new town hall of Oslo. In many ways the town hall represents the need for change in the industrialized Christiania and is symbolic in the birth of Oslo. I have used the book "*Piberne og pigerne i Vika: av en Christianias-forstads historie*" by Mentz Schulerud from 1963 to supply the thesis with additional information about the area selected.

Figure 1: *Pipervika 1910 & Pipervika 1937*

1.5 The history of Pibervigen

> Stadig var det gamle Vika – det som ble kalt Piperviken og i eldre tid Gyljandi – i våre tanker. Hvordan så det egentlig ut her før? Hvem levet her i de gode gamle dager? Skjønt, *gode* har de vel ikke nettopp vært dagene her i det gamle Vika – så meget vet vi. (Schulerud, 1963)

In the opening statement of his book, Schulerud (1963) asks how Piperviken looked like in the past. The very same question I asked myself in the beginning of this project. This area, as I´ve learned through this book, has had a great history dating all the way back to the Viking era. In the Viking age, the area was known as Gyljandi (which means "the windy bay") and was in most likelihood fairly empty with residents in the early days. It was not before king Håkon V decided to build his castle at Akersnes around the 12th century that the area was being inhabited, where the first residents lived on the crumbs that fell from the kings' tables. Schulerud writes that from early on, it was Pipervikens destiny to live in the shadows, first in the shadow of the castle, then in the shadow of the city Christiania, then again being overshadowed by the amusement area of Tivoli and Cirkus. The street known as Søgaden was the last remaining street still representing the old structures of Piperviken before being replaced by the new town hall. Schulerud states that "it is a transformation in reality – the likes of which can only be found in fairytales" (Schulerud, 1963, p. 19).

The City Hall project was initiated by Christiania's former mayor, Hieronymus Heyerdahl, in 1915. He put out the proposal to build the town hall in Pipervika because he felt that a representative town hall on the oceanside would be visible if you came by sea. He also noted that the area was one of the ugliest and least appealing areas in the city; making this a project to not only show the sovereignty of Oslo, but also clean out the area of poverty (Meling, T. C., 2022).

Piperviken is claimed to be the oldest suburb of medieval Oslo and has been known under many different variations of its name: Peberwiigen; Pebervig; Pibervigen; and Peperviik, to name a few. The name is often related to the pipers and musicians that worked under the king's staff and consequently lived in the area. While it was an area of great poverty from early on, it was also the place where salutations to the monarch's events took place. The area is known to be one of four suburbs that was secluded from the town of Christiania, along with Vaterland, Fjerdingen and Sagene. These suburbs, according to

Henrik Wergeland, would be known as the city's stepchildren. It became a residency for people who could not afford to live within the city walls; foreigners working on the construction of the city; or prostitutes and others less fortunate. It was also the area most exposed when there was a war; it was burned to the ground three times between the 1500s and 1600s. It was also an amusement for the king in 1602, who was on record firing his cannons on the residents of Piperviken, giving a finder's reward for any cannonball retrieved. (Schulerud, 1963, p. 29)

The government of Christiania tried to remove and demolish the area of Piperviken already in 1635, writing a letter saying that anyone who could afford to live inside the city walls will each get their designated spot; anyone who cannot afford it will be evicted and their house will be destroyed. This plan was interrupted by the Swedish invasion in 1658, and the area was burned down so that the Swedes could not use the area for cover. It was rebuilt every time it was destroyed, and under the same bad standards and conditions as before. It was mostly predominated by wooden shacks with next to no standards of design on the infrastructure (Schulerud, 1963).

The area provides rich history when it comes to the clear differences between the wealthy and the poor in the old town of Christiania. The construction of the new town hall is in many ways representative of this struggle, and while the area has had a substantial physical transformation from its earliest conceptions, the history of its people and their struggles are easily forgotten.

In my research I found many interesting areas in Oslo to study and examine. I landed on Pipervika because of the obvious change that had happened with the implementation of the new town hall, and also because of its history and the apparent differentiation in the communities that evolved around Christiania in the 1800s. If I had the time and experience, I would really like to portray the area around the old Klingenberg. It was previously known to be the amusing part of Oslo, where buildings like Tivoli and Cirkus resided. These buildings burned down, and the area has later been rebuilt in the same fashion as the area I have chosen myself, depicting the progression of Norway becoming a rich country.

2 General outline of the application

Anno Pipervika is a fully working prototype in the form of a situated simulation that is positioned in the area around the town hall square of Oslo. It gives the users an insight into what the area looked like a hundred years ago. This chapter describes the progression and the functionality of the application from when it started as simply an idea and until the prototype was finished.

2.1 Architectural Research

In the beginning of this project, I tried to find an area in Oslo that has gone through some physical change in relation to its surroundings. After some research I found the area around the town hall square quite interesting. My approach was to look at pictures online using the database of Oslobilder and Digitalt Museum. I accumulated around a thousand pictures of the area all the way from the 1700s to late the 1900s. It became evident that at the time of 1930 there was an ongoing construction of the new town hall. I noticed that the changes in the area had started at a previous date and that the town hall was the final piece of the project to be put in place before completing the change. The street that stood out the most was the street known as Søgaden. One can see some of the buildings of Søgaden in the photos which dated all the way back to the early 1800s. The same buildings appear in the photos from 1930 as well.

The photographs of the area are mostly black and white, but they give a general outline of what the area might have looked like. I used the photographs as a reference point when constructing my models, looking for details or textures I could emphasize in the demonstration in order to get the placement of the housings correct. I used an old map of the area as a blueprint when creating and positioning the buildings in relation to one another. This, in combination with the photographs, gave me a right sense of scale and I was also able to use “Vestbanestasjonen” as a reference point both in the application and on location. As seen below I used different maps in the beginning of the project in the hopes that I would be able to represent multiple timelines in my demonstration. In the end I landed on only using the map from the 1900s.

***Figure 2**: Pipervika 1811*

***Figure 3**: Pipervika 1870*

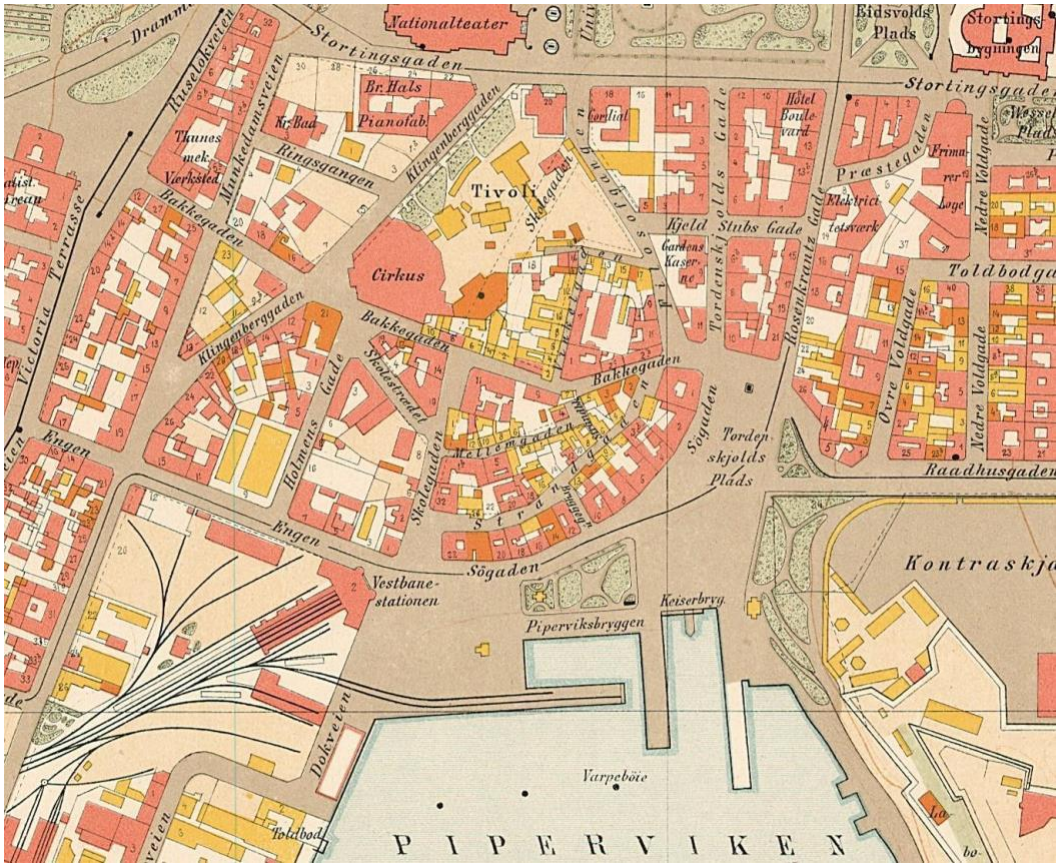

***Figure 4**: Pipervika 1910 – I used this as a blueprint for my model.*

Figure 5: *New map of the area over the old map. Red marking the new, and yellow marking the old.*

Figure 6: *Aerial photo of Pipervika from 1930, and picture from Blender file.*

Figure 7: *Aerial photo of Pipervika from 1930, and picture from Blender file.*

Figure 8: *The yellow house and the advertisement on the side of the building. Original photo is from 1906.*

Figure 9*: The yellow house. Sjøgata 22.*

2.2 Designing Anno Pipervika

The idea for the prototype was first initiated because I wanted to portray the area in 3-4 different stages of time. One being before any population, another being at the introduction of the first population, the third being the street of Søgaden already half demolished and the last being the installment of the new town hall. This task proved to be very challenging, seeing I had no prior experience in working within this field beforehand. In the early conceptions, I wanted to create an application that consisted of these different levels of development while at the same time being colored by hyperlinks which included additional information about the area. But I only ended up creating one of these iterations, and this is the street of Søgaden in around 1910. This proved to be challenging enough, and my research question needed to be restricted to that of the design, and not its functionalities.

Figure 10: *The city hall and Sjøgata.*

2.3 The design process

The design process consists of seven steps or iterations introduced by Sharp et al. (2011), which is an approach within HCI (Human Computer Interaction) that regulates the creation of a prototype, its testing, the evaluation, and then creating another iteration with new solutions installed.

1. **Idea phase**. What area is prompted for this type of research? I found the area of Pipervika to be intriguing because of the enormous change that had taken place. I also looked at the area of Trefoldighetskirken, and the buildings known as Tivoli and Cirkus. I landed on Pipervika because of its vast open space, which was easily navigable and accessible. This also meant that the connectivity between the device and the satellites would provide a sufficient GPS signal.
2. **Collecting historical research and documentation.** I contacted different historical institutions that may have dated information of the area selected, and I was referred to the online sites of oslobilder.no and digitalmuseum.no. These sites provided me with

information in the forms of photography or old paintings, and I found additional information about the area through the book *Piberne og pigerne i Vika: av en Christianias-forstads historie* by Mentz Schulerud from 1963.

3. **First test on location.** These tests are often related to the issue of connectivity between the terminal (iPhone or iPad) and the satellites which provides for an accurate GPS location. The area around the city hall is close to the sea and has no tall buildings or any obvious blockers that would interfere with the connectivity and therefore proved to be a reliable area.
4. **Production of 3D models.** Every one of the objects I have created for this application was created through the use of a free software known as *Blender*. After these models were created, they were exported into another program called *Unity* which is a game engine that uses these models to create a prototype in the form of a simulation to run on devices such as the smartphone or the tablets. The 3D modeling was both a demanding and creative process in which I had no previous experience with dealing with such solutions or possibilities.
5. **Content creation.** While previous iterations of such simulations has carried out the use of hyperlinks and diverse audiovisual techniques in order to enhance the user experience, my model is simple in that it is a purely static solution constructed to examine the user experience of these graphical solutions. The main creation which takes place in these situated simulations is the creation and demonstration of an alternative environment which is rooted to a specific location. These environments demonstrate the relationship between today's urban landscape and the reconstruction itself.
6. **Second test on location.** This test was used to investigate positioning and orientation, and that the application worked as intended. This test was the first time I could see if the calibration between the old reconstruction would match the present physical environment.
7. **User testing with a survey.** The last and final point is testing the application through other users. The users in this case are students from the University of Oslo with different research backgrounds. This is followed by a questionnaire of 22 questions enquiring about the experience.

This application is mainly constructed through the use of four different software's: Blender, Unity, Xcode and TestFlight. Blender is a free software program for the MacOS and

Microsoft Windows and is considered one of the main actors within the 3D modeling community. I used the old photographs to detail out specific features of each house, and also used the photos to determine what texture I should use to best match the photographs. I had a challenge in finding out the differences or similarities in the color choosing of each object. But I found that old paintings of the area in combination with information from Byantikvaren gave a reliable source of information regarding the predominant colors used in that era.

After modeling and texturing every object, I needed to prepare them for exporting them into Unity. Unity is a game engine which does not have the capacity to create these models itself, only to modify and arrange them. This program is generally used for creating interactive content and serves as the implementation of the models created.

After implementing all of my objects into Unity this then needs to be verified through Xcode. Xcode is an integrated developing environment (IDE) tool connected to Apple. This software is used to create applications or other software for Apple that functions on the iOS system. It supports the source code for programming languages like C, C++, Objective-C, Java and many more.

After these stages, the application is exported through the application known as TestFlight, which is a downloadable application that is able to run these prototypes and make them ready for use on IOS systems such as the iPhone or the iPad. TestFlight is a beta testing/mobile application distribution software which allows developers to do a limited testing of their prototype. These platforms or systems are in a continuing development stage, so there are certain limitations to converging materials and applications to such platforms. They do not have the inherent computing power of personal computers, and so they are restricted in how much information they are able to contain. When creating these 3D models, there are many concerns regarding the construction of objects which are to be presented through a handheld device. One thing I needed to be wary about was how many triangles and polygons I had included in my overall model. These terms are connected to the efficiency of the visual elements, where each of the models are constructed of different polygons and each of these polygons consists of triangles and vertices. If any of these are intertwined or interfering with each other in any way, the visual representation suffers. And if the overall model consists of too many polygons and triangles, the handheld device is not able to generate the virtual representation because of the limitations in hardware.

With no background in working with 3D modeling, the process of taking low-resolution photographs of an area and turning them into a high-fidelity prototype (Sharp, et

al., 2011) is both a very demanding and interesting way of research. In my application I first wanted to include three different representations of the area within the simulation. I therefore started with trying to model the city hall of Oslo. I contacted different institutions and searched everywhere online before I found actual blueprints from the construction of the building. I probably spent about three months integrating the blueprints into the program, and then using them as a scale and reference when creating my object. The interesting thing about designing 3D models is what used to take months now perhaps only takes a day, or even a couple of hours. I created about four different city halls before I found an approach that I liked which correlated with the measurements from the blueprint. These models got put away as I needed to focus on depicting how the area looked like before the implementation of the city hall. I then started to think about all the houses that once occupied that space and attempted to figure out how I would be able to model each of them. I was concerned about how the objects would relate to each other, and how they were connected. I used a cropped-out version of a map from the 1900s (see *Figure 4*), then I proceeded to add cubes on to the perimeter of each of the housings before extruding each cube to match the extents of the photographs. I then used the photographs as reference when detailing out the houses and applying different textures. The textures are added on the surfaces on each object in order to achieve a more natural look. After modeling the houses and positioning them correctly, I built a simple construction of "Vestbanestasjonen" located in the western point of the area. I then added the underlying foundation of the area where I added the tram rails, the park, the dock, and the water. Later I added the pavement surrounding the houses and started outlining where the street was. I wanted to add moving trams pulled by horses in this demonstration but that proved to be a larger project than anticipated.

I wrote in my introduction that this is a simple reconstruction. While my initial approach to this project was to be able to generate an environment which had multiple functionalities within itself, my lack of knowledge on the creation of such prototypes proved to be difficult in more ways than one. My intention in design is therefore reduced to that of simplicity in order to study the concept of situated simulation. It is defined as simple because of the static environment; other applications that rely on the usage of virtual environments are often entrusted with different features that create a more dynamic experience such as moving objects, different interaction possibilities and a greater sense of narrative that could be compared to that of a game.

2.3 Navigation

As part of the interactive design method used to create this application. The conceptualized model that is the situated simulation relies on the principles of augmented reality and location-based computing. One of the most distinctive aspects of the situated simulations is how navigation and movement are integral parts of the system. In concept, the movement conducted in a situated simulation functions as a direct extension of how we experience and navigate in the real world, where the movement becomes part of the simulation. This is enabled through the inherent features of smartphones, such as the iPhone in this case. The GPS registers the coordinates of the user and matches these against the location within the simulation. The virtual and graphical representations are already generated through the information found in maps so that the virtual environment pairs with the real environment. The movement of the device triggers features like the gyroscope and the accelerator which in combination with the GPS has the ability to generate low-latency input through the movement of the actual device. These registrations are transferred to the visual representation on display and become a vital part of the demonstration. This technical solution is called sensor fusion, which relates to the important aspect of converging technologies. This fusion creates the correlation between the virtual and the physical environment and is an important factor when it comes to the usability and experience of such simulations (Liestøl & Morrison, 2013). The relationship between the virtual and real environment may enhance the experience of a certain location or in some ways help contextualize the past with the present. The smartphone functions as a conduit for the virtual environment. See the examples below.

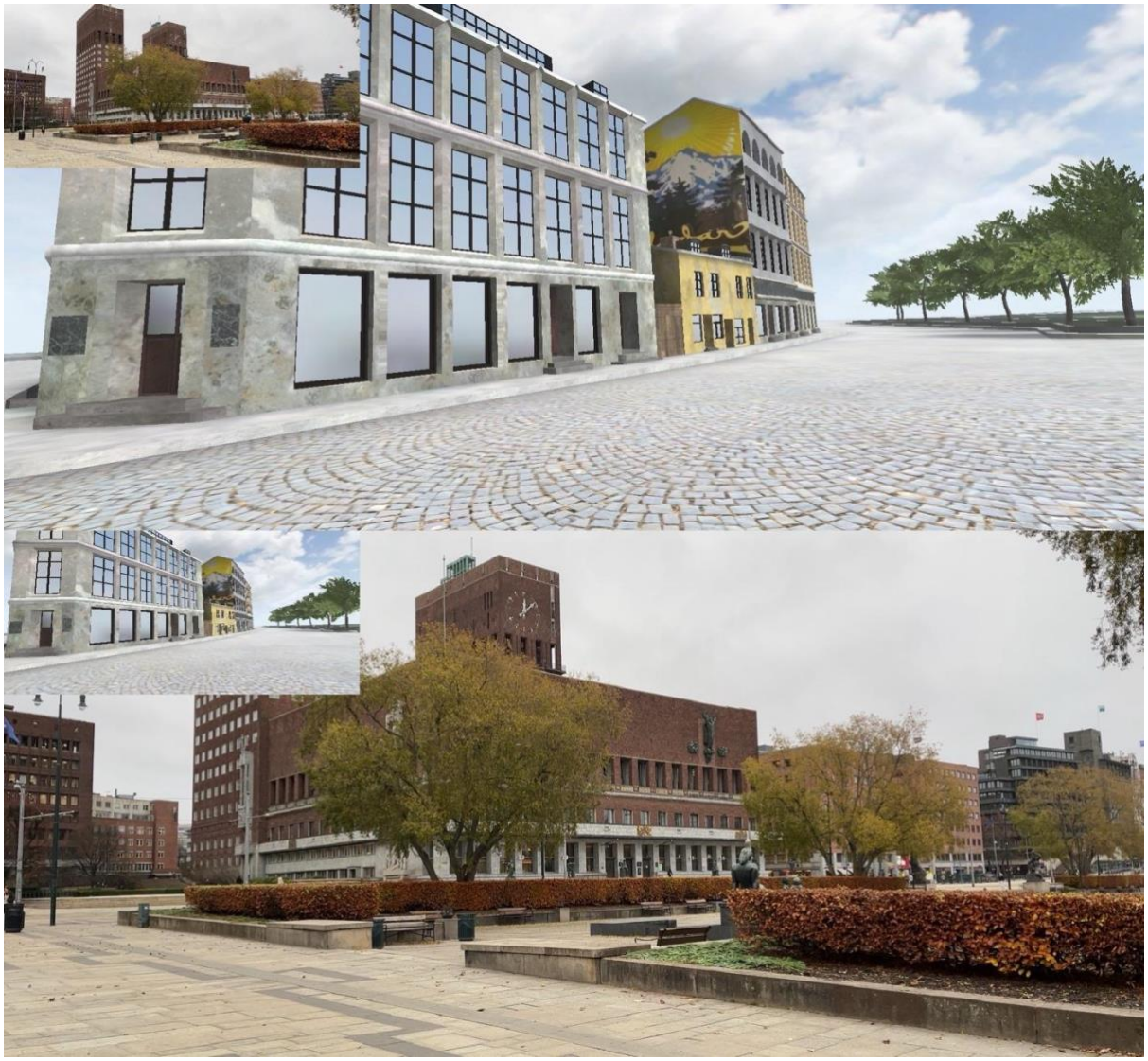

***Figure 11**: Screenshot of the "Snapshot" function found in sitsims. This enables the user to switch between the real and the virtual on display.*

***Figure 12**: Screenshot of the "Snapshot" function found in sitsims. This enables the user to switch between the real and the virtual on display.*

3 Theoretical perspectives

In this chapter I wish to explain the theoretical framework that is the foundation in which this thesis is situated. Theories on augmented reality, location-based services, interaction design, and place specific computing are the four concepts I wish to focus on. The theories provided on Augmented Reality are important to understanding the basic functionality, navigation, and movement in the sitsim. Location-based services (LBS) is the most fundamental aspect of the construction and functionality of the situated simulation, which uses the geographical location of the device to activate the service (application). Theories on interaction design have been used in the construction, testing and evaluation of the prototype. And the theories on place specific computing are serving as a contrast to the typical understanding and implementation of location-based services, and as a perspective on interaction design in location-aware systems.

3.1 Augmented reality

> Like all previous "new" media, what make augmented reality and virtual reality new are the ways in which they satisfy expectations that our media culture has already had, in some cases for hundreds of years. AR and VR are digital media that depend on the recent developments in smartphones (iPhone, Samsung Galaxy, Google Pixel), headsets (HTC Vive and Oculus Quest), and graphics and other software (Unity and WebGL). (Bolter et al., 2011, p. xvii)

As mentioned, an important aspect of situated simulation is its relation to augmented reality or AR. The term augmented reality is described by Milgram and Kishino as a collective term for "all cases in which display of an otherwise real environment is augmented by means of virtual (computer graphic) objects" (Milgram & Kishino, 1994). In these studies, they describe the subsections of AR such as virtual reality (VR) and mixed reality (MR), where MR is described as a subsection of VR. Virtual reality is often a completely synthetic world in which normal laws do not apply, while MR demonstrates the concept of having both "virtual space" on the one hand and "reality" on the other; both being available in the same visual display environment. These differences are found in the scale of ranging between the

completely virtual and completely real, and this is what Milgram and Kishino call the reality–virtuality continuum.

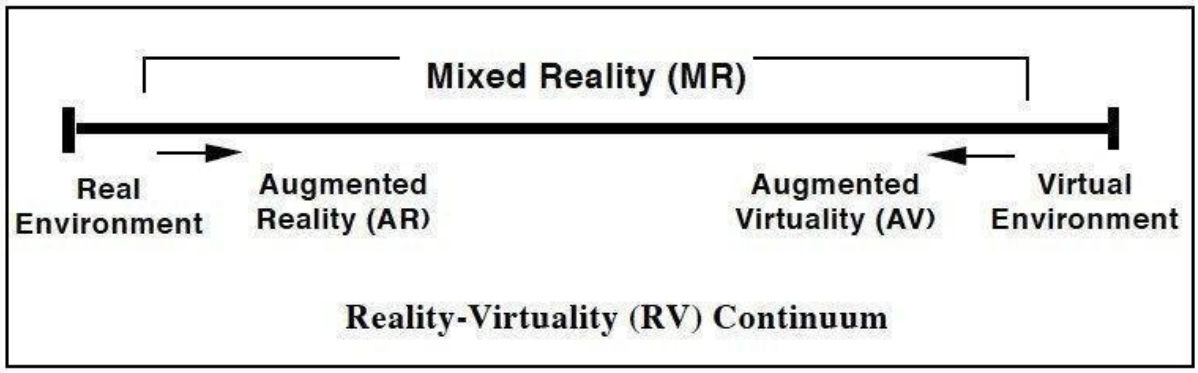

Figure 13: *The Reality-Virtuality Continuum*

There are others who also define AR as a variation of VR; where the difference is that in VR one is completely surrounded by a complete virtual (computer-generated) environment, whereas in AR you are able to visualize your real-life surroundings in synchrony with the virtual. Bolter et al. (2011) explains VR as something that is encompassing and isolates the user within the environment created by the computer. The AR only replaces parts of the physical world, and keeps the user situated in the world.

Azuma et al. (2001) claims that there are three important criterions in the definition of AR. The first being that it combines real and virtual objects in a physical setting; the second is that it is interactive and happening in real-time; and the third is that real and virtual objects are being registered and adjusted when conferring with each other. In this way, the content could be virtual or real, or a combination of both.

There are instances of complete virtual worlds which are designed for humans to interact with each other only by using digital material and sources. The online platform known as *Second Life* (2003) consist of these virtual worlds where the users are interacting with each other through the use of text or audio. *Second Life* is meant to be a complete digital representation of our real-life interactions. But it is a place where you would not need to represent yourself, and the term virtual applies not only to the world, but also the users. They are in fact not only experiencing these virtual worlds and environments, but they are a part of it, deeply associated with the experience itself. In some sense, it may serve as an augmented or enhanced experience, but it is a completely virtual one, which has no linkage to real physical location or place.

The most popular mobile game connected to augmented reality is the Pokémon Go game. This application uses the inherent functions of a smartphone to send information to the application about the users' whereabouts. This would trigger different functions in game in the form of spawns or other additional information connected to the current location of the user (Rauschnabel, Rossmann, Dieck, & Claudia, 2017). Even within the game itself, it provides the user with augmented options. The most apparent augmented function in Pokémon Go is the moment where you catch a Pokémon. You would get the option to capture the Pokémon with an AR camera, which uses a live feed link of your camera and your surrounding elements to position the virtual graphical Pokémon on your screen. This is a form of mixed reality, which mixes the virtual and the real in real time. It also has a second option of a non-mixed screen where the digital environment is all the users can interact with. This is completely virtually generated and is not affected by the movement of the camera or the exact position of the user. This is called non-mixed reality.

Figure 14: *The difference between AR (on the left) and IAR (on the right) in Pokémon Go.*

In the research done by Wither & Azuma (2011), they propose a new type of mixed reality experience which they call indirect augmented reality (IAR). They claim that AR projects in general "suffer from poor registration because they rely primarily on built-in sensors (GPS, compass and sometimes gyroscopes) for tracking." In indirect augmented reality, the visual disturbances are non-existent because the entire scene inside of the device is virtual. This notion of indirect augmented reality is what the situated simulations are based upon. Where the importance lies in that the mixed reality boundary no longer resides at the level of display. The frame of the display has itself become the border between the computer graphics generated environment and the real (Liestøl, 2011a).

> AR requires precise tracking, even more so than VR does. For many AR applications (especially indoor apps like placing virtual furniture in a room or playing a desktop game), the system needs to know exactly where the user is looking in order to line up graphical images with her view of the physical world. (Bolter et al., 2011, p. 6)

3.2 Indirect augmented reality

Liestøl & Morrison (2013) claim that the alignment of the real and the virtual has been the defining quality of mixed and augmented reality. But when it comes to indirect augmented reality, the problem of alignment with the live video feed and the 3D graphics layer on display no longer serve as an issue. The indirect augmented reality is more concerned with the "relationship between the visual information on the display and the real-world perspective outside the display of the device" (Liestøl & Morrison, 2013, p. 24). It differs from augmented reality in that it does not rely on the display of both the real and the virtual representations utilizing the same screen space. It is indirect because the user is able to register both of the representations simultaneously when interacting with the design. The situated simulations are created to operate as an extension of the terms and criteria Azuma et al. (2001) present in their research. This involves the combination of both real and virtual elements; it should be interactive in design approach, and the registration and representation of both real and virtual components are represented in real time.

> Given these qualities, situated simulations have proved suitable for representing, on a given location, an item or topic (knowledge and information), which is relevant to that

> specific place or site, but which is some way or another absent or not accessible to the user. These could either be objects that have ceased to exist, that are hidden or have not yet come into being. (Liestøl, 2011a, chap. 2, para. 2)

Münster et al. also agrees that mobile augmented reality has the ability to indulge itself more easily in topics or subjects that are inherent to the studies on cultural heritage.

> AR environments allow the user to combine the virtual data to the real world (in place), using mobile platforms. In this way they allow for a better understanding of the elements of visible and non-visible cultural heritage, not only in the present, but also in the past and future (re-present). (Münster et al., 2020, p. 74)

While these approaches to design is closely related to the technicalities and visualization techniques found in augmented reality, the overall experience and perspective in which these simulations are being represented are slightly different from the traditional experience of AR or VR. Most augmented or virtual reality applications need a conduit in the form of glasses or a headset. At the same time, most of them could be turned on and used anywhere. Bolter et al. (2011) states that the development of powerful smartphones began to make AR accessible for a large mass of potential users who already owned a phone; and that this has encouraged the development of solutions within the studies on augmented reality in general.

In reference to Milgram & Kishino´s (1994) description of the virtual-reality continuum, indirect augmented reality, or the situated simulation, may find itself in the center of this continuum. Where the real and the virtual elements are not mixed in the traditional sense, but where the real environment is actually present through the users' eye; only using the virtual elements on screen to enhance and contextualize what can be seen on location. Liestøl claims that the digital representation of the virtual environment is only half of the experience. This design approach is reliant on the real environment in order to contextualize the design's intentions (Liestøl, 2011).

3.2.1 Indirect augmented reality in sitsim

The situated simulation has been identified as a form of non-mixed reality, or indirect augmented reality, which uses the full screen for the digital representations. This provides more screen space and has fewer problems with calibration (Liestøl et.al, 2011). Even though comparison and alignment of real and virtual objects are an important feature in Azuma et al. (2011) criteria of AR, solutions such as the indirect augmented reality does not interfere in the calibration between the virtual and the real, and therefore it has a larger capacity for graphical solutions, additional features, and general interaction with both the real and the virtual. These applications are a demonstration that presents an alternative version of the environment in which the user is situated (Liestøl, Smørdal & Erstad, 2015). These simulations use all the sensory capabilities of the smartphone and utilizes them through a prototype which functions within an indirect augmented reality system. It is a simulation because it is a virtual constructed computer-generated environment designed for a purpose, and it is situated because of the importance of place, both in the framework of location-based computing and in relation to historical objects. Previous projects that the INVENTIO-team has done are applications like the *Old Narva* (2019), *Omaha Beach* (Liestøl, 2018) and *Phalasarna* (Liestøl & Hadjidaki, 2019), to mention a few. These applications, though they provide different research and findings, all use the same integral features of a smartphone or tablet to reconstruct lost architectural buildings that once were established on a specific location (Liestøl & Morrison, 2013).

Another important aspect that separates the situated simulation from other augmented reality applications is the aspect of motion and navigation. The smartphone functions as a medium that illuminates the environment for the user. It generates the virtual content that is highlighted by the motion and direction of the phone, and it is also affected by the actual movement of the user. This makes the application function as a digital walk-in closet; not because of the option of different clothing, but because the smartphone functions as a gateway between the virtual content and its receiver. Even though my application is that of a static environment, the creation of these 3D objects and its integration with the smartphone still creates a navigable environment. This dualistic perspective which occurs between the interaction of virtual and real objects creates the notion of something that remains hidden for the visible eye and may only be activated through a designated lens. The combination of the virtual and the real in situated simulations is closely related to Gregory Bateson´s (1979) notion on double description.

3.2.2 Double perspective

According to Bateson's notion (Bateson, 1979; Hui, Cashman, & Deacon, 2008; Bøe, 2021) on double description the idea is that the combination of two or more sources of information provide another understanding or new qualitative information which is not inherent in either of the original sources. Bateson associates this description with the notion of stereotypic vision, which states that the human eyes generate two different images of reality, but which in real time are understood as one. This quality of "oneness" cannot be traced back to its original source, "but emerges as a new quality in the combination of the two" (Liestøl, 2009a, chap. 5, para. 3). According to Bateson, "the two-eyed way of seeing is itself an act of comparison" (Bateson, 1979, p. 87). As seen in *Figure 5*, the new map of the area is added to the old map which creates this kind of double perspective where you are able to experience both of the perspectives at the same time. The situated simulation is a visualization of both of these perspectives, which is reliant on the location of the "new" map in order to project the "old" virtual elements that once occupied that area. The effect of the double perspective in this example does not share the effect of stereotypic vision which may be found in the experiences of the situated simulations, they only display how two perspectives may correlate. The sum of this correlation is what relates to stereotypic vision.

The idea of a double perspective in relation to the situated simulation describes the combination of two different perceptions, such as the real and the virtual, which in combination creates this double perspective. This makes it "possible to present (on screen) topics and subject matters, which are otherwise (in reality) absent or invisible" (Liestøl, 2009a, chap. 3, para. 1). These subject matters may include topics from the past, present or future. Liestøl also distinguishes between three modes of the state of the simulation and the user's relation to it. These are static, dynamic and/or participatory. I compared these terms with the three levels of learning from Bateson which Liestøl & Morrison (2013) presents in an earlier article which states that the *first* consists of the mere reception of information (zero learning); the *second* being the placing of information in the context of other information one achieves a new comprehension (learning how to learn); and the *third* is the comprehension of the diversity of contexts to place that information which constitutes yet another level of learning (how to learn).

Anno Pipervika is an example of static objects that are reconstructed to their original past shapes and are virtually placed in their former context. In these simulations there are no actions or events taking place, and the user is navigating and experiencing the environment in

an experimental mode. In this sense, I would call my demonstration a simple construct which emphasizes the concept of visualization.

> In the experiential mode the purpose is to create the experience of being present there in real time, or at least have access to this particular place in time. In the informative mode the purpose is not primarily to create an experience but to inform the user and convey knowledge on the subject matter. (Liestøl, 2009a, chap. 4, para. 3)

The dynamic simulations are described by Liestøl as events depicted. This could be future events where one could portray or demonstrate, as an example, how much the sea level would rise as the average temperature increases. In a comparison to Bateson, I would argue that the dynamic aspect of a simulation may be understood as the interactive one. Interactive through navigation in the application and in the relationship between the device and the application itself, while at the same time the information that is accessible transcends the static environment. It is additional information in the forms of audio, hyperlinks, videos, or other design methods such as gamification, or different usage of perspectives such as the *featured views* that would enhance the application to be more interactive (Liestøl & Morrison, 2013; Münster et al., 2020).

The user is learning how to gain information through the application, and at the same time contextualizing the information in real time. The context in both cases represents the same thing. It relies on the comprehension and the cooperation of the other two in order to surpass and combine that which is given. In his paper, Azuma (2015) suggests a threefold taxonomy for location-based mixed reality storytelling, suggesting *reinforcing*, *reskinning*, and *remembering*. His definition of remembering is in many ways natural to connect with contextualization, where "one augments a place with memories and stories so that a new experience is created that is more powerful than the real location by itself, or the virtual content by itself" (Azuma, 2015, p. 26). In the case of the situated simulation, there is obviously nothing stopping anyone from gaining information about any of the areas which has spawned a situated simulation, and it stresses the importance of mixing information together and wrapping them up as something new.

3.2.3 Contextualization

Through his research regarding film theory, Sergei Eisenstein (Eisenstein, 1949) suggests that there are five different "methods of montage" in the production and editing of a film. While some of these methods could be related to this thesis, it is the last method which Eisenstein calls for the "intellectual method" I find the most relevant. The definition of Ronald Azuma's (2015) *remembering* I presented earlier shares this idea of contextualizing different information in order to gain a higher understanding of what is being presented, or how it is digested. Many theories seem to share this holistic notion that the sum of the whole is greater than the sum of its parts. As a continuation of this idea, Liestøl describes the term "meaningware" which is "the level of textual discourse where digital material markers are employed to communicate and exchange information, meaning and signification." (Liestøl, 2009a, chap. 1, para. 2) The illustration of information and how it may be received is an important aspect when it comes to theories related to interaction design.

3.3 Interaction design

The studies on interaction design done by Sharp et al. (2011) claim that the aim of interaction design is to reduce the negative aspects related to the user experiences and enhance the positive ones. The negative effects are linked to feelings of frustration or annoyance, whereas the positive aspects include terms like engagement and enjoyment, which are perceived as easy, effective and pleasurable to use. Another important aspect is the usability of the design. It needs to be easy to learn, effective to use and provide for an enjoyable user experience. In interaction design, there is an importance in who is going to use the product, how it is going to be used, and where it is going to be used. Sharp et al. suggest that "Another key concern is to understand the kind of activity people are doing when interacting with the product" (Sharp et al., 2011, chap. 1.2.1, para. 1). They define interaction design as "designing interactive products to support the way people communicate and interact in their everyday and working lives" (Sharp et al., 2011, chap. 1.3, para. 1). It is about designing user experiences that enhance and augment the way people work, communicate, and interact. Some may reference it as the designing of spaces for human interaction and communication (Messeter, 2009), and some may emphasize the products and their technical aspects. In fact, they are related to each other in more ways than one. Interaction design is the interface of many different technologies and is connected to the usability of a product, see *Figure 15*.

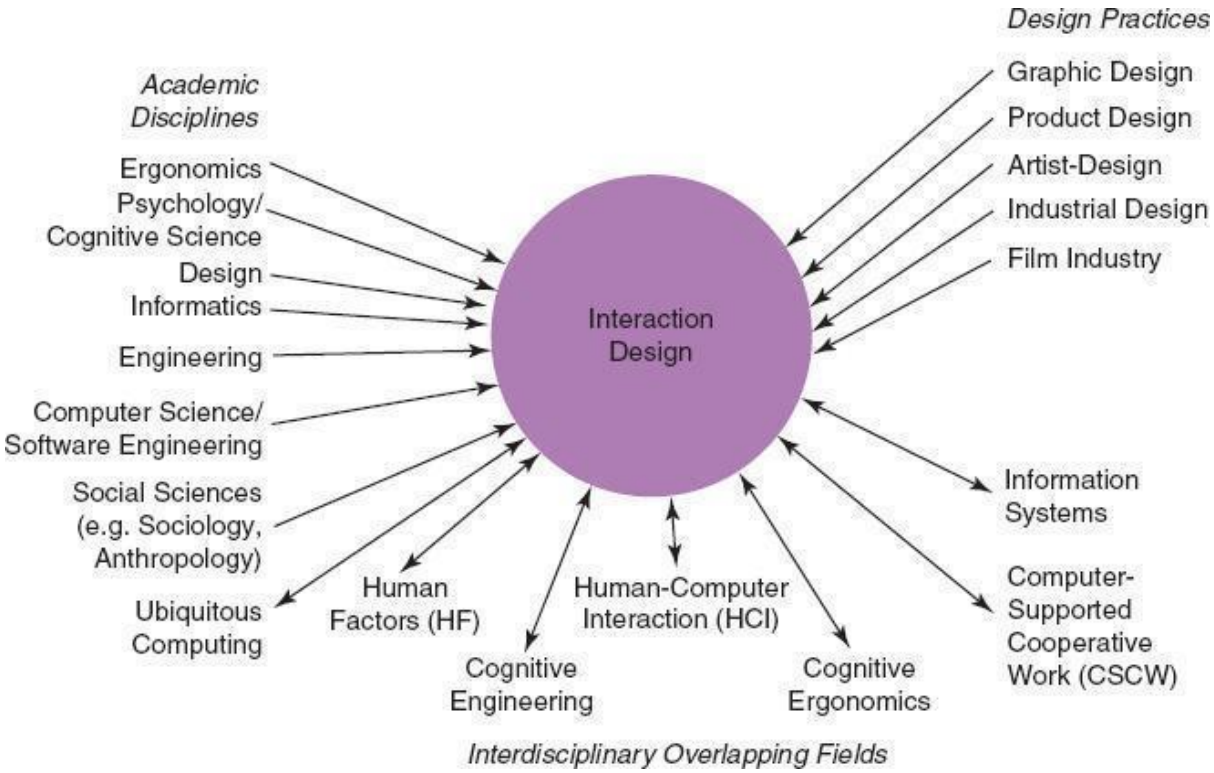

Figure 15: *The interdisciplinary fields of interaction design*

The most important aspect of interaction design is the user experience. Any interaction with any product will be associated with a user experience. The reading of a newspaper, going to the movies, booking a plane ticket, buying groceries etc. The user experience is the overall sum of the experience of each part of the product. It is the overall impression of the feeling of it, its usability, and how it can satisfy certain needs or just simplify everyday life. Sharp et al. points out that "It is important to point out that one cannot design a user experience, only design for a user experience. In particular, one cannot design a sensual experience, but only create the design features that can evoke it. (Sharp et al., 2011, chap. 1.4, para. 2)

My emphasis on the smartphone's applicability and as a widespread commodity is an important aspect because the user experience of such devices has already been grounded and established as a positive experience. I think the idea of using a personal device such as the smartphone to access information that is invisible to the eye, such as the virtual elements provided by the simulation, is one of the most intriguing aspects of the sitsim projects. Would the experience be as significant if one were to access these simulations from home? The approach in design to place-specific computing and location-based services serves as a contrast to the approaches of the widespread applications that only needs to be downloaded in order to function.

In their studies, Sharp et al. (2011) claim there are four basic activities that need to be involved in the process of interaction design. These are:

1. Establishing requirements
2. Designing alternatives
3. Prototyping
4. Evaluating

These four activities are grounded in what they call a user-centered focus. Where one needs to establish the requirements of the users to design an alternative, to test this alternative Sharp et al. suggest creating a prototype which is being evaluated through user testing. To evaluate what has been built is at the "heart of interaction design" (Sharp et al., 2011, chap. 15, para. 2), they state that the process of interaction design should be based on a user-centered focus, which means that the users often are included or involved throughout the design process. In the case of *Anno Pipervika*, I chose to do this through observation followed by a user study.

Another important aspect of interaction design is that one size does not fit all, and that there is a weight towards the intended user group when creating a product. An example of this can be seen in the studies of Borrehallen, where the young students had a different experience with the product than the other group consisting of senior citizens (Liestøl et al., 2012). An example of design where users were not included in the process before it was produced was in the release of the 3D television. The annoyance and frustration that related to usability of these 3D glasses would overcome the joy of experiencing 3D television at home instead of the cinema. Sharp et al. ask, "Will it be unpleasant having to constantly switch between the real world, a 2D display, and a 3D TV? Or will it become second nature?" (Sharp et al., 2011, chap. 2.2, activity, 2.1)

While this example may not serve a purpose in the design of *Anno Pipervika*, I felt that the notion of something becoming second nature is an important aspect in the discussion of interaction design seen in relation to mobile technology. The strive to digitize our everyday tasks or interactions has enabled the growth of new technical solutions, their accessibility, functionality, and applicability. Products like the smartphones have arguably become second nature for most of the human population. Its applicability to most digital media makes it a highly interactive device, and combined with its connectivity, the smartphone may be the most practical interactive design ever created.

3.3.1 Types of interaction

While the smartphone serves as an interface or as a mode of interaction itself in relation to the situated simulations, it also enables the type of interaction through its features in the form of the indirect augmented reality system. This form of interaction is constricted to the technicalities that relate to location-based computing on location-aware systems. Sharp et al. (2011) claim there are four different types of interactions in interaction design:

1. Instructing: This relates to how the user instructs the program in the form of issued instructions.
2. Conversing: This where the user is in dialog with the system. Where users can speak through an interface or type questions to which the system replies.
3. Manipulating: This is where the user can interact with objects in a virtual or physical space by manipulating them (e.g., opening, holding, closing, placing). Users can hone their familiar knowledge of how to interact with objects.
4. Exploring: This is where the user can move through a virtual environment or a physical space. These include 3D worlds or augmented or virtual reality systems. Users can hone their familiar knowledge of physically moving around.

The characteristics of the situated simulations are often related to their ability to manipulate and explore the virtual environment they have created. Manipulation involves the knowledge of how people interact with objects in the physical world and is implemented through the usage of computers. Here one would have the ability to zoom in on certain objects, click on them, open them up, or close them. These actions can be reproduced through the use of physical controllers, such as the smartphones, or as in early iterations of digital manipulation – the Kinect feature of the Xbox or the Nintendo Wii console.

The situated simulation is also a very exploratory type of interaction. This type of interaction happens when the user has the ability to explore a virtual 3D environment, such as the interior of a building, or as in the case, the exterior of an old structure that used to inhabit a certain location. In situated simulation, the important aspect of navigation and perception of space is a key factor of the user experience. Sharp et al. states that “the fundamental idea is to enable people to explore and interact with an environment, be it physical or digital, by exploiting their knowledge of how they move and navigate through existing spaces. (Sharp et al., 2011, chap. 2.5.4, para. 1)

3.3.2 Genre design

An important aspect on how situated simulation separates itself from other solutions, is the fact that the user is connected to the area in which the simulation takes place. While it may seem sufficient to make the content user-centric, meaning that the application could be downloaded and used at home like through a browser, the simulation would arguably not have the same effect. The combination of old virtual structures that would appear on the future structures visible for your own eyes is the *experience* of a situated simulation. But genre design does not only apply to the technical aspects; often it is driven by additional features that would help improve the experience in the direction of being more manipulative.

In an effort to change the conditions of the static environments which are often presented in digital reconstructions, Liestøl suggests a link-node structure that he calls the "Balloon Label" and the "Balloon Link" (Liestøl, 2009b). These links are hovering in the air and are visually tied to the object of the place that is the topic of research. These additional features may also include the construction of different narratives which may be portrayed as more playable than other static solutions (Liestøl, 2018). There are many different design choices when it comes to the construction and research involved with the situated simulations; there is gamification as seen in the "photo puzzle" example presented by Liestøl (2019), or in solving the "Centre-periphery problem in cultural heritage" (Liestøl, 2012), which discuss how relics or historical artifacts are often being moved from their initial position in order to be displayed. There are also studies relating to the educational value of these solutions (Liestøl, 2009a; Liestøl et al., 2015; Smørdal et al., 2016; Münster et al. 2020; Liestøl, G. 2011b). This form of expression is used to "improve the quality and quantity of relevant contextual information available at a certain place and time" (Liestøl, 2011, p. 2). The combination of the real and the virtual creates a new foreground for location-based technology where the obvious comparison between the virtual and the real creates a notion of something new. Design genre in digital media is not constricted only to the presentation of verbal material, but it is the method of invention of new forms of expressions. In entertainment there are many different categories or genres to choose from, and it is human nature to keep fracturing these genres into smaller pieces to give a broader understanding of its extensiveness. Genre design in mobile augmented reality is an effort of converging and diverging the functionalities and sensory applicability of the smartphone, or other mobile devices.

3.4 Location-based services

Innovations within mobile computing is ever increasing and developers are always looking for new ways to enable devices to support commonplace activities. These commonplace activities may involve finding out when the next bus home leaves the station, what route to follow when going to the cabin, or if you're wondering which restaurants are open in your vicinity. All these examples involve the concept of location-based services (LBS). LBS are often related to mobile devices with network access and positioning technologies. And unlike many other computer applications, LBS is fundamentally service-oriented, which means that the "streams of location-sensitive information to the user have to be supplied and maintained" (Raper, Gartner, Karimi & Rizos, 2007). An example of a stand-alone LBS-system is the GPS devices. The determination of location is a detrimental part in how the LBS functions. The technology needs to answer questions like "where am I, the user", "where is the target, or object", and "how do I get from A to B using a route optimized against certain criteria"? (Raper et. al., 2007; Bolter et al., 2011). Where the target or object is situated in *Anno Pipervika* is based on the location of the object "Vestbanestasjonen". The built-in GPS in the smartphone relates the users to the object, and the virtual environment created.

The research done on LBS by Huang, Gartner, Krisp, Raubal & Van de Weghe (2018), has shined a light on the development of the services or applications that are being made based on LBS. They claim we are evolving into becoming a mobile information society, where (anytime, anywhere, for anyone and anything services are being developed to benefit our human society and environment (Huang et. al., 2018). They divide these services into different categories such as location-based social networks, location-based gaming, location-based fitness monitoring and healthcare, transport LBS, and location-based assistive technology. While they are all somewhat applicable to the situated simulations, Huang et. al.'s definition of location-based gaming is probably the most relatable:

> Location based gaming (LBG). Typically, LBG maps real world environments into a virtual world, where players must move themselves in real life to explore the virtual world and accomplish tasks related to the game itself. The maps, tasks, and other contents presented on the mobile devices are adapted to the location of the player. (Huang et. al., 2018, p. 67)

In most of the iterations of the situated simulations the development is growing steadily towards implementing gamification, or other forms of manipulation in their genre designs. Where additional tasks, features, or set of goals are integrated into the simulations in order for them to become "playable" and not just function as exploratory in the sense of movement and navigation.

3.5 Place specific computing

In his article, Jörn Messeter (2009) claims that there has been an increased interest in the notion of place in interaction design based on wireless infrastructures and with newer developments in digital media. He states that "the idea of ubiquitous computing was that low-cost technology embedded in the environment, in combination with mobile devices, would make access to computing resources available everywhere. In essence, the world would become the interface" (Messeter, 2009, chap. 1, para. 5.).

It seems obvious that the interaction with real-life elements which are enabled by our phones is a natural foundation for studies on interactive design. Messeter suggests place-specific computing as a genre design enabled by location-aware systems such as the smartphone. Place-specific computing is suggested as an alternative to the user-specific computing approach within the discourse of digital design, whereas user-specific computing often is connected to an application that is downloaded and could be used anywhere in the world and is often marketed for a specific user group. The place-specific computing group of users are only determined by the place in which it is designed for. Messeter claims that "place-specific computing is a design approach that should not only be grounded in deep field studies of place and its social, cultural and material conditions, but must also account for the dynamics of place and continually change these conditions" (Messeter, 2009, chap. 5.8, para. 2).

3.5.1 Sense of place

Messeter claims that the recent changes in the landscapes of interaction design have warranted a renewed concern for how we relate interactive technology to place. These changes are mainly driven by the development in mobile and global computing both in the utilization and its technologies. Messeter states that the strong connection of wireless infrastructures and networks provides increased connectivity; this, in combination with the development of mobile devices has increased their applicability and expanded on their functionalities. Although most of the applications found today are what Messeter calls

location-based services, which includes applications like *Google Maps* or other applications that utilize the users' current geographical positions for navigation, he stresses the importance of furthering the developments in applications created for location-aware systems such as the smartphone (Messeter, 2009). Messeter also sees the important potential in the contextualization of different content on location-aware systems, where the focus should be on the content of information and the information delivery. He gives an example of one the first location-aware systems called *CyberGuid*e which was "a mobile context-aware guide, which uses location and the history of past locations to provide contextual information to tourists" (Messeter, 2009, chap 2, para. 1).

Messeter states that the "user-centric perspective and lack of contextual grounding in location-aware systems motivate the exploration of a place-centric perspective for the design of digital systems and services" (Messeter, 2009, chap 2, para. 4). This place-centric perspective is not restricted to the delivery of place-specific content but also includes the notion of the *here-and-now*, as opposed to the *anytime-anywhere* approach. As mentioned, one of the important aspects of the situated simulation is its connection to place, which resonates with the feelings related to the here-and now. This connection is strongly related to the navigational aspect that derives from the fact that the smartphone is used as conduit in producing and displaying the virtual environment. This environment is connected to the users' location which may generate an experience of an enhanced perception of the surrounding environment.

Figure 16: *Photo from the user testing showing how the smartphone functioned on location.*

3.5.2 The distraction

The loss of the here-and-now, or perhaps also the lack of general awareness, is arguably one of the most used arguments in the case of handheld devices; where it is claimed to be a source of distraction either in relation to learning, working or just in the general interaction with other people. The anytime-anywhere approach has proved to be successful when it comes to its applicability to mobile devices. It is something which is generated upon need, and its accessibility is persuasive. While there are different studies that proves that in the case of learning, the use of applications like situated simulations are helping students to contextualize information easier through the use of interactive devices (Münster et al., 2020); Liestøl, 2011). And in cases like Borrehalen (Liestøl et al., 2012), the difference in the study groups proved that the younger children were easily engaged with the technology itself, while the senior citizens were engaged because of their interest with the Viking settlements and culture. In this sense, I would argue that in the case of situated simulation, or place-specific computing done on location-aware systems, need to engage with the user base of such devices. The applicability of smartphones may very well serve as a distraction if not suited for its user group.

> As a genre of interaction design, place-specific computing may be described as computing in which the designed functionality of systems and services, as well as information provided by these systems and services, are inherently grounded in and emanating from the social and cultural practices of a particular place, and account for the structuring conditions of place – social and cultural as well as material. (Messeter, 2009, chap. 6, para. 1)

Is there a possibility to make the younger students of the Borrehallen experience to be more interested in the era of the Vikings and its history; and at the same time make the senior citizens more interested in the technological representation? While place-specific computing is entirely connected to location or environment, interaction design is related to the communication between the project and the user, and it's where the improvements happen.

The general principle of interaction relies on that of participation. And in general, most forms of participation need to create a sense of meaning, or understandability. Messeter brings forth the notion of embodied interaction which emphasizes the qualities of participation with our immediate surroundings. He argues that embodiment is about establishing meaning, where the "underlying purpose of embodied interaction is to let us engage with technology in ways that allow the development of meaning of use as it is incorporated in practice" (Messeter, 2009, chap. 1.4, para. 2). Liestøl calls this level of textual discourse for *meaningware;* the digital domain where digital material markers are employed to communicate and exchange information, meaning and signification. It is the domain where the individual messages and texts reside (Liestøl, 2009b). Messeter claims that this meaning is not inherent in the technology, and therefore is not completely determined by the designer; it rather emerges through the encounter with technology. This notion of *embodied interaction* (Messeter, 2009), *meaningware* (Liestøl, 2009b), *the intellectual method* (Eisenstein, 1949) or *remembering* (Azuma, 2015) all share the important principle of contextualizing information to increase understandability on a certain subject or topic.

4. Methodology and testing

In this chapter I wish to explain how I used these theoretical perspectives as my methodological approach when creating the prototype *Anno Pipervika.* This prototype was tested out in the field, on location by six participants before they conducted a user survey related to the design and research questions. While the previous chapter discusses the theories on augmented reality, interaction design, LBS and place specific computing, this chapter tries to explain how the approach to design is used as a method within scientific research.

4.1 The user-centered approach

The user-centered approach is what Sharp et al. (2011) mostly emphasize through their studies. This approach is described as being a philosophy that governs the fact that applications and prototypes of interactive design need to be focused on the goals and needs of the user and include them as early in the process as possible. This should be the driving force behind the development of the product, and it will support rather than constrain the user. Through the studies of Gould and Lewis (1985), "Designing for usability", Sharp et al. presents three principles which would lead to a useful and easy to use computer system.

1. **Early focus on users and tasks.** This means first understanding who the users will be by directly studying their cognitive, behavioral, anthropomorphic, and attitudinal characteristics. This requires observing users doing their normal tasks, studying the nature of those tasks, and then involving users in the design process.
2. **Empirical measurement**. Early in development, the reactions and performance of intended users to printed scenarios, manuals, etc., is observed and measured. Later on, users interact with simulations and prototypes and their performance and reactions are observed, recorded, and analyzed.
3. **Iterative design.** When problems are found in user testing, they are fixed and then more tests and observations are carried out to see the effects of the fixes. This means that design and development is iterative, with cycles of design–test–measure–redesign being repeated as often as necessary. (Sharp et al., 2011, chap. 9.2.3, para. 2).

These three steps are a primitive representation of the design process which is being used for situated simulations. And they are meant as a pure form of illustration when it comes to the unspecific representation of interface and/or interactive design. Projects like the situated simulations are based on the principles regarding the creation of a prototype which I will

explain later on. But these principles rely entirely on the role of participation of test subjects, and also involve the observation of these demonstrations to gather empirical data. This whole process is based on the concept of iteration where the prototypes are improving on their qualities and functionalities and are being refined based on the feedback. Iteration within interactive design is one of the most important factors for creating an engaging and enjoyable user experience.

> When the design has been around the iteration cycle enough times to be confident that it fits requirements, everything that has been learned through the iterated steps of prototyping and evaluation must be integrated to produce the final product. (Sharp et al., 2011, chap. 11.2.6, para. 1)

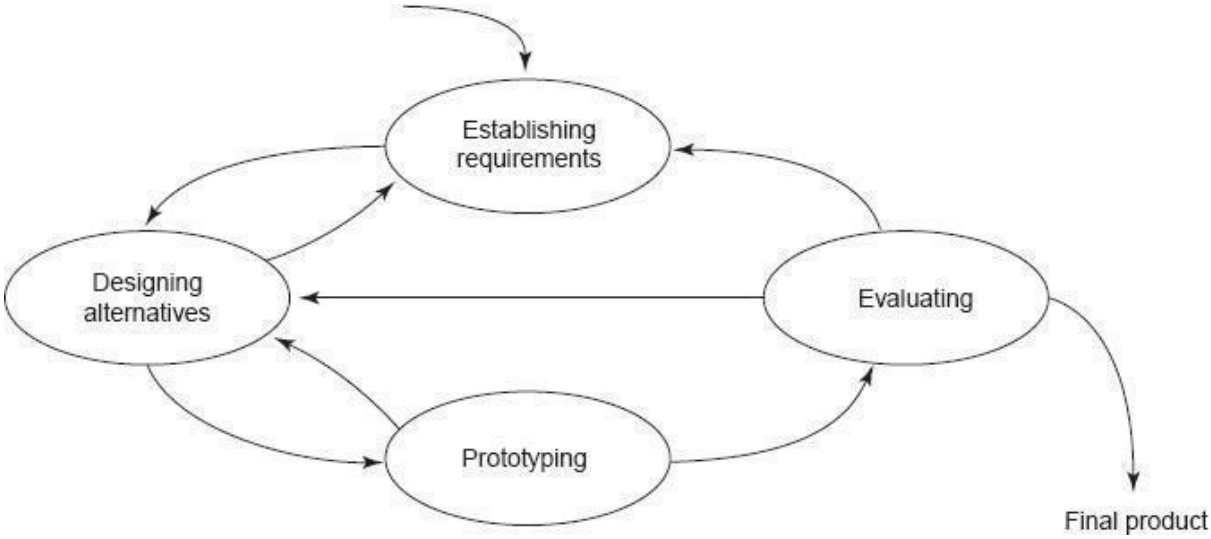

Figure 17*: Method of interactive design*

Sharp et al. (2011) claim there are four basic activities within interaction design, see (***Figure 17)***. It is the establishment of requirements in the user experience; designing alternative solutions which meet these requirements; prototyping alternative designs that can be assessed and engaged with the purpose to evaluate what is being built throughout the process, and the user experience it offers. They state that establishing requirements is essential in the user-centered approach and is very important in interaction design in general. It is essential to understand how the product is going to be used, for what reason, and by whom.

When designing *Anno Pipervika* my target group was somebody who owned a smartphone, as I thought this was the most important aspect of these simulations; that it could

run on a device which most people would not relate to such activities. I initially wanted the application to function as a tool for educational purposes, but I merely managed to create the basic skeleton of such a simulation. Still, the static environment created would give a glimpse into how the area might have looked like in the past, which can only be experienced in another way by looking at old photos or paintings. The smartphone's increasing developments in hardware and software now supports the testing of different designing alternatives such as the situated simulation prototypes as a method in design.

4.2 Prototypes

Sharp et al. describe a prototype as a "manifestation of a design that allows stakeholders to interact with it and to explore its suitability" (Sharp et al., 2011, chap. 11.2.1, para. 1). Prototypes can come in many different forms and are not always related to software. A prototype is merely a type of interactive design which functions as a brief installment of the solutions created. Design approaches like the prototype are more easily tested and evaluated than other forms in that it is clearly applicable and utmost reliant on user testing. Evaluation is needed to create iterations that are increasing the overall user experience, which is the "process of determining the usability and acceptability of the product or design" (Sharp, et al., 2011, chap. 9.2.4, para. 5).

> The activities of establishing requirements, designing alternatives, building prototypes, and evaluating them are intertwined: alternatives are evaluated through the prototypes and the results are fed back into further design or might identify missing requirements. This iteration is one of the key characteristics of a user-centered approach. (Sharp et al., 2011, chap. 9.2.4, para. 6)

There are two types of designs that exist according to Sharp et al. (2011); these are conceptual and physical. The physical is concerned with the structures of the menu, display options and details within the design. The conceptual type concerns the exhibition of what the product will do and how it should behave. They state that creating prototypes out of ideas is the easiest solution for a user to evaluate an interactive product efficiently. These prototypes may start off on a piece of paper or through the use of cardboards; and are created to resemble the final product. In the creation of a prototype, it is often common to empathize on certain aspects of the prototype while de-emphasizing others.

In the case of *Anno Pipervika,* I have reduced the amount of detail and visual resolution in certain objects in order to study the importance of higher quality objects in these simulations. Not only is the construction of these simulations or prototypes important when it comes to the user of such implementations, but in some cases, like in the studies of Mohammad et al. (2014), construction workers or architectural designers for larger projects also see the value in creating prototypes before starting the actual construction. While it only may serve as an unfinished visualization, it enables such solutions to be tested beforehand, and make changes accordingly before a complete installation or construction is completed.

4.2.1 Low- and high-fidelity prototypes

Low-fidelity prototyping could be understood as kind of a rough cut of the final product, in which it shares almost no resemblance to that of the final product. These solutions tend to be more simple, cheap, and quick to produce. The high-fidelity prototype uses materials that you would expect to find in the final product and produces a prototype that looks much more like the final product than in the low-fidelity case. There are claims that a low-fidelity approach is more suitable for generating rapid iterations because of the time it takes to produce one. And high-fidelity prototypes suffer from the fact that it takes too long to build. This makes it harder to implement changes in later stages, and users tend to comment on superficial aspects rather than its content. At the same time there is a "growing interest in producing high-fidelity prototypes by modifying and integrating existing components" (Sharp et al., 2011, chap. 11.2.4, para. 2). The hardware and software that exists within smartphones are one of the driving forces in the field of indirect augmented reality. It seems apparent to me that my prototype, *Anno Pipervika*, is a mix of both low-fidelity prototyping and high-fidelity prototyping. It is a high-fidelity product in a sense that it modifies and uses the integral capabilities of the smartphone. But it exhibits low-fidelity traits in the form of the lacking in detail found in certain objects. It is also low-fidelity in a sense that it does not contain any superficial distractions in the form of different functionalities in order to portray the virtual content that is to be interacted with. In many ways, this thesis seeks to understand how low-fidelity elements can be implemented in a high-fidelity product in order for it to be perceived as purely low-fidelity. How far have we come in our acceptance of the digital representations?

Throughout my thesis I have emphasized on the fact that my representation is a simple reconstruct. While it is simple in functionality, it is also simple in its visual

appearance; it is a simple way of visualizing information. In certain contexts, there is an advantage to simplicity in the representation of information. Think of road signs that are meant to be registered at certain speeds which signals what dangers lures ahead. They are simple visualizations that has value in their rapid comprehension. While they may suit better for high-velocity cases, in the context of digital design, the idea of simplicity might be shared in the sense of comprehension between the content and its intended user. But from a user perspective, simplicity may also stand for an underwhelming experience in regard to the already existing solutions or technologies that does it better. Robert Spence (2014) states that there is an implied assumption to be adding as much detail as possible within a display in order for it to be informative or appealing enough. He rather suggests that the focus should be on instead making these features as useful as possible. It could be argued that my representation of Pipervika may serve as a useful representation of the past because of its simplicity, but at the same time it could be argued that it represents something which should be considered interactive; and a simple representation may not be as useful in that sense. The expectations of the user play a significant role in the experience of any form of interactive design, and as Bolter et al. puts it "we feel the urge to believe in the truth of a photo unless we have good reason to think otherwise" (Bolter et al., 2011, p. 44).

4.3 The science in design

The developing stage of prototypes like *Anno Pipervika* includes extensive research on software engineering, archeological research, and the creation of viable solutions through handheld devices. While all this research went into the design of the simulation, these only explain the technical solutions and progressions. For the design to be considered and analyzed as something scientific, Anders Fagerjord presents seven criterions:

1. The science should produce an artefact in the form of a term, a model, a method, or a sample.
2. The science should produce a technological solution on an important and relevant subject or topic.
3. The artefacts usability, quality and effectiveness shall be demonstrated through a systematic evaluation.
4. The result should be a clear and testable contribution in the form of an artefact, theoretic design-knowledge, or method.

5. Rigorous methods should be utilized in construction and evaluation.
6. Design is an iterative process in which one seeks satisfactory solutions in a concrete environment.
7. The results must be communicated effectively both to technology-oriented and management-oriented audience groups. (Fagerjord, 2012, chap. 4, para. 1)

Fagerjord claims that the inequalities between media and computers are continually getting blurrier; that the producers of content and consumers of content are in a symbiotic relationship within the digital media environment. In his studies, Fagerjord presents design as a research method. It is a research method in the production of visual communication and new systems for textual information. The term "design science" is presented by Fagerjord through the studies of March & Smith (1995), where design science tries to create things that serve human purposes; where it is technology oriented, and its elements are assessed against criteria of value or utility. He calls this normative science, where you first build something, then evaluate it (Fagerjord, 2012).

4.3.1 The synthetic-analytical method

This type of normative science that Fagerjord mentions is an integral part of what Liestøl calls for the synthetic-analytical method. This term was first coined by Gunnar Liestøl in his doctoral thesis from 1999, and is based on the desire that a humanistic theory should be able to generate new texts and not just be used to analyze what others have previously written. This method starts with an analysis, where the researcher formulates a solution to a design-problem. This is followed by a synthesis, where the researcher constructs an example that relates to this solution. The result is then to be assessed and analyzed against previous theories to see if the theory has been strengthened or if it can be modified or expanded. This research uses the last analysis as the starting point for the new synthesis (Fagerjord, 2012).

4.5 Evaluating the design

Sharp et al. (2011) claims that evaluation is an integral part of the design process, where the study and observation of users experiencing the prototype is done in order to improve on the design. The evaluation is focused on that of usability, and the overall experience of the system created.

> More recently, there has been a trend towards conducting in the wild studies in HCI and ubiquitous computing. These are essentially field studies that look at how new technologies or prototypes have been deployed and used by people in various settings, such as the outdoors, public places, and homes. In moving into the wild, researchers inevitably have to give up control of what is being evaluated in order to observe how people approach and use (or not) technologies in their everyday lives. (Sharp et al., 2011, chap. 12.3.2, para. 2)

4.6 Prototype as design method

Much like Fagerjord and Sharp et al., Lars Nyre (2015) stresses the importance of creating a prototype, not just for design purposes, but as a reason for implementing a culture which focuses on creating and improving new digital solutions. He speaks on the importance of educating students that are to work within the studies of media to have an internal environment that focuses on the production of direct technologies. This is to both invent and innovate the environment the students will work within later in life. Design as method derives from the fact that design is both used to exhibit certain types of outcomes in the interaction with the product, and at the same time it is controlled by the development of the interaction design itself. While other research may implement different methods in their studies, they rarely develop the method themselves. Prototypes or systems are examples of design methods that have their foundations in the construction of models to conduct their research.

4.6.1 Invention and innovation

Nyre argues that *invention* and *innovation* are two important aspects of the developments that occur within the studies of media. He claims that an invention is a new practical solution to a technical problem. The invention is a reference to the artefact, prototype, or the content created. Innovation is described as a process that happens after the invention, where the implementation of products that are new to consumers is accepted as that of higher quality.

The evolution of the DVD-players is a good example of the clear difference between the invention of a product and the innovation of one. When the DVD-players first arrived, the DVD-discs were an innovation of the VHS-cassette, but the player itself would be considered an invention. Companies like Microsoft and Sony would later apply or innovate this

technology into their gaming consoles such as the Xbox and PlayStation. This convergence of technologies and its consumers made the gaming consoles more accepted as a player used for DVD-disc, while at the same time being applicable to games. Adaptations from books to movies is a simple innovation in regard to the visualization of information. Streaming services like Netflix, HBO, Amazon Prime and Disney+ are inventions that are innovating the production and consumption of movies and television series. The video assistant referee (VAR) that is found in football or soccer is an invention that is innovating how incidents on the field are being analyzed and later judged upon.

The situated simulations could be considered an invention itself. But as mentioned above, it would seem that most inventions derive from the fact that new innovative solutions now exist or are in the need to be produced. *Simulation* itself is a recognized term which is in most cases related to work forces like the military, pilots, firefighters, oil rigs etc. So as an invention, simulations have existed for quite some time, but using the integral features of handheld devices such as the smartphones is an innovative way of integrating other forms of simulations. Innovation and invention do not only concern the technological aspect, but they also derive from a place of theory such as in the case of their previous successors. These simulations are created rapidly to study their different qualities which makes them unique and then later improved upon. The innovative functionalities that Orkelbog presented in *Holmenkollen Time Travel* ten years ago are now being created and implemented in an entirely new fashion than before, and later iterations of situated simulations often include these functions while testing for something different.

In this thesis I claim that the demonstration is a simple reconstruction of an old structure, where I wish to study the applicability of the smartphone to applications like situated simulations, and to see how simple the models could be textured in some cases while others appeared more vibrant and detailed. I did not add any functionality to this application purely to assess the effect of being present on a selected location which was connected to a digital environment, or an alternative solution of virtual elements related to that location. The invention of situated simulations suggests innovative features within the discourse of augmented reality, human computing interactions, digital learning, location-aware systems, and place-specific computing (Liestøl, 2013).

4.7 Testing *Anno Pipervika*

In this part of the thesis, I wish to elaborate on how the testing for this application was carried out through my personal experience, and also present the findings of the user testing and the user survey.

When it came to the testing of *Anno Pipervika* it was an enduring process of testing and failing. And as a reference to Nyre, it proved to be quite liberating to create technical solutions within an environment such as media studies, which led to practical acquired knowledge on certain topics or subjects. While I had full control of how I created my models in Blender, it was constrained to certain limitations in order for it to be representative in Unity. I had the help of Šarūnas Ledas from *Tag of Joy* when it came to the implementation of my models into Unity; he created the *SitSim Pipervika* as a prototype for TestFlight, which could then be downloaded and used for devices which run on the iOS system. After sending my Blender project to Ledas for the first time, there were a lot of changes that needed to be made in order for the project to be implemented in Unity. They were mostly related to how the objects and their supported textures were linked, and the scaling values of these textures and objects.

When I first got my testable prototype, it was sent to me through a link which I have included in my references (SitSim Pipervika, n.d.). This allows the prototype to be tested through a web browser, without worrying about the sensory plug-ins of the iPhone or the iPad. This looked pretty good, so I gave Ledas the thumbs up, and he began creating a prototype which could be downloaded through the TestFlight.

Another problem arose when it came to the coordination of the virtual with the real. As mentioned in my design of the application, I had used an old map from 1910 to create the framework, scale and positioning of my specific objects. Gunnar Liestøl had mentioned to me early on the importance of geo-positioning when it comes to the situated simulations. It becomes fairly apparent on location when testing the application, and often causes an interference with the experience of the simulation. In the development of my models in Blender, I had created all the objects that the street Sjøgata consists of, and then tried to position and scale them in relation to each other after creating them. This caused some problems in that the visual design choices began interfering with the positioning of the objects which was being measured in relation to the old map of 1910. In order to coordinate this virtual design with the real location, I added the object of "Vestbanestasjonen" as my geo-location point for my project, as its construction dates back to 1872. Because of all the

iterations that my Blender project had gone through, when I added the object "Vestbanestasjonen" it proved to not correlate to the other models. Ledas helped me in coordinating the virtual object created with the real and the coordination of the simulation now matched that of reality.

After solving the problems of coordinating the exact location for my simulation the application, *SitSim Pipervika* was installed on my iPhone through the application TestFlight. I then went down to the location myself to test the GPS signal and calibrate the design to fit the real environment on a micro level. There was no calibration needed because of the anchorage I had in the object "Vestbanestasjonen".

4.7.1 User testing

As explained in my introduction, my emphasis on using a personal device such as the smartphone was an important factor in how I approached the design and the testing of the application. My user study consisted of six participants all testing the application on location before answering the 22 questions in the questioner. Another important aspect for me in regard to testing and evaluation is the notion that users should come from different backgrounds in order to get different perspectives. Out of my six, two were studying law, two were teachers, one was just out of high-school and the last studied programming. While the importance of this is not detrimental to the discoveries, I think this idea may create variations or larger inequalities in the answers submitted. I did not succeed in gaining any unfamiliar students to join my testing, so it could be argued that some of these findings may bear the mark of being biased to some extent. But at the same time, it could be argued that some of these answers could be perceived as more heartfelt and may bear the mark of confidentiality. After a brief introduction into how to activate the application and which direction to point the device, they went out in pairs each sharing a device.

The user test took place in mid-November of 2022. The testing of the application lasted for about 15-20 minutes. It was raining/snowing, and the conditions were not as perfect as when I first tested it myself in early October. After the testing we went into a café where we could warm up; I ordered some coffee and pastries before they took part of the user survey again through their smartphones, which I created online through *TypeForm*.

4.8 Findings

In this part of the thesis, I wish to discuss and present the feedback I received through the user field testing and the survey that followed. I will first present the user survey and the answers submitted. I will then discuss these findings in three parts: the smartphone´s accessibility, the concept of situated simulation and the application itself.

The user survey:

1. On an average normal day, what is your preferred source of entertainment?

a. Watching TV (3)

b. Listening to music or a podcast (1)

c. Reading a book

d. Reading the newspaper

e. Playing games (1)

f. Other (TikTok, 1)

I have highlighted the users´ reply in the brackets above.

2. On an average normal day, how many hours do you spend consuming entertainment or news?

Scale from 0-10. 0=15 min or less, 10= 12 hours or more

Five of the participants answered with the value of 6. While one of them answered with 7.

3. On an average normal day, how many hours do you spend on a smartphone?

a. 15 Min or less

b. 15-60 min

c. 1-3 Hours (2)

d. 3-6 Hours (4)

e. 6-12 Hours

f. More than 12 hours

I have highlighted the users´ reply in the brackets above.

4. If you needed access to entertainment or general information on a subject, through what source would you uncover the information?

a. TV

b. Newspaper

c. Book

d. Smartphone (4)

e. Computer (2)

5. What is the primary use of the smartphone in your case?

a. Communication (3)

b. Consumption of Media (2)

c. Using Applications

d. Other (1), *TikTok*

I have highlighted the users´ reply in the brackets above.

6. Have you ever downloaded an application for learning on the smartphone?

a) Duolingo, app for programming
b) Yes, math teacher and various other school related apps
c) No, I feel there are other sources for learning than through applications.
d) Duolingo
e) Yes, Dragonbox
f) Duolingo

7. Would you prefer using your smartphone as a tool for gaining information in contrast to a book, guide, museum?

a) Yes and no, I don't like to read, but I love museums.
b) Yes actually. The phone is smarter and faster and generally easy to use.
c) Yes, I prefer my smartphone because of its accessibility.
d) Yes, because I am lazy.
e) No, because I generally find that learning from books, or museum visits is both more efficient and more rewarding.
f) Yes, the iPhone is easier to use and more accessible.

8. Have you ever wondered what an area looked like in the past?

a. If yes, how would you like to experience it?

a) It was nice to experience it through an application, if that wasn't an option, I would use Google.
b) Yes, all the time. Especially areas where I know there have been a lot of changes.
c) If I wonder what an area looked like in the past, I will just look it up online.
d) Yes, I would like to experience it through visualization.
e) Yes, through visual media in general. Most preferable in high fidelity.
f) Yes, through a video or documentary.

9. Do you feel applications like the Situated Simulations are viable in the high-choice market of applications?

With high-choice markets I mean the various options to choose from.

a) I think this app would be very viable for tourism and sightseeing. If I went to another country and this app was working there, I would use it.
b) I don't think so.
c) No, I think that in most other cases I would use other methods in order to find out how the area looked like before, mainly because the application is reliant on the user position.
d) Yes, if it reaches its target audience, like old people would probably love this.
e) Unsure, the graphics would have to improve.
f) I wouldn't know.

10. Did you know about the area of Piperviken before today?

a) Not that it was called Pipervika
b) No. I knew that the current building was not there before, but I didn't know what was really there before.
c) No
d) No
e) No
f) No

11. Do you feel as if the simulation is simple enough to spark interest on a subject, or is it too simple?

a) I liked the texturing of the buildings, especially the Yellow House, but some of the buildings and objects remained too simple.
b) I feel that if the application would have been completed and marketed enough, I would absolutely have it downloaded.
c) I feel as if the application gave me an impression of how the area looked like. But I would like to have some form of additional information or even animations that would make it more interactive.
d) It sparks an interest. But I would appreciate it if there were more details or functionalities.
e) It may be too simple.
f) It definitely sparks my interest, but it may be too simple in execution the way it is now.

12. Describe the experience of using Anno Pipervika

a) Exciting, and if the weather was better, it would be really nice! Some bugs on the iPad but it worked well on the phone. Some details were very cool, like the *Nidar* advertisement, and the texture of the pavement on the ground.
b) I was surprised by how detailed you were able to see the buildings and their former locations as well as the details of the building. Even though the details aren't done yet.
c) I thought it was fun to test out an application like this, the concept seems really intriguing and it feels as if it is something that has a natural foundation for further development.
d) Interesting.
e) Adequate.
f) Exciting.

13. Is this sort of simulation a valuable representation of history?

a. If yes, why?

b. If not, how come?

a) Yes, it's fun to view history in an interactive way like this.
b) I would absolutely say so. You get a more visual representation of the past and all the more depths of the buildings and places around.
c) Yes, it could be a more fun and interesting way of learning something about history and place.
d) Yes, because visualization is often overlooked when learning information about topics or subjects.
e) With regards to historical placements of buildings, I would say yes. On the other hand, detail would have to improve if it is a goal to give accurate representations of history.
f) Yes.

14. To what extent did the simulation provide a credible and realistic representation of the past?

a) The overall impression was good, but I think it needs more detail to be realistic.
b) It helped show some of what we could expect it to look like. Although we know that there will be some more wear and tear all around.
c) Yes.
d) To quite an extent, loved the details on several of the buildings, would love even more detail
e) To some degree, as previously stated, the lack of detail is a serious limitation when it comes to realism. It does seem credible with regards to placements and the general feel of the area.
f) It was maybe too simple; it should have been more detailed.

15. How was the general quality of the 3D-models and their graphics?

a) Some buildings lacked texture, but the rest of the buildings and the ground looked good
b) Some of the buildings were quite high quality, but others were not.
c) I think the models looked fine, and the resolution was good; even though I missed details like humans or trams etc.
d) It was good. I liked the mobility, that you controlled the movement through the experience.
e) Inadequate detail.
f) Some objects looked nicer than others

16. This simulation lacked some of the immediate surroundings that supported the area that was being reconstructed. Did you feel as if the area should have included more details? ***Details in the form of other buildings nearby, people, different streets, statues etc.***

a) Yes. I think it would've been fun to have both other buildings and people walking by.
b) Well, it may have given a more accurate representation. But it's not a dealbreaker.
c) Yes, it would have given a much better overall impression.
d) Yes. I would love all those things.
e) Yes.
f) Yes, it would have made it more interesting to use the application.

17. Three of the buildings were designed to lack texture and detail. Did you find the lack of texture in objects like "Vestbanestasjonen" and the other two objects as an interfering factor in the total experience of the simulation?

a) Yes, I think they took too much of my attention.
b) At some level it did. In a final App i would definitely not like this.
c) Didn't really think about this.
d) No not interfering, I would have liked them to have as much detail.
e) Not in particular, partly because they seem to be intended more as representations of the historical buildings, rather than actual copies.
f) I wish all the buildings would contain the same amount of detail.

18. Did you experience something troubling when using the application?
Technical functions, usability, connection issues etc.

a) On the iPhone everything worked, on the iPad there were some bugs.
b) No, everything worked fine.
c) No, it was easy to use the app, and it worked great to move around on location. The only problem was when you walked into a building, and it lacked a physical "backside".

d) Yes, the iPad was unstable to the app, and it did not calibrate or position us correctly.
e) No.
f) It was irritating to log in on another AppleID to test the application.

19. How did you experience the relationship between the real environment and the reconstruction shown on a screen?

a) I would really like to experience the application through a more augmented reality sense.
b) The experience was cleaner than I thought it would be, but I didn't really focus on this, so it didn't make a huge impact.
c) It was good.
d) It fitted well, very cool.
e) Slightly jarring.
f) It was obviously cool that it was connected to that location.

20. Is there any value in experiencing a digital reconstruction at the original location as opposed to a reconstruction placed in a museum?

a) Yes. This is much more interactive and would be really cool to use this on other places around the world.
b) Yes, I would say so. You get a more in-depth view and understanding of the location.
c) Yes, it was fun to see the objects in their right sizing and scale in relation to how it looked like today. But I would probably favor a museum over this application.
d) Yes. It feels much more real. It's interactive, you feel as a part of history.
e) Yes, because it could enable you to see the differences between the current state of the location, and the historical state, to a larger degree.
f) There is a lower threshold to the usability of an application like this, it is more accessible to everyone.

21. In what way does the simulation differ from the classic way of experiencing cultural monuments (text posters, guides and possibly audio commentary)? Is the simulation a better alternative?

a) I like the interaction, and I think this is much more interesting from the consumption of information.
b) You don't necessarily get the right information you would need. But I wouldn't say it affects it that much.

c) If the application was extended through the use of audio, facts or animation, this would be a great alternative. But as it is now, I would prefer experiencing cultural heritage through different sources.
d) Yes, much better, I think.
e) It does at least enable some larger degree of participation. I do not, however, believe that it is in general a better alternative.
f) As it is now, this application is not a better alternative, but it has the right foundations to become one.

22. This simulation is based on a combination of historical documentation and interpretation. To what extent do you think historical accuracy is important for such simulations? ***By historical accuracy I mean the attention to detail and the use of historical sources as basis for the 3d models.***

a) I think it is very important. With historical accuracy this could be used in school and for tourists.
b) It is very important that it is historically accurate. Otherwise, it wouldn't be as learning and useful.
c) It is important to have additional information to give a better overall impression.
d) Very important. That's what makes it interesting and is the motivation to use it.
e) Extremely important, if it does not provide accuracy, I believe the entire concept of using simulation in learning, is set aside.
f) It is really important.

4.8.1 The smartphone´s accessibility

Through this entire thesis I have brought up the notion of the applicability of the smartphone. I have raised a concern when it comes to what it means within a high-choice media environment; and the value of having a highly user-centered focus on constructing viable solutions to specific target audiences. This idea of the applicability of the smartphone creates a notion of accessibility to designs such as the situated simulations. When explaining and discussing my prototype through the user testing, or with previous discussions with friends or family, the most intriguing aspect was not the generated simulation itself; it was that in order to receive the virtual information one would have to use a device such as the iPhone as the conduit.

Through my user survey it is clear that they all appreciate only having to use their smartphone as a way to experience the simulation. They enjoyed the simplicity of it, and proving that the concept was in fact favorable, at least as an alternative to something less

interactive. But as a device for learning, some of the answers differed. Most of the participants answered that they had used their smartphone in order to access different educational or entertainment sources; and some even shared which applications they have previously downloaded for educational purposes. When asked if the smartphone is valuable as a tool for gaining information in contrast to traditional reading or other exhibits; many agreed that the accessibility of the smartphone is of value in an educational context. But for some, the experience of a museum would prove to be more of a rewarding experience than anything you could find through your smartphone, or at least through *Anno Pipervika*.

4.8.1 The concept of situated simulations

Most of the participants agreed that the lowered threshold for discovering factual information about certain locations seems more accessible through solutions like the situated simulations. They appreciated the interactions with the virtual and the real, and thought it was a refreshing way of experiencing the past. They seemed to agree that contextualization of information through visualization is an important factor in how they prefer to experience information from the past, and that even though my application only presented the basic skeleton of the old area, most agreed that the concept was intriguing. Many of the participants claimed that they wished that such interfaces could exists on every location in the world. That you could be anywhere in the world and apply your smartphone to find out information about the area you are in, in the form of visual content. “The ultimate AR mirror world would be a complete digital doubling of this world. Everywhere we looked—every street, house, office, factory, store—would have its digital twin that our AR devices could make visible” (Bolter et al., 2011, p. 124), or to quote Messeter again, “the world would become the interface.”

As an application that would function in the high-choice media environment there was an agreement towards creating such applications specifically for targeted audiences. At the same time, the participants stated that having additional features and different interactive functionalities would help the simulation in being experienced as more stimulating for anyone. Some also pointed out how such solutions seem to be very easy to create and modify, and that the applicability seems overreaching. Most of the participants agreed that this way of representing history is valuable in that it creates a visual experience through the combination of something known and something hidden. This unveiling of old structures in combination with their natural surroundings seemed to be an important factor in connecting the virtual and historical to a place in reality.

Some claimed to appreciate the general feeling of mobility, where one would move through the surroundings of the virtual elements while being very perceptive of the surrounding natural reality. In some iterations of these simulations the notion of connectivity in relation to the GPS signal proves to be a difficult issue for some of the chosen locations or spaces. The area around the city hall of Oslo is large in space and already used as a tourist attraction, so the navigation and movement in the simulation worked effortlessly. This openness of space is also what allowed the devices to have a reliable connection with the orbiting satellites to get a steady coordination within the simulation.

4.8.2 The application itself

Most of the participants liked the overall feeling of the application in terms of navigation, resolution and overall flow. While some of the objects inherited less details than others, the detailed objects were in some fashion appreciated more because of the choices in texture and detail. While most agreed that it was easy to spot the difference between the less detailed objects and the others, they couldn't quite agree on the importance of these differences. Some argued that it was annoying that the objects lacked detail, especially regarding the object "Vestbanestasjonen". In truth, it may have very well served the application well if this object would have been fully textured instead of gray; in a sense that it was the only object which had a real representative in reality. Others stated that the difference in texture was noticeable, but not detrimental to the experience; but most agreed that the overall application would have been more appreciated if it did contain more objects, animation or additional information about the area. My intention was to supply this application with the information I found in Schulerud´s (1963) book, but there was no specific information connected to the objects I wished to portray, and so I found no plausible way of interjecting such information into the design. But most of the participants agreed on that the application needed more functionalities, accessories, and more detail in general in order for it to be viewed as a real experience. The users' expectations of the application was indeed higher than what I managed to represent, and so its simplicity may have permeated the experience.

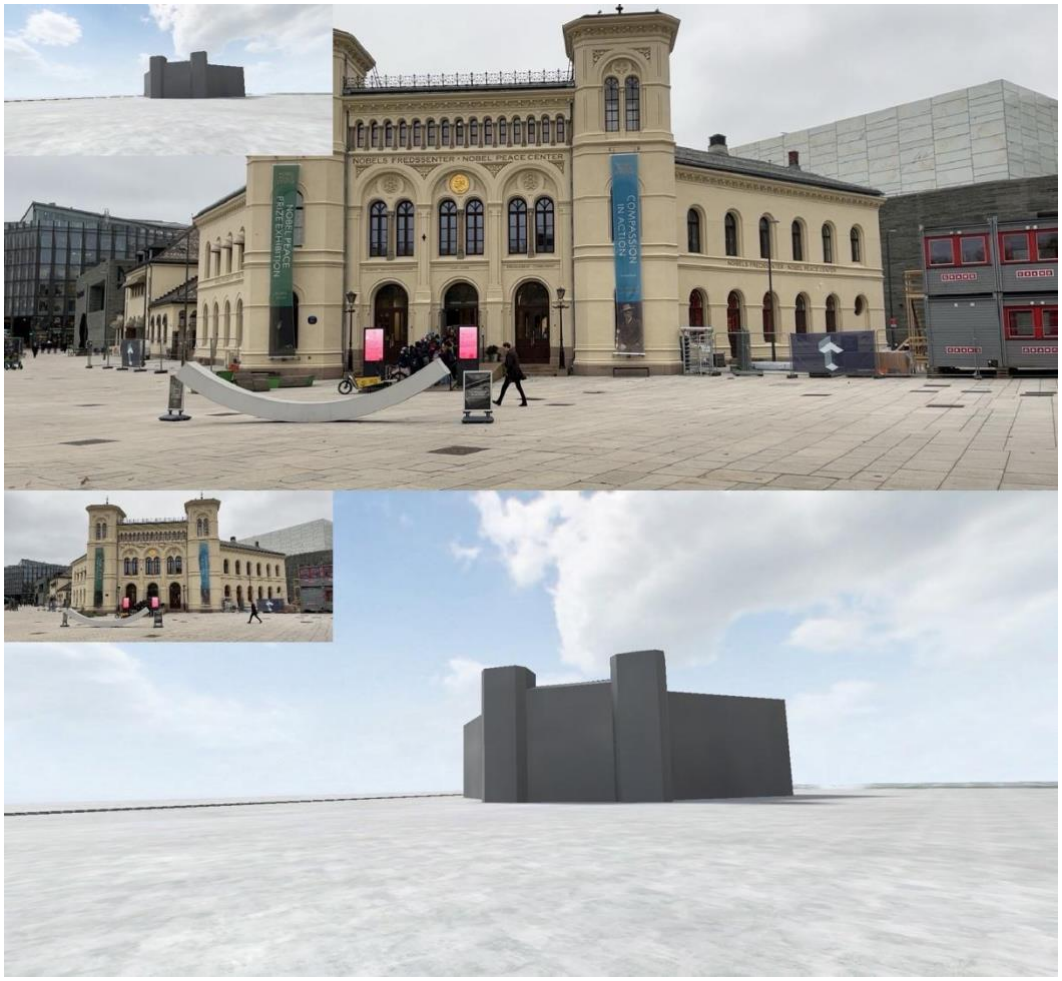

Figure 18: *First test on location. Vestbanestasjonen.*

Overall, I would argue that *Anno Pipervika* was experienced as too simple in its execution in that it did not contain any additional information, animation or interactive possibilities. It was appreciated as a concept, and in many ways, it sparked an interest in the new digital solutions to gaining historical information or its contextualization. Most of the participants agreed that it was an adequate representation of how an area might have looked like in the past, but not much more.

5. Conclusion

In this thesis I have described and discussed the development and testing of the application *Anno Pipervika*. This application was created as an attempt to study the concept of situated simulations at its core. At the same time, I have tried to outline the importance of the accessibility and applicability provided by the smartphone, and how it may be a challenge to create viable solutions for location-based services within place-specific computing through a sense of importance on the high-choice media market. This thesis was more enticed to explore and study these ideas through observation and discussion rather than to give any specific answers or solutions to a given problem. I only wished to highlight and discuss how these converging technologies are enabling solutions within mobile augmented and how they may be perceived.

5.1 The ultimate interface

When I started with this venture, I was surprised by how many people actually understood what the project was about, just by mentioning the words *mobile* and s*imulation,* the vast majority of the people I talked to understood what was going to happen and how it was going to happen. This led me to believe that people expect and assume a lot of today's technologies, that we may have developed a sense of collective taste when it comes to the consumption of content and through what sources we consume them. In some of the talks I had with the user testing group, we discussed the idea of a worldly interface. Where every object relating to the real world would have something virtually created connected to it, and that this should be accessible through personal devices such as the smartphones. In my thesis I have put much effort into the discussion regarding the smartphone as the ultimate extension of man; its accessibility has made it applicable to so many of the digital solutions that we surround ourselves with every day, and it is arguably the ultimate interface.

Imagine a virtual world that is symbiotic to our natural world, where the smartphones functioned as a gateway to this alternative representation. Where you could use your personal device to interact with all your surroundings. The access to the virtual content is amplified in places and spaces where people have gathered throughout history, either through population or historical significance. It is a complete virtual environment that coexists with the real; accessible at all times and always constricted to its place. The interaction between the virtual and the real are becoming more coherent and the virtual is in fact becoming more real than ever. There have always been movies or games that play around with this futuristic approach

to the development in technology. Movies like *Ready Player One* (2018) by Steven Spielberg, or series like the *Peripheral* (2022) on *Amazon Prime* both toy with the idea that real-life interactions would end up becoming a completely digital experience.

5.2 The SitSim solutions

Through my studies I have discovered that these situated simulations are very much appreciated as a concept, and that even a low-fidelity prototype of the basic skeleton of an old reconstruction is enough to spark an interest in both the approach to design and to that of factual information related to a specific location. Most of the participants also appreciated the fact that the smartphone was the only tool enabled to display the virtual elements. As a tool for learning, the situated simulations need to exhibit certain traits of interaction which is designed to create engagement with the application and the location. While some of the participants in my study argued that the fact that it was location-based was somewhat of a concern in a way that it is accessible, most of them agreed that the experience of such solutions would not been the same if they were to experience it from their home. It is an engaging solution at its core, which demands participation, and therefore it should be designed to extend such needs.

I would argue that my initial lack of knowledge when it came to the creation of such applications does in fact play a huge role in how the application was developed and presented. Most of the participants claimed that if it would entail all the other functionalities found in other sitsim projects it may have enhanced the experience to some degree. In many cases, augmented reality, or virtual reality, serves a purpose in the representation and visualization of certain data or information. It is applicable to all areas which seek to create a rapid visualization of certain elements before implementing them fully; either through high-fidelity prototypes that are evaluated and tested, or as in the representation of the future constructions that are to be created for a specific location. But as a simulation, these solutions need to be related to more game-like features in order for it to be experienced as something enhancing by users.

5.3 Further development

Through my studies it is clear that the situated simulations should be created with all the functionalities available in order to enhance the location both in a peripheral sense, and in relation to content creation. It is not sufficient to only represent a static environment for it to

be experienced as something enhanced. While this is a perspective on the educational value these solutions exhibit, there is also a seemingly heightened sense in the expectations and how people welcome new digital solutions. With the general increase and development in anything that operates digitally, the expectations of such solutions are entirely based on what already exists. As seen in my testing, the overall experience of using the smartphone as a conduit for sourcing the virtual elements did not exceed the expectation for the interactive capabilities these simulations may and should inherit. While movement and navigation are an important aspect in how these simulations are designed and experienced, this experience is not interactive enough in itself for the application to be acknowledged as something augmented or enhanced.

As a concept, the situated simulations are experienced as interesting and intriguing. It has an apparent advantage in the accessibility and navigational aspects of handheld devices. But if the access to the virtual elements only consists of the importance of accessibility and navigation of the handheld devices, the design would appear to become substandard in that it does not support any form of interaction. The design is therefore only experienced as a bleak representation of what may have been.

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