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Designing for a Multiple Screen Setup

Interactive Storytelling and Attention Guiding for a Perceivable and Engaging Experience of UTM Explore

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Abstract

An interactive multiple screen visualisation might become an opportunity for engaging and illustrative presentations of scientific, complex, and abstract research. With multiple (interactive) monitors, storytelling and interfaces could bring engagement, immersion, and attraction to the audience. The challenge of designing for a multiple screen setup is that the amount of information can be overwhelming, causing the perception of it and engagement with it to decrease. This thesis explores approaches that could enhance the perception and engagement of the content for a multiple screen setup.

The *Research Through Design* approach sets the structure for the entire thesis. It consists of methods for exploration, concepting, prototyping, and user testing. By following this research approach, three versions of a prototype were developed and tested which led to the results of this thesis. The overall nature of this research process was exploratory and the design decisions were applied during the activities.

The main findings of this thesis regarding the multiple screen setup during the research process included three attention guiding approaches: *black and white, blur,* and *pause*, and according to the user test participants, the preferred approach was *black and white*. The second vital aspect of the research and testing were the five-act story arc and interactive storytelling structures. According to the data from user tests, interactivity helped to increase the engagement and perception of the exhibition piece.

Keywords: Multiple screen setup, Perception, Engagement, Digital storytelling, Interface design, Attention guiding approaches, Interactive storytelling, User experience design, Exhibition design, UTM City.

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OUR SINCEREST GRATITUDE TO ALL OF YOU ♡

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1 Introduction

This chapter presents the overall thesis and begins by explaining background, motivation, and starting point. Further, it elaborates on the problem formulation, the scope and style of the thesis and research questions.

1.1 Background

Exhibition design is an experimental area of research where a variety of design subjects and unique setups are implemented into the space (Locker, 2011, p.7). An interactive multiple screen visualisation might become an opportunity for engaging and illustrative presentations of scientific, complex, and abstract research. With multiple (interactive) monitors, storytelling and interfaces could bring engagement, immersion, and attraction to the audience.

The starting point of this thesis was an exhibition presented and supervised by Jonas Lundberg at the Expo 2020 in Dubai. The exhibit consisted of a multiple screen setup, which showed the key elements of the ongoing research project “UTM City” by Linköping University. In the following paragraphs the research project itself and the resulting exhibit will be explained in detail as it is the content of the multiple screen setup that this thesis focuses on.

1.1.1 UTM CITY

First of all, the above-mentioned UTM Explore exhibition piece relates to the term of UTM and it is important for understanding the context to discuss the meaning and purpose of UTM. In the following subchapter the purpose and definition of UTM will be presented.

UTM or Traffic Management for Urban Air Mobility, describes a service for air traffic in and between cities. UTM is a field with a fast growing development, however, this rapid growth does not consider the aspect of urban environments. New types of traffic with a high level of automation and autonomous systems need new concept ideation and approaches which can help with high levels of automated transport handling (*Amplify teamwork with automation*, no date). The unmanned traffic in urban areas will have to deal with different types of drone usage. This usage will involve a new management system for unmanned traffic development that will be able to control and manage high levels of autonomy (*Amplify teamwork with automation*, no date). The fundamental goal of UTM is to improve the safety and efficiency of drone traffic operations, as well as regulate airspace utilisation, by taking into account essential information (e.g. drone locations, obstructions, forbidden zones, and drone IDs) that are not visible to drone operators on the ground (Lundberg *et al.*, 2018, p. 904). However, the main control principals from existing ATM (Air Traffic Management), where

every aeroplane is monitored separately for conflicts, are not possible to implement to the UTM due to the scale of work, which approximately could necessitate 35 times more force than existing ATM (Lundberg *et al.*, 2018, p. 905). Moreover, drones will have different 'missions'. Package delivery, emergency service, monitoring, and other types of missions will cause interactions and conflicts between drones. UTM is supposed to control and manage these interactions, although the challenging part is that drone missions and traffic do not exist yet (Lundberg *et al.*, 2018, p. 905).

UTM City is a research through design project of Linköping University that explores different future drone traffic scenarios and simulations. UTM City discovers 'what if' scenarios in order to frame the design effort (Lundberg *et al.*, 2018, p. 904). The interactive simulations and visualisation of drone missions in cities are designed to create a simulation of traffic management in the future (*Amplify teamwork with automation*, no date). This project led to a collaboration between Linköping University and University of Sharjah, Saab, LFV and Dubai Aviation Engineering Projects (DAEP). Consequently, the purpose of the project was to create an interactive prototype that would envision and test the main concepts of UTM by simulating scenarios on a Dubai City map. "The goals of the project are (1) to visualise in 3D unmanned air traffic (delivery drones) for Dubai City. Moreover, the goal (2) is to define an operational concept for unmanned traffic and (3) to use it to define optimal routes for parcel delivery drones"(*Amplify teamwork with automation*, no date).

1.1.2 UTM Explore project

In 2021 the UTM Explore project was established in order to visualise UTM City research outcomes for the presentation at Dubai Expo 2020. The purpose of UTM Explore is to introduce how UTM City could work and to explain its key concepts in an engaging way. The goal is to create awareness about how future cities could look like with drone traffic and how UTM could work to manage this traffic. Four scenarios were created to show the main elements of the UTM City system: cake delivery, medicine delivery, post delivery, and fire emergency. The chosen setup for the UTM Explore project was a multiple screen setup with three screens (50 inches each) connected to a touchscreen that controlled the content on them. Each screen showed a specific perspective of the overall UTM City story. The left screen showcased the original UTM City simulation part, the middle screen was devoted to the user perspective, and the right screen showed an animated story part of the city's isometric view to explain the terminology. All three screens and their story parts were adjusted and synchronised to each other. The interactive screen served as a controller to the other three screens, where users were able to pick scenarios. It also served as an interactive simulation exploration, where the users could explore UTM City by simulating drone missions on their own in a limited context.

Figure 1.1: The multiple screen setup with UTM Explore project at Dubai expo 2020. Presented by the head of the project, professor Jonas Lundberg.

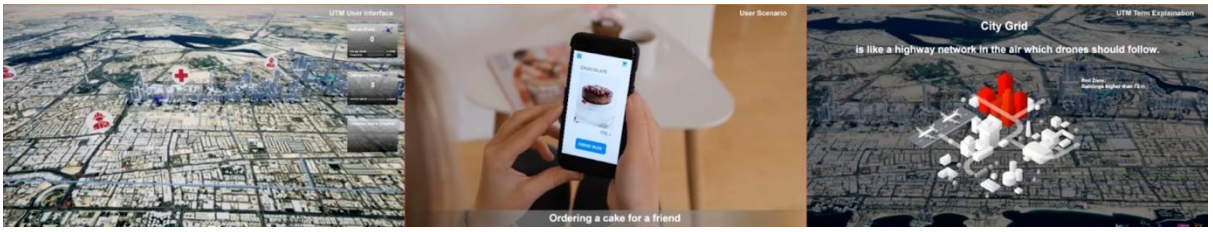

Figure 1.2: Cake delivery scenario. The middle screen introduces the story of the user who orders a cake. The left screen shows cake delivery in the UTM City simulator. The right screen illustrates the animated cake delivery on the isometric view, indicating and explaining key terminology.

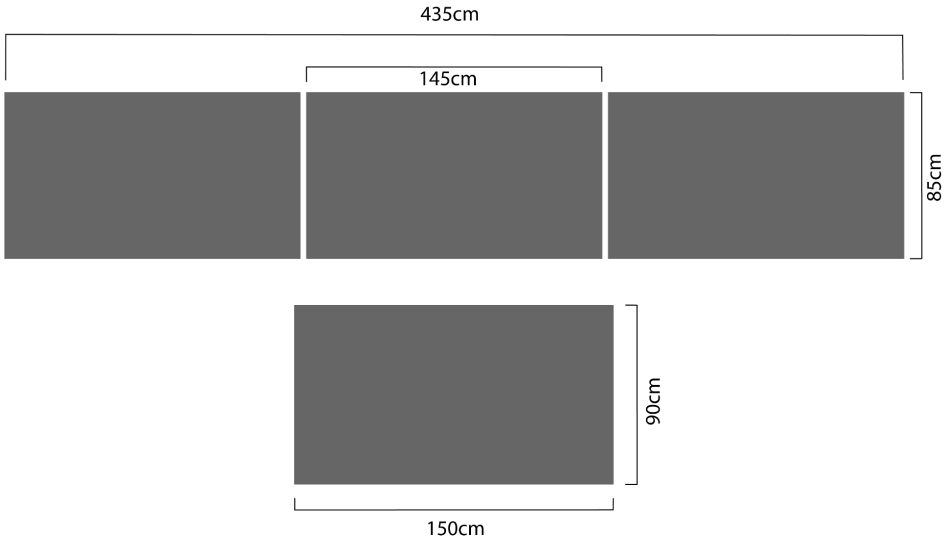

Figure 1.3: Sketch of the multiple screen setup

The four scenarios were based on four main terms and concepts in UTM and future drone traffic that were explained and illustrated through video storytelling.

1. The cake scenario tells a story of a person who orders a cake. On the middle screen visitors can see a chronology from ordering the cake to the cake delivery with a drone and customer parcel pick up. Meanwhile the right screen explains the key term for the story and UTM - city grid. By using animation, it illustrates the city, main actors of the story, and drone movement on the city grid. The left screen shows a simulation of a drone's actions on a UTM Dubai City map.
2. The medical emergency scenario tells a story of a person who has an asthma attack in the park while walking with a friend. By using the sky service app his friend calls medical emergency help. The middle screen shows the process of medicine delivery from the doctor's prescription to drone medicine delivery. The right screen explains the concept of conflict solving by showing the cake drone from the previous scenario and the medicine drone flying on the same route at the same time. The left screen visualises how conflict solving will take place in UTM City simulation.
3. The post-delivery scenario shows a mass delivery of drones. The user perspective screen demonstrates a parcel tracking process and the drones' flight from the post hub. The right screen demonstrates point to point routing from the hub to the customer delivery. The left screen showcases a simulation of a mass delivery in UTM.
4. The fire emergency scenario shows the story of an emergency and a no fly zone for drones. The right screen explains the geofence concept and how drones avoid dangerous zones (e.g. a fire) by establishing a no fly zone. Meanwhile, on the left screen a simulation of this situation is presented in UTM City.

The three-story parts use different visual approaches. The story on the middle screen was produced with a video recording to make the user perspective more realistic and easier for the visitors to empathise with the stories. The right screen with the isometric view was illustrated through an animation approach that helps to simplify scientific terminology and shows the main concepts for the audience. The left screen is a recorded video of the UTM simulation, which was made in Unreal Engine. The whole story was combined and adjusted in the Dataton Watchout software for easier projection and control of the triple screen setup.

1.1.3 Visualisation Centre C and Exploranation

The location for the prototype that this thesis worked on is Visualisation Centre C in Norrköping, Sweden. It is necessary to highlight this organisation's principles and structure, in order to understand the requirements for the future prototype.

According to its website, Visualisation Centre C is a science and research centre that displays “a unique mix of leading visualisation research and public outreach activities” (*Visualisation Centre C*, no date). Underneath a 3D fulldome theatre, Visualisation Centre C hosts an arena for public visits, media labs, and interactive exhibitions. Their website states: “One of the ideas behind Visualisation Centre C is to bring the world of visualisation to a wider audience than science and research labs usually do (...) interaction and digital imagery as key ingredients” (*Visualisation Centre C*, no date). The focus of the science and research centre is interactivity. “At Visualisation Centre C, we create mind-blowing interactive digital experiences by combining state-of-the-art visualisation technology with intuitive interaction design. We bring scientific data to life and make it available in a fun and exciting way" (*Visualisation Centre C*, no date).

The audience of Visualisation Centre has a wide range. The focus lies on the younger generation, which is reaching from children to young adults. Their philosophy is to get young people excited for science and let them explore.

To go more into detail of the digital and interactive exhibits' philosophy, the following paragraph deals with the key term for Visualisation Centre - *exploranation*. According to the founder of Visualisation Centre, Anders Ynnerman, and LiU professors, Jonas Löwgren and Lena Tibell, the term *exploranation* was invented to combine two terms and meanings - exploration and explanation. “A visualisation enabling effective data analysis leading to scientific discovery (exploratory visualisation) and visual representations used to explain and communicate science to a general audience (explanatory visualisation)” both are the key elements of each exhibition at Visualisation Centre (Ynnerman, Löwgren and Tibell, 2018). Due to that, a synthesis of both elements received the term *exploranation*.

The UTM Explore project was designed at Visualization Centre C based on the principles of *exploranation.* The storytelling of UTM Explore is constructed not linearly but in a way that the user is triggered to explore different things about UTM City concepts and terminology. It brings together explanation storytelling where users could watch scenarios with clarifications but also interactivity. The touch screen with UTM simulation helps to explore what is seen on the triple screen setup.

1.2 Motivation

Designing the multiple screen exhibition setup for UTM City, which was presented at Dubai Expo 2020, revealed several challenges. In multiple user tests it showed that conventional user experience design, interface design, and storytelling was causing an overload of information. Because of that it was difficult to follow the story, which led to problems with perceiving the overall exhibit of UTM Explore on three screens. The final review of the UTM Explore application started a discussion on potential improvement and further challenges.

The motivation of this thesis is to structure the user experience and research approaches for multiple screens that could be implemented in the future.

1.2.1 Challenges

The multiscreen setup that was used for UTM Explore and for this thesis is an established exhibition setup at Visualisation Centre C on the fifth floor where it is presented with other exhibition pieces. The setup is fixed and the presentation of different exhibition pieces can be switched easily through a connected computer. The main challenge of designing for such a setup was discovered during the production process of UTM Explore. It relates to attention guiding between four screens (three top screens and touchscreen). The advantage of this setup is that different content can be shown from three perspectives simultaneously on the top screens, for example in Figure 1.4, where three perspectives of the story are shown: isometric view animation on the left, user story video in the middle and UTM City recording on the right. Additionally, three screens are connected to the touchscreen through which the UTM City interactive map could be explored after the video.

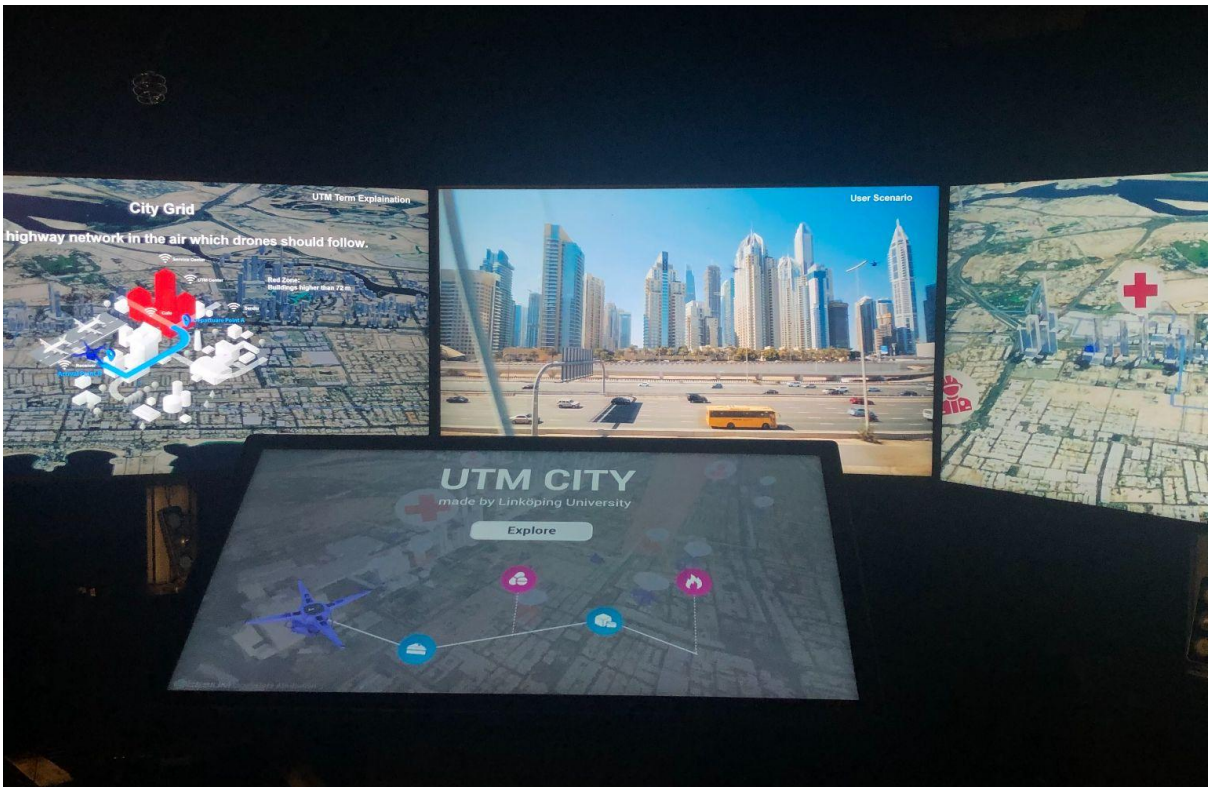

Figure 1.4: The multiscreen setup with UTM Explore project on it

The two main problematic aspects were observed during the user test and expert screening that formed the basis for this thesis:

1. Adjustment and navigation as well as guiding the user's attention on the wide screen between storytelling parts that serve as different perspectives of the story, but aim

to convey one solid, perceivable message about UTM City. This caused uncertainty of the plot and the overlooking of important information. After the user test, it was discovered that the viewers mainly focused on the middle screen (user story part), which made them unable to perceive the whole story.

2. The visual elements had a different effect on this multiple screen setup than on a common one screen setup so that the perception of those elements decreased. This led to difficulties in understanding and following the whole story. Since all of the three screens contained some kind of graphic elements like animation, data visualisation, or movie (Figure 1.4), it was hard to grasp the presented information which led to an overwhelming experience. Another factor was the lack of structure and hierarchy on the interface. The user was distracted by elements on the middle screen, which made them disregard important information on the other screens. Also, the content lacked a clear guiding, which led to the problem of directing attention across the screens.

These two aspects were observed as the main establishing parts of a perceivable and engaging presentation for the audience. After identifying the problematic aspects of the current presentation of UTM City, it was decided to deal with them through a *Research Through Design* method and improve the current version of UTM City. Even though reducing the amount of screens and coming back to a traditional one screen setup might seem like the most simple solution, it could cause the loss of engagement and immersion which is counterproductive when presenting complex scientific content.

The goal is to develop an exhibition prototype about UTM City that fulfils the criteria of successful user experience design with focus on storytelling and interface design. The expected design result is a multiscreen prototype with focus on storytelling and interface design to make the scientific nature of UTM City perceivable for the target audience. The medium that will be used is video based on filmmaking, animation, and graphic design since that is the medium that was used in UTM Explore. A mix of these three media types worked well to communicate information. The physical location for the exhibition setup is Visualisation Centre C in Norrköping. The content of the final prototype will consist of a scenario that potentially increases a perceivable and engaging storytelling and interface design (Figure 1.5) that explains UTM City to the target audience.

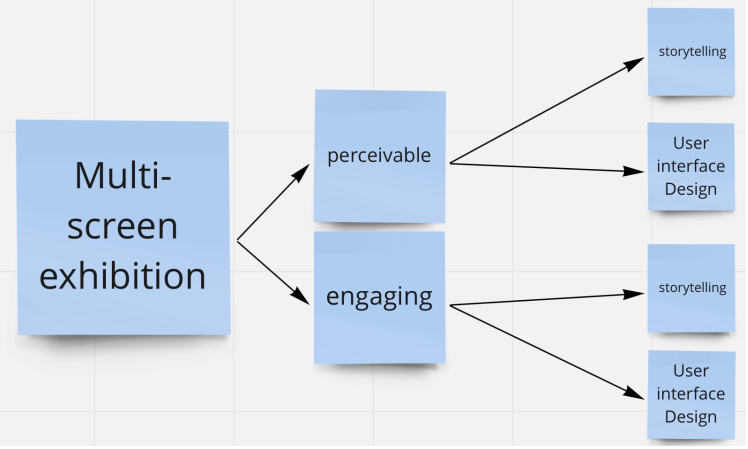

Figure 1.5: Objectives tree

1.3 Exploratory Design Study

Based on the previously described background and motivation of this thesis, it is also necessary to outline the format in which the following work is carried out. The aim of the whole thesis is to research and study solutions and approaches for the main topic of designing for multiscreen setups, rather than to produce a polished product. In addition to that, the further research process is done in the explorative format, which means that said process involves improvisational elements. The overall nature of this research process was exploratory and the design decisions were applied during the activities. "Exploratory design study investigates distinct phenomena characterised by a lack of detailed preliminary research, especially formulated hypotheses that can be tested, and/or by a specific research environment that limits the choice of methodology" (Mills, Durepos and Wiebe, 2010, pp. 373-374). This thesis is based on the project of UTM Explore and its unique setup described above. There is a lack of detailed research for multiscreen design that could be applicable to such a project. This thesis researches the potential solutions to build a hypothesis and then tests it in the prototyping part.

1.4 Research Question and Outline

The purpose of this thesis is to discover principles and methods for the successful multiscreen communication of a complex, scientific topic (UTM City) for people outside of the field. Furthermore, it aims to contribute knowledge about designing the exhibition of UTM City for multiple screen environments. More specifically this research will focus on the two key aspects of multiscreen design: interface and storytelling development that will explore solutions for perception and engagement improvement suitable for a multiscreen setup. Additionally, it is important to mention that floor five of Visualisation Centre C (this thesis' setup location) advises not to include sound to the prototypes due to the general atmospheric music in the exhibition space to avoid overlapping sound. Sound is an

important aspect of videos and its absence may cause the decrease in entertainment and engagement (Byun and Loh, 2015, p. 129). However, this thesis will only focus on the visual aspect, not audio. The main research question will be:

How can the key elements of UTM City be visualised on a multiple screen setup by using the principles of story structures and attention guiding, in order to make it perceivable and engaging for a small group of young adult visitors in Visualisation Centre C in a public exhibition context?

To clarify some terms in this research question the definitions are elaborated here. 'Perceivable' means that one is capable of being apprehended or understood (*Perceivable - Definition, Meaning & Synonyms*, no date). 'Engaging' means tending to draw favourable attention or interest (*Engaging Definition & Meaning - Merriam-Webster*, no date). The storytelling structures and its perception and engagement will be described in the theoretical framework section *2.3 Storytelling*. Attention guiding approaches will be described in the section *2.4 Interface Design and Visual Hierarchy*. According to the project leader at Visualisation Center C, a small group includes 1 to 5 visitors, for instance a family, a group of friends or students. Young adult visitors include people from the ages 16 to 25.

To structure the thesis, a four activity division was created. This structure refers to the Research Through Design method and will be described in detail later in the method section. This chapter aims to give an introduction about the structure of the thesis activities and purpose of them.

Each activity consists of a purpose, a research question, sub questions, method steps, and expected results. The main focus will be the prototyping process and both research and concepting activities will serve as a preparatory process for the prototype development. Even though the four activities are presented separately from each other here, they inevitably merge and flow into each other and there are no clear boundaries. The first three activities include an overall question and an individual/sub question for both thesis participants Jekaterina and Charlotte. The thesis has been collaborative in all accounts but Jekaterina's contribution focused on storytelling and Charlotte's contribution focused on interface design.

1.5 Research Activities

0- Background Activity, UTM Explore project

Intro: UTM Explore project was designed for the Dubai Expo 2020 and the design was created for the multiple screen setup

Purpose: For exhibition participants to become introduced to how UTM could work, and its key concepts in an engaging way. The reason for that is that many people, even in key roles in society, do not know how UTM could work, or what it could be like in a city with more intense drone traffic.
Result: Exhibition piece with two modes: *story mode* that was shown on the top three screens with four illustrated scenarios about drone future; *explore mode* for the touchscreen where participants could experience UTM City software.

1 - Exploration Activity

Intro: The research will be carried out through different methods. Besides the literature research there will be an explorative interview with experts in the field of exhibition and a study visit at Visualisation Centre C.
Purpose: To build the framework we will work in, figure out how to improve and change the UTM Explore project, specify the target group.
Overall question: What are fundamental elements that could contribute to a potential improvement for a successful interface and storytelling design of the UTM Explore project on a multiple screen setup?
Sub question: What are the different types of visitors of Visualisation Centre C and how does Visualisation Centre address them?
Method step: Show experts from the Museum of Work and Visualisation Centre the UTM Explore setup and application, and provoke a discussion through an explorative interview. While conducting the interview, write a protocol, take photos of important elements and sketch ideas and information. Conduct a study visit at Visualisation Centre C to understand the structure of the museum and specify the target group. Analysis through prioritisation matrix based on the opposing parameters important for the following research activities.
Result: Notes, sketches, pictures, Prioritisation matrix and protocol. Analysis of interview outcomes.

2 - Concepting Activity

Intro: The research questions during this activity are based on the outcomes of the research and refer to the findings from the interview with the experts as well as findings from literature. The methods used to answer the general research question are ideation techniques (lotus blossom brainstorming, synectics, participant journey map, scenarios and storyboarding).
Purpose: To explore solutions for the improvement of the visual element structure and navigation of the story for UTM Explore multiple screen design.
Overall question: What are potential solutions that can be retrieved to improve the perception and engagement for a multiple screen setup of UTM Explore that are based on the ideation process?
Sub question:

- What is an approach for a perceivable and engaging storytelling structure on the triple screen setup?
- What are approaches to archive a perceivable hierarchy of visual elements on a multiple screen setup to guide the viewer through the story?

Method step: Initial brainstorming, synectics, participant journey map, scenarios and storyboarding, concepts evaluation.
Result: Storyboard of the detailed concept for the multiscreen setup.

3 - Prototyping Activity

Intro: Given the results of the previous research questions the prototyping and testing is based on those findings.
Purpose: To create a detailed design of interface and storytelling, specifically of the navigation in the storytelling and visual elements structure to enhance the concept, identify the general methods for multi screen designing.
Overall question: How can the findings from the concepting activity be implemented in order to design a prototype that includes chosen approaches (interactive storytelling structure, attention guiding)?
Subquestion: How can interactivity in the prototype be created that can be tested by potential users?
Method step: Prototyping in DATATON Watchout production, Wizard of Oz prototyping technique with midiboard.
Result: One prototype scenario based on the user test outcomes and consisting of visual elements, a developed structure, and a developed storytelling navigation, which could potentially enhance perceivable and engaging storytelling and interface design.

4 - User Testing Activity

Intro: After the completion of the prototype, user testing is supposed to unveil misconceptions and flaws as well as reveal the best out of the prepared approaches.
Purpose: To test the prototype, to unveil the most suitable of three approaches, to identify errors and potential solutions, to evaluate the level of engagement and perception.
Question: Which approaches can potentially enhance the attention guiding and video storytelling dynamics on a multiple screen setup to improve perception and engagement of the presented content for the potential user?
Sub question:

- What is the story structure that makes UTM storytelling on a multiscreen setup engaging and dynamic?
- What is a perceivable structure of the visual elements to guide a small group's view/focus on a multiple screen setup in a scientific exhibition context located at Visualisation Centre?

Method step: Two separate user tests with different focus. The first user test focuses on the overall perception of the story as well as attention guiding approaches, the second one on perception and engagement. The Wizard of Oz technique makes the user test seemingly functional. Both user tests were based on the prepared questionnaire and *Thinking Aloud* technique that aims to identify problems that participants encounter. Analysis through prioritisation matrix based on the opposing parameters important for the following research activities.

Result: Answers to the questionnaire, protocol from *Thinking Aloud* technique, notes from conversations with participants, evaluation of feedback and revision, prioritisation matrix.

2 Theoretical Framework

This chapter introduces an overview of the theoretical framework. It introduces the exhibition design as the context where the setup is located in and its connections to computational interactivity for learning. In the following part, user experience design for screens is researched and the fields that this thesis focuses on are clarified. The next part discusses digital and interactive storytelling and its approaches and presents further research options that could be used in Concepting Activity and tested in the Prototyping Activity and User Testing Activity. Following the storytelling, interface design and visual hierarchy is introduced and takes up on interface design principles and attention guiding approaches. At the end of this chapter a collection of potential design approaches from other previously mentioned parts are presented as an overview.

2.1 Digital Exhibition Design, Science Centres, and Interactivity

UTM Explore was exhibited at Dubai Expo 2020 but the future exhibition space is intended for the Visualisation Centre in Norrköping. The exhibition space has a great impact on the perception and engagement of the exhibits (Black, 2005). Due to this the following chapter investigates the role of the science centre and its influence on the exhibits located there. It will touch upon computational interactivity for learning with displays and exhibits.

2.1.1 Exhibition Design Definition

According to the Society for Experiential Graphic Design “Exhibition design is the process of conveying information through visual storytelling and environment” (SEGD, 2014). Exhibition design includes several interdisciplinary areas such as graphic, interaction and experience design. Additionally, complex storytelling is accomplished by the choice of format and setup. According to Pam Locker, exhibition means to communicate a story in a three-dimensional space (Locker, 2011, p.7).

2.1.2 Science Centres and Their Role

In science centres scientific ideas are presented through innovative exhibits and hand-on experiences for the visitors. Referring to Short and Weis, museums are traditionally lacking in interaction and tend to merely display an artefact, while science centres aim for communication and interactivity between visitors and exhibits (Short and Weis, 2013, pp. 27-38). However, the line between science centres and museums is getting blurry.

The educational role of science centres it not to be disregarded. Short and Weis also mention that science centres belong to the top five stimuli that influence the choice of careers in the science sector. Further, they mention that science centres play a vital role in

the ‘free-choice learning sector’ and that the playful approach of science during childhood and youth is influencing the interest in it (Short and Weis, 2013, pp. 27-38).

2.1.3 Computational Interactivity for Learning

The indication that science centres are usually tending to a ‘hands-on’ experience requires a more detailed consideration of the interactivity of the displays. Hereby, the focus lies on digital interactivity, since the fundamental elements of this thesis originate in a digital set up. Nevertheless, the interplay between digital screens that are interacted with and haptical/tangible elements is described as well.

Lewi *et al.* write in their book that “hands-on activities are more effective in increasing people’s attention and facilitating learning than more passive forms of engagement” and further they write: “that interaction with exhibits can reduce the intellectual distance between the audience and the abstract science(...)*”.* It is significant evidence that interactive science exhibitions increase the visitors’ knowledge and understanding of science, but also that science centres provide memorable learning experiences, which might have an enduring impact on the attitude and behaviour towards science (Short and Weis, 2013, pp. 27-38). Interactivity and engagement is a crucial factor to enhance the attraction to and understanding of an exhibit for children (Li, 2022, p.126). Li highlights a significant difference in hands-on and hands-off digital exhibits. The application of innovative and human-centred technology is an opportunity for museums to tell new stories and reinvent the experience of the visitors (Lewi *et al.*, 2020, pp. 322-325).

2.2 User Experience Design for Screens

Looking at the complexity of the multiscreen set up of UTM Explore, many aspects of user experience are present. The field of UX design includes many intersecting topics like user research, usability, information architecture, user interface design, visual design, interaction design, and content strategy.

Nagel describes User Experience as followed: *“*User Experience (abbreviated as UX) encompasses all aspects of the experiences (perception, reaction, behaviour) of a user during the interaction with a product, system, service, environment or institution” (Nagel, 2016). In this thesis, a user experience is created whereby the focus lies especially on interface design and content strategy but also visual design and interaction design. Even though the focus lies in these fields it is impossible to divide them clearly since they are intersecting with each other.

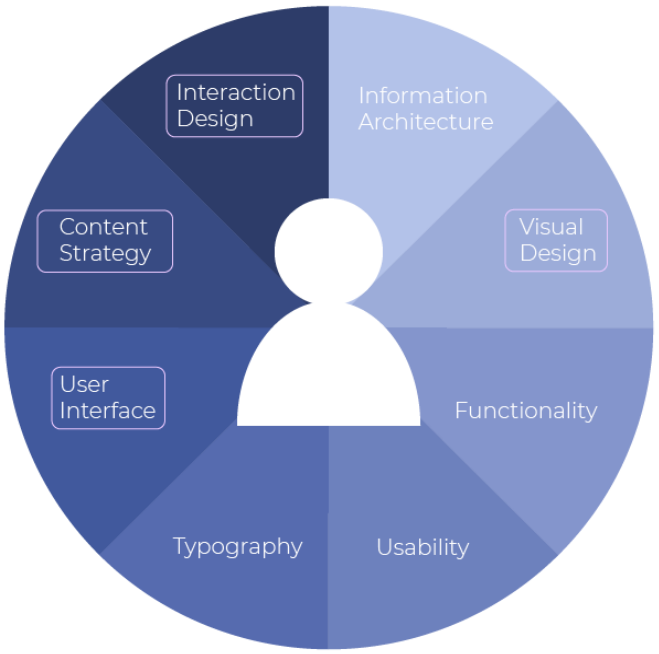

Figure 2.1: User experience topics and disciplines, adapted from Wolfram Nagel

In the following paragraphs, the areas of UX design on which this thesis focuses are elaborated on.

Interaction Design

Interaction design describes the interaction between users and a product. Often, these products refer to softwares, applications, or websites. Interaction design has the aim to support the user in achieving their objectives in the most convenient way *(What Is Interaction Design?).*

Visual Design

Visual design improves the user's experience through suitable images, typography, space, layout, and colour. It enhances the aesthetic appeal as well as the usability of an interface (*What is Visual Design?*)**.**

User Interface

Interface design is the touchpoint where interaction is taking place between users and computers, websites, or applications. Interface design aims to improve the user's experience and create an intuitive interface that requires minimum effort from the user to achieve maximum desired outcome (*What Is a User Interface?).*

Content Strategy

Content strategy helps to build a structure of the content that establishes suitable and for the user experience adjusted content (Kissane, 2011). When it comes to video storytelling, visual content strategy aims to find the most appropriate visual elements to convey the story message.

In the next chapter, aspects of storytelling are discussed and potential approaches for the improvement of engagement and perception of the future storytelling on the multiscreen devices are introduced with regards to user experience design.

2.3 Storytelling

Storytelling is a way of conveying information in the form of a story to engage the sensory and emotional experience of the listener. The location and trust of the audience largely depends on the emotional attachment to something. A story is a way to initiate that connection. From a narrative standpoint, storytelling design investigates the psychology of visual communication. Humans actively seek and establish patterns as they traverse the environment, and when patterns break, humans are curious, excited, and occasionally frustrated. Storytelling may assist goods and communications in capturing peoples' imaginations and encouraging actions and behaviours (Lupton, 2017, p.20). The second term that is commonly used in relation to the topic of stories is a narrative. The narrative is a means of communication, a form of knowledge and a mode of cognition, an intermediary between the self and the world, between the self and others, and a way to create order and meaning for a human being’s distinct experience. Narratology studies the narrative structure and mode of people, things, space, time, and other factors, emphasising the attention and grasp of the elements of things' internal relations (Xia, Liu and Wang, 2020, pp. 64-67).

2.3.1 Digital and Interactive Stories

The narrative concepts primarily built on literature and film and the research about storytelling structure are mainly connected to the linear narration method. However, with the appearance of new digital media, storytelling has transformed too (Xia, Liu and Wang, 2020, pp. 64-67). Interactive storytelling is a part of digital storytelling and tends to involve the user in the process of the story. Traditional storytelling such as literature, movies, or television usually do not engage the audience in the story physically, they mostly tell the story without the user's ability to influence it. Even though the main difficulty for interactive storytelling is integrating interaction into stories or even blending the story aspect with a game aspect, interaction that severely affects that chronology is incompatible with the entire concept of stories, because stories are typically linear structures with a predetermined chronology of activities (Laaksolahti, 2008, p.21). As Laaksolahti argues, “Interactive story makes the story events themselves virtual” (Laaksolahti, 2008, p. 21). One

of the biggest advantages is that it is individually adaptable, and each user can build their own unique experience. Interactivity helps to raise more interest and attention from the viewer, to bring a unique atmosphere to a place and build close relations between viewer and story (Xia, Liu and Wang, 2020, pp. 64-67).

When it comes to exhibition spaces “experience design is more and more applied in a narrative context. How to better present the content to participants and how to construct contextualised and immersive experiences are the hot topics in spatial experience design research” (Xia, Liu and Wang, 2020, pp. 64-67). The importance of exhibition content delivery in the digitization of exhibition space is largely determined by the interaction between the viewer's expertise and experience and the storytelling told by the authors. The way the storytelling is built from context perspective, arrangement of story parts, etc. may all impact the audience's perception, emotional level, and overall impression (Xia, Liu and Wang, 2020, pp. 64-67). It is possible to emphasise that interactive stories at an exhibition space have more advantages over traditional exhibition spaces in terms of visitors’ involvement. The main advantage is the interaction that builds connection between visitor and exhibition piece which consequently helps with increasing learning experience (Li, 2022, p.127). Interaction brings communication between the visitor and the presented topic, moreover, the participation of the visitor becomes a key aspect in the whole experience. Involvement in the learning process happens in a more engaged way, which leads to an easier topic perceivability (Xia, Liu and Wang, 2020, pp. 64-67).

2.3.2 Perception of a Story

When it comes to the basics of story understanding or perception, usually the discussion the audience goes around is whether the story is 'good' or not. With this question the audience tries to measure the quality of the story. "Story quality may sometimes vary depending on such things as the story's basic structure, the storyteller's motivation or goals, the audience to whom the story is being told, or the topic of the story" (Baron and Bluck, 2011, p. 93). There is a difference between creating 'a story' and 'a good story', the second one must contain fundamental structural elements, which are rising action, climax, and resolution. Additionally, good stories have certain key qualities such as plot to even be deemed a story. Furthermore, stories conveyed in ordinary life must have a certain level of consistency, otherwise they will be difficult to comprehend (Baron and Bluck, 2011, p. 94). Consequently, in order to measure the basic quality of a perceived story it is possible to base it on the existence of story structure . In the next sub-chapter storytelling structures will be explained.

2.3.3 Storytelling Structures

Action stands at the key point in each story. The three-act drama curve that was described by Aristotle has served and continues to be a classic structure for storytelling to this day. Every action needs a reason behind it and all actions in the story are a way to the culmination point, which acts as a most powerful and attractive point in the whole storyline. Classical storytelling is a 'question-answer' journey, where the storyline starts with a question trying to catch a viewer's curiosity and leads to the climax point, while postponing giving an answer (Lupton, 2017, p. 20). The five-act story structure (Figure 2.2) usually starts with an exposition where the context and characters and what is deemed the most important 'conflict' of the story are being introduced. After that action starts rising, or in other words events happen that ultimately lead to the crisis moment, which serves as the most vivid point of the story. After the crisis, the story gets to the climax point, which is the most awaited and interesting point where questions will finally be answered. Then follows the final stage of falling action that leads to the end of the story (Laaksolahti, 2008, p. 9).

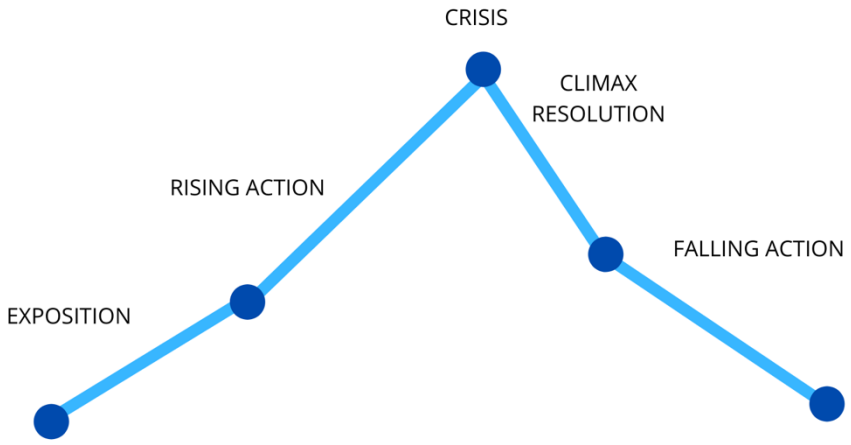

Figure 2.2: The five-act story structure adapted from Lupton, 2017

In terms of the chronological order, stories could be divided into linear and non-linear structures. The linear structure is the most common and acts as already predefined actions. Non-linear structure includes an interactive storytelling structure, which mainly means the opposite to the linear.

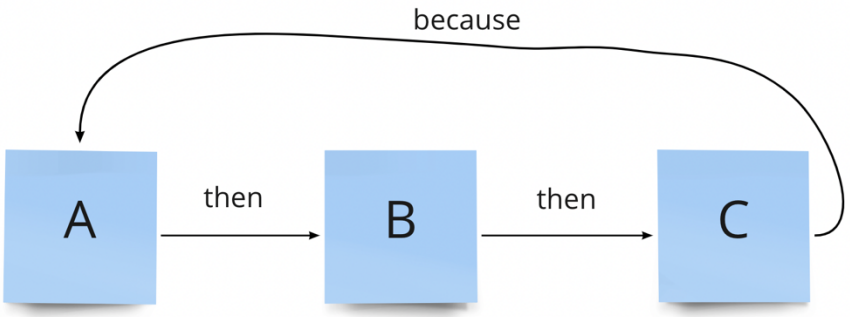

Figure 2.3: The linear structure by J. Laaksolahti

In interactive storytelling, the storyline cannot be predefined and predicted and, at some point, the audience is always faced by a choice (Laaksolahti, 2008, p. 21). Depending on the choice, the next action part or ending will vary, which makes it more engaging and more closely related to the audience due to the given power of choice and influence on the story events.

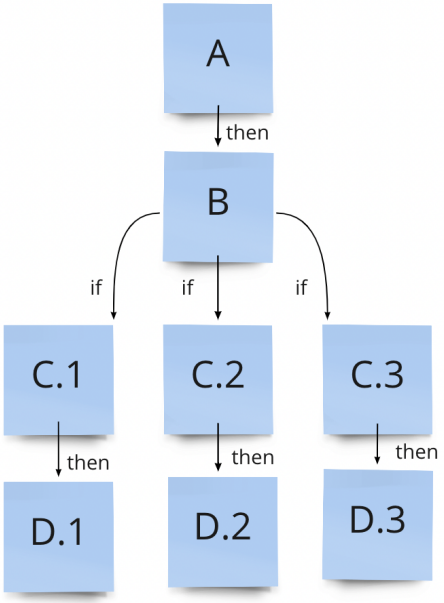

Figure 2.4: The interactive storytelling structure based on J. Laaksolahti theory

2.3.4 Presentation of a Story

Looking at the storytelling in relation to the choice of media and consequently the setup type, some academic authors state that storytelling has no dependence on media type. However, when it comes to complex stories, almost every user can notice the difference in experiencing the same story but in a different medium context. The most basic example could be to read a book and afterwards to watch a film based on the same story, and it is very common to hear from people that their impression is very different (Laaksolahti, 2008, p. 6). Therefore, it is possible to conclude that the medium gives its own perspective on the storytelling. Interactive storytelling is still not a fully developed field and because of that its genres, methods, and approaches need future research and discovery (Laaksolahti, 2008, p. 7).

Referring to the earlier explained project UTM Explore, it is possible to highlight how influential the multiple screen setup was on the prism of the main storytelling part. The division of a triple screen into three perspectives and angles of the story gave the story multidimensional UTM City topic explanation from three perspectives. The combination of different media such as cinematography, animation, and interactive exploration gave the overall storytelling the ability to represent very different perspectives of such a complex story. The cinematography enabled it to build a general user angle in the future with unmanned traffic management drones. The animation production assisted with a simplification of the future concept illustration and presentation. The interactive simulation recordings served as a representation of a main product of UTM City to the audience. Despite these mentioned advantages of each used media, it, overall, created an overwhelming flow of information, which led to audiences being unable to focus or keep track of three screens at the same time.

2.3.5 Cinematography Guiding Approaches in Storytelling

Producing storytelling in audio visual and video format, such a process could refer to film approaches and cinematography. Cinematography answers questions about how something is filmed and not what and is mainly based on three aspects: shot photographic settings, shot framing, and shot duration (Laaksolahti, 2008, p. 79). Each of these aspects helps to build a visual structure that consequently guides the viewer through the story scenes, revealing to the audience situations and actions (Laaksolahti, 2008, p. 79). The colour approach in the video production is one of the most emotional and metaphorical. It is well known that colour affects how things are being perceived, guides the gaze and focus point, and builds a hierarchy of important and less important details in the picture (Laaksolahti, 2008, p. 80).

2.3.6 Layers of Storytelling Experience - Immersion and Engagement

Immersion and engagement are usually used as criteria of successful learning in game experiences (Hamari *et al.*, 2016, p.171). Active participation in the experience is tightly related to engagement level (Özüdoğru and Çakır, 2020, p. 106). Fredricks, Blumenfeld, and Paris state that engagement contains three aspects: behavioural, cognitive, and emotional, "and recommend studying engagement as a multifaceted construct". (Fredricks, Blumenfeld and Paris, 2004, p.60). Based on this, it is possible to look at the engagement as layers of experience that can only be reached by covering different layers. The success of the story could also be evaluated by its immersion level. In the game design theories, immersion and engagement go hand by hand and both signify the success level of users' learning experience (Hamari *et al.*, 2016, p.420). "When one loses self-consciousness during flow, this may lead to a sense merging with one's environment. This description seems consistent with gamer's accounts of immersion or “being there” in the game. Research also suggests that the higher the challenge, the greater the engagement or sense of immersion" (Hamari *et al.*, 2016, p.420).

Looking at how to build and evaluate the immersion and consequently engagement, Gröppel-Wegener and Kidd suggest the storytelling layers theory. The framework is based on four orientations and its layers. The first orientation on the path to immersion is the participant. This orientation builds up on the motivation, role, and identity of a participating person. The second orientation is process, an aspect that could talk about the story development and who its creator is and their intentions. Following this, the creation orientation presents how the story is told covering the layers of different senses. The fourth orientation is the story, which is a combination of three previous orientations and reveals the “properties of the story told and experienced” (Gröppel-Wegener and Kidd, 2019, p. 27). Looking at Figure 2.5 with all four orientations interfering, it is possible to notice the immersion circle that appears due to four aspects layers. To sum up, in order to create and measure the engagement level it is beneficial to follow the suggested layering structure from Gröppel-Wegener and Kidd by covering all presented aspects that create a circle of immersion (Figure 2.5).

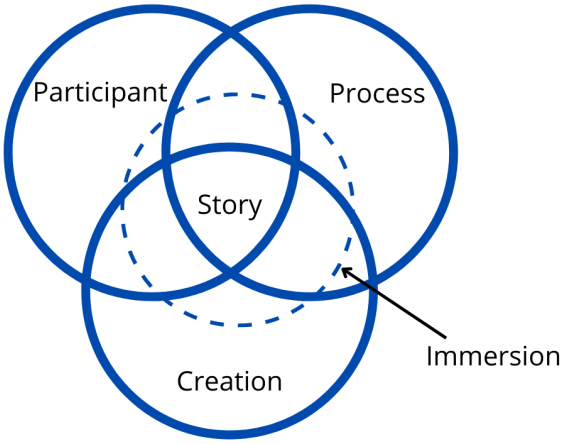

Figure 2.5: Layers of story experience adapted from Gröppel-Wegener and Kidd, 2019

After reviewing storytelling principles, it is necessary to investigate the visual aspect of creating the content for multiscreen exhibits. Consequently, in the next chapter interface design and visual hierarchy theory is unveiled.

2.4 Interface Design and Visual Hierarchy

User interface "refers to how the design presents information to users so that users can process information as required to complete a task" (Raskin, 2000).There are different kinds of user interfaces, for instance voice controlled interfaces or gesture based interfaces, but during the course of this thesis the focus lies in graphical user interfaces that are controlled through a touchscreen.

According to the Interaction Design Foundation, important aspects of user interface design are the usability and the likability of the interface. They state that the design itself should be "invisible" and not stand in the way of the actual interaction. Another important factor that contributes to a successful user interface is that it is enjoyable and satisfying to use without any kind of occurring problems or frustration (*What is User Interface Design?*, no date).

2.4.1 Design Principles for an Engaging User Interface

Metros and Hedberg describe in their article that a motivating strategy to stimulate interaction is to create an explorable environment where the user can think about a multitude of options and experiences. Metros and Hedberg further state that interaction design, which matches cognitive expectations and is represented correctly through a graphical user interface, leads to the motivation and engagement of the users. The requirements to ensure the engagement and motivation are that the interactions are

adapted to the user's technology skill level (Metros and Hedberg, 2002). To achieve a more engaging and motivating user interface Jakob Nielsen developed 10 Usability Heuristics, which are general guidelines that support the design of a successful user interface. Some of the guidelines that are applicable and relevant for this thesis are listed below and are divided into *Principle* and *Explanation*.

Principle	**Explanation**
Visibility of system status	The design of the interface should let the user know at what point they are. Appropriate feedback in close time can enhance that. This procedure can establish trust and learning from previous interactions can help to initiate the next steps.
Match between system and the real world	The design should not use professional jargon that users might not understand. Relatable communication and real-world conventions as well as a natural and logical order support the user. It helps to make the experience more intuitive.
Consistency and Standards	Used terms, actions, situations or words should be coherent throughout the design but also matching with other products, since incoherent usage of terms, actions, situations, or words is increasing the cognitive load of the user.
Recognition rather than recall	Elements, actions, and options should be visible to minimise the memory load of the user. The information should not be remembered but shown instead throughout different interfaces. This is reducing the cognitive effort of the user.
Aesthetic and minimalist design	Information that is not relevant should not be shown, otherwise it can distract from the more important information. The visual elements should support the user’s goal and be limited to the essentials.
Help and documentation	If it is necessary to add some additional information, it should be kept concise and concrete. It should be easy to locate and focus on the user's task.

Table 2.1: from Nielsen, 2006.

2.4.2 Visual Hierarchy - Attention Guiding Through Interface Design

Based on the identified problems with UTM Explore it became apparent that the participant needs an improved guidance to follow the action on the screen due to the width of the set up. This can be achieved for instance by visual hierarchy. The hierarchy in a graphical user interface describes the principles of arranging elements in order of their importance. By placing elements strategically, the hierarchy can influence the perception of the user and guide them through the interface (*What is Visual Hierarchy?*, no date).

The following table explains characteristics and their effects on visual elements.

Size	Larger elements are noticed easier
Colour	Bright colours are more noticeable than muted colours
Contrast	Strong contrasts between colours are more noticeable
Alignment	Elements that are not aligned stand out more than aligned ones
Repetition	Repeating a certain style can indicate that content is related
Proximity	Elements that are placed closely together seem related
Whitespace	If there is more whitespace around an element, it is more noticeable
Texture & Style	Richer textures are more noticeable than flat ones

Table 2.2: Table of characteristics that can influence the hierarchy (*What is Visual Hierarchy?*, no date)

Figure 2.6 shows which effects can be used to let something stand out. The importance of something that stands out is significant if it comes to the cognitive workload that is connected to the interface. If important information or elements do not stand out, the search is cognitively more effortful. Something that stands out can be found with just one glance at the interface, while unremarkable elements can require several eye movements to recognize it. For the specific multiple screen setup time is an essential factor to consider, since the story is moving on and needs to be followed accordingly in order to understand it (Ware, 2008, p.29).

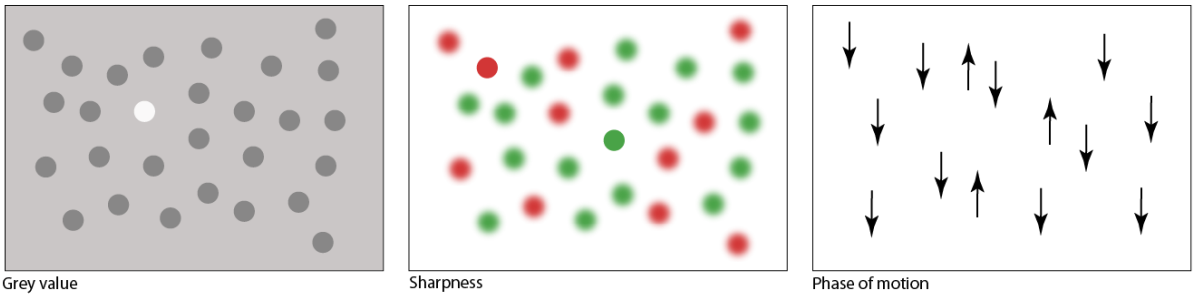

Figure 2.6: A selection of effects of highlighting visual elements adapted from Ware, 2008

According to Swaminathan and Sato's paper “Interaction Design for Large Displays”, the human vision has a total visual angle of almost 170 degrees (Swaminathan and Sato, 1997, p.15). They elaborate that only 1° degree of visual angle is available for recognizing details such as lettering. Beyond this the visual perception is decreasing significantly and rapidly (Hoppe *et al.*, 2022, p.65). The approximate reading distance is about 45 to 60 cm, which is about an arm's length. Especially for reading, this means keeping the width of the text small and centred in the visual cone can reduce neck and eye strain (Swaminathan and Sato, 1997, p.15). However, according to Hoppe *et al.*, visual tasks involve eye movement so this area expands to approximately 15°. This range is described as easily recognisable. Everything that is outside of that range up to the borders of the visual field is part of the peripheral vision (Hoppe *et al.*, 2022, p.67).

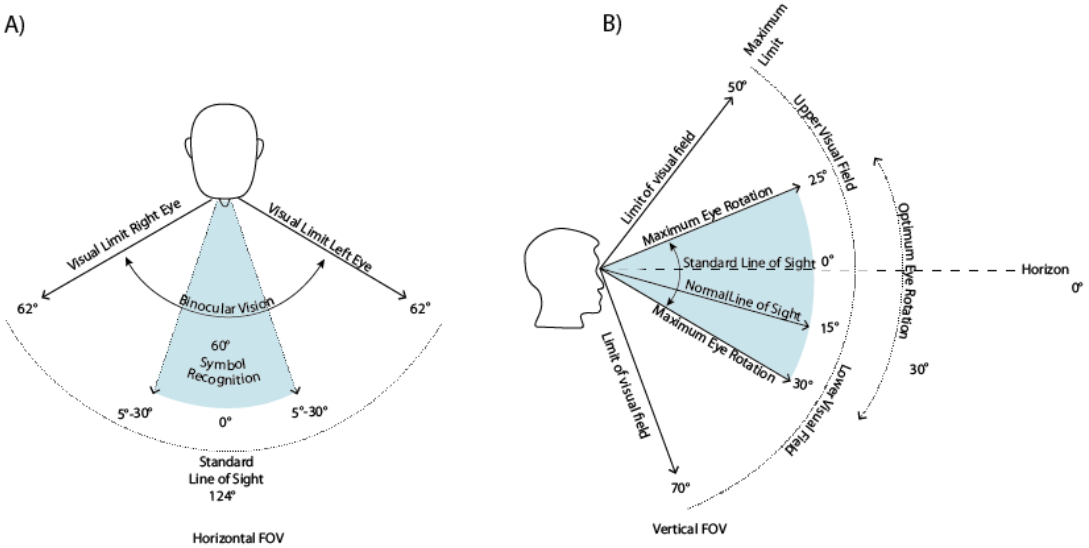

Figure 2.7: Field of Vision adapted from Tara, Lawson and Renata, 2020

After reviewing this information, it becomes apparent that a multiple screen setup can only focus on a small area at a time. The storytelling and the interface design need to guide the viewer's eye over the screens so all the displayed information can be perceived and understood.

2.5 Outlook for Multiple Screen Design

After reviewing the information gathered in the theoretical framework, it was possible to decide on the further process of this research project in terms of potential solutions and methods that could be researched and implemented in the following activities of this thesis. Since there is a lack of research on the particular setup chosen for this thesis, related and comparable literature was reviewed instead.

Referring back to the UTM Explore project, the challenges (Chapter 1.2.1) of developing a design for multiple screens that could be engaging and perceivable to the audience became apparent. These findings built the base for the theoretical framework chapter, which includes research about engagement and perception in storytelling and user interface design. These two terms, engaging and perceivable, formed the foundation of the overall research question in this thesis. To sum up the conducted research, it is necessary to state the importance of the storytelling's perception level because it refers to the quality level of the story itself (Baron and Bluck, 2011, p.93). In order to evaluate this perception level, it is needed to look at the key elements and structure of the story ie. Does it have a plot? Does it contain the beginning, middle, and end parts? (Baron and Bluck, 2011, p.93). The engagement of the storytelling is tightly connected with game design theory and learning (Hamari *et al.*, 2016, pp.170-179). In some previously mentioned literature the success of user experience refers to the level of learning and consequently to its engagement and immersiveness (Hamari *et al.*, 2016, pp.170-179). According to Hamari et al. "the higher the challenge, the greater the engagement or sense of immersion". Additionally, the storytelling layer theory formulated by Gröppel-Wegener and Kidd assists in the realisation of necessary aspects in the story for engagement level creation. When it comes to interface design, research showed that the improvement of the perception of the multiple screen setup interface can be achieved through the effective use of visual hierarchy. By structuring visual elements according to their attention catching attributes (size, colour, contrast etc.) it is possible to help guide the viewer across the screens (Ware, 2008, pp.29-31). Looking at the improvement of the engagement of the participant towards the user interface design, an explorable environment with a variety of options should be created that fits to the technological skill level of the participant. Another factor that could enhance the

engagement and motivation is fulfilling the expectations of the user towards the interaction, which is represented through the user interface (Metros and Hedberg, 2002, p. 191)

To conclude this chapter, the findings that determined the process of activities that were carried out should be highlighted. The interactive storytelling structure constructing approach discussed above was one of those theories that was applied and tested in the next stages. The second crucial finding that was taken to the following activities were approaches to the attention guiding that were benefitting and feasible to explore in the prototype.

3 Method

This chapter provides an overview of all the methods and activities that were applied in this thesis. It starts with the research approach and continues with methods for exploration, concepting, prototyping, and user testing. The measurement of the engagement and perception are taken through questionnaires and not through technological tools (e.g. eye tracking), since it is considered to be outside of the scope of this thesis.

3.1 Research Through Design

The research in this thesis follows the research through design methodology, which means that the research is developed during the process of designing and thus leads to knowledge contribution. Research through design consists of four phases: Exploration, Concepts Generation, Prototyping and User Evaluation. (Stappers and Giaccardi, 2017) These phases build the basic structure of the thesis.

Exploration
The researching activity started with a literature research and was enhanced by collecting knowledge through a study visit and an explorative interview with experts.

Concepts generation
The concepting activity was based on the exploration and consisted of different methods like brainstorming or synectics to start the ideation process and then concluded with a participant journey map and storyboarding.

Prototyping
The Prototyping Activity consisted of the collection of footage and compiling it. Three versions were made, which would be tested later. The versions include different theories on how to steer the view of the participants to guide them through the story.

User testing
The user testing was divided into two phases. The first phase was to evaluate the perception of the story in visual terms where the three versions would be tested.
The second phase would evaluate the overall perception of the story as well as the engagement through interaction.

3.2 Exploration

The exploration and researching process of this thesis included different activities that contributed to a comprehension of the context in which the project is established. The acquiring of the knowledge was aligned with the research questions' objectives and was

based on initial theory research followed by the study visit to Visualisation Centre C and the explorative interview with experts.

3.2.1 Fundamental Knowledge

The fundamental knowledge development is divided into several topics that aim to cover different aspects of research questions. Overall, the theory part includes the exhibition design in order to establish knowledge about the exhibition specifics that need to be considered in the final prototype. The storytelling and interface parts attempt to find approaches for UTM Explore project evaluation in order to spot improvements in visual elements and story structure to be able to raise visitors' engagement and perception. The multiscreen theory presents a theory about the challenges and particularity of such a setup that need to be considered. As a consequence, the theory study aims to highlight main insights based on which UTM Explore project will be assessed, in order to find what could be improved and potential solutions for that.

3.2.2 Study Visit to Visualisation Centre C

To get information on the location and the visitors that the prototype of this thesis is designed for, a study visit was carried out. Consequently, a meeting was organised with the project leader at Visualisation Centre C. The aim of the study visit was to gain insights about the type of VC visitors, visitors' behaviour, as well as the structure themes of VC exhibitions located on the different floors. The main purpose of this method was to define the target group for the future prototype and how it would be integrated within the other existing exhibits. Data was gathered during the discussion with a project leader at Visualisation Centre C by taking notes. Based on the notes, it was possible to build a list of insights that became the results of the study visit activity.

3.2.3 Explorative Interview

To get a better understanding of the potential improvements for UTM Explore, an explorative interview was conducted. To direct the interview in the specific field of interest, three experts from various fields were invited to the Visualisation Centre’s fifth floor where the UTM Explore setup is located.

Expert	Function	Expertise
E1	Research director of Arbetets museum	expertise covered the designing for exhibition places and how to create an engaging storytelling for museum environment

E2	Producer at Visualisation Centre	knowledge of designing for unusual digital setups and immersive experience creation
E3	Professor in culture and society at Linkoping University	provided expertise in bringing together exhibition studies and media and about using physical props in the digital experience

Table 3.1: Experts

The named experts were invited to first try out and test the current UTM Explore application and later on evaluate it. Feedback was gathered by open discussion and taking notes and pictures of details for potential improvement. Based on the notes and pictures, the analysis process started by categorising all data into four groups: general impression, storytelling, interface, and other feedback. The evaluation was moderated through a question catalogue which focused on:

- Engagement of the presented content and the interaction
- Perception of the displayed story and visuals on the multiple screen setup

These points were addressed in regard to storytelling and interface design for multiple screens.

The interview generated insights specifically adapted to the UTM Explore and on how to adapt and improve the current UTM Explore application towards the purpose of this thesis. The challenges of the previous work with UTM Explore were laid open and through the different perspectives of the experts potential solutions and improvements were revealed. Categorised lists with insights were analysed with a *prioritisation matrix* according to a feasibility of its implementation in relation to value to the research topic of this thesis.

A prioritisation matrix is a tool that can be used to identify key issues and interpret which improvements should be prioritised. It also gives an overview of which issues should be implemented first (‘Prioritisation Matrices - Project Management Knowledge’, no date). For the positioning matrix, two parameters are chosen and placed on a matrix where each parameter has an opponent (see Figure 3.1). For explorative interview analysis parameters of feasible/not feasible and high value/low value were used to identify the improvements that will be in the focus in the following activities.

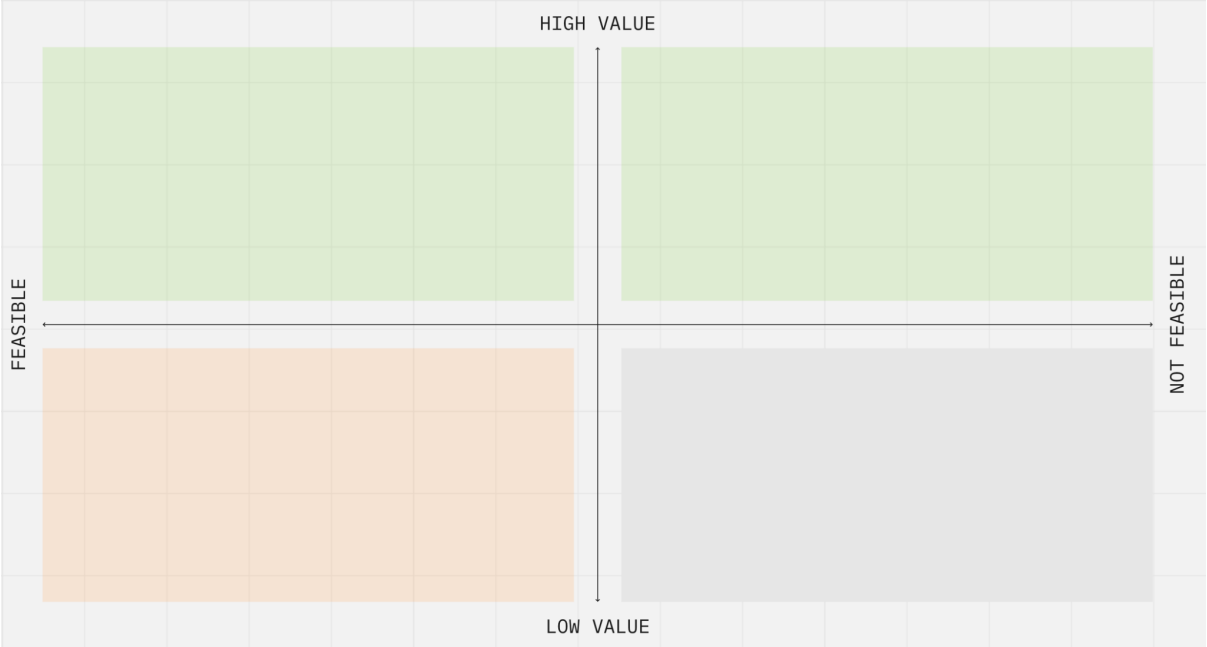

Figure 3.1: Prioritisation Matrix with opposing parameters

3.3 Concept Generation

The ideation phase was introduced through different ideation methods often found in the field of co-design. At first, there was an initial brainstorming to generate a lot of ideas. Those ideas were then elaborated on with the lotus blossom brainstorming technique. At the same time, the synectics tool made it possible to generate unconventional ideas. After an evaluation phase the ideas were narrowed down to three ideas, which were then defined with more detail. For that, a user journey map was created on the basis of which a rough storyboard was developed. After further evaluation with the weighted objectives methods and a discussion session with the UTM expert, it was decided on one idea. Due to the workload that this idea carried, the focus was shifted to certain parts of the idea and this was then put into a detailed storyboard on which the prototyping can be carried out. The platform *miro* was used throughout the ideation process.

Figure 3.2: Miro board with ideation

3.3.1 Initial Brainstorming

The aim of the brainstorming method was to generate a lot of ideas on how to solve the problems mentioned. Typically each participant of the brainstorming is gathered in a room and writes notes down on a paper and then collects the ideas all together, which then potentially sparks more ideas. In this case, the process was carried out remotely but in a similar manner (Lowgren and Stolterman, 2004, p.71). Some of the ideas that were generated during the brainstorming session originated from the group interview, where the experts expressed potential solutions or ideas on how to improve the display of UTM City. After the process of generating, the ideas were structured, elaborated, and defined with the Lotus Blossom technique.

Lotus blossom is a brainstorming technique that serves as idea generation on the surface and deep detailed level. It helps to generate up to 64 ideas and solutions for the given topic. During the brainstorming process, lotus blossom was used for detailing and generating a lot of ideas that address topics of user feelings at the future exhibition and what users could potentially gain out of the future experience that will be designed.

3.3.2 Synectics

Synectics is a method aimed for problem solving and helps to provoke thoughts and ideas through metaphors and analogies. According to Tang, Chen and Gero, "the main idea is to link initially unrelated issues together to change thinking models and then produce new concepts" (Tang, Chen and Gero, 2012). The process of synectics is divided into several steps according to which concepts related to the chosen topic can be generated. Steps that were

included in this work: descriptive for the topic adjective generation, physical objects that incorporate adjectives from previous stages, selection of the most suitable physical object from the previous step and its feeling adjective generation, combining antonym adjectives from previous step, generation of idea that incorporates these opposing feeling objectives.

During the Concepting Activity, the main goal for the use of the synectics tool in this work was to define a potential theme and, consequently, name of the future exhibition. Additionally, at the end stage of the synectic process, it stimulated the generation of practical ideas about the experience for the user. The main topic for the synectics was formulated as "a theme for multi-screen exhibit about UTM in a science centre".

3.3.3 Participant Journey Map

The participant journey map is a tool to define the timeline and structure of the application. It outlines key interest points that determine the user's *awareness, interest, intention to participate, exploration* and the *finishing* (Mast *et al.*, 2021). It was adapted slightly to the purpose of the previously generated ideas but the fundamental parts remained.

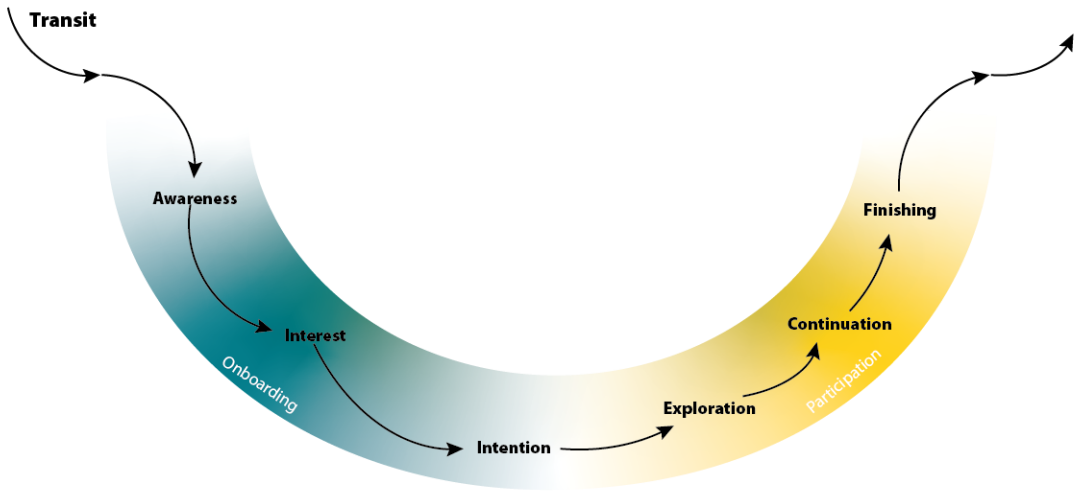

Figure 3.3: Participant Journey Map adapted from Mast et al., 2021

The participant journey map is based on research from Mast *et al.*, 2021 and is “providing insight into people’s engagement with interactive augmented play spaces (APS) and the influential factors” (Mast *et al.*, 2021). The map is divided into two phases: ‘*Onboarding*’, which includes the states Awareness, Interest, and Intention to Participate, and ‘*Participation*’, which includes the states Exploration, Continuation and Finishing. Even though this structure inherits many states of the different steps one after another, it is possible that they flow into each other within the phases.

The first point in this map is '*Transit*'. Transit is the state of entering or passing by, in this case the public space (Mast *et al.*, 2021). Since the application is located in a science centre, the intention of the visitors most likely is to get involved, hence it can be labelled as a deliberate encounter (Mast *et al.*, 2021).

The second step on the map is *'Awareness'*. For the visitor to become aware of the application it needs to stand out and be visible (Mast *et al.*, 2021).

As a next point on the map there is *'Interest'*. According to Mast et al., "[i]nterest indicates a state where a passer-by is aware of the interface and shows interest by observing, approaching and/or standing still" (Mast *et al.*, 2021).

Then the '*Intention'* follows. This state describes the desire of the visitor to interact with the application. It can be just a short state and then going over to the actual participation or it can involve looking for an opportunity to start interacting, for instance waiting (Mast *et al.*, 2021).

Next ist the '*Exploration*'-state. This is the beginning of the Participation phase and the most influential aspects in this state are curiosity, usability, and reward.

After the '*Exploration*', the '*Continuation*' follows. This is the main state for the visitor. It means that they are now interacting with the application.

After the visitor's participation the last step, "*Finishing*", is on the map. "[T]here comes a moment at which the participant wishes or needs to stop, either voluntarily, because of external reasons or because the game ends" (Mast *et al.*, 2021).

In addition to the Participant Journey Map by Mast et al., three scenarios were chronologically integrated into the map. These scenarios consist of an introduction, the *explore mode* (interaction), and a *story mode*. These scenarios will build the story that will explain the functions of UTM City to the audience.

This setup of the Participant Journey Map made it possible to create a feasible timeline of events including the fundamental aspects that affect the participants' journey.

3.3.4 Scenarios and Storyboarding

Based on the Participant Journey Map, where the scenarios, triggered by interactions, that are supposed to happen on the screen are noted down in form of text, scenarios were created and depicted in the form of storyboarding.

Scenario is a time based tool that illustrates the process and action of events, which can support the guiding during a design process but it also helps to communicate concepts to

the outside (Tang, Chen and Gero, 2012).

For this thesis the scenario was used to visualise the actions of the plot on the multi screen setup. The form of visualising was the storyboard, so each screen of the multi screen setup, including the touchscreen, was a field where parts of the story were shown.

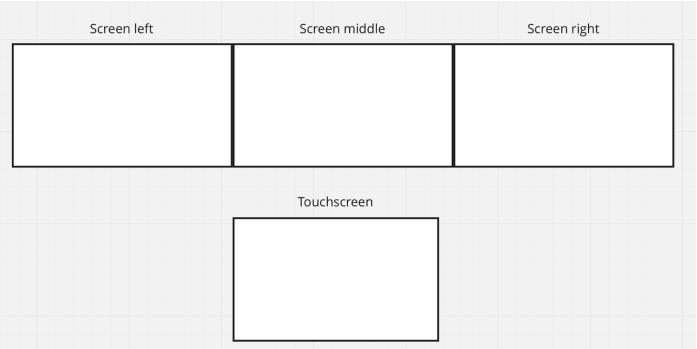

Figure 3.4: Structure of screens

The story was illustrated with detail and more information to support the design process was added. The actual footage on the screen was portrayed with sketches or images and the way of footage retrieving, filming, animation, or stock footage was marked through colour coding (pink, turquoise, and yellow dots). Additionally, the actions of the plot on each screen were described next to it (blue tiles) and the potential thoughts of the user were named in a speaking bubble. Through this it was possible to generate a plan of what should happen on the screens, while showing at the same time how feasible each scene was for production and what role it might play for the user.

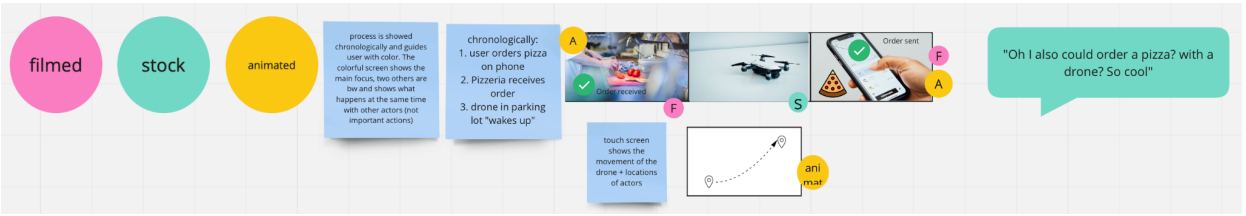

Figure 3.5: Structure of storyboard including information on type of footage, potential thoughts of user, and text description

3.3.5 Concept Evaluation

Evaluation of the three final generated scenarios included several methods and served for establishing the final concept for prototyping. Firstly, the weighted objectives method was used (Boeijen et al., 2014, pp.135-136). The criteria for evaluation was defined and included the weight for each criteria (suitability for UTM topic - 15%, feasibility for the future Prototyping Activity - 30%, suitability for the defined target group - 15%, story engagement - 40%). After that, grades up to 3 were put under each idea and criteria. This method was aimed at evaluating ideas from a number of perspectives and encountering the differences

between them. In addition to this method, a pros and cons list was produced to write down the main outcomes.

After these weighted objectives, the method concept evaluation process included several critical discussions with the UTM topic expert. This discussion was formed around the feasibility of three generated ideas and the engagement presentation of the UTM topic. These discussions stimulated the final choice of the idea for the next step: prototyping. Based on the expert opinion, the chosen idea was shortened to one scenario and further detailed including different perspectives, such as content for both storytelling on the three screens and user experience on the touchscreen, user feelings for each scene of the concept, and production aspects of each scene.

3.4 Prototype

The Prototyping Activity aimed to answer the research question: "Which approaches can potentially enhance the hierarchy of visual elements and video storytelling dynamics for a multiple screen setup to improve perception and engagement of UTM City?". According to Stappers and Giaccardi, the development of a prototype is not the same as product production and it takes "a central role in the knowledge-generating process" (Stappers and Giaccardi, 2017). In this thesis' case, the prototyping part aims to create different versions of an artefact (video) that could raise a discussion about the chosen approaches in the following step - the user testing.

The final concept was prototyped into three versions of a presentable video, demonstrating the previously discovered approaches for guiding the user through the three screens. With the help of a midiboard it was possible to make an interactive prototype using Dataton Watchout software for editing and projection on the multiscreen setup. The production process involved filming the user perspective of the story to make it realistic and closely related to the final viewer. The scenario for touchscreen development was created in the UTM City application, in order to present the core topic of this project - a future management system for drone traffic control.

3.5 User Testing

The prototype was tested by users that correspond to the target group of the application. The data was gathered from two testing rounds with participants based on a questionnaire that combined open questions as well as elements from the *User Experience Questionnaire* (*UEQ*) and the *Game User Experience Satisfaction Scale* (GUESS). In between two user tests, a review with a UTM expert was conducted to gather feedback on the prototype's scientific precision concerning the topic of UTM. Overall data was gathered by taking notes and filling in the questionnaires. Consequently, insights were listed, categorised, and summarised in

relation to the theory on 1. attention guiding approaches, 2. perception of the story, 3. engagement level of users after watching the video prototype.

The chosen method of the user testing is the UEQ, which measures different attributes of a product, for instance "both classical usability aspects (efficiency, perspicuity, dependability) and user experience aspects (originality, stimulation)" (*User Experience Questionnaire (UEQ)*). The *attractiveness* aspect means "overall impression of the product" (*User Experience Questionnaire (UEQ)*. The second aspect, *perspicuity* answers the question "Is it easy to get familiar with the product and to learn how to use it?" (*User Experience Questionnaire (UEQ)*. The *efficiency* aspect evaluates how fast the prototype is. *Dependability* evaluates the interaction of the prototype, if it is predictable or not. *The stimulation* aspect analyses the question "Is it exciting and motivating to use the product?" (*User Experience Questionnaire (UEQ)*. Finally, the *novelty* aspect evaluates the creativity of the prototype and how eye catching it is (*User Experience Questionnaire (UEQ)*). The questionnaire enabled a quantitative measurement of the characteristics of a product tested by the user itself (Laugwitz, Held and Schrepp, 2008, pp. 63-76). This method of evaluating the product is necessary during the process of developing the multiple screen setup to validate or discredit implemented design proposals and to gain a new perspective on the matter. The questionnaire is used to collect information of the users in an efficient way. Overall analysis of UEQ responses was based on the UEQ data analysing tool, data was inserted in the premade Excel, where the graphs with six aspects were created and analysed in the chapter “User Testing Activity ''. Additionally, all answers were compared with feedback from the *Thinking Aloud* input.

Additionally, the GUESS was partially used in the questionnaire to evaluate the story engagement. This instrument was developed "to comprehensively measure video game satisfaction based on key factors" (Phan, Keebler and Chaparro, 2016, p.1217). The GUESS questionnaire is divided into nine factors: Usability/Playability, Narratives, Play Engrossment, Enjoyment, Creative Freedom, Audio Aesthetics, Personal Gratification, Social Connectivity, and Visual Aesthetics. The Narratives Factor is the only one that was included in the final questionnaire to analyse story engagement. The collection of data for the GUESS was conducted through Google Forms where users needed to grade included statements from the Narratives aspect on a scale from one to seven. Analysis of the results was based on the received graphs from Google Forms and compared with received feedback from an open discussion and *Thinking Aloud* method.

The *Thinking Aloud* tool requires the participant to express their thoughts regarding the product as they are proceeding through the user interface (Nielsen, J., 2012). Jakob Nielsen states that through the *Thinking Aloud* tool it is possible to discover eventual misconceptions

that the participant encounters. This can lead to concrete revisions of the design (Nielsen, J., 2012).

The first user test will focus on the perception of the prototype. In this test, the understanding of the story as a whole and what experience the participants have with the guiding of their view will be tested. The test will be conducted by showing a screen recording of the Watchout production. The second user test will focus on the perception of the story as well as the engagement level. The participants were invited to test the whole application at Visualisation Centre C. The method Wizard of Oz will be applied, since the actual functionality of the prototype will not be developed. That means that the participants use the prototype as intended but an additional operator is controlling the prototype manually.

After the user tests are carried out and input is collected and categorised, suggestions and observations that can lead to potential improvement are gathered and positioned in a *prioritisation matrix* ('Prioritization Matrices - Project Management Knowledge', no date). Depending on the positioning of the options/issues on the positioning map it can be determined how to further deal with it. The prioritisation matrix is divided into four segments, which are *Do it now*, *Do it next*, *Do it if/when there is time* and *Don't do it* (*Perceptual Maps*, no date). This tool supports decision making and provides a visual framework for the further treatment of issues or options.

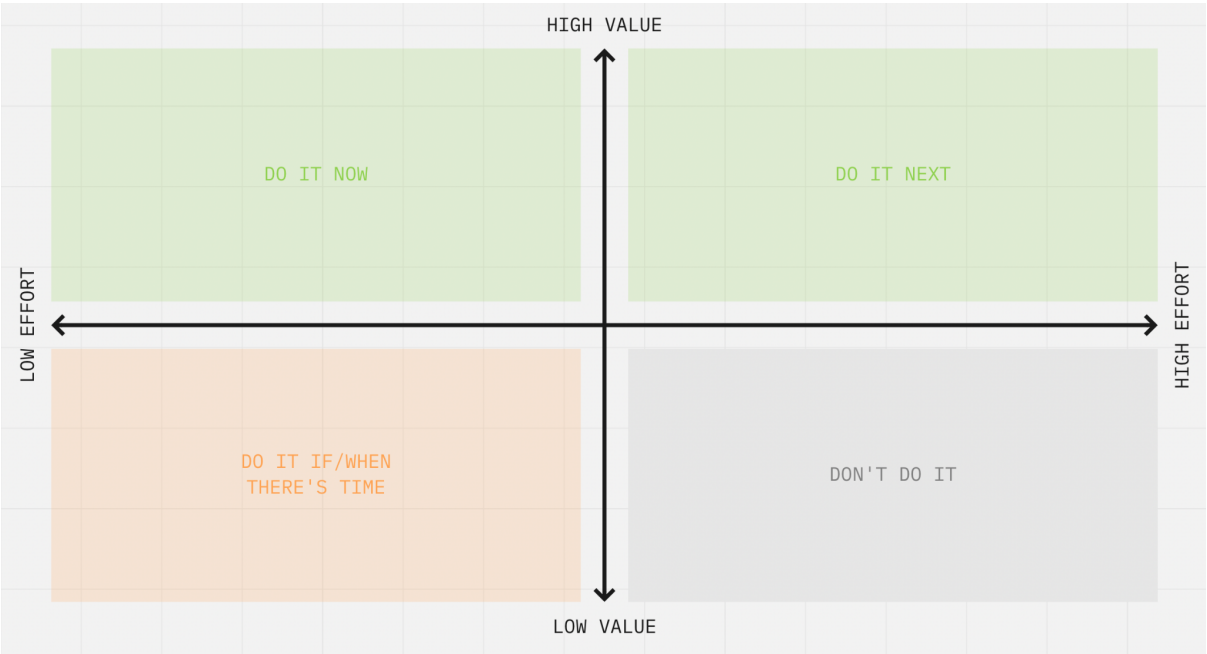

Figure 3.6: Construction of a prioritisation matrix (*Miro | Online Whiteboard for Visual Collaboration*, no date)

3.6 Research Ethics

All interview and user test participants in this thesis took part in the activities on a voluntary basis. Before each interview and user test every participant signed a consent form that stated that they are willing to share their opinions and feedback for the purpose of research and that said information will be used in this thesis anonymously. It was explained that all gathered information will be kept confidential and analysed not in relation to an individual person but as a group of people that participated in the activities (*Good Research Practice - Vetenskapsrådet*, no date).

4 Exploration Activity

This chapter aims to answer the research question: "*What are fundamental elements that could contribute to a potential improvement for a successful interface and storytelling design of the UTM Explore project on a multiple screen setup?*". The chapter describes the outcomes of a study visit to Visualisation Centre C and the conducted explorative interview, and extracts the main insights for the next research step- concepting activity.

4.1 Study Visit to Visualisation Centre C

To get a better understanding of the location and audience the prototype of this thesis is designed for, a study visit was carried out. For this, a meeting was agreed upon with the project leader at Visualisation Centre C.

According to the project leader at Visualisation Centre C, the audience of the centre has a wide range: children from age five to the grandparents accompanying them. During the study visit and discussion with the project leader it was possible to specify potential users to which the design decisions are directed. The focus lies on young adults between 16 and 25, but should also be appealing for children of a younger age. In terms of the size of the audience, it was suggested to decrease it to a small group, about one to five people (families, groups of friends or students, etc.), due to space and activity limits. It also could be suitable for school classes, although supervisors will be needed.

According to the discussion with the project leader, in Visualisation Centre C different floors are directed to different age groups. Floor 5 is directed to the older visitors and is currently showing a wide range of exhibition pieces addressing sustainability. The exhibition is exclusively happening on screens and multi-touch screens.

Floor 4 is addressed to younger visitors and is constructed as a spaceship with integrated screens with information and several topics merged together in a playful environment.

Floor 3 is the main exhibition, which consists of different kinds of screens, mainly touchscreens, which show things that cannot be perceived with the human eye. For example, the inside of a virus, a sarcophagus, or a closeup of a painting. The main exhibition is directed to a wide range of visitors and addresses children as well as young adults and adults.

Floors 2 is directed to younger children, presenting the topic of coding and maths, and why they are needed. It has a variety of different exhibition methods which range from console games to little racing robots to a simple coding tool that shows the effects of different parameters.

The most suitable floor for the multiple screen setup is floor 5, since it matches the age group addressed in this thesis. The current exhibition theme is not completely overlapping with the theme of this thesis but it might adapt at a later stage.

4.2 Explorative Interview

The following subchapter includes a description of the explorative interview and how it was planned and executed. The key findings of the generated insights that the experts provided in the interview are mentioned below.

4.2.1 Interview Preparation

To get a better understanding of the potential improvements for UTM Explore, an explorative interview was conducted. The interviewees that participated in the interview were experts from various fields in exhibition design and culture (see Table 3.1).

The chosen format was a screening of the already existing UTM Explore project on the multiscreen setup with a further discussion based on the impression of the exhibition piece. A question catalogue (Appendix A) was created to moderate the interview after the interviewees tested the existing application UTM Explore. The questions focused on two main topics, storytelling and interface design, in context with perception engagement and coherence. The purpose of organising such an explorative interview/ discussion was to define and highlight places for improvement in the existing exhibition, but also to receive practical advice for redesigning the concept. The interview catalogue was based on challenges that were faced during the creation of UTM Explore (Chapter 1.2.1) and evaluation of its engagement, perception aspects.

4.2.2 Insights from the Explorative Interview

The experts indicated deficiencies and weaknesses in the application and suggested improvements to enhance the engagement, perception and coherence of the application. The beginning of the interview focused on their overall experience with the application followed by their expectations towards UTM Explore. Afterwards, the questions got to more specific disturbing elements and potential improvements. The interview concluded in an open question about their final thoughts. It was conducted in English, the lead designer of UTM Explore was present and took part in the concluding discussion of the design team after the experts left. The feedback was collected via note taking, audio and video recording, and photography. Based on the collected material feedback was categorised into four groups: general impressions, interface design suggestions, storytelling suggestions, and other feedback.

General impressions and potential enhancements:

- The connection between the three screens is not clear. It is difficult to grasp all perspectives since the user can only focus on one part at a time. Using the screens as a unit rather than four individual elements could enhance the connection of the screens. (1)
- It was mentioned several times that the user should quickly realise what they potentially gain from spending their time at this exhibit. A clear mission should be indicated early. (2)
- To create a better connection between the touchscreen and the three screens it might be helpful to tilt the touchtable so that there is less of a visual gap between the screens and the transition is more seamless. (3)

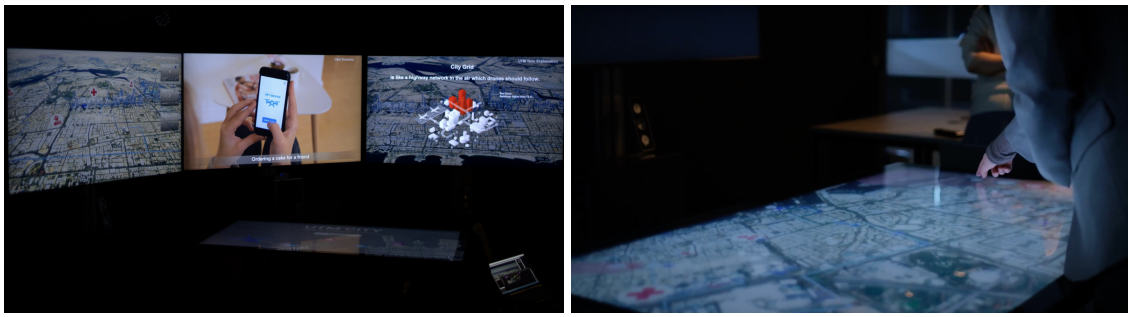

Figure 4.1: Left, set-up during the interview, presentation of the *story mode* with three perspectives; right, exploration of the *explore mode* of the UTM Explore application

Interface design:

- The interactive interface does not provide feedback to what the user is doing, which results in confusion. By implementing feedback, possibly through visuals or sounds, the user would get a better understanding of the effect their actions have. (4)
- There is too much text that is impossible to read in a short amount of time without missing important elements on the other screens. (5)
- The different elements on the screen in the *explore mode* are unclear even though they were explained before in the *story mode* because they are not visually connected. This led to confusion and difficulties to understand the *explore mode*. (6)

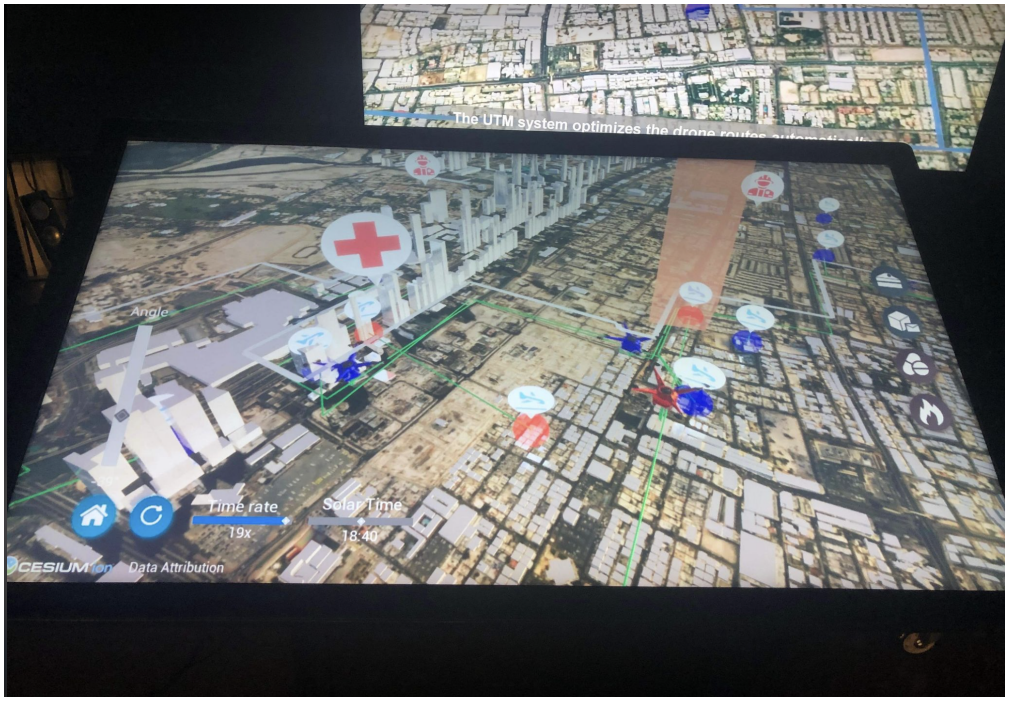

Figure 4.2: E*xplore mode* without a feedback or clarification on specific terms or elements

Figure 4.3: shows the three perspectives and the amount of text on each screen

Storytelling:

- Repetitive and flat storytelling. All four stories are illustrating similar situations but with different technical highlights of UTM that make the viewer feel like the scenarios are repetitive. This leads to a lack of story and topic immersiveness. (7)
- One of the proposed ideas was to concentrate the main story line on the middle screen as it is the main focus point for the user and it is hard to grasp all three screens with different perspectives at the same time. Other screens could serve as a complement and provide mood and atmosphere to the story, creating immersion (8)
- The story lacks climaxes which would help to highlight the most important moments of the story. Setting up the right storytelling structure will guide audience attention and keep engagement high. (9)

Other relevant feedback:

- Suggested perspective for the overall storytelling: the theme of tension between the futuristic and the everyday in order to make it more engaging and thought-provoking

for the audience. One of the messages for the story could be worded as "What does the future of everyday life look like with drones? (10)

- The name of the exhibit has an effect on the engagement with it. It should be descriptive and understandable for the target group. (11)
- An important aspect that was mentioned several times was that the use of sound can potentially enhance the whole experience drastically. (12)
- The *explore mode* provides the possibility to generate individual drone delivery routes for different purposes. This is not clear, the users are looking for a purpose and are not able to find it. This results in frustration. A clear task with simple explanations is missing. (13)

After categorising insights to a bullet point list, a number was assigned to each point and the analysis was based on the positioning of the insights on the *prioritisation matrix*. The *prioritisation matrix* shows which ideas have a *high value* in regard to the research questions and are feasible in regard to the following Concepting and Prototyping Activities. The main focus lies on the lack of structure in the storytelling (7,9), and restructuring the visual elements on three screens (8,5).

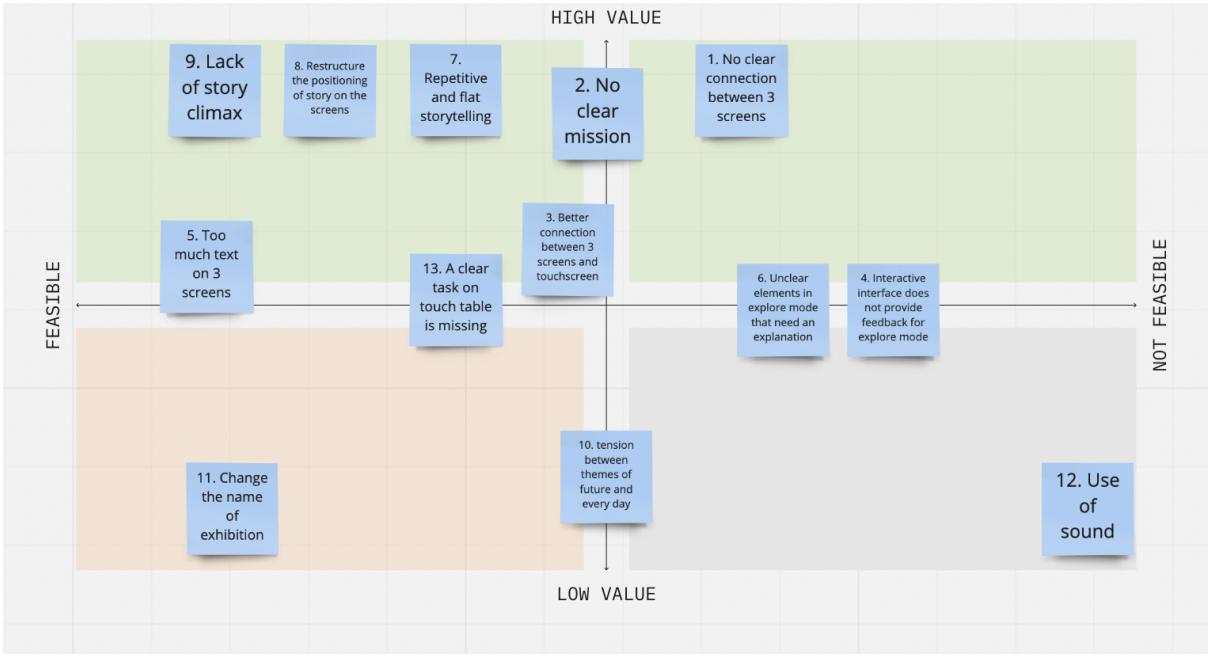

Figure 4.4: Prioritisation Matrix with positioned results from the interview

To summarise, the generated insights show the complexity of designing for public exhibitions in the context of multiple screen design. The issues with the UTM Explore that were encountered by the audience relate mainly to 1. storytelling structure and 2. information overload on the screens, meaning the lack of the visual structure. These lead to challenges in following the story on three screens. The suggestions on improvement that the experts provided during the explorative interview form a connection to the Concepting

Activity where ideas will be formed and concepts will be developed. Additionally, the study visit helped to identify the target audience for this exhibit at Visualisation Centre C, which are mainly children and young adults.

5 Concepting Activity

This chapter aims to answer the research question: "*What are potential solutions that can be retrieved to improve the perception and engagement for a multiple screen setup of UTM Explore that are based on the ideation process".* It describes the ideation process of this thesis and starts by defining the message of the application through the brainstorming and synectics method, and continues on to telling the story through a participant journey map and storyboard. It ends with elaborating on the final concepts that were afterwards prototyped.

5.1 Ideation - Defining the Message

The initial brainstorming phase, based on the Exploration Activity made it possible to outline a message that should be communicated to the user. Through different brainstorming tools three main aspects stood out: The exhibit can be used to raise general awareness about drones and how they could affect broader society in the future and reveal opportunities, to take away potential negative connotations and worries people might have, and the role that UTM City could play in all of this. Techniques that were used during this process were lotus blossom brainstorming and synectics.

The initial brainstorming session helped to generate various ideas regarding potential scenarios surrounding the application, challenges UTM is addressing, potential takeaways for the participant and possible solutions to guide the participants view. The role of the user was also elaborated on. One idea that stood out and influenced later concepts was that the user could take the role of an UTM manager and help to organise the drone traffic. Overall, it was a very broad brainstorming session which would later on be specified.

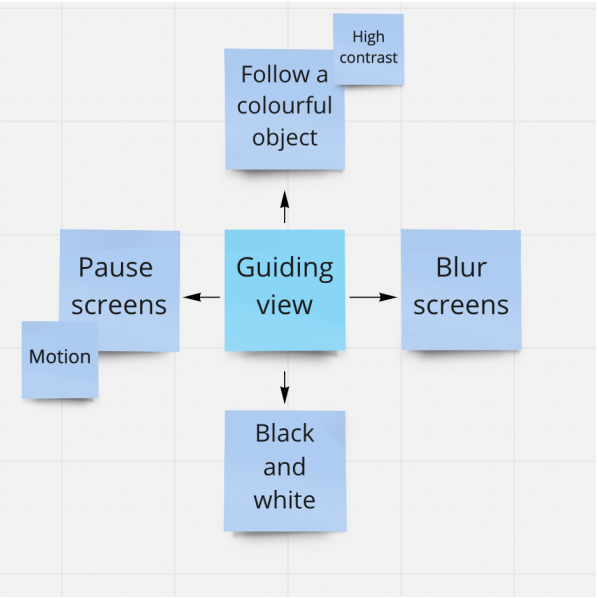

Figure 5.1: Ideation for attention guiding approaches

The Lotus Blossom brainstorming was conducted after the initial brainstorming session. Initial ideas could be elaborated on and it became apparent that the focus should be on what the audience can gain from using this application. Several ideas on what could affect the user in a meaningful manner were collected whereby the potential feelings of the user were addressed, by, for example, a certain physical setup of the application or specific content.

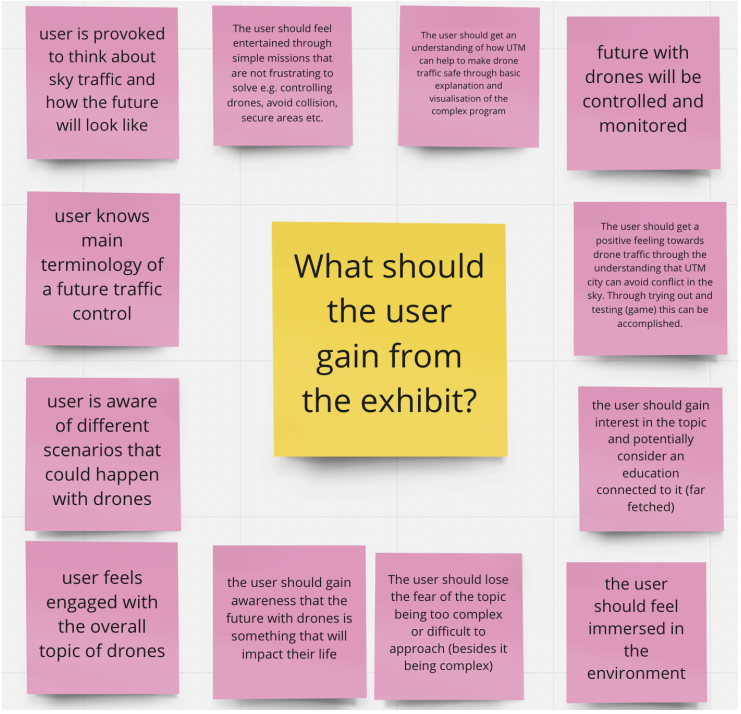

Figure 5.2: Lotus Blossom "What should the user gain from the exhibit?"

Another technique that was used is synectics, which brought a new perspective to the topic. For this thesis it mainly helped to define the core message that should be communicated even clearer and to come up with names for the exhibition which describe its content better that the current working title “UTM City”. The chosen theme for the multiscreen exhibit about UTM was "Sky traffic guard" and the users' mission should be to protect the city from conflicts in the sky.

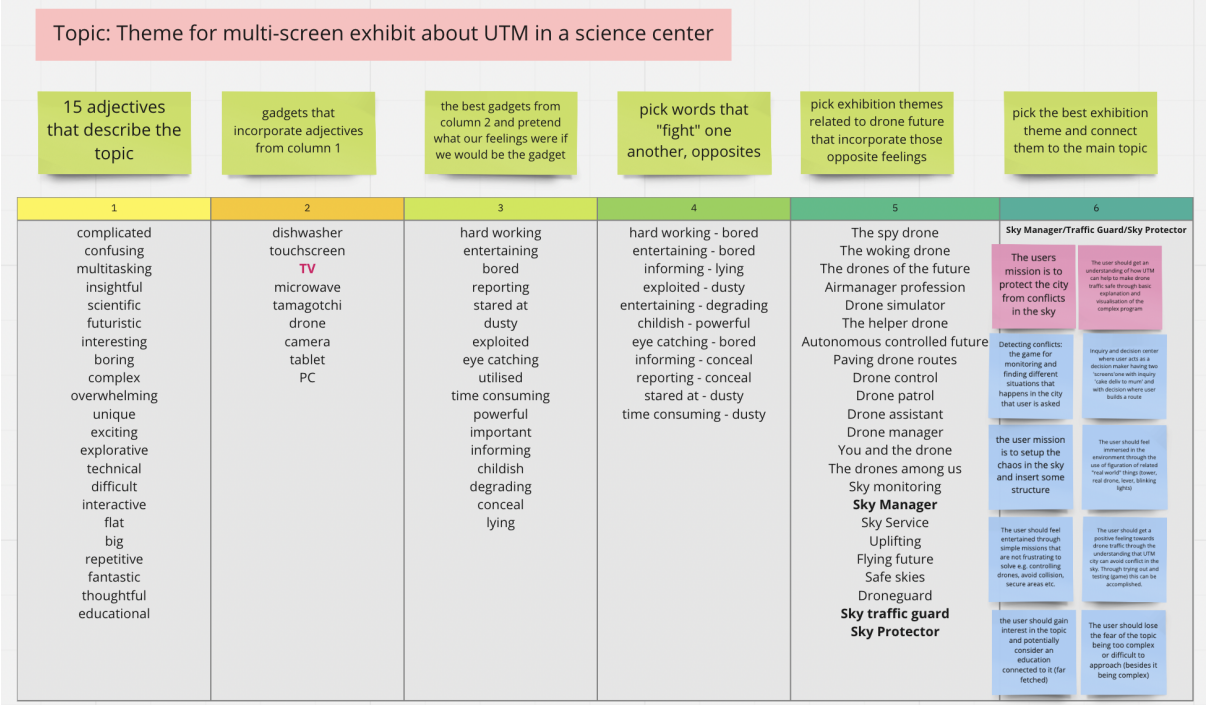

Figure 5.3: Table of synectics technique

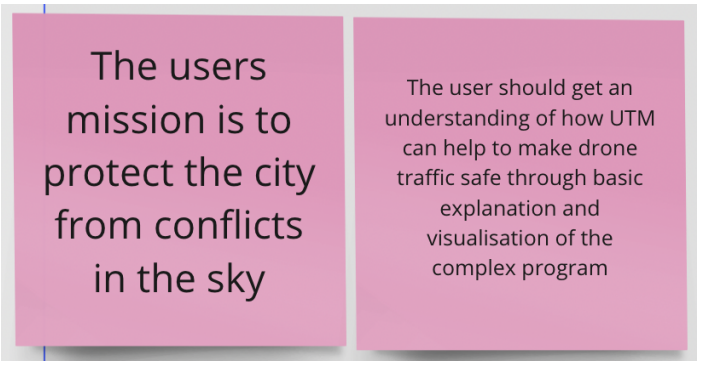

Figure 5.4: Outcome from the synectics method

5.2 Concepting

5.2.1 Participant's Journey

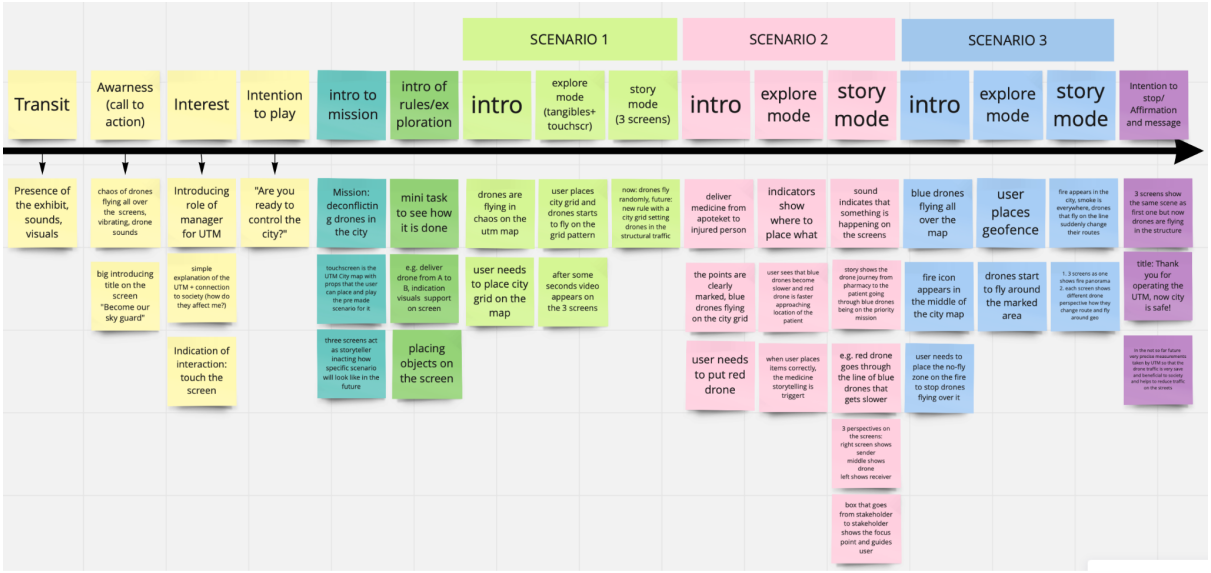

Figure 5.5: Participant Journey Map Idea 1 - Drone Operator

The participant journey map was used to detail three concepts and applied as follows. At first, all different states (from transit to finish) were written on cards along a timeline, then below attributes that contribute to the implementation of the prototype for the application were added.

For *Transit* it was decided that the presence of the application is distinct and that it should be enhanced by dimmed light in the room letting the light up screens get more attention.

Awareness should be created by the visuals on the screen which consist of a ‘chaotic’ sky full of drones flying around and a written out message directed to the potential participant. This message is the call to action for the potential participant to interact.

The next step is *Interest*, which is not clearly distinguishable from *Awareness* in this context. The interest of the participant should be aroused by the information about drones and how they might affect the participant personally this application can provide.

The *Intention to participate* should be triggered by a quote that asks the potential participant to take action. This step is linked to the previous steps of *Awareness* and *Interest*.

What follows is the participation phase, which starts with the state of exploration. Here, the mission is explained in more detail without overwhelming the participant. At this point, the first interaction takes place which is an important step towards continuation. It consists of a simple task that the participant needs to solve to get an understanding of how this

application works and to provide the first bits of information during and after this task. The feedback that the participant receives is supposed to convey achievement in the form of successfully solving a problem - In this case draggin a drone from one point to another.

The continuing step is divided into three scenarios which each consist of an introduction, the task, and a feedback in form of a story.
The scenarios will be elaborated on in the following subchapter.

After the participant has gone through the different scenarios the state of finishing the application arrives. In this state the participant is praised for solving the tasks and gets a virtual reward to leave the application with a positive feeling. Then, the application starts from the beginning.

Through the application of the Participant Journey map it is possible to create a structure that is engaging to the participants and leads to participation. The map enabled the development of scenarios that would explain the content in an interactive and explorative manner which leads to a better experience for the participant.
Integrating the scenarios into the Participant Journey map helped to frame them but it was not used to determine the content for specific screens.

5.2.2 Scenarios and Assessment

Based on the insights gained from the participant journey map (Figure 5.5), three ideas for scenarios were created for further development. All three concepts revolve around the chosen message of the future exhibition: “A communication of future opportunities that drone traffic could bring to society and the safety aspects that will be of importance.” The storylines for the scenarios were visualised and structured via storyboarding.

First concept "Drone Operator"

In the *Drone Operator* concept, the user is in the role of the UTM manager who needs to use drones to bring the city from chaos to structure. The type of interaction involves a touchscreen. In comparison to the UTM Explore project, where the story and explore modes are separate, the user experience in the *Drone Operator* concept is redesigned. Story and explore modes are braided together, which means that every exploration task will trigger related storytelling.

The point of these scenarios is to introduce and explore UTM City and its functions, learn how it affects everyday life and how it enhances safety in air traffic, and to create awareness about a future with drones. The overall story is divided into three scenarios with additional intros and endings. Each scenario has explore and story modes.

The intro scene starts with the chaos of drones flying on all three screens and attention sign on the touchscreen to click and try out the role of a future drone traffic manager.

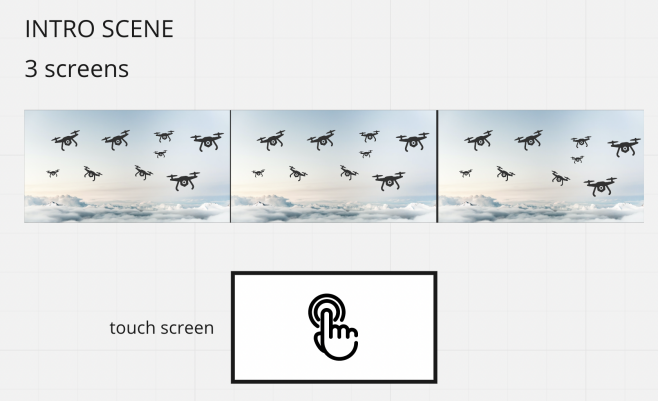

Figure 5.6: *Drone Operator* concept intro scene

The first scene introduces the UTM term, *city grid*. The user needs to grab from the prop box and place the city grid on the touchscreen to trigger a story that shows drones going from initial chaos to structure.

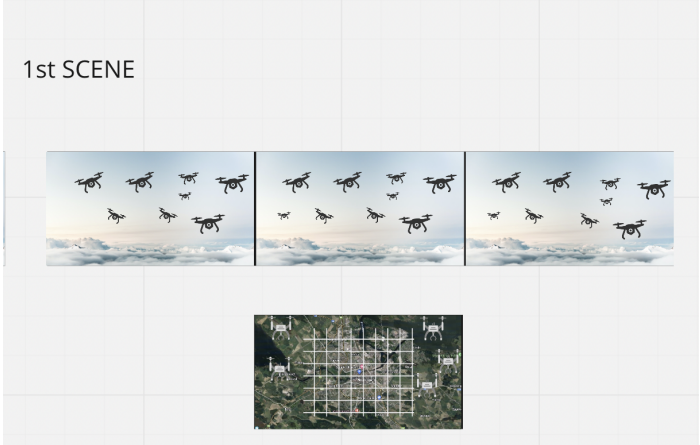

Figure 5.6.1: *Drone operator* concept first scene

The second scene introduces the *priority* concept and tells the story of a red emergency medical drone that flies to the patient and needs to avoid sky traffic jams. The user needs to place a prop of a red drone on the UTM City map to trigger the story.

Figure 5.6.2: *Drone operator* concept second scene

The third scenario introduces the term *geofence*. The story explains how something like a fire creates a no-fly zone (*geofence*) around the location of a fire accident. The user needs to drop a geofence on the UTM City map to trigger the story.

Figure 5.6.3: *Drone operator* concept third scene

Finally, the end scene gives feedback on the user's completed tasks and shows the now safe and structured traffic of drones.

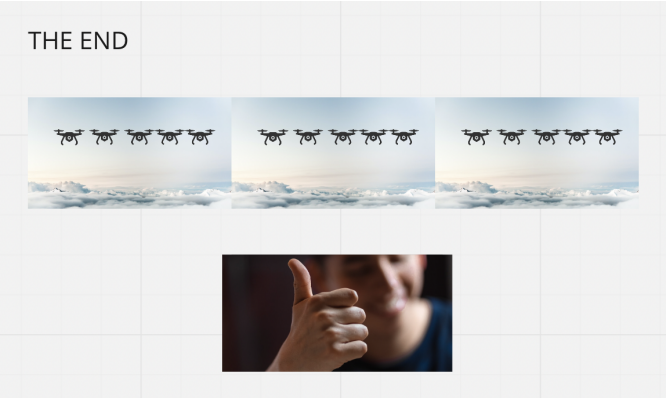

Figure 5.6.4: *Drone operator* concept end scene

Second concept “Sky Service User”

In the *Sky Service User*, the participant takes on the role of a future air traffic service user and can experience the potential future of drone services. The point of this concept is to understand the benefits of drone use for the general public. The explore mode setup in this idea is designed in a way that lets the user scan a QR code on their smartphone instead of using the touchscreen. After scanning, the smartphone starts the "Sky Service" app with different delivery options that could potentially be available in the future. The overall story is divided into three scenarios with intros and endings.

The intro scene shows the panorama of a city with a few delivery drones and invites users to scan QR codes and try future delivery options. After scanning, the phone screen shows a menu with 3 scenarios: food delivery, sending waste to recycling, and calling an air taxi.

When selecting food delivery, the three screens illustrate the process of order preparation and delivery with a drone to the customer.

After selecting which waste to recycle, three screens show the process of waste being picked up from the person with a drone and delivering it to the recycling facility.

The Air Taxi scenario will show a drone taxi journey to the customer's house to the moment when it arrives at the user and welcomes them on board.

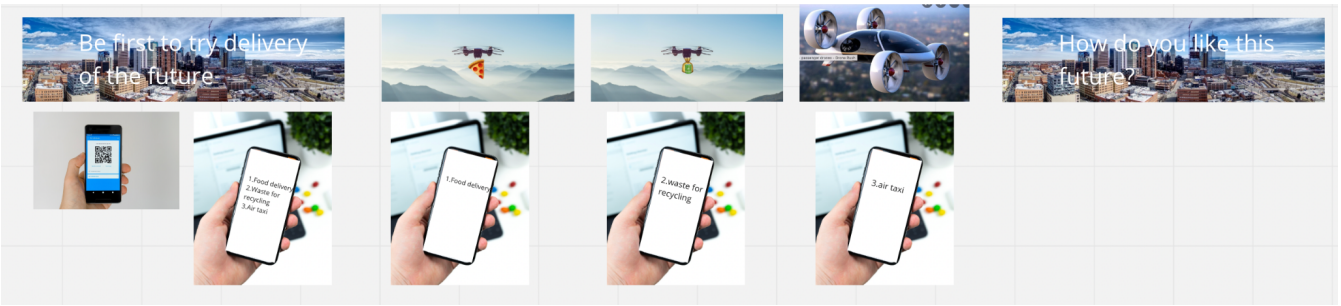

Figure 5.7: Second Concept *Sky Service User*

Third concept “Tower Manager”

In the *Tower Manager*, the user is in an airport tower and has an overview of the city. They are taking the role of an UTM Manager and can impact the drone movements. The point is to convey the basics of drone traffic (simplified UTM), create awareness of potential situations, to build trust, and create positive associations toward drones. The touchscreen setup is changed to a joystick instead of the touchscreen, which gives the impression of being in a control room. The three screens represent the windows of the tower. The joystick is potentially attractive to the visitor because of the more tactile interaction process.

Figure 5.8: Concept *Tower Manager*. Windows of tower should be represented by the three screens from the inside (Unsplash, no date)

The intro scene shows drones flying around in confusion over the city from the perspective of being inside the tower. On the screens the visitor is guided through a simple task of bringing “order” into the chaos by manoeuvring a citygrid over the map with the joystick to make the drones fly on it.

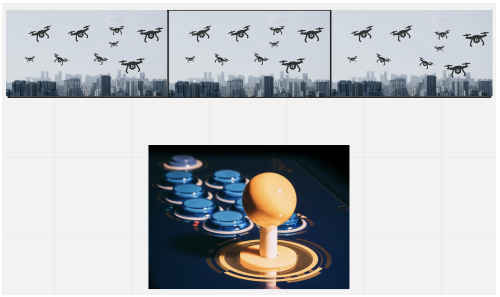

Figure 5.8.1: Setup of concept *Tower manager*

After this, three different “minigames” can be played by the participant which consist of steering around a geofence, bringing a drone from point A to point B and delivering a priority package. The last task has a timer to challenge the user.

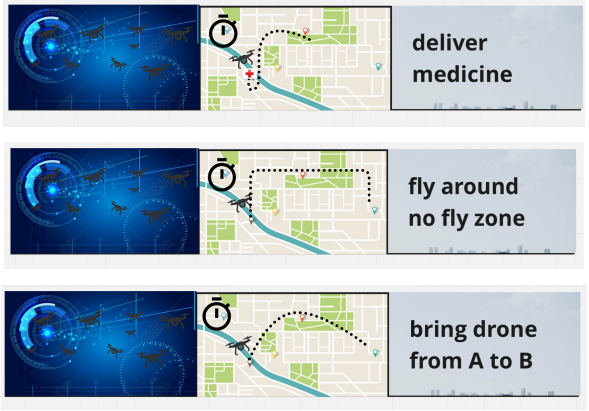

Figure 5.8.2: Three tasks in the concept *Tower Manager*

The setup of the screens is divided into the task description on the left, the interaction with the joystick in the middle and technical information about the drone on the right .

Grading and Choosing the Best Concept

After finalising all three concepts, a weighted objectives method was used to compare them using four criteria for the grading. Each criteria had a specific rate based on the importance of the future design. The first route of this weighting method shows similar grades for each concept and it was not possible to decide which idea would be the best for prototyping.

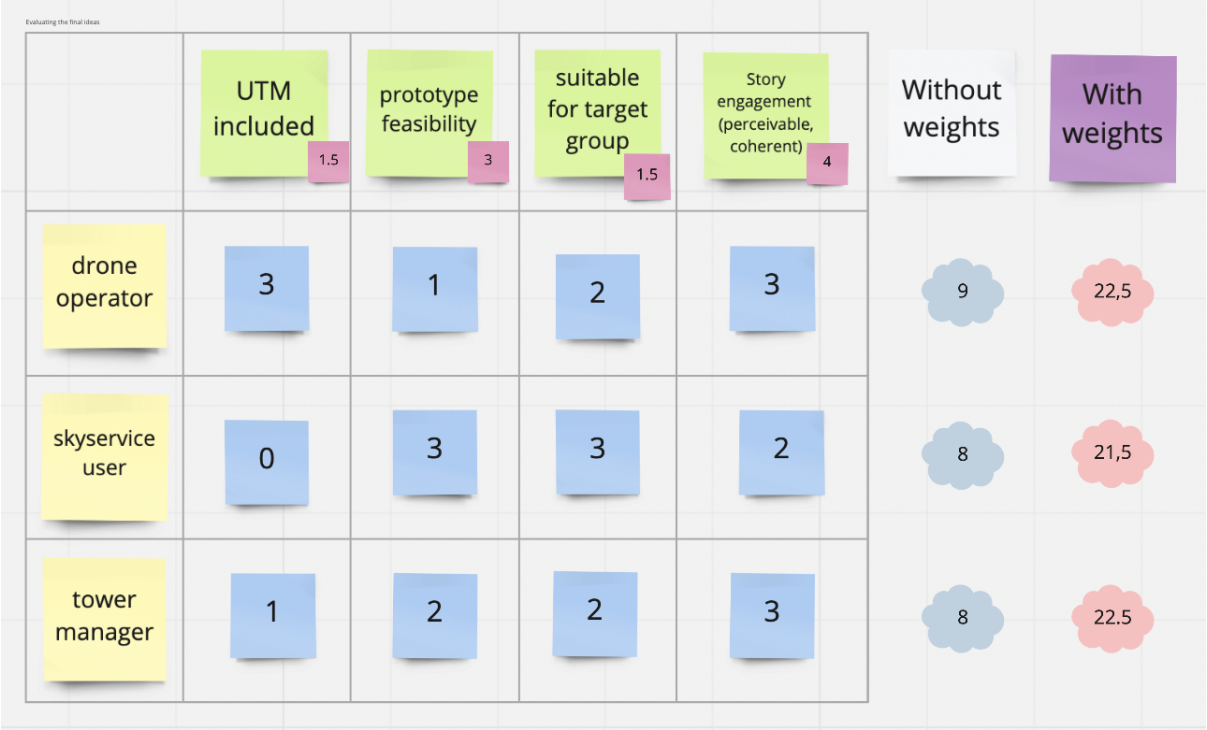

Figure 5.9: Initial evaluation table for the concepts

Therefore, a pros and cons list was made for each concept in addition to the weighting method. The result was that the first concept *Drone Operator* would be the most communicative and explain the UTM City in a way that illustrates the safety aspect of future drone traffic. However, *Drone Operator turned* out to be the most complex and long concept, which made it less feasible to be prototyped. The advantage of the second concept, *Sky Service User*, is that it is the most straightforward and closely related to the general user. It could potentially inspire confidence in future drone traffic and make it engaging. However, this concept does not include the UTM City. Also, according to the explorative interview with experts, the UTM Explore project could be very repetitive in its storytelling , which breaks the engagement. The third concept, *Tower Manager* is mainly based on missions and games, which makes it fun and engaging for the young adult target audience, but it was the least feasible for the prototype due to the involvement of the joystick and the need for game creation.

The next step was a discussion with an UTM expert, who commented on each idea and his feedback was summarised into another weighted objectives method table. After evaluating all the arguments by using Weighted Objectives method it was decided to continue to work on the first idea as it fulfils most of the criteria in the Concepting Activity.

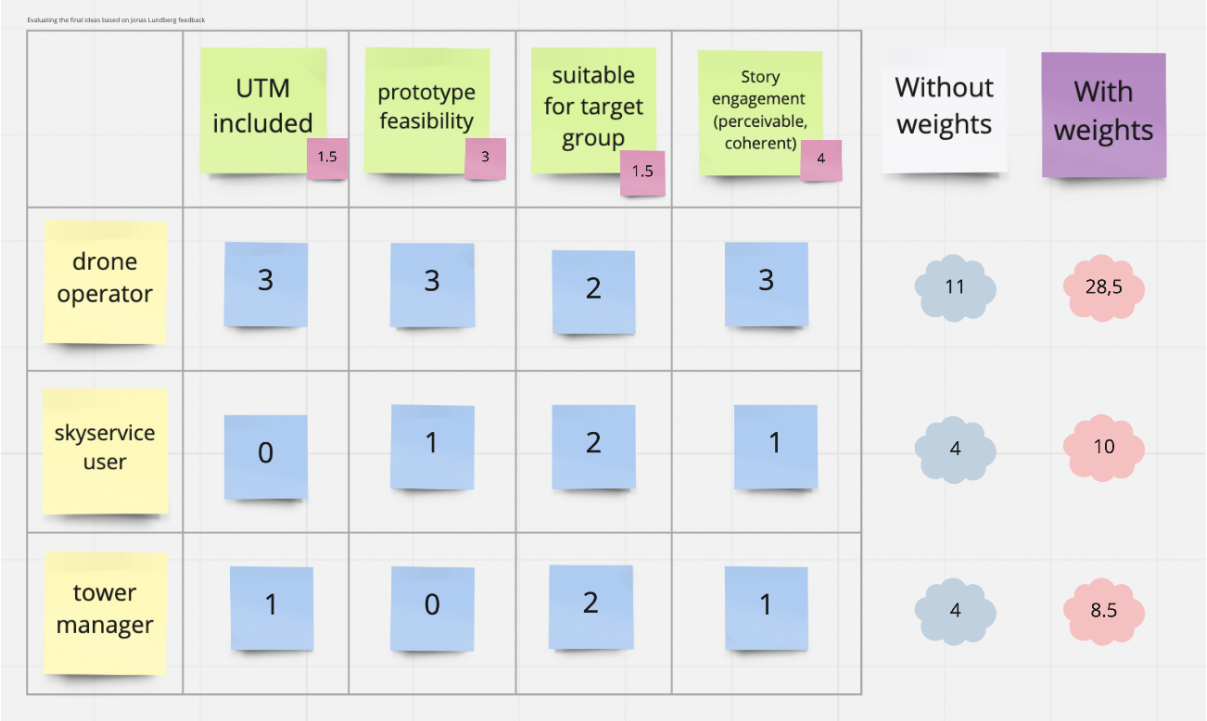

Figure 5.10: Evaluation table for the concepts with adjustments

5.2.3 Final Concept and Scenario

After the evaluation of the concepts, one out of three was chosen for further development. It has a general introduction, intro to the mission, scenario 1, scenario 2, scenario 3, a final message and affirmation. In order to be able to portray the whole concept it was decided to pick one scenario that will be more detailed than the other two. This scenario, the intro, and the final message and affirmation, was then visualised in a storyboard. The medium of visualisation was chosen and options for guiding the direction of gaze on the three screens were discussed. The selected scenario from the first concept *Drone Operator* was the fire emergency story, which was developed and prepared for prototyping.

The scenario starts with an introduction and information about the UTM "geofence" and a small task to explain it. The fire icon appears in the middle of the touchscreen on a UTM City map, and the user needs to put a geofence on it. After this, the drone on the map changes its route, and the storytelling starts on the three screens.

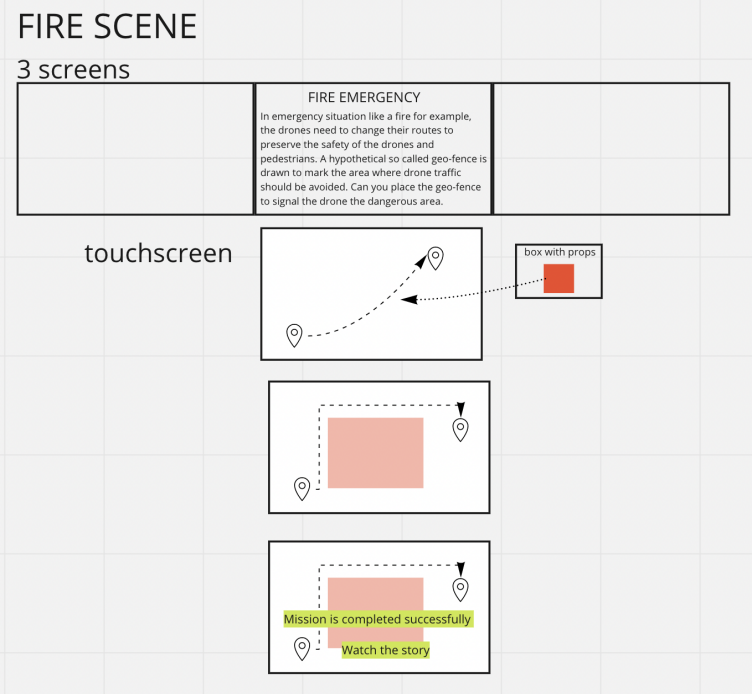

Figure 5.11: Intro of the story *Drone Operator*

The story mode starts with a shot of an empty fridge and a person who is hungry. The screens divide into three story perspectives: Pizzeria, drone, and customer. Action on three screens is shown chronologically:

1. The customer orders pizza on phone
2. The pizzeria receives the order
3. The drone in the parking lot "wakes up"
4. The chef is putting pizza in a box
5. The drone starts to move towards the pizzeria, picks up pizza
6. The customer gets a notification with estimated delivery time

At the same time, the touchscreen UTM City shows the movement of the drone and the locations of the parties.

Figure 5.11.1: First scene of the story *Drone Operator*

In the next scene a shot of smoke and a red frame appears on all screens. The screens are then divided into two parts, on the right side the customer gets a delay notification, and the left side shows smoke and writing that tells the user to select a path on the touchscreen. Meanwhile, on the touchscreen a fire icon and three routes appear: 1. avoid fire and smoke, 2. fly through the fire, 3. avoid fire but fly in the smoke.

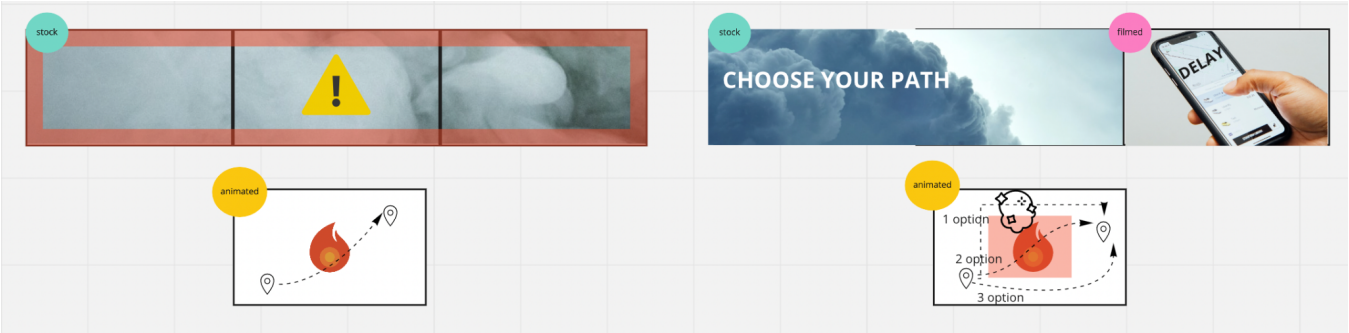

Figure 5.11.2: Second scene of the story *Drone Operator*

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Depending on the user's choice, the ending for this story will vary. Choosing the option "avoid fire and smoke", will complete the mission successfully and consumers in the story will receive a notification to pick up their pizza. Selecting to ignore the geofence and fly through the fire, will fail the mission and the pizza will burn. The choice to go through the smoke will lead to the pizza having smoke dust on it, which means that it should not be eaten.

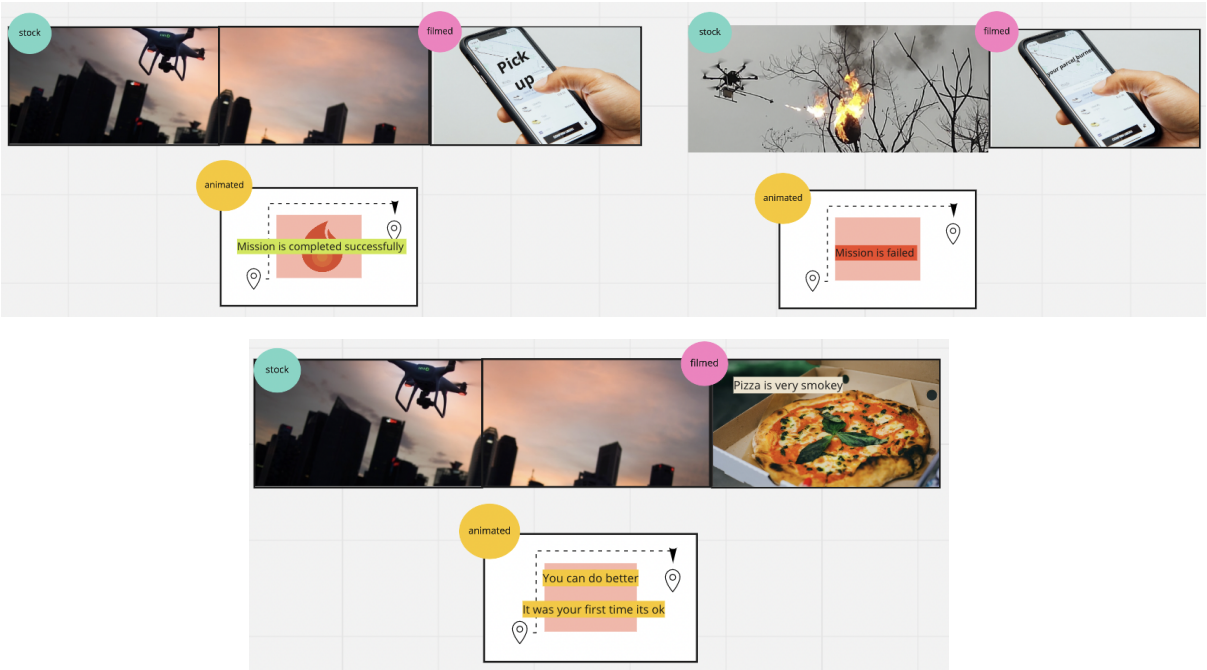

Figure 5.11.3: Three ending option of the story *Drone Operator*

To get an overview of the screens that actively convey information which should be in focus, a storyboard was created and those screens were marked red. This also helped to understand that only one screen should be in focus at a time when three perspectives are shown. When all three screens are showing only one perspective, the outline of the storyboard is green. In this case the focus point lies usually on the middle screen. In most cases the left and right screens are used to contribute to the atmosphere or show the surroundings of the focal point when only one perspective is shown.

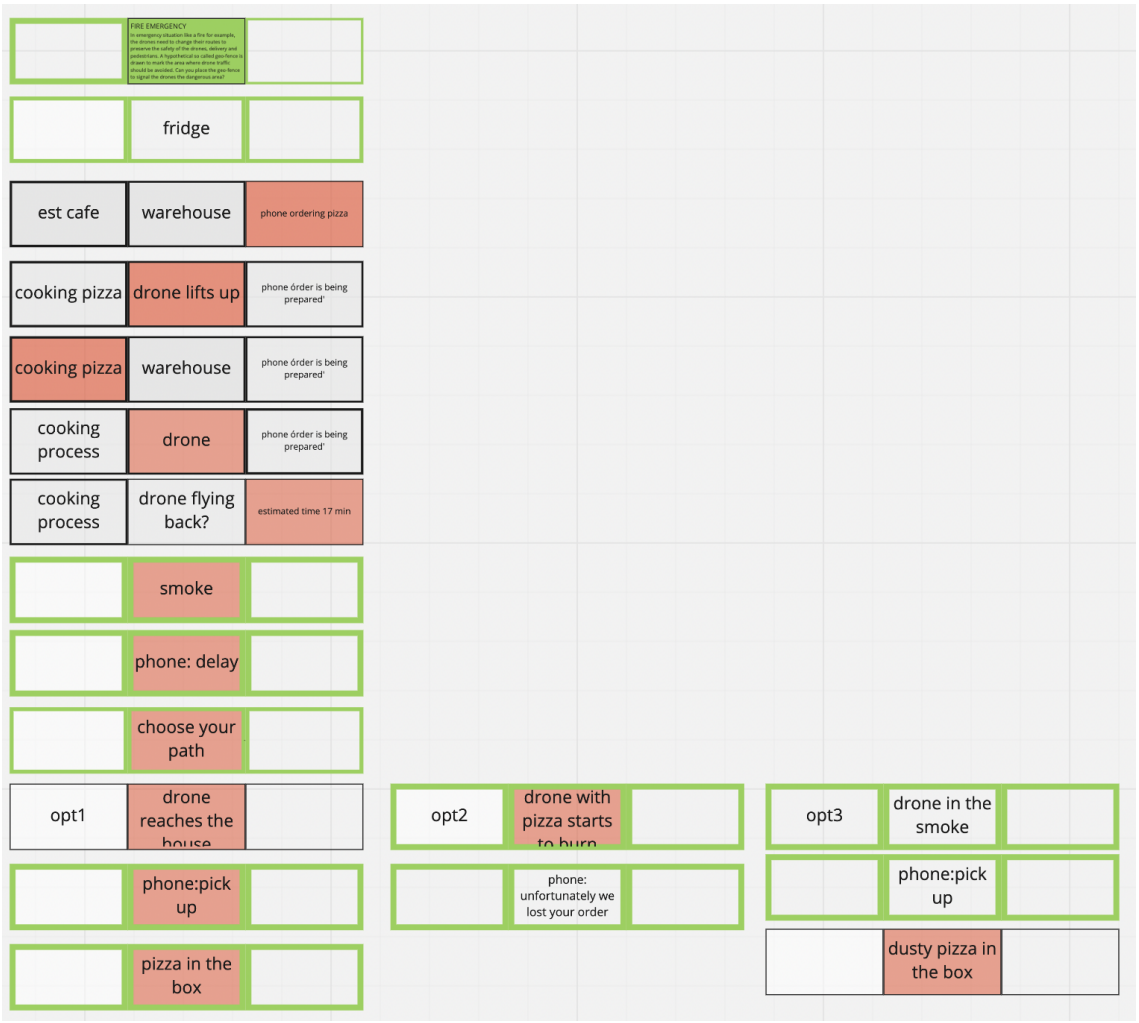

Figure 5.11.4: Screens in focus are marked with red

5.3 Evaluation of the Concepting Activity Results

Based on the Concepting Activity outcomes, the final concept included main feedback points from the Exploration Activity, specifically theory and explorative interview with experts. First of all, the final concept's storytelling included the five-act story arc structure, which solves the problem of repetitiveness and lack of dynamic storytelling that the experts pointed out in their feedback.

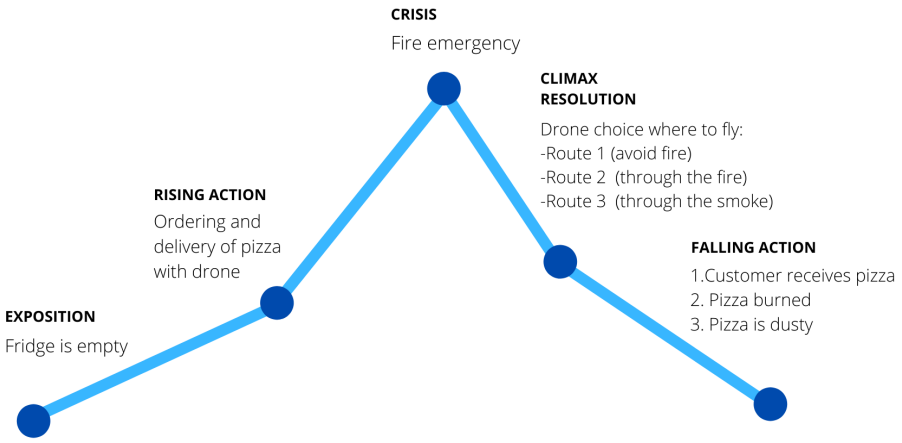

Figure 5.12: Fire scenario five-act structure arc with final concept scenes

The fire scenario covers all five events of the five-act arc. It tells the story from a rising action, hungry person who orders food with a drone delivery, to the crisis point where there is a fire emergency in the city. At the climax point the audience needs to decide the trajectory of the drone. The choice will influence the resolution and falling action of the plot. The ability of the viewer to choose between three different endings to the story refers to the interactive storytelling theory (Laaksolahti, 2008, p.21). The interactive storytelling structure (Figure 5.13) allows the viewer to become part of the story and make a choice, which can build a closer connection between user and story and raise engagement.

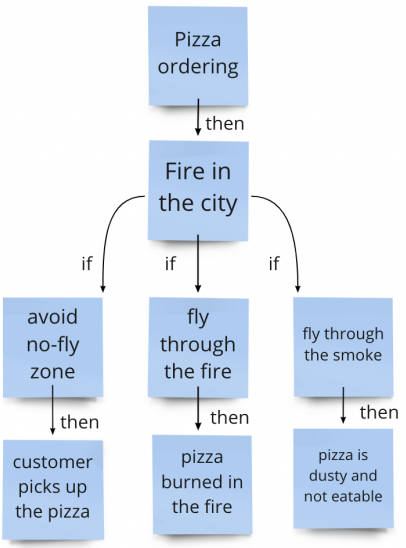

Figure 5.13: Fire scenario interactive storytelling structure

The solutions to how the viewer's gaze could be guided on the three screens and how this could be used for story division was explored during the concepting phase. Drawing on Hoppe *et al. 's theory* about *field of vision* it was decided to let all three screens act as one unit with focus on the middle screen for scenes that only show the action of one party. The goal of the pizza ordering story is to show three parties involved in this process- customer, pizzeria and drone. Because of this it was decided to divide three stakeholders onto three screens to be able to show each action chronologically. Three approaches were created during the storyboarding process which were based on the cinematographic colour and shape guiding approaches outlined by Ware about storytelling and visual theory (Ware, 2008, pp. 29–31). The first approach is gaze guiding through colourful pictures that highlight actions on the three screens. As is shown on Figure 5.14, the process of pizza delivery is presented chronologically and divided into three parties' perspectives (pizzeria, drone, customer). The colourful screen shows the main focus during storytelling, while the two others are black and white and show the less important actions that happen at the same time with other parties. The second approach is similar but instead of the black and white effect it uses blurriness to establish hierarchy between the actions. The third approach is supposed to steer the gaze by having the important screens in motion while the others paused. The gaze of the user is attracted by motion which can be detected fast and easily and can help to show where the important action is happening on the screen. All three approaches of guiding the user through the three screens will be tested during the prototype and user test activities and will be assessed by the engagement criteria.

Figure 5.14: Three different approaches (*black and white, blur, pause*) for an improved attention guiding

To summarise, the concepting was successful in terms of answering the research questions for the concepting activity. A scenario was created which suits the next Prototyping Activity and following research. The question that was set for this phase was answered with different proposed solutions that could be applied to improve the perception and engagement for a multiple screen setup of UTM Explore. Finally, the above described solutions for the prototyping are based on the findings from the explorative interview with experts and the theoretical framework.

6 Prototyping Activity

This chapter aims to answer the research question: "*Which approaches can potentially enhance the hierarchy of visual elements and video storytelling dynamics for a multiple screen setup to improve perception and engagement of UTM City?*" After the development of the concept, the Prototyping Activity could begin. The previously created storyboard was a supporting structure which could be used as instruction for the prototype. The first draft of the prototype was compiled through film, animation, and various graphic elements. Since the production of the material was time intensive, it was decided to only produce one of the scenarios, the introduction, and the end scene, as this was enough to test the prototype and then focus on the improvement of those parts. It is out of the scope for this thesis to develop a complete prototype.

6.1 Creation of Footage

The creation of footage required several different aspects. Part of the storytelling consists of a person ordering pizza via a phone application. The different pages for the interface of the application were created in Canva (*Canva*) and the design was based on the video that was created for UTM Explore. The goal was to create a simple interface which only consisted of the necessary functions that would help the participant understand what the story is about. The pages of the interface were then transferred to Adobe XD (*Adobe XD*) to create a seemingly working application that could be used on a smartphone.

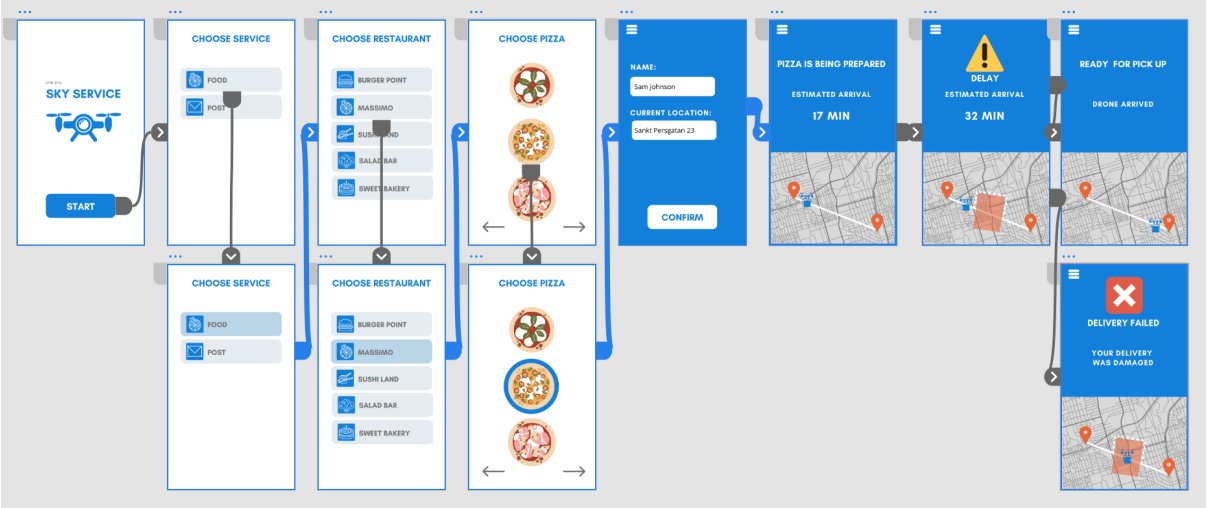

Figure 6.1: Pages created in Canva and assembled for prototype in Adobe XD

Filming was another technique used to collect footage. The shots were filmed and edited in 4K and panorama format to suit the frame size on all three screens.

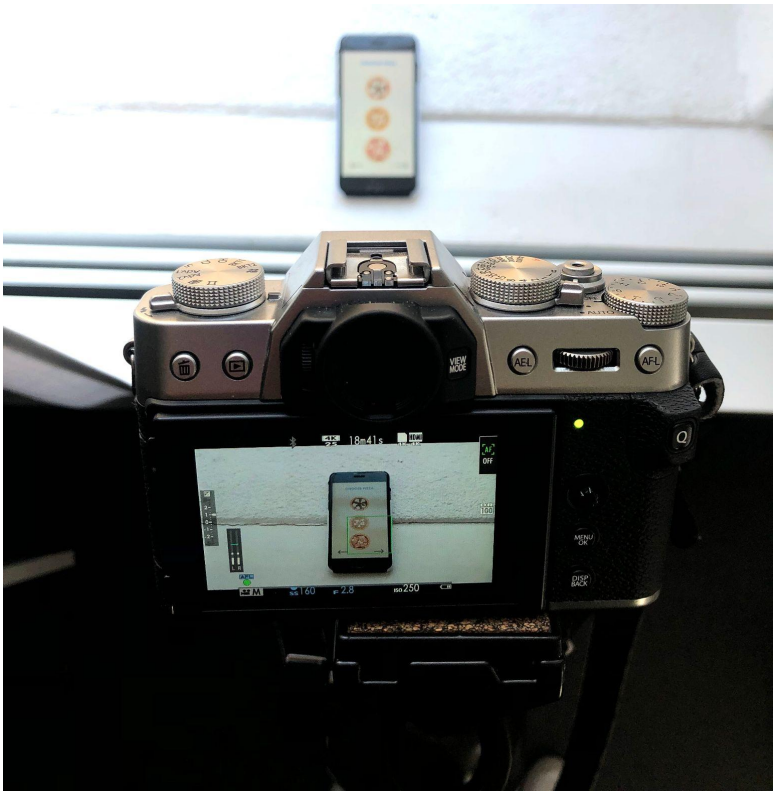

Figure 6.2: Footage recording process

The animation scenes were made and edited in Watchout software with pre-made Adobe Illustrator graphic elements. Some elements, such as drone pictures, were taken from the UTM Explore project.

Stock materials such as videos, pictures, and graphics that could be more generic, for instance preparing a pizza, were taken from pexels (*Pexels*) and freepik (*Freepik*) and altered.

6.2 Development in Watchout

All the footage was then assembled in Dataton Watchout. Watchout is a multi-display software that manages different media elements like text, videos, or images and enables projection to multi screen setups . The software is timeline based and lets media play synchronised on multiple screens. All the footage mentioned above was edited and compiled in the Watchout software. It was edited into three screen divisions, which helped adjust the timing and projection of the scenes. In addition, the story was divided chronologically into several timelines (introduction, main part, 1st option for the ending, 2nd option, 3rd option, and outro), in order to enable the user to interact on the touchscreen between story parts and choose the ending.

Figure 6.3: Option 1, 2 and 3 after choosing a path

Midiboard was used to connect the timelines to the buttons and make play and pause cues to be able to control and switch between the story parts. The use of the buttons to switch between parts was necessary to create an interactive prototype without coding. After the completion of a task users will be able to press buttons on the touchscreen to trigger the suitable storytelling part. In the UTM Explore project it worked the same way, the communication between the simulator and watchout occurred through a midiboard. For example, the three ending timelines of the story were connected to the buttons and to select one of them users could press the button on the midiboard.

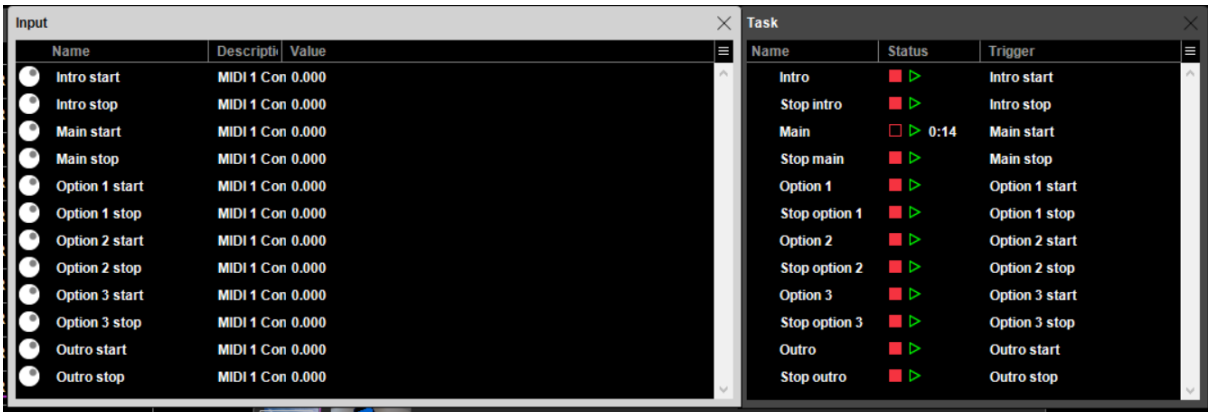

Figure 6.4: The connection between the auxiliary timelines and the midiboard

Figure 6.5: Midiboard and functions of the Buttons

6.2.1 UTM City

The touchscreen content was produced in the UTM City software, which enables the creation of different scenario simulations for the drones. By placing two points on the Norrkoping map (i.e.pizzeria and customer) the software is able to simulate a point-to-point delivery route. It is also possible to place a no-fly zone (geofence) which was used in the first interactive task of the final concept (to place a geofence on the map).

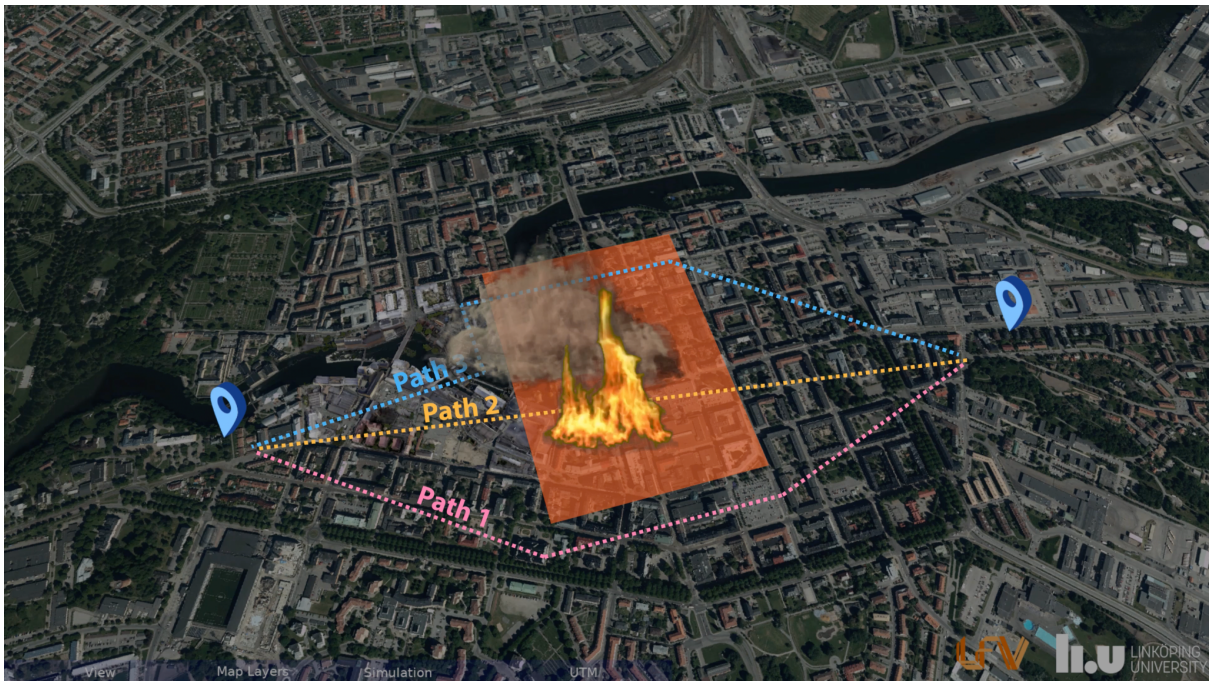

Figure 6.6: Interactive screen scenario in UTM City software shows the fire, geofence and three options for the paths from the pizzeria to the customer, Background generated from GSD-Ortofoto25 and GSD-Höjddata, grid 2+ © Lantmäteriet

6.3 Versions of the Prototype

As mentioned in chapter 5.3 of this thesis, three video editing approaches were chosen to research the user guiding between three screens.

The first version of the prototype was edited so that the colourful image indicates a focal point, while black and white images show less important events of the story. For example, the overall goal of the story is to show three main parties in the future of food delivery with a drone (customer, pizzeria, and drone), the actions of each party divided onto the three screens. Figure 6.7 shows a part where the customer is sending out the order, while the pizzeria is waiting and the drone is at the transport base.

Figure 6.7: *Black and white* approach (left and middle screen are black and white, right screen in colour)

The second version uses the same principle but instead of black and white effect it uses blurriness for the less important actions in the story.

Figure 6.8: *Blur* approach (left and middle screen are blurred, right screen is sharp)

The third version uses motion to get the attention of the participant. The videos for the less important actions of the story are paused while the screen that is telling the essential part shows a video.

Figure 6.9: *Pause* approach (left and middle screen are paused, right screen is in motion)

6.4 Evaluation and Conclusion of Prototyping Activity

The main design choices made for the prototype were based on the outcomes of the concepting phase and visualised and detailed during the prototyping process. Overall, three versions of the prototypes were produced to test attention guiding approaches- *blur, black and white*, and *pause*. These approaches were applied only to the 'pizza delivery' part of the story to highlight and illustrate the perspectives of the three parties that interact with each other. For the other parts of the story, content on the three screens was designed in a wide angle (panoramic) to demonstrate one perspective, and take into consideration the limitations of human vision. Referring back to the explorative interview, the experts suggested using the screens as one unit at times to limit the events on the screens. Another

approach that was designed in the prototype is 'the three ending' concept where the audience is able to decide the story resolution. The three different endings of the story were connected to a midiboard, which made the prototype seem interactive for the later user test.

The chosen design decisions refer back to the theory about field of vision from Hoppe *et al.* and suggestions during the interview. The area of focus for each screen is kept relatively narrow compared to the wide screen size so that the visitors do not have to search for vital information on the screen and are able to keep their attention and eye on a limited area. Elements like text or isometric city maps were placed in the middle screen and other screens acted as atmospheric background without information on them. This design choice was made due to suggestions from the experts about visual elements overload in the UTM Explore project. Another design decision was that text elements were not placed together with detailed visual elements on the screens to limit distraction during the reading process. It was also considered to use contrasting and bright colours to highlight elements that required more attention to support the viewers' perception of the story. For some important elements motion was added to make them stand out from the overall image. These decisions were in consideration of the research question for Prototyping Activity "*How can the findings from the concepting activity be implemented in order to design a prototype that includes chosen approaches (interactive storytelling structure, attention guiding)?*"

7 User Testing Activity

This chapter follows three steps: preparation, initial user test, and final user test. These describe the testing of the prototype and the identification of the prototype's weaknesses and potential solutions for improvement. The testing is split into two phases, the initial user testing and the final user testing. The first phase focuses on the perception of the story and the three attention guiding approaches. The second user test assesses the overall perception and engagement with the prototype and tries to give an answer to the main question of this thesis "*How can the key elements of UTM City be visualised on a multiple screen setup by using the principles of story structures and attention guiding, in order to make it perceivable and engaging for a small group of young adult visitors in Visualisation Centre C in a public exhibition context?*". After the initial user test there are reflections based on the insights that were gained. After the final user test the feedback for prototype iteration will be concluded in the *Future Work* section.

7.1 Preparation for User Testing

Preparation started with connecting the midiboard (Figure 6.5) to the Watchout file. It was possible to control the different video snippets in the prototype so that it was seemingly functioning. The Wizard of Oz method was applied for the user test and was practised in advance so that during the user test the illusion of a functioning product arose. The participants were recruited from schools (age 18-19) in the surrounding of Linköping and were invited to the Visualisation Centre to test the prototype. The prototype itself was prepared so it was seemingly working with the help of the control with the midiboard. Before it was shown to the participants of the user test, there was a review with experts that gave feedback, which was then implemented.

The next step was a questionnaire (Appendix D) preparation that included parts of the User Experience Questionnaire (UEQ) (Laugwitz et al. 2008, pp.63-76) and Game User Experience Satisfaction Scale (GUESS) (Phan, Keebler and Chaparro, 2016, p.1217) that were related to the research questions. The UEQ was used for evaluating the overall perception and engagement level of the video. The GUESS was used only partially to evaluate the engagement of the story, which is why *the Narrative Factor* was the only used item from GUESS in the questionnaire.

The overall questionnaire was divided into three parts that were necessary to test with users:
1. The perception of the story plot and its interactivity, including questions about the narratives aspect from GUESS,

2. Which attention guiding approach is the most helpful for users to follow the content on three screens,
3. Engagement assessment of the whole prototype including UEQ.
Due to that, the first part included open questions and GUESS questions about narratives that would point out if the participants understood the story and asked if it was engaging for them. The second part had open questions about the three attention guiding approaches to identify the best way to follow the happenings on the screen. Finally, the third part involved UEQ's descriptive adjective scaling, which meant to evaluate the engagement level of the exhibit and answer the overall research question of this thesis.

7.2 Initial User Testing

For the first round of the user test, five participants (age 18-29) were invited to watch a screen recording of the prototype that was retrieved from Watchout. The user test took place via video call and did not focus on the multiple screen setup but rather on the perception of the story and if it was understandable per se. The initial user test served as preparation for the final user test, which was carried out using the multiple screen setup.

The user test was structured in three parts. At first, the participants were introduced to the topic and reason of this thesis . After that, the story as well as the three options for attention guidance were shown. Lastly, the participants were asked questions about the story and the interface. The questions were based on the questionnaire for the initial user test but were shortened because the participants could not answer questions about the setup itself since they could not experience it. The answers were noted down and categorised.

Overall, the story was perceived well and the content was understood. The preferred option for attention guidance was *black and white* as well as *blur* since the participants quickly understood the distinction of scene in focus and out of focus between the three screens. The option with *pause* was not that intuitive for the participants because it was not clear from the beginning which screen was supposed to be in focus. Furthermore, it did not work when the scene contained still images that were in focus, as all screens did not show any motion then and it became unclear which screen should be focused on at that time. A comment from participants was that it could be interesting to combine the blur and black and white effect to distinguish the screens even more. Further feedback and answers referred to the text, visuals, and the touch interface.

The initial user test led to a revision of the prototype that implemented the feedback of the participants where it was feasible. The main changes that were made concern the text, which was relatively technical in the prototype and now has a less technical but more story-like approach. Due to this, the storytelling might be more engaging, since the text

implies a story instead of technical information and UTM is explained in a simpler way. Another change that was implemented was the representation of an actual drone in order to give a better idea of the topic and make the story more relatable to the viewer by using real footage. The touch user interface was adapted by making the map excerpt smaller so that the routes on it became bigger, which enhanced the visibility of them. Smaller changes like the length of certain scenes and text formulations were made as well.

7.3 Review with UTM Expert

After the implementation of changes, the prototype was shown to a UTM expert to validate that UTM was represented in the precise UTM theory way. According to the expert, it was engaging to select paths on the touchscreen and see how it will influence the storytelling. The possibility to choose an option oneself led to an increased engagement with the story. Feedback that was received included visual changes, for example, the idea to make visually clear which paths on the touchscreen are most and less advantageous to make a distinction between them even more vivid. Another comment was to include smoke and fire icons in all three options of endings that the participant can choose from and not only for the smoke option.

To sum up, the expert approved our prototype and only minor suggestions were made for the testing of the prototype during the final user test.

7.4 Final User Testing

Final user testing aimed to answer the research question: *Which approaches can potentially enhance the attention guiding and video storytelling dynamics on a multiple screen setup to improve perception and engagement of the presented content for the potential user?* For the final user test five participants aged 18-19 from a school in Linköping were invited to watch and test the prototype on a multiple screen setup. The final user test focused on the perception and engagement of the prototype in a suitable environment for the whole setup.

7.4.1 Setup

The prototype for the user test was prepared so that it came as close as possible to an actual exhibition environment. The test was conducted in the *Exploranation Lab* at Visualisation Centre C. The setup was surrounded with actual exhibition pieces and the light was dimmed to increase the contrast of the screens in comparison to their surroundings. The three screens were standing against a wall and in front of them the touch table was placed (see figures below). The touchscreen was tilted so that the gap between the three screens and the touchscreen was relatively small. The interface for the touchscreen consisted of an

animated video that should represent and imitate the interactive user interface. Upon the arrival of the participants the screen showed an excerpt of the UTM City application. The three screens behind the touchscreen showed a blue sky, since this would be the same visuals that would be shown if visitors of the Visualisation Centre C would enter the space. To the right of the setup was a table on which the midiboard was positioned, which was later on used to start and stop the videos accordingly. The participants did not know that the interactions were created through the midiboard, which made the presentation situation realistic.

Figure 7.1: Setup with prototype front view

Figure 7.2: Interacting with the touchscreen

Figure 7.3: The whole setup, three screens, touchscreen, midiboard

7.4.2 User Test Structure

The structure of the user test was built in four parts. First, a welcome and small introduction about the project and its goal to the users. After being informed about the project and user test details, users could sign the consent forms. The second part was set aside for the screening of the prototype and was divided into three parts: 1. Watching the whole prototype with interactions, 2. Trying every path on the touchscreen and watching three endings of the story, 3. Watching three approaches of attention guidance (*black and white, blur, pause*). During the whole process of showing the prototype, the participants were asked to think aloud. After the screening, in the third part of the user test, participants needed to fill in the prepared questionnaires (Appendix X). The final part was intended for the discussion with participants, where open questions from the questionnaire were discussed together. During each part, notes were taken and participants were continuously expressing their feedback.

7.4.3 Thinking Aloud and Open Discussion

During the open discussion, some comments from the participants were apprehended and noted, as well as observations from the presentation of the prototype. It was noticeable that the view of the participants was fixated on the three screens when the fire appeared on the touchscreen and was only noticed later during the presentation. Another significant finding was that during the first screening participants did not notice that the chosen approach of guiding the view was the *black and white* approach and instead, it was believed that all

videos were in colour. Nevertheless, most participants felt guided during the first screening, one mentioned that it was hard to concentrate on one thing because there was still too much going on. Another comment regarding the *black and white* design was that it was interesting to have the opportunity to watch all screens, because it made the story more predictable and one could 'puzzle' the story together. One participant mentioned that the blurry version of the prototype was almost too blurry, since it was not recognisable what was happening on the other screens. According to the participants, the *pause* approach of view guiding was 'less alive' and very static and missed the point of using three screens. Another comment was that the blurry and the *pause* version of the prototype felt slower than the black and white version. The feeling of slowness also occurred while watching certain scenes like the fridge scene or the isometric view scenes on the middle screen. The overall impression from the video was that the participants started to think of future scenarios with drones by asking themselves questions about, for instance, the size of drones that could deliver pizza boxes.

When it comes to solutions for engagement level improvement, participants suggested adding more problem solving tasks into the application as well as more interaction to increase the engagement for the potential users. One participant said it would be helpful to have sound effects to help the potential user switch their attention from the three screens to the touchscreen. Another comment was that the participants appreciated that the videos were colourful and the overall design of the video was well structured. One participant mentioned that they could imagine playing a video like this as a YouTube ad to increase awareness on the topic of drones in the future.

Regarding the different path choices on the touchscreen and the three options for the ending, the participants mentioned that it was helpful to get a reasoning for the delay of the pizza delivery in the story and that this would be nice to implement into current delivery applications, because it helps to illustrate the delivery process. The interaction itself supported the participants to stay motivated and focused because they connected the interaction with the video and did not digress from the video. One participant mentioned that it could be more involving for the user to draw the path on the touchtable themselves. Another suggestion from all participants was to include more interactive choices in the whole user experience that would increase engagement, for example, choosing the pizza yourself as well. In contrast to this, it was mentioned that the focus should not be too much on the delivery but more on the drones. A game-like appearance was desirable and the font could be a little bit more appealing. It was mentioned that the guiding of the view starts from the right screen to the left screen, which makes it less intuitive to watch because it is common (in Western cultures) to read from left to right. The last comment was that the *intro* part is lacking the chaotic atmosphere it is supposed to have and in order to make the

contrast between the *intro* and *outro* scene, which is meant to ‘solve the chaos’, more explicit organised drones flying should be shown in the structure.

7.4.4 Questionnaire Results

The questionnaire aimed to evaluate two aspects of users' impression after screening: perception and engagement levels after watching the video. First perception related question was about the impression of the video and the main feedback was that the video is very realistic, it was easy to follow and the interactive part was a nice addition. The second question related to the story and asked the participants to summarise it in two sentences. According to the answers the story was clear to the users as they wrote about key moments of it: how drones in the air can be managed, food delivery with drones, avoiding dangerous areas (fire). Looking at the user interface, a question about three attention guiding approaches (*black and white, blur, pause*) was asked and according to answers the *black and white* approach was the most eye-catching and guiding through the triple-screens setup. The first engagement related question was about interactive storytelling structures and the ability of the user to choose between actions of the story. Feedback from the participants was positive towards this approach. Some stated that it was educational in the sense that it showed what can happen to a drone if, for example, they chose the fastest route and flew through the fire, others mentioned that it feels like a game, which makes it more engaging. Following engagement related questions were based on the GUESS and UEQ questionnaires, where users had to evaluate their emotions on the scale from 1 to 7. The GUESS statement about narratives contained statements on how captivated by the video user is, how enjoyable the story was, was the viewer emotionally moved by the plot, were they interested in the progress of events, and was the story clear.

The result shows that captivation was more towards the mid-high level, and users were interested and amused from the beginning. The exact same results appeared in the question about video enjoyment, two users graded it in the middle and others put the highest grades. In the open discussion, all participants stated that they were interested in the story and that it was thought-provoking in terms of the future of drones.

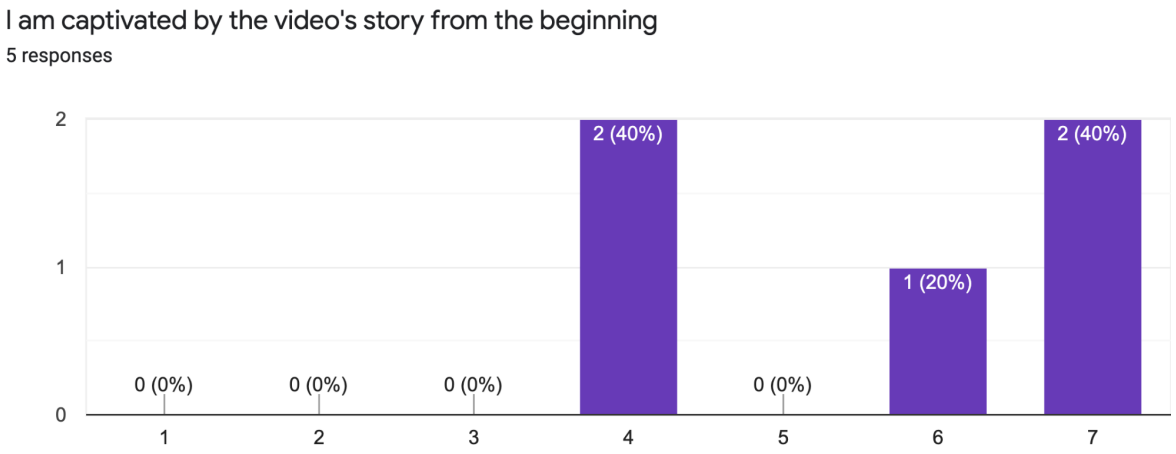

Figure 7.4: GUESS questionnaire results

The statement about emotional involvement towards the events in the story had controversial answers, two users felt very emotionally moved by the video, and other three users seemed not to be moved by the plot of the story. According to the feedback from the discussion, some participants felt excited and interested in choosing the ending and being able to interact with and influence the plot, which could relate to their emotional involvement.

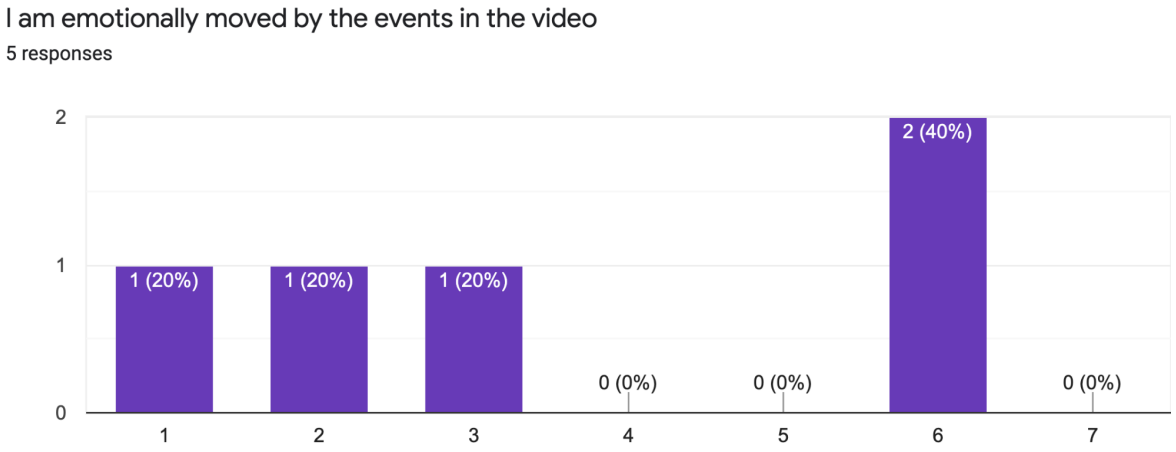

Figure 7.5: GUESS questionnaire results

When it comes to the interest in the story's progress, almost everyone stated that they had a high level of interest. During the discussion almost every participant expressed interest about the video and events of the plot. For some, future scenarios where drones could

deliver pizza to humans was an interesting prospect. Others reacted to the fire scene as one of the most exciting parts.

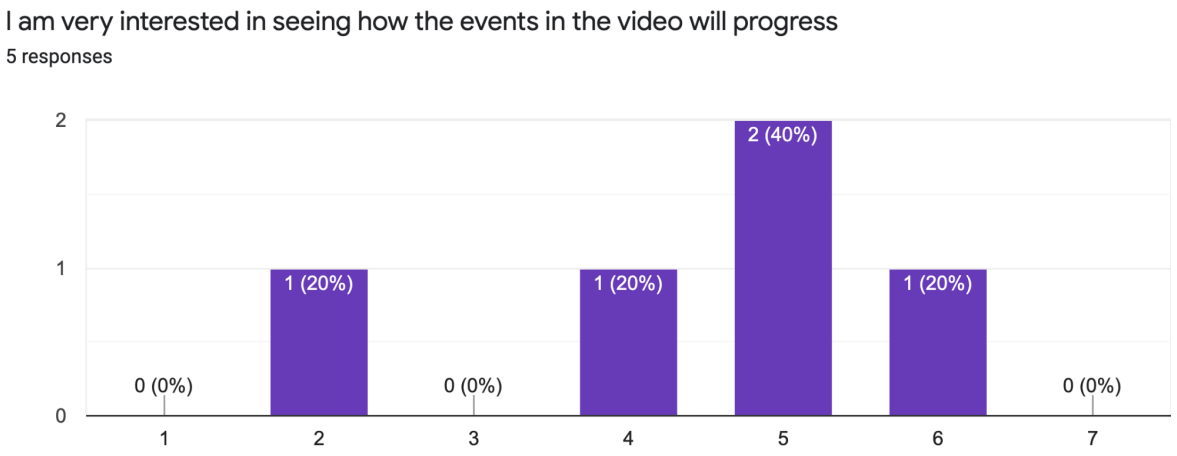

Figure 7.6: GUESS questionnaire results

Finally, it is possible to see that the video's story was clear for the users and they were able to comprehend the plot. According to *Thinking Aloud* it was also clear that every participant could clearly explain the story's beginning, middle and end.

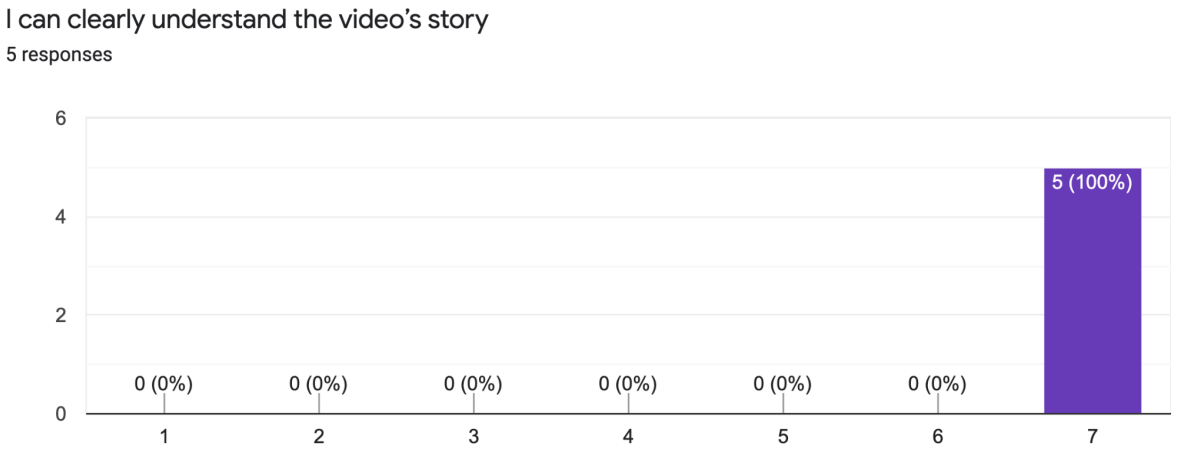

Figure 7.7: GUESS questionnaire results

The UEQ questions involved marking opposing attributes on a scale such as: annoying/enjoyable, boring/exciting, slow/fast and others.

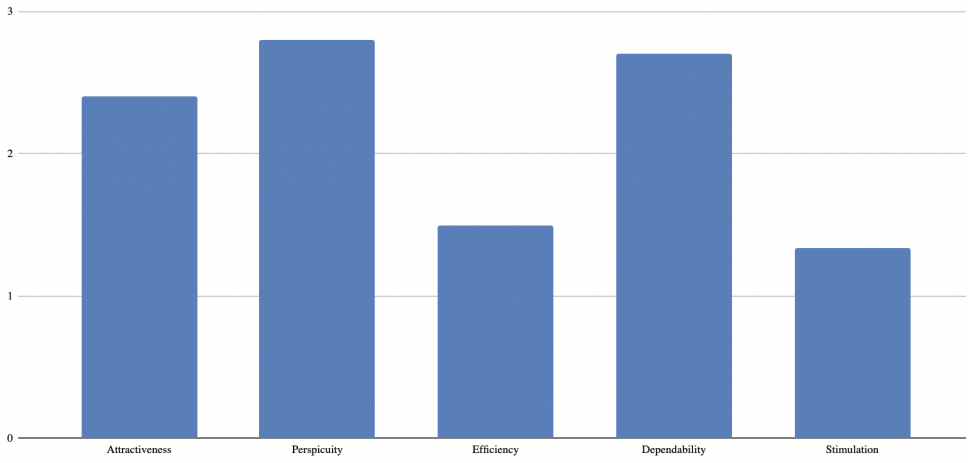

Figure 7.8: UEQ questionnaire results

After entering the collected data in the UEQ data analysing tool, a graph was created which showed where the different aspects of usability and experience scored on a scale of zero to three. The graph shows that *attractiveness*, *perspicuity* and *dependability* score relatively high whereas *efficiency* and *stimulation* score in the middle of the scale. The result states that the overall impression of the prototype is positive and users tend to like it. The graph (Figure 7.8) shows that it was easy for the participants to get familiar with the prototype and quickly learned how to control it. They were able to quickly find the desired functions but it had the tendency to seem slow. The users felt in control of the interactions and the outcomes seemed predictable and secure. Participants were also stimulated by the process of testing but the lack of more interactive tasks resulted in a decrease of motivation.

The outcomes of the analysis tool corresponded for the most part with the notes of the open discussion with the participants and it reflects their comments and concerns in a comprehensible way. Taking a closer look at the aspect of *stimulation*, it is coherent with the feedback of the participants. The comments addressed that more interaction would help to keep the participants motivated and engaged during the whole process and retain focus. Some of the participants mentioned that increasing interactions would also bring more enjoyment to the process of watching. *Efficiency*, which scores on the middle range of the scale, reflects in the feedback of the participants as well. It was mentioned that some scenes in the video seemed slow at times. *Attractiveness*, *perspicuity* and *dependability*, which score relatively high on the scale, were addressed positively during the open discussion and when the participants were thinking out loud. The opportunity to choose options was addressed as a positive attribute as well as the overall clarity and structure of the prototype.

The majority of the participants chose the *black and white* attention guiding approach as the most attractive approach, since it was the easiest to follow without taking away from the differing perspectives on the other screens. Another positive aspect of the *black and white* version of the attention guiding approach was that it was relatively subtle and did not interfere with the overall experience of watching the story. Nevertheless, it also revealed some issues that might have an influence on the attention guiding qualities of this approach. After the participants of the final user test were asked how they perceived the approach that was presented first, they did not recall that it was in *black and white.* This could be due to the lack of contrast in the *black and white* videos, which makes them less distinguishable from the coloured screens. Another issue that was raised by some of the participants was that it was slightly distracting to have clear images and motion on all screens.

The attention guiding approach with the blurred screens was chosen as the preferred approach for some participants with the reasoning that the difference between the screens was very distinguishable and it was easier to focus on one screen due to less distraction from the blurred screens. Even though this was enhancing the perception of the story for some, it also led to misconceptions for others. A comment received during the initial user test was that it seemed like the screens were not loading correctly and it gave the impression of an error on the display. Another participant expressed that the amount of blurring would make the content on the other screens unrecognisable, which led to uncertainty.

The *pause* approach was the preferred version of one participant with the explanation that it had the least distraction from the other screens. However, this approach received negative comments from the majority of the other participants. One issue that was mentioned several times during the initial user test, the expert review, as well as the final user test, was that some scenes were static pictures, so that it did not become apparent which of the screens needed to be focused on. The overall footage is generally not suitable for pausing and might need to be rethought. The participants also expressed that the *pause* approach seemed less ‘lively’ and due to that it was less engaging.

7.5 Potential Improvements

The potential improvements resulting from the initial usertest, the review with the UTM expert, and the final user test regarding the *engagement* of the prototype are listed below, the most mentioned suggestions are listed first.

1	More interactions to enhance the engagement
2	Shorten specific sequences (fridge scene, isometric view drone flight scene)

3	Improving the readability and aesthetics of the text
4	More complex options to create challenges which could be more engaging

Table 7.1: Potential improvements regarding engagement

The improvements regarding the *perceivability* are listed below, beginning with the most mentioned ones:

5	Focus less on the process of ordering and instead present key topic of UTM and its role more
6	Combine the *blur* and *black and white* approaches to test one more guiding approach
7	Enhance the contrast of the *black and white* screens to make them more vivid and less grey
8	In the *pause* approach prototype enhance the contrast between the moving and pause screens

Table 7.2: Potential improvements regarding perception

After the potential improvements were identified and sorted after how often they were mentioned, they were positioned on a Prioritisation Matrix (see Figure 7.9). The parameters chosen are *High Value/Low* Value and *High Effort/Low Effort* to determine which issues are the most feasible to solve. The improvements that address the engagement of the prototype are displayed on blue squares and improvements that address the perception are displayed on green squares.

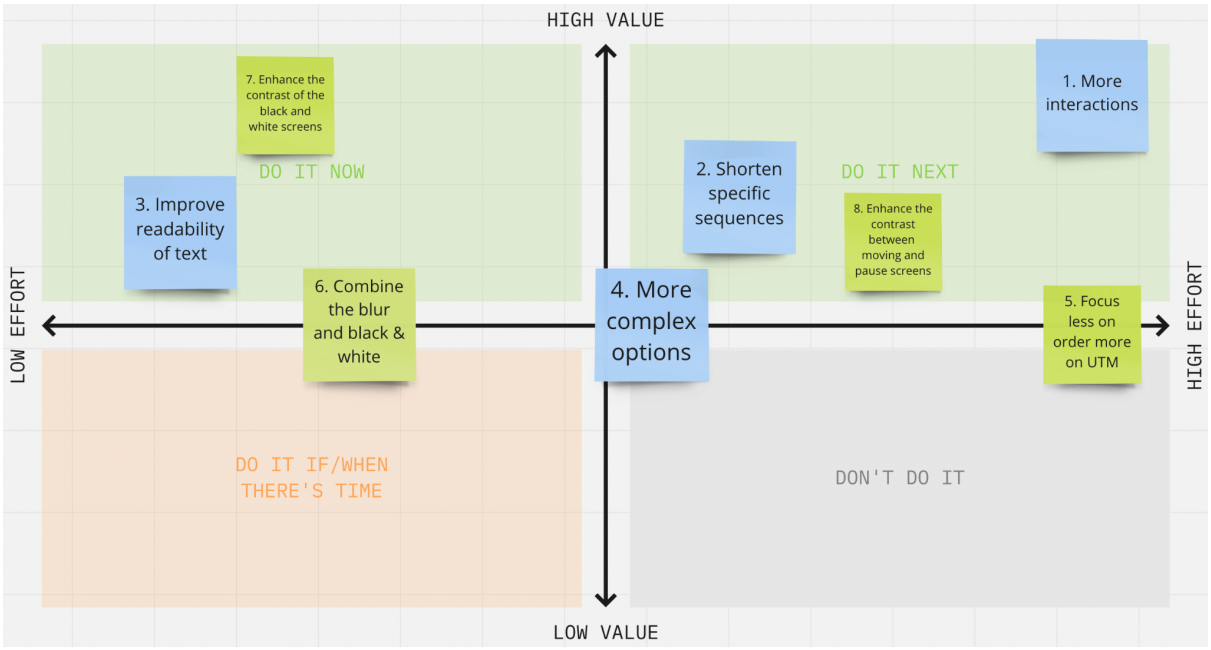

Figure 7.9: Prioritisation Matrix with potential improvements

The category *Do it now* includes point 7 and 3 since they have a relatively high value but can be implemented quickly due to the low effort they take. The category *Do it next* includes 1, 2, and 8 because the value is relatively high but so is the effort to implement them. *Do it if/when there's time* included point 6 since the value is unknown and it is a new approach of attention guiding that needs to be tested. The effort to implement it is low but the user testing requires a high effort. Points 4 and 5 are on the verge of *Don't do it* because the value is undetermined, to focus more on UTM instead of the delivery especially takes a lot of effort.

The Prioritisation Matrix provides a good overview of what could be changed to further develop the prototype. However, the implementations might need another testing round. A visual outlook for the potential changes is compiled below for changes that can be portrayed in the form of a picture.

Figure 7.10: Potential improvement 6, combination of the *black and white* and *blur* approach

Figure 7.11: Potential improvement 7, Enhancement of the contrast of the black and white screens

To summarise, the User Testing Activity was successful in terms of screening the prototype, answering the research questions, and to get insights about the perception and engagement level of the prototype. The input and feedback from the participants was valuable, thought-provoking, and at times surprising and it was possible to gather new ideas and suggestions for further improvement. Overall, it is possible to say that the general concept and story was perceived well and understood by the participants and that the interface design supported the user in navigating through the prototype. The preferred view guiding approach was the *black and white* version, followed by the *blur* and *pause* approach. The interactive storytelling structure was confirmed to be engaging and exciting to experience.

8 Discussion and Conclusion

This chapter provides the conclusion of the thesis. In addition, it includes a discussion subchapter, evaluating the work and results of this thesis in relation to the research question. Following this are subchapters on *Limitations* and *Future Work*. Finally, this section ends with a conclusion subchapter.

The main findings of this thesis regarding the multiple screen setup that were revealed during the research process include:

1. Three attention guiding approaches: *black and white, blur, pause*. Of which the most preferred approach was *black and white* according to the user test participants.
2. Five-act and interactive storytelling structure where users had a choice. According to the data from user tests, it helped to increase the engagement and perception of the exhibit piece.

These findings will be discussed in the following sections, as well as the findings that were revealed during different activities of the research process.

8.1 Discussion

This thesis was based on the UTM Explore project for Dubai Expo 2020, where a final review with experts showed issues with guiding users across the screens and a lack of perception (clarity) and engagement in the storytelling. This starting point helped to form the interest towards the design complexity for a multi-screen setup and highlight the main challenges that occurred during UTM Explore's development. The main challenges were based on the research of improving perception and engagement, with individual interest about solutions for interactive storytelling and visual hierarchy and attention guiding on the multiple screen setup. Based on that, the main research question was formed as well as multiple sub-questions that concerned the research along the process. The overall thesis was divided into four activities (research, concepting, prototyping, user test), which were related to the research sub-question. The theory which included exhibition design, storytelling, and user interface with a perspective on engagement and perception was studied and consequently established a theoretical background for this project. With the help of different methods, the concepting activity was fruitful and resulted in a feasible concept for the Prototyping Activity. The outcome of the prototyping phase was a semi-functioning, interactive prototype with three versions of attention guidance through the multi-screen setup. The aim of the User Testing Activity was to test the perception and engagement of the story and to evaluate which attention guiding technique worked best on the setup. The user test was conducted with young adult participants, who were established as a main audience for this thesis. Data was collected with the UEQ and GUESS questionnaire, analysed based on the

UEQ data analysing tool and Google Form graphs, and compared to the feedback received from the open discussion. The outcome of the user tests as well as the UTM expert review can be considered as insights and answers to the research question, while also highlighting and offering indicators for future research in the field of multiscreen design.

8.1.1 Implications of the Results

The implication of the results will be discussed in this subchapter and will summarise the findings to sub-questions corresponding to each activity of this thesis.

Exploration Activity

What are fundamental elements that could contribute to a potential improvement for a successful interface and storytelling design of the UTM Explore project on a multiple screen setup?

After the Exploration Activity it was possible to answer the research question about improvements that could contribute to the perception and engagement level of the UTM Explore project. The explorative interview (Chapter 4.2) revealed that there are two main issues that need to be addressed. Firstly, it is the overall storytelling dynamic, which is repetitive and does not reach any climax. The other main issue is the information overload of the visual elements distributed on the three screens as well as the touchscreen.

To address these issues, several suggestions from the experts were mentioned. The storytelling could be improved by a more dynamic and interactive storytelling structure, which includes a five-act story (Lupton, 2017, p.20) to improve the perception of the story as well as the engagement. A less repetitive story leads to more engagement, and one of the possible solutions could be to apply the interactive storytelling structure, which presents challenges and choices within the plot (Hamari *et al.*, 2016, pp.170-179). The combination of the story mode and the explore mode of UTM Explore could potentially improve the perception, since it could minimise the cognitive effort of the user by recognising elements rather than recalling them (Norman, Nielsen, no date). The combination could also ensure that the story becomes more engaging because of the exploring or learning experience offered by the interaction with the story (Özüdoğru and Çakır, 2020, p.105). Adding clear tasks to the story can help the user avoid uncertainty of their concrete missions. At the same time the missions would promote an interactive storytelling structure that leads to a more engaging process of the story.

Implementing a visual hierarchy by structuring the elements on the screen can help the user to be guided across the screens. Another improvement that could potentially enhance the perception of the story is the focus on only one item at a time on the screen, since the

human field of vision can only take in a small percentage of the whole width of the screen at once (Hoppe *et al.*, 2022).

Overall, the Explorative Activity was preparatory to the Concepting Activity, which focused on the improvements of the UTM Explore project's storytelling dynamics through the usage of the five-act and interactive storytelling structure. The improvement of the interface of UTM Explore focused on a visual hierarchy, which could enhance the view guiding throughout the story, as well as applying design principles for a successful interface design.

Concepting Activity

What are potential solutions that can be retrieved to improve the perception and engagement for a multiple screen setup of UTM Explore that are based on the ideation process?

During the Concepting Activity it was possible to create concepts, which were based on the previous findings of the theoretical framework as well as the Exploration Activity. Improvements regarding the storytelling structure could be achieved through the application of the five-act. In order to create a 'good' story, which will be perceivable according to Baron and Bluck, it needs to contain the fundamental structural elements of rising action, climax, and resolution, which are based on the five-act structure.

The implementation of an interactive storytelling structure was achieved by combining the two modes UTM Explore already includes: *Story mode* and *Explore mode*. The challenges a user faces are connected to an increase in engagement, as "research also suggests that the higher the challenge, the greater the engagement or sense of immersion" (Hamari *et al.*, 2016, pp.170-179). This enables the story to develop a plot that is determined by the choices of the user. In contrast to UTM Explore the *Explore mode* and the *Story mode* are now intertwined and experienced simultaneously.

Visual hierarchy was applied throughout the whole story and addressed the previous mentioned overload of information on the screens. In concrete terms this means that the structure and distribution of elements on the screens was planned so that only one screen at a time would show significant elements that contribute to the plot of the story and, in the meantime the other screens would just continue with the background story. Three approaches to guide the user’s gaze were chosen, which include the distinction of the screen in focus by either showing the others *black and white, blur*, or *pause*. The chosen effects are based on the effects for highlighting visual elements (Ware, 2008, pp.29-31). Design principles for a successful interface design were applied with the intention to support the potential user while navigating through the story.

To sum up, the concepting was effective in terms of answering the research question for the Concepting Activity and resulted in a concept that included three different versions of potential attention guiding solutions and an interactive storytelling structure with three options for the story's ending, which might improve the perception and engagement for a multiple screen setup. This provided a starting point for the Prototyping Activity.

Prototyping Activity

How can the findings from the concepting activity be implemented in order to design a prototype that includes chosen approaches (interactive storytelling structure, attention guiding)?

The findings of the Concepting Activity were implemented quickly without many changes of the concept thanks to the thorough preparation beforehand. After the creation and compiling of the footage the components were inserted into the Watchout software. The area of focus for each screen was kept relatively narrow compared to the wide screen size so that the visitors do not have to search the vital information on the screen and can keep their attention and gaze in the limited area. Elements on the screen like text or the isometric city were placed in the middle screen, while other screens acted as an atmospheric background without any vital information on them. This design choice was made due to suggestions from the experts about visual elements overload in the UTM Explore project and also referred back to the theoretical framework on the effect of highlighting visual elements (Ware, 2008, pp.29-31). Another design decision that was made was that longer paragraphs were not placed together with detailed visual elements on the screens to limit the distraction during the reading process. The design also paid attention to the use of contrasting and bright colours, in order to highlight elements that required more attention to support the viewers' perception of the story (*What is Visual Hierarchy?*, no date).

The implementation of the interactive storytelling structure has ensured that depending on the choice of the user the story had a different ending. Due to this interaction the user was able to feel more immersed in the experience compared to just watching a video.

To reduce the cognitive effort of searching for the screen that includes the significant information the screen was visually highlighted so that it stood out from the others. Therefore three different effects were prepared, which later on could undergo user testing to confirm the best possible option. The three approaches included grey scale, sharpness, and phase of motion according to (Ware, 2008, pp.29-31).

Subquestion: How can interactivity in the prototype be created that can be tested by potential users?

The interactivity was seemingly working for the participants since the Wizard of Oz method was applied. Through the usage of a midiboard that was connected to the Watchout file, it was possible to mimic the interactions and immediately react to the actions of the participants. The fact that the participants felt like the prototype was functioning became evident in a feedback question asked by participants who wondered how the interaction was created.

User Testing Activity

Which approaches can potentially enhance the attention guiding and video storytelling dynamics on a multiple screen setup to improve perception and engagement of the presented content for the potential user?

The initial user test, the UTM expert review, and the final usertest could contribute to answering the research question for the User Testing Activity. The participants as well as the expert provided valuable feedback, which helped to validate previous research work. Although it led to some unexpected results, overall it was possible to say that the general concept and story were perceived well and understood by the participants. The interface design supported the user's ability to navigate through the prototype. The majority of the participants preferred the *black and white* attention guiding approach, followed by the *blur* and *pause* approach. The interactive storytelling structure was approved to be engaging and perceivable by all participants as well as the UTM expert. According to the feedback of the participants, interactivity enhanced the perception of the story, since it kept them from digressing from the story.

8.1.2 Limitations

The main limitations of this thesis touched upon Prototyping and User Test Activities. Looking at the prototyping to evaluate the overall exhibit and to receive broader feedback on the exhibition piece itself would be helpful to produce a complete concept. Due to the scope of the thesis, it was only possible to produce one scenario (Fire Emergency) from the *Drone Operator* concept. Based on that, some of the results received from the user testing could only be related to one scenario. For example, participants stated that in terms of engagement they were lacking interactivity in the prototype. However, the *Drone Operator* concept consisted of two additional scenarios that were not prototyped due to time limitations and that had more interactive tasks, which could potentially enhance the overall feedback and give more complete results on the prototype. Another limitation that was known from the beginning of this thesis is the usage of sound, which could potentially enhance the experience and improve the guiding across the screens. Almost every participant from the open interview, the initial, and final user tests lacked sound effects because it is one of the crucial aspects of entertainment and consequently audience

engagement (Byun and Loh, 2015, pp.129-138). Due to the requirements of Visualisation Centre's fifth floor exhibition, general atmospheric music already existed at the setup location and, in order to avoid a confusing overlap, sound in the prototypes was not advisable. The lack of time of the project was another limitation to the research on sound effects.

The final and main limitations of this project touched upon the user tests' participants. For the initial user test, five young adults (age 18-29) participated in a screening over zoom and the main limitation was the inability to show the setup itself and convey the exhibition experience accurately (large screens and a dark room adding more immersion in comparison to watching the video on a laptop). As a result, the engagement evaluation could be not considered valid because the participants were not present in the original environment. However, the results on the perception level of the story were fruitful and highlighted a lot of suggestions for enhancing the prototype. For the final user test, five high school students aged 18-19 were able to visit Visualisation Centre C and participate onsite. Attracting more participants of different ages and different backgrounds for the test could lead to more accurate and precise results. Other assessment methods, such as the compilation of a full UEQ and GUESS questionnaire and eye tracking devices for an evaluation of the best approach, could add more reliable feedback into the insights of this thesis. Looking at the generalizability the results can be applied to the same or similar setups. On other multi screen setups the results can potentially have the same effect but this could require further research and testing and an adaptation of the approaches.

8.1.3 Future Research and Work

The future work that can be done relates to both prototype and further research. Potential improvements to enhance the perception and engagement of the multiple screen design suggested by the user test participants are presented in Tables 7.1, 7.2 in the User Testing Activity chapter. The concept *Drone Operator* with two additional scenarios could be prototyped and tested to receive a more precise feedback on the overall engagement with the exhibition piece. Some of the attention guiding approaches could be combined, for example *black and white* and *blur* (see Figure 7.10), and tested to see if it will further enhance the effect of attention guidance. Methods for testing in future research could include eye-tracking technology to get more explicit data on the evaluation of the approaches. In order to get more accurate data in the final user test, more rounds of onsite user testing could be done with an increased number of diverse participants of different ages and from different backgrounds. The aspect of audio elements and the use of tangible objects could be explored from the perspective of engagement improvement. In the *Concepting Activity* chapter, other concepts that include ideas of tangible implementation are described and could be revised, prototyped, and tested in the future.

The produced prototype will be adapted and implemented in another traffic management for urban air mobility project with *CORUS*. The next step will be to research how to guide the viewer between the triple screen storytelling video and the interaction on the touchscreen.

8.2 Conclusion

The purpose of this project was to research "*How can the key elements of UTM City be visualised on a multiple screen setup by using the principles of story structures and attention guiding, in order to make it perceivable and engaging for a small group of young adult visitors in Visualisation Centre C in a public exhibition context?*" Referring to the analysis of the final user testing part, it is possible to see that the overall outcome was successful. The perception of the story or as Baron and Bluck name it, the “quality” of the story depends on its structure and key elements such as plot. Based on the theory from Lupton, the five-act structure for the overall prototype story was designed (Figure 2.2). According to data from UEQ and GUESS questionnaires, the question about story clarity received top grades from all participants, which leads to the conclusion that the challenge of visualising traffic management for urban air mobility (UTM) and presenting it to the group of young adults was successful.

After studying J. Laaksolahti’s theory on storytelling, an interactive storytelling structure was implemented to the overall story (Figure 2.4). Interactive storytelling requires a storyline that cannot be predefined and predicted, and at some point, the audience is always faced by a choice. In the final prototype this was applied in the way of 'path choosing' on the touchscreen and the viewer’s choice influencing the resolution of the story. The use of an interactive storytelling structure was engaging for the participants according to the collected data and feedback. Referring back to the theory from Hamari *et al.*, immersion and engagement both signify the success level of users' learning experiences in game design. The higher the challenge the more immersive and engaging the experience becomes (Hamari *et al.*, 2016). Looking at the outcomes and user feedback, the challenge of path selection was not particularly advanced but still made it easier to stay focused and interested.

Finally, based on the researched theory of the visual elements hierarchy from Ware, three approaches were chosen for prototyping and testing: *black and white, blur, and pause*, to solve the challenge of navigating the user through the triple screen setup. The collected data and feedback showed that the *black and white* approach was the most comfortable in terms of being guided through the screens for the majority of the participants.

Looking at the multiscreen design theory and research that was conducted before, it becomes apparent that studies were mostly related to the multi screens between different

devices. The most vivid example in this field is the book by Wolfram Nagel *Multiscreen UX design: developing for a multitude of devices*, which "offers a hands-on guide for UX design across multiple screens" but for different devices. This thesis contribution is based on one device, a solid setup with multiple screens that is firmly located in the exhibition context. After reviewing existing literature, it was possible to state that the purpose of this project to conduct research on such a setup and context is a relatively unexplored field.

Overall, this thesis explores the representation of science and complex topics, and its research about perception and engagement provides potential solutions for increasing the interest in such topics, thus enhancing the interest for science education. The use of digital and interactive storytelling, which was also applied in this project, is tightly connected to the improvement of education engagement (Özüdoğru and Çakır, 2020, p.105). The research that was carried out during this thesis could be a step towards a more engaging presentation of scientific research to a broader audience, especially young adults. The representation of complex and abstract topics on interactive multi-screen setups could potentially enhance the interest of children and young adults, which could lead to an increased interest in seeking out education in the field of science, since science centres count towards the top five stimuli that influence a career choice in the science sector (Short and Weis, 2013, pp.27-38).

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Appendix

Appendix A - Interview guide

- How did you experience the presentation?

- After watching stories, what do you expect to see on the touchscreen?
    - When you use the explore mode, what are you expecting to see on the three screens?

- Could you tell us what the story was about?
    - What was the most engaging part of it?

- Which part of the story should be in focus to make it more engaging and thought-provoking? The user experience, the isometric view or the UTM simulation?

- What would you say are the most important changes that are needed so that this setup is more engaging for young adults (around age 16-25)?
    - How would you design a setup that engages a wide range of visitors on different levels? → (use example of Andreas)

  Example: Each exhibition concept involves learning, for example kids find the basics (buttons and lights) interesting, young people understand the connections between those and a young adult is able to retrieve a deeper understanding of the context

- What do you think doesn't work so well regarding storytelling and interface design?
    - How would you approach this setup with the challenges in mind we just mentioned?

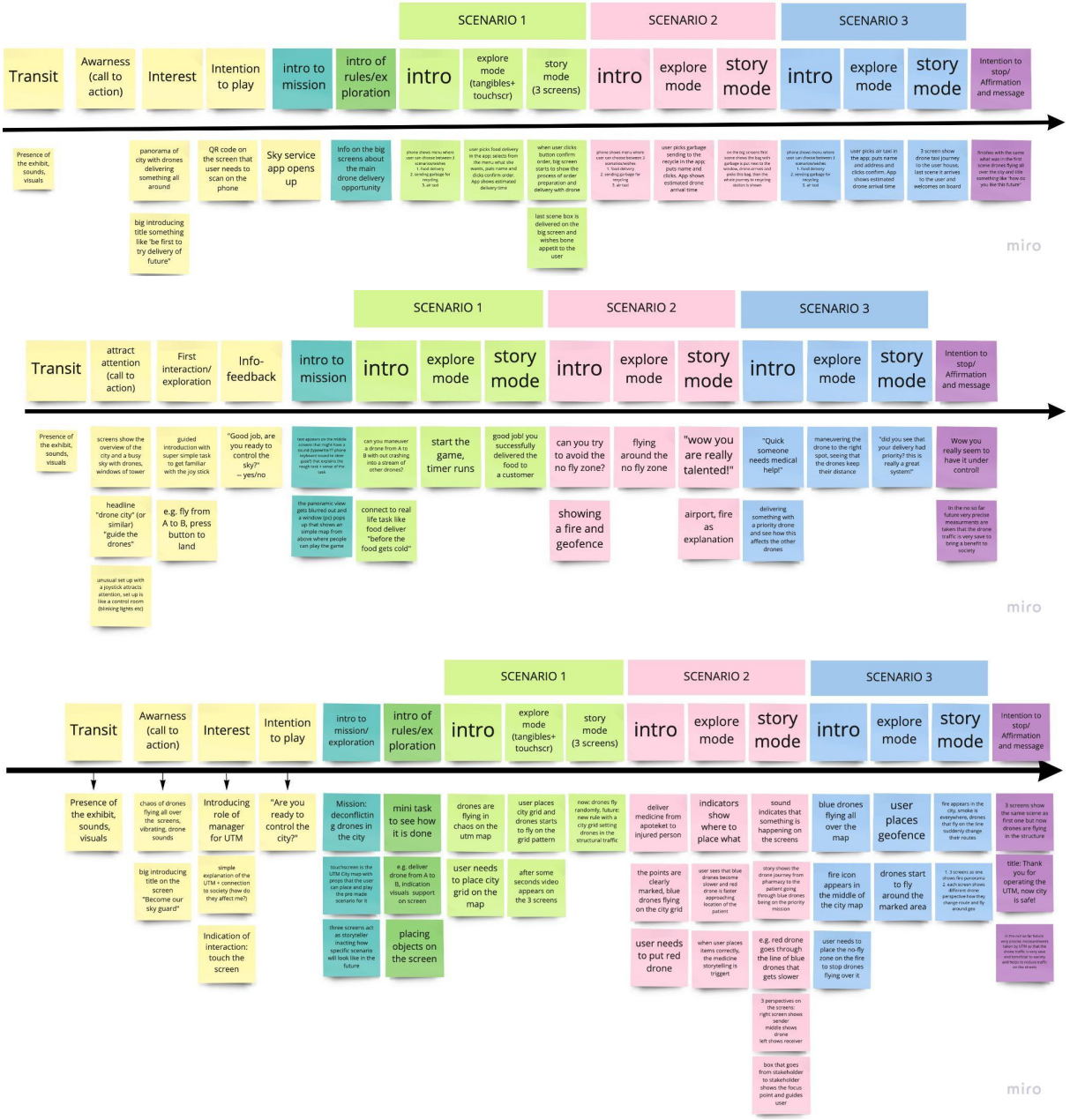
- What do you think about the content by itself? Is it perceivable?
    - What could you suggest for a smoother viewer guiding through all three screens in order to be able to catch all 3 story perspectives? (UTM simulation on the left, user story in the middle, isometric view on the right screen)
    - What do you think about the separation of the screens to three different perspectives?
    - Should the screens act as one sometimes?
    - How would you integrate the narrator into the presentation?

- What do you think of the visual elements?
    - Are they understandable?
    - Do they contribute to an intuitive interface?
    - Do you get the feelings that the three screens belong together?
    - Are the visuals engaging to you? Why? Why not?
    - Are there elements you think are too much or too little?
    - In what way data visualization can be improved to make it perceivable?
    - Can you detect a hierarchy of interface design in the setup?

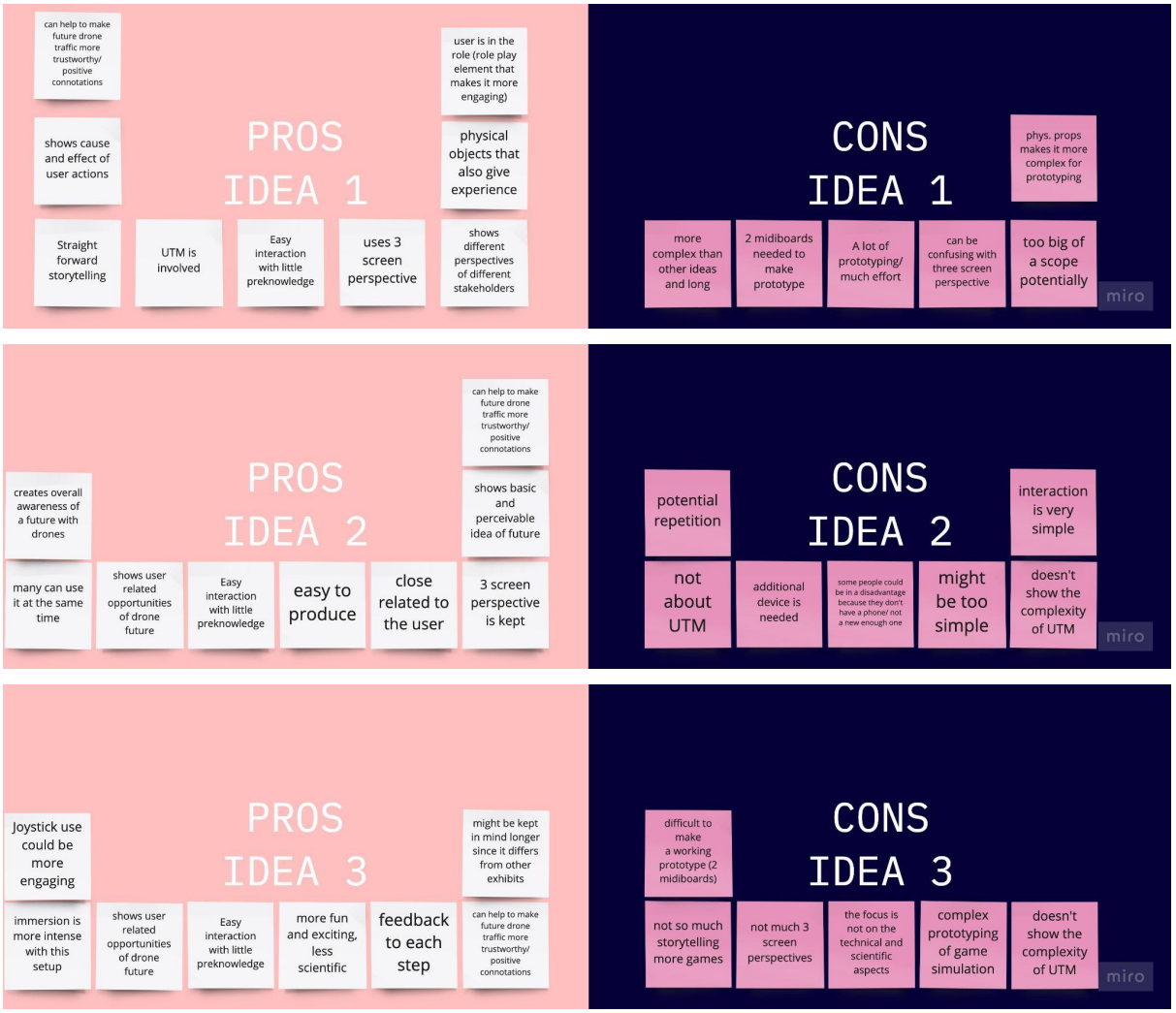
- What do you think about the pace and dynamics of the whole storytelling? Is there enough time to catch the story and all its details (data vis, term explanation etc.) ?
    - What do you say about the duration of the story mode?
    - What do you think about the scope of the explore mode?
    - How to structure the storytelling dynamics so it can be dynamic/active enough but at the same time for the user to be able to catch details

- After all the things we discussed now, what do you think are the most important aspects we need to consider when designing the setup?
    - Perceivable, Engaging, Coherent?

Appendix B - Journey Map Idea 1+2+3



Appendix C - Pro and Contra List of Concept Ideas



Appendix D - Questionnaire for User Testing and Answers

This test is anonymous and there are no right or wrong answers, so please fill in :) You can fill this questionnaire in Swedish or English.Thank you for participating!

- How old are you?
- What was the very first impression when you saw the setup (three screens+touchscreen)?
- What is your overall impression about the video?
- Can you tell us what the story was about in 1-2 sentences?
- How did you feel about choosing options for path yourself in comparison if the story would be predetermined (with one ending option)?
- Which approach (black and white, blur, pause) helped you the most to follow the story on three screens? Why?

Tick one circle for every question

The following questions consist of pairs of contrasting attributes that may apply to the product. Please decide spontaneously. Don't think too long about your decision to make sure that you convey youroriginal impression.It is your personal opinion that counts. Please remember: there is no wrong or right answer!

7. I am captivated by the video's story from the beginning *

Mark only one oval.

	1	2	3	4	5	6	7	
strongly disagree	◯	◯	◯	◯	◯	◯	◯	strongly agree

8. I enjoy the fantasy or story provided by the video *

Mark only one oval.

	1	2	3	4	5	6	7	
strongly disagree	◯	◯	◯	◯	◯	◯	◯	strongly agree

9. I am emotionally moved by the events in the video *

Mark only one oval.

	1	2	3	4	5	6	7	
strongly disagree	◯	◯	◯	◯	◯	◯	◯	strongly agree

10. I am very interested in seeing how the events in the video will progress *

Mark only one oval.

	1	2	3	4	5	6	7	
strongly disagree	◯	◯	◯	◯	◯	◯	◯	strongly agree

11. I can clearly understand the video's story *

Mark only one oval.

	1	2	3	4	5	6	7	
strongly disagree	◯	◯	◯	◯	◯	◯	◯	strongly agree

12. Mark how perceivable* the story is *To become aware of (something) directly through any of the senses, especially sight or hearing. *

Mark only one oval.

	1	2	3	4	5	6	7	
not perceivable (svårt att förstå)	◯	◯	◯	◯	◯	◯	◯	perceivable (lätt att förstå)

13. Overall video *

Mark only one oval.

	1	2	3	4	5	6	7	
annoying (irriterande)	◯	◯	◯	◯	◯	◯	◯	enjoyable (angenäm)

14. Overall video *

Mark only one oval.

	1	2	3	4	5	6	7	
boring (Tråkig)	◯	◯	◯	◯	◯	◯	◯	exciting (Spännande)

15. Overall video and story *

Mark only one oval.

	1	2	3	4	5	6	7	
not interesting (Ointressant)	◯	◯	◯	◯	◯	◯	◯	interesting (Intressant)

16. Overall video (endings of the story) *

Mark only one oval.

	1	2	3	4	5	6	7	
unpredictable (oförutsägbar)	◯	◯	◯	◯	◯	◯	◯	predictable (förutsägbar)

17. Overall video *

Mark only one oval.

	1	2	3	4	5	6	7	
slow (Långsam)	◯	◯	◯	◯	◯	◯	◯	fast (Snabb)

18. Story *

Mark only one oval.

	1	2	3	4	5	6	7	
complicated (Komplicerad)	◯	◯	◯	◯	◯	◯	◯	easy (Enkel)

19. Overall video *

Mark only one oval.

	1	2	3	4	5	6	7	
unpleasant (Inte tilltalande)	◯	◯	◯	◯	◯	◯	◯	pleasant (Tilltalande)

20. Interaction *

Mark only one oval.

	1	2	3	4	5	6	7	
demotivating (Omotiverande)	◯	◯	◯	◯	◯	◯	◯	motivating (Motiverande)

21. Overall video *

Mark only one oval.

	1	2	3	4	5	6	7	
does not meet expectations (lever inte upp till förväntningarna)	◯	◯	◯	◯	◯	◯	◯	meets expectations (lever upp till förv

22. Story *

Mark only one oval.

	1	2	3	4	5	6	7	
confusing (Förvirrande)	◯	◯	◯	◯	◯	◯	◯	clear (Tydlig)

23. Interface (visual elements) *

Mark only one oval.

	1	2	3	4	5	6	7	
cluttered (Rörig)	◯	◯	◯	◯	◯	◯	◯	organized (Strukturerad)

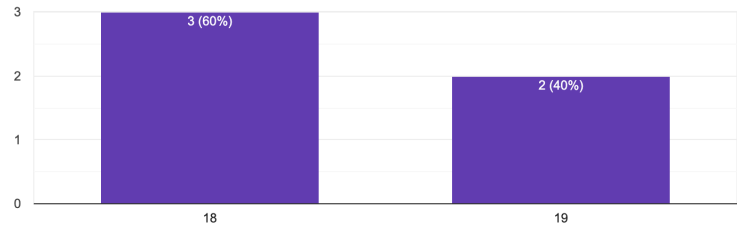
- Do you have ideas on how to make this video story more perceivable?
- Do you have ideas on how to make this video story more engaging?

QUESTION 1

How old are you?

Copy

5 responses



QUESTION 2

What was the very first impression when you saw the setup (three screens+ touchscreen)?

5 responses

- High-tech, interesting, didn't know what to expect.
- Cool something that I would see in the future
- I was very interested in seeing what it would do.
- I thought it looked very technological and future. How I imagine the future.
- It felt exciting and interesting

QUESTION 3

What is your overall impression about video?

5 responses

- well done, realistic scenario
- I liked the video not too much or too less context. You got hungry when you saw cooking -stimulates to order with drone
- It was interesting, though some parts could be shortened (mainly in the blurred and stopped versions)
- It was good! A lot happening, but not too much. It was also colorful - caught my attention.
- The video was very easy to follow, and the interactive aspect was a cool addition

QUESTION 4

Can you tell us what the story was about in 1-2 sentences?

5 responses

The story was about a future where we use drones to do errands for us and also how to manage the drone traffic.

How to in a smart and effective way to order something by using your phone and receiving it by drone. Knowing how to plan because of the estimated time

Getting pizza frpm point A-B with a drone

Someone who didn't have a lot of food at home (empty fridge) "needed" to order a pizza which was transported by a drone that also needed to avoid the fire.

How drones in the air can be managed

QUESTION 5

How did you feel about choosing options for path yourself in comparison if the story would be predetermined (with one ending option)?

5 responses

Always fun to interact with screens and new technology, but it doesn't really matter so much.

Getting a choice is always good but I mean with the 3 paths you got a picture of what you could wait for when delivered. If I wanted it fast I know it's gonna be burned. Know the reason behind each path and time

It makes it easier to stay focused and interested.

It made it a bit more fun. Kinda like a game. Although it was very easy to predict what would happen.

It would have been less interesting

QUESTION 6

Which approach (black and white, blur, pause) helped you the most to follow the story on three screens? Why?

5 responses

Blur- the black and white got me distracted wheras with the pause I didn't know what screen to look

Black and white many stimulie, people nowadays dont focus on one thing only. Or pause blur was too much

Black and white for me the other ones felt slower in comparison.

I think I liked the black and white one the most. Because you could kinda figure out what would happen and start to predict the story in your head and then get the answers and puzzle the pieces together

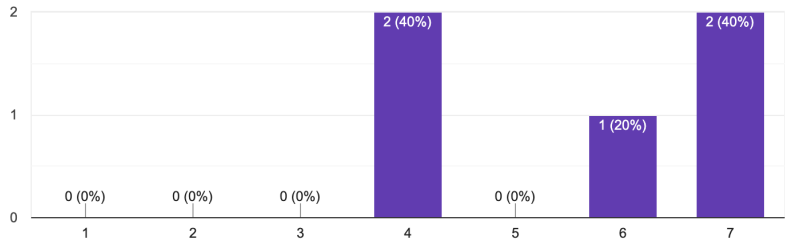
Black and white

QUESTION 7

I am captivated by the video's story from the beginning

Copy

5 responses

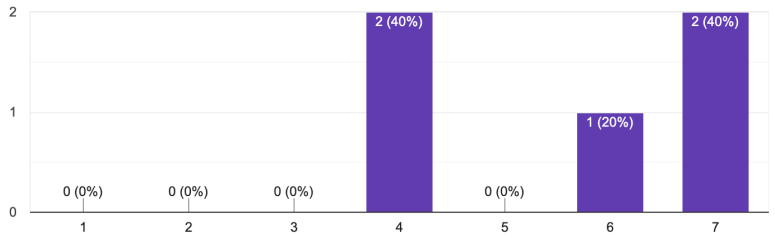


QUESTION 8

I enjoy the fantasy or story provided by the video

Copy

5 responses

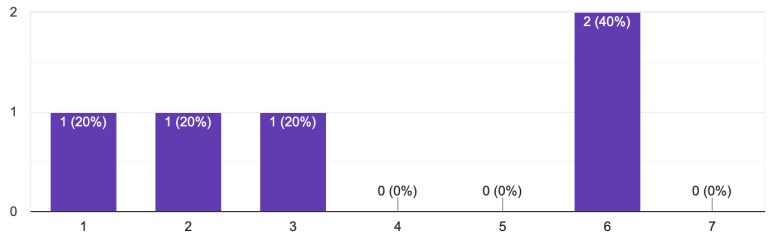


QUESTION 9

I am emotionally moved by the events in the video

Copy

5 responses

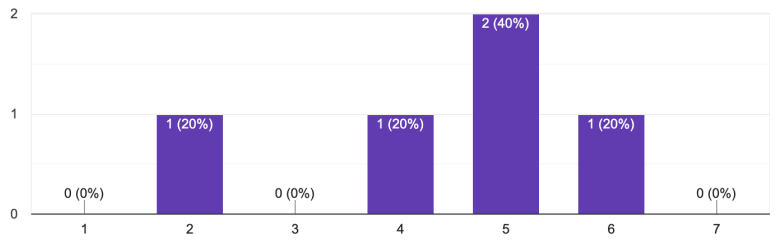


QUESTION 10

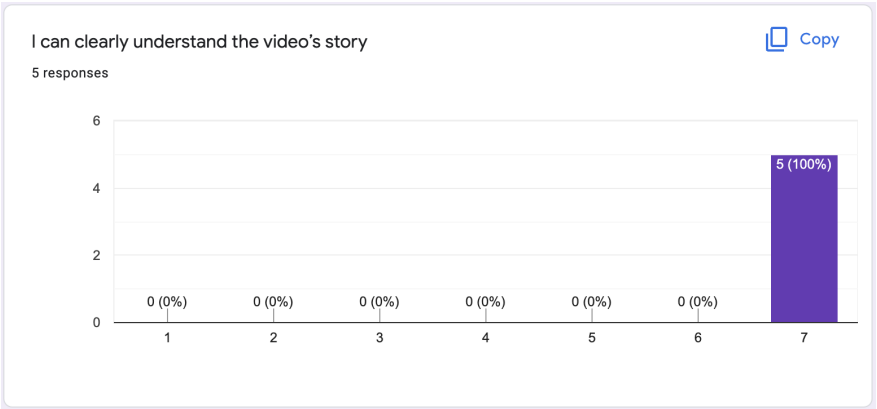
I am very interested in seeing how the events in the video will progress

Copy

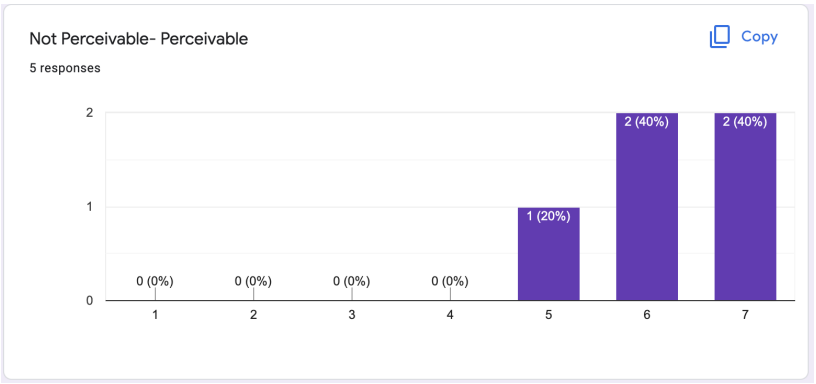
5 responses



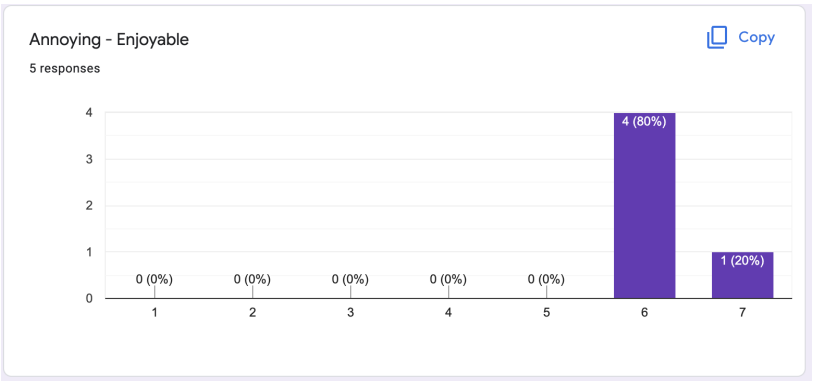
QUESTION 11



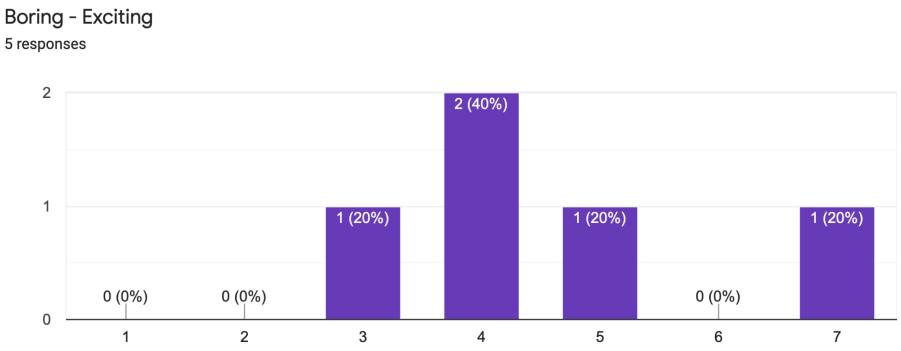
QUESTION 12



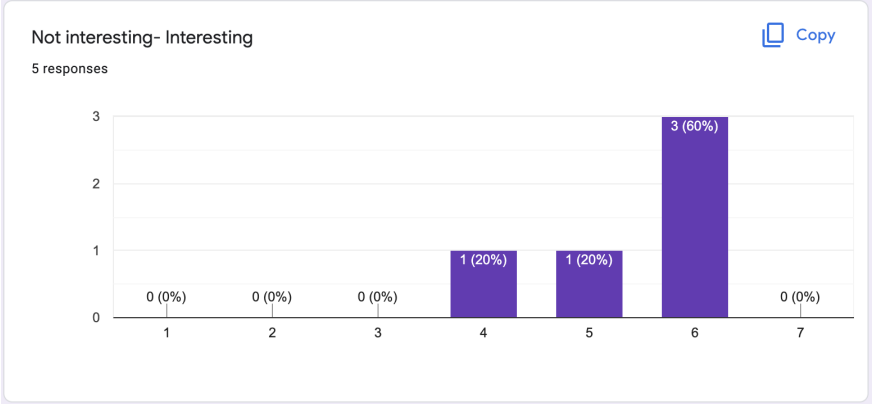
QUESTION 13



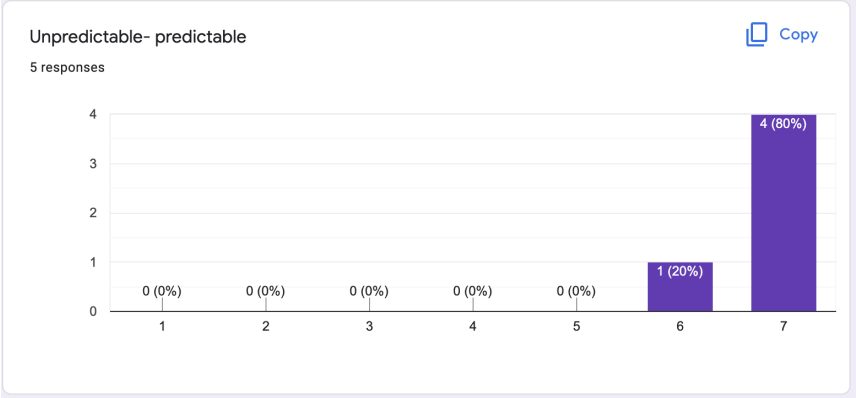
QUESTION 14



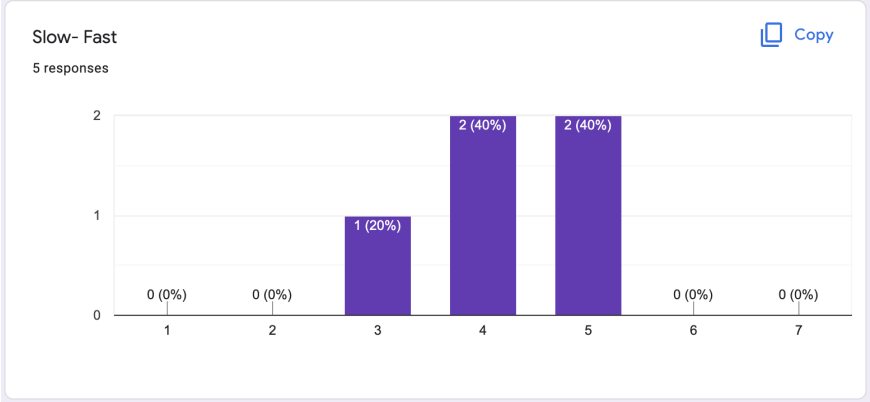
QUESTION 15



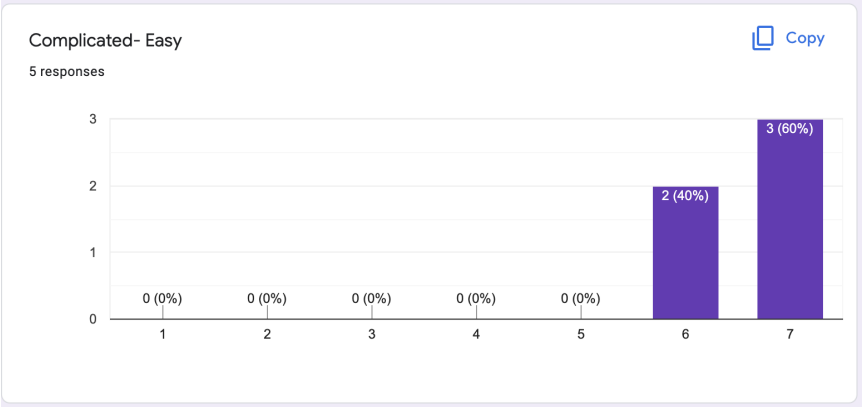
QUESTION 16



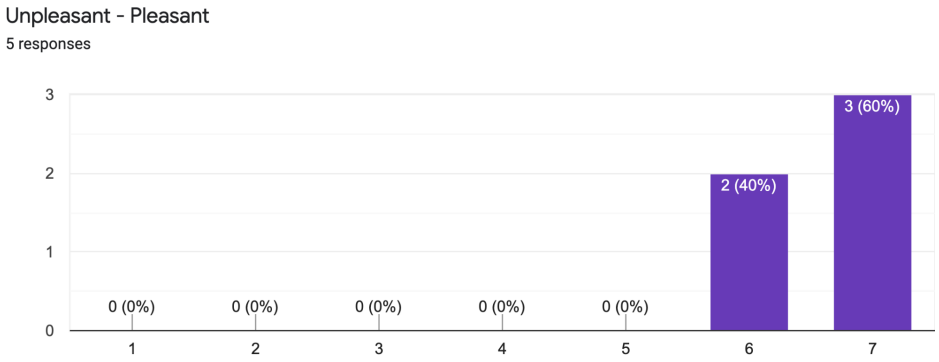
QUESTION 17



QUESTION 18



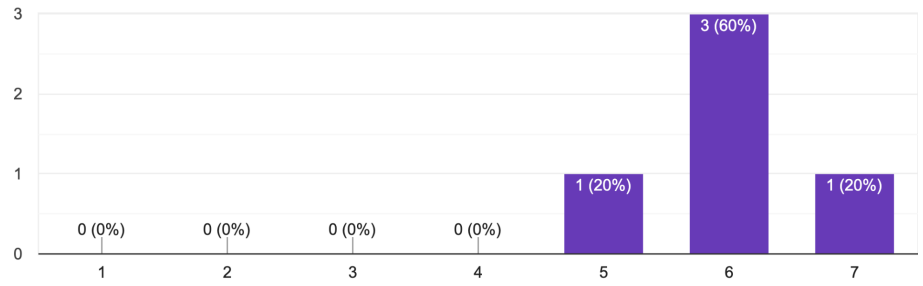
QUESTION 19



QUESTION 20

Demotivating - Motivating

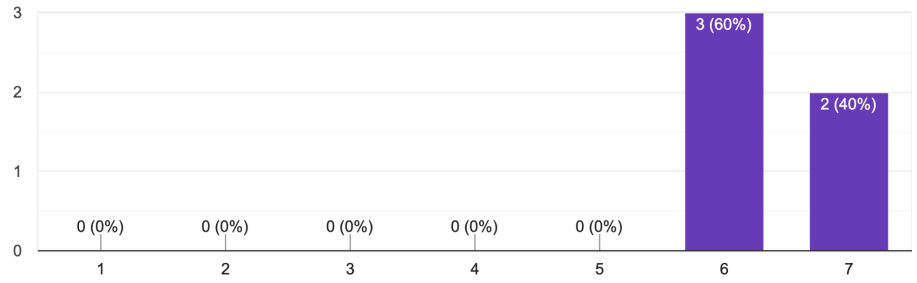
5 responses



QUESTION 21

does not meet expectations - meets expectations

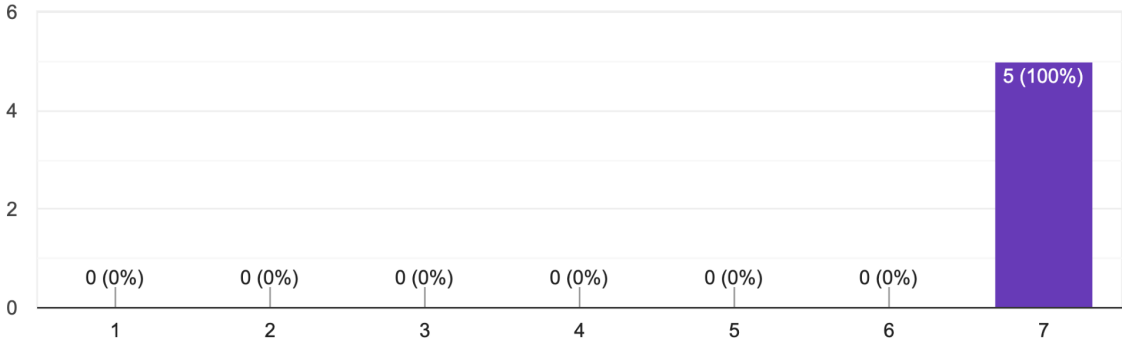
5 responses



QUESTION 22

Confusing - Clear

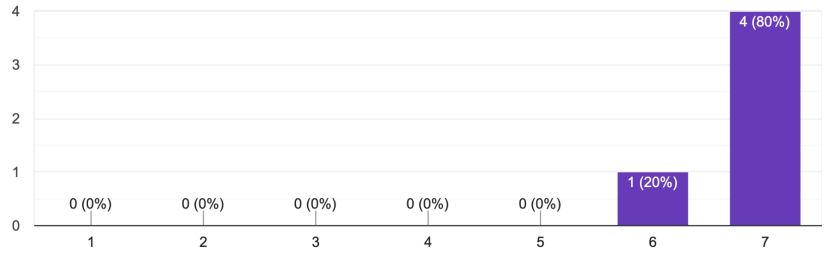
5 responses



QUESTION 23

Cluttered - Organized

5 responses



QUESTION 24

Do you have ideas on how to make this video story more perceivable?

5 responses

- Not much to improve
- Shorten it down maybe a little or fasten it up. Make the different paths a little bit faster. Advertise more UTM
- No, it was very easy to understand and follow.
- no answer
- Focussing more on the ordering process and adding more info on the UTM might assist the story further.

QUESTION 25

Do you have ideas on how to make this video story more engaging?

5 responses

- Less predictable endings
- More interacting choosing own path from the beggining and also other things such color. Combine playfulness and shopping (for some people have it as an option)
- Perhaps involve more problem solving and shorten certain sequences of video. For example the fridge opening clip could be done faster, watching it a second time also may have made it seem slower. The on screen text could also be changed to be more appealing.
- Maybe being able to choose more things, not only "the path". More Interesting (noises) background noise of a fire maybe
- Perhaps adding further interactive elements would make the story even more engaging, e.g. drawing paths yourself