“Organization is what you do before you do something, so that when you do it, it’s not all mixed up.”

An investigation of behaviours using digital visual planning.

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Abstract

This thesis sets out to investigate and understand behaviours and interactions between individuals while using a large touch screen to plan a holiday trip. By using this approach, the tool digital visual planning by Yolean is indirectly examined. The tool is examined by looking at how it is used and the environment it is used in. The research question in this research paper is “How is interaction between individuals affected by using large touch screens with a digital visual planning tool in a meeting?” It is answered by using a mixed method approach containing grounded theory and design research methodology applied to an observation study. The results suggest that a group working for the same goal tend to get a leader without appointing them directly. This leader is also usually the person who stands in front of the rest and dictates what goes where. If problems arise, a shift in leadership occurs naturally and fluently. The digital visual planning tool helped the participants to easier express themselves and to motivate decisions. By using their whole body, they could more easily communicate.

Keywords: Large touch screens, public displays, Digital visual planning, Behaviours, Observation study, Design research, CSCW

Sammanfattning


Nyckelord: Stor pekskärm, stora pekskärmar, digital visuell planering, beteenden, observationsstudie, designforskning, CSCW
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I would also like to give special thanks to my brother. This thesis would not have been possible without your encouragement and continuous support you have given me during all these years.

The title is a quote by Winnie the Pooh created by A. A. Milne. It might be silly, but it does describe this thesis quite nicely in a charming way. It also serves as a reminder to allow some silliness and playfulness in work.
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1. Introduction

By now, there are no surprises that user interfaces for all sorts of computers are evolving year after year. A need for helping, aiding and guiding individuals by means of navigating to reach their goal on a computer is still very much a priority. This has been solved and built upon many times, starting with a graphical display that could visualise data in a way that anyone could relate to. This paradigm shift started out with the computers created by Xerox in 1970s. With the creation of a graphical user interface (GUI), Merzouga Wilberts coined the term WIMP, or windows, icons, menus and pointing device (Techopedia, u.d.). Terms that to this day are used and helped bringing the computer to anyone without having to be an engineer to operate or understand. The graphical icons representing objects anyone would be familiar with such as desktop, folders and trash cans were created for this reason, to humanise the computer (David Canfield Smith, 1982). To interact with the machine, a pointing device was created. The result was the mouse. A device that is still in use today. But as technology evolved, new means of interactions had to be invented. The mouse, which essentially is a wired brick with a button on it was not the best solution for handheld devices or portable computers. One such invention was the stylus, a pen that was used to navigate a GUI by pressing on the screen directly. One company that popularised this technology was Palm with their Palm Pilot, a handheld computer operated with a touch screen (Kairer, 2006). While this technology became popular, one of the largest paradigm shifts was created by Apple in 2007 with their release of the iPhone. They introduced a technology called multi-touch (Apple). This technology only responded to input by fingers, eliminating the need of accessories such as a stylus. This new technology was later implemented in a wide range of products from laptops, televisions and even to watches. In the same year as the iPhone, Microsoft reviled a product called Microsoft Surface. It was a table where the large surface on top was a touch screen. It was a 30-inch screen meant to be used in a social setting such as at a coffee house. One could share photos, order food and drinks and some windows software. It was an early attempt at using large surfaces as touch screens and targeting it as a consumer product (Bowden, 2017).

While these leaps of technology have been studied and implemented in hundreds of products the area that this thesis is interested in is how such a technology shapes or promotes behaviour. Many studies and programs have investigated GUI design from computing performance to interaction performance. Where objects should be placed in an interface and what hardware to use. An aspect not so often discussed is where this technology is used, and under what circumstances. By defining a clear environment and a specific touch technology, this will be investigated in this thesis. Behaviours and attitudes will be observed and analysed to understand how a technology could be improved by looking at how and where it is used rather than looking at what specific technology.
1.1. **Problem area**

The area of this research is limited to investigating how meetings take place and how people interact with each other to make plans for the upcoming days or weeks. This thesis will investigate how a common scenario such as planning during a meeting with others would be different if it was done with a large touch screen in place. With an understanding surrounding human computer interaction and similar applications involving large touch screens, this research will draw conclusions based on empirical studies conducted with relevant methods derived from a relevant theory.

There is plenty of research done in User Interface (UI) performance both measured by the computing and technological performance but also performance of individuals interacting with said UI. Kang and Shin (2017) and Chen et al. (2013) are examples of research in this area that gives a deeper understanding of touch screen performance. Another well researched area is public displays that investigate how individuals interact with UI’s that can be found in for example city centres (Peltonen et al., 2008) or ones that are confined to a specific building or specific department at a work place (McCarthy et al., 2008). What has been troubling to find more research about is the marriage of both those worlds, combining the performance of individuals with technology in a collaborative setting. This is why this research is being made. To find out how we could go further with technology by stepping back and looking at a context and the people acting within it.

1.2. **Research question**

The research question (RQ) distil the concepts discussed earlier and narrows down this rather large area of research to one question that will be answered. And the question is as follows:

“How is interaction between individuals affected by using large touch screens with a digital visual planning tool in a meeting?”

This question will be approached by investigating current research, finding theories that can be associated with this topic and to design and perform user tests with a scenario that will be performed with and without a large touchscreen to be able to draw conclusions and suggest improvements and further research in the area. A large touch screen in this thesis is defined as the equivalent of a large television, about 50 inches.

In this context, the interaction suggested in the RQ is focused on the individuals using the screen. How they interact with each other when conducting a meeting where the plan is shown on a large touch screen. This is what is meant by affect in the RQ. It suggests looking into if individuals behave in a certain way within the large touch screen context or not.

1.3. **Intentions of research**

The intentions of this thesis are to contribute with knowledge of how individuals perform in a meeting with a digital visual planning tool and how this knowledge can be used to implement in similar areas where it is important to understand collaboration between individuals. It aims to find key elements that could be used and applied for research not only within a similar context but to other domains within HCI.
1.4. Limitations

This paper will focus on the interactions between individuals, their behaviours and attitudes. It will encompass where a person is standing in relation to others and if hierarchies will occur during a visual planning meeting. This means that the research is confined to investigating a space where people interact with each other. This thesis will show one variant of an observation study with unique participants with each session.

Large touch screens are not readily available nor are they affordable. This means that tests conducted within this thesis utilise different approaches to simulate the ideal setup as close as possible. Some of the tests are performed with a so-called wizard of oz approach (Knowledge, 2010) where a regular television is used and is manipulated by the moderator of the test as participants “touch” the screen. Most tests, however, are using a projector that can detect touch scaled down to a consistent size. The conditions in which the study is conducted is explained later in the paper.
2. Background

This section will provide an in-depth look at the UI that is used in the tests and how it works. The tool used is defined as “Visual planning” and will be explained and explored. A review of various literature will be presented by categorising them into appropriate sections. This review will be the groundwork on which the methodology will be based on for answering the research question.

2.1. Yolean

This thesis is done with the help of a company called Yolean. Yolean is a company based in Göteborg, Sweden and are responsible for web-based products that aim to help teams and companies to organise and create a more efficient execution of planned work (Yolean, 2018). Their products can be used on both traditional computers and touch-based screens. A plan for a project can be created in advance on a traditional computer to later be presented and manipulated in a meeting with a touch-friendly interface. They have three main products that they provide at present time: Digital visual planning, checksheets and Yolean for construction.

2.2. Digital Visual Planning

The tool that is used in this paper is Digital Visual Planning (Yolean, 2018). It was created to easier synchronise people in a team with each other. It enables users to clearly see what responsibilities each person in a team has and if plans collide or show to be problematic. This transparency that is provided can help individuals to better understand their co-workers and their responsibilities to create a more streamlined and efficient work environment. A screen shot of what the product looks like can be seen in figure 1 below.

![Figure 1 Screen shot of how Yolean’s visual planning tool looks like.](image-url)

On the left-hand side of the interface, people involved with the current project can be seen. Each person has their own row in the interface. In this case, the period of time set in the interface is two weeks where each day is represented at the top with their own column. Each cell can be filled with a note added by dragging one of the coloured squares on the right-hand side into any of the cells. The
colours add a layer of complexity by offering a project group to assign these colours to desired people or other functions relevant to the project.

There are principles that Amer et al. (2016) discuss in their book “Visuell Styrning” (Amer Catic, 2016) that apply to digital visual planning. They discuss how to reach a goal of a project using visual planning. The mentality is based on the lean methodology of working where daily activities are continuously revisited and mended if the project, for example, takes a slightly new approach or if goals have been moved forwards or backwards in time (Amer Catic, 2016). The main principles are what, who and when. “What” refers to short activities such as daily deliverables set day by day. “Who” refers to clearly defining individuals to specific tasks so that several people do not work on the same task unnecessarily. And finally, “When” is the principle of having a clear timeline on the final product in the project. They further argue that these principles when used in a project planning using visual tools help individuals and teams to become more efficient and to clearly define work between people in a team.

2.3. Literature review

In this section papers will be summarised and categorised according to their domain. Their purpose for being used in this research will be stated and how they can be connected to one another will be presented. There are two main categories for the literature, touch screens and social interactions with touch screens. These categories were chosen based both on what the search for literature turned out and to enable multiple areas to focus on. As this thesis focuses on interactions between people and with a large touchscreen, it is important to investigate those two domains to be able to find the best possible solutions for test purposes and to create a solid foundation.

2.3.1. Touch screens

When it comes to the technology itself, the most important aspects to investigate are technology performance, that is, both how the technology performs and what practices and standards are preferred for human interaction. The goal is to find if there are reoccurring results or themes in previous research that can aid in the investigation of this thesis. These findings will be discussed and applied as closely as possible.

Yolean’s visual planning tool relies on an interface that resembles a schedule where sticky notes are placed. Because it has been determined earlier that the touch screen is to be large for visual planning, the field of object size in relation to human interaction as well as the location on the screen in the screens has been investigated. In their research, Kang and Shin (2017) set out to investigate just that, accuracy of target selection in touch screens. They tested objects in different locations on a screen as well as the location of the physical screen in relation to the participant. They found that lower areas of a screen that was placed upright and close to the participant was the preferred way of interaction. Other visual content was preferred to be at the upper part of a screen. Their findings suggested better performance and less muscle fatigue compared to other setups. This suggests that the interaction with the large screen to be used in this thesis must be placed in a way that enables the participants to interact with the screen at a close proximity as well as focusing on having the interaction not be focused in the higher parts of the screen.

When looking at target size Chen et al. (2013) looked at a similar topic and test as Kang and Shin with the difference being that they focused on the size of targets. Having a large touch screen enables a much larger range of sizes of objects while still retaining a lot of information at the same time.
compared to small screens. The knowledge found on optimal target sizes will be used when designing the observation study performed in this thesis. It would dictate size and resolution for the sticky notes in the visual planning interface. It is important because determining this factor would eliminate potential mistakes, irritations and confusion from participants so that they can focus on the task and not the technology. According to the findings by Chen et al. (2013) a size of 20 mm across for any single target is the optimal size. The size worked best performance and preference wise. Interestingly, size increase beyond 20 mm across did not find any significant change in performance, rather, it plateaued after that size. The size has further been confirmed by another investigation by Colle & Hiszem (2004). They investigated target size on touch screen based numeric keypads. Their findings found optimal performance by participants being between 20 and 25 mm across. These findings that were conducted in isolation from another suggests that these numbers seem to be a good foundation to support the interface on. Using this knowledge, the interface will be scaled so that the interface touch targets will correspond to a size of about 20 mm.

2.3.2. Social interactions with touch screens

As this thesis is concerned with behaviours and patterns that might occur in groups of people while using technology, relevant areas were searched. One such area that has been explored is Computer supported cooperative work or CSCW. The term was coined by Wilson (1991) and is meant to be a generic term for understanding group work using technology. Lanzilotti et al. (2015) explored cooperation using a large touchscreen with children. In their findings, they suggest that collaboration and performance was improved using technology. Some other aspects observed that are interesting for this thesis was how some in the group showed “Anti-social” behaviour and that those usually were persuaded to join the study by other classmates. These findings could suggest that using a visual planning tool could improve cooperation between individuals. Even though this thesis will not have children as participants, the findings might help understand some parts of group dynamics as they unfold. In a similar vein, Westendorf et al. (2017) explored collaboration but with a horizontal screen and with larger groups of 8 – 12 participants. Like the study designed in this thesis, the goal was to create a task that required collaboration to complete. Their results show that participants often started collaborating with others closest to them creating small groups, this would in some occasions hinder group conversations. Now, Westendorf et al.’s approach to their study was mostly based on overall performance and use of the screen. They state that space was a problem at times were participants explicitly pointed out that the test felt cramped, both on the screen and in the environment the test took place in. This suggests to me that the context of a collaborative test does indeed have a significant role in how interactions and behaviours are expressed in any given group. Other important aspects brought up was to examine both group and individual behavioural patterns as people took different roles during the test and behaved accordingly to that role. Another study close to the subject explored in this thesis was conducted by Jakobsen and Hornbæk (2014). They explored collaboration using a multitouch wall display with pairs of participants. The task in their study was to organise documents on the large touch surface and to examine how this space was used. Their conclusion suggests that physical movement around the screen was prominent and important. It improved interaction between participants and to easier communicate to understand each other. These findings motivate further investigation and research. All these studies show parts of how interaction take place and how large touch screens can shape behaviours. They either investigate pairs or larger groups of participants in their studies and performance using the technology. This leaves plenty of room to investigate medium sized groups and to put focus on the interactions and behaviours.
The findings in CSCW has shed light on how collaborations can be affected by large touch screen and how group dynamics can shape the overall results of a task. As this thesis is looking at smaller groups, individual’s attitudes could potentially shift the whole attitude and dynamics of the group. For example, a person might not feel comfortable to take a step forward, take the lead and decide who does what in a visual planning meeting. They might be more inclined to make changes privately on their own time and computer. Peltonen et al. (2008) found in their research that people preferred to be as private as possible while interacting with public displays. They also interestingly found that collaboration using a public display mainly took place when two or more people where in disagreement with each other on how to proceed in the interface. Another view on using touch screens in a public setting discussed by Chen et al. (2014) is that it can be seen as a performance where a person acts differently when they know people are watching. They argued that people tend to be concerned on how other people might perceive them in a setting where they are up front interacting with a public display. Chen et al. (2014) suggested that people have their own spheres around them where they perceive their group members differently. These spheres vary in size and are highly individual. These arguments and findings might not be universal in the sense that they might change depending of the context of the public display interaction. The study performed in this thesis will not be performed in a public space, rather it will be confined to a room with three participants and me, the researcher. In their paper, McCarthy et al. (2008) discussed an approach called “C3C” or context, content and community. They studied a form of social media that was confined to a work place with a large touch screen. Any co-workers near that display would be able to share media from their phones using Bluetooth. Opposed to Peltonen et al. and Chen et al.’s studies which were performed in a public place, McCarthy et al.’s study was performed in a more private setting where people knew each other and had a working relationship. They found that in this type of context the large touch screen could help people bond and connect with one another creating an even friendlier environment.

Building upon these findings, how a group of people can change behaviours and how the context of technology can create contrasting attitudes in individuals, the environment has not been discussed in greater detail yet. Understanding how individuals behave from previous experiments builds a solid foundation for further exploring the area and to contribute with new knowledge and insights. The previous papers did not focus on where the displays were situated, at what height or how it was placed in relation to other objects in close proximity. Harrison & Dourish (1996) put emphasis on the terms “space” and “place”. They discussed that space is the environment in which objects exist, their distance from one another and this distance also determines the affordance of use. A hard to reach object has low affordance while an object that is placed somewhere that is close and easy to reach has high affordance. Place as they discuss it is the architecture where the space is. A place can according to the authors, frame a behaviour. For example, big halls, stadiums or studios can set an individual into a set of behavioural patterns. Using this theory of how objects are placed in relation to each other, and the place they are put in will be important to consider. If the study performed will be in a very small space, the participants might feel discomfort and behave unnaturally. Or if the large touch screen will be placed in an awkward position in relation to the participants it could skew the results.
3. Theory and Methodology

In this section, different theoretical frameworks will be presented and discussed. The theory will be a foundation for what the methodology and analysis will stand on. The theory will not be based on one theory, rather, different frameworks will inspire the research and will be used together.

When it comes to methodologies within the design domain, the term design research is often found. Something that be problematic with design research, or an advantage in some cases, is that there are many different definitions of it. Often, a set of different methods and concepts are used to research design and the aim tends to improve upon a current design (Blessing & Chakrabarti, 2009). This describes quite well how the research question of this paper will be approached. Many different theories and concepts are going to be used to find nuances in data that will yield a conclusion.

3.1. Grounded Theory

The concept of grounded theory was first created by Glaser & Strauss in 1967 (Glaser, 1967). They created the theory while conducting observation studies with the aim of finding out how people acted and managed in specific contexts of work (Bell, 2006). The idea of grounded theory is not to be a formal framework to be used as traditional theories that rely on specific data or field of study. It is more of an approach that encourages continuous analysis, to actively categorise actions, individuals or groups to create your own aggregated data set that can be quantified with codes and that enables comparisons and conclusions in a rich and messy raw data set (Bell, 2006). Often research relies on having the theory well developed and set before doing any data gathering or tests. Grounded theory takes that process and turns it the other way around by first gathering data and then develop the theory section during testing (Corbin, 2017).

This approach to research works well with this thesis as the premise is to observe people, their behaviour and how they interact in a specific setting. Similar to how grounded theory came to be developed. As the aim of this thesis is to observe behaviour within an environment where the participants are free to choose however they want to interact to solve the task, it seems fitting to choose a theory that has basis in forming opinions and theory during testing. As stated previously, the method of this thesis will be inspired, not based on Glaser & Strauss theory. Reason being that grounded theory alone does not fit completely to this research. As discussed by Bell in her book, the theory itself can create results that are strictly confined to the context of the study. It can also create complex results that are hard to interpret and present. As all categories would be defined by the researcher, it can create a data set that not only might be bias but creates a narrow understanding of the study that has been conducted (Bell, 2006).
3.2. **Review based DS-1**

An approach that was used is called “Review based DS-1” (“DS” standing for descriptive study) and is proposed by Blessing and Chakrabarti in their book “DRM, a Design Research Methodology”. This approach consists of an iterative ladder with five distinct steps: Reviewing literature, Determining research focus, Developing research plan for DS-1, Undertaking empirical study and Drawing overall conclusions (Blessing & Chakrabarti, 2009). An illustration of this approach can be seen below, taken from the book.

![Illustration of DS-1 from “Review based DS-1”](image)

This approach lets the researcher revisit previous steps throughout the project to always have current and relevant information.

The approach of DS-1 is used because of its wholesome nature. It encompasses a strategy that can be applied to all parts of a study. The iterative and revisiting way of DS-1 is not only relevant but vital to how this thesis is approached and worked on. Most parts of this thesis have been revisited many times to shape and refine content and approach. The literature relevance might need to be updated during the span of the thesis as the research question, exercises and methods are fine tuned.

### 3.2.1. Real-time observation

A part of DS-1 describes data collection methods that can be used in studies. Similar to how grounded theory is described in its data collection methodology, “real-time data-collection methods” describes how data can be collected in relation to the study performed (Blessing & Chakrabarti, 2009). The experiment conducted in this thesis will have no interference from the researcher and an approach that fits is the observation method outlined in DS-1. The observation method discusses taking notes during the test, recording the event via viable and relevant equipment and keeping track of specific events or other occurrences. By creating categories and codes during observation, concrete data can be extracted that enables an analysis of results to take place. The goal is to find concrete trends and behaviours to be able to answer the research question and suggest results and improvements.

To create codes and categories that is going to define the results, a clear goal must be set. As discussed by Bell (2006) where some methods are described but it is argued that sampling of behaviours during observations is hard if there are too many categories and sample rate is too high. A total of three to six categories is described as manageable and creating good results. The codes must be defined to make it clear what it is categorising. For example, categorising a behaviour as “upset” could mean that a person is angry, confused or is arguing with others. In this study, categories will be defined and coded for, they will mostly encompass behaviours during participant interaction with each other as well as
interactions against the touch screen. The categories will be organised between the three different roles a participant can have in the observation study. Data will not be recorded during the study sessions, rather they will be analysed from the video recorded during the test.

3.3. Embodied interaction

Embodied interaction is a term created and used by Paul Dourish in his research to investigate interactions that occur outside of the screen and technology. Some of his work has been shown in the literature research earlier but it goes more in-depth with his books. The theory of embodiment is between the realm of HCI and philosophy, but the concepts brought up by Dourish (2004) can help as a foundation in understanding human interactions with technology rather than the performance of a particular technological interface. He has several definitions of the term “embodiment” but it can be summarised as actions taking place in the world, in real time, in real space through a physical medium (Dourish, 2004).

Some concepts described through this theory is “The reactive room”, “Space” and “Place”. These are terms that give a solid ground for basing the experiment conducted in this thesis on. “The reactive room” points to a physical or virtual room where collaboration and interaction is performed through audio, video and technology. These actions and interactions manifest through “technology in context”. It is argued how the most important aspects in the reactive room is to focus on what a user does, who the user is and how the user performs a task (Dourish, 2004). Dourish (2004) argues that these aspects of interaction are what we should measure and put focus on rather than focusing on one aspect, the interface, which in the whole is just one small part of a large rich context with many variables.

“Space” and “Place” are concepts that have been described previously but tie into the reactive room very tightly. A Space could be virtual, such as a desktop of a computer or a real one, the space between objects and artefacts in a place. Actions and interactions happen in a space. The place is concerned with what is where in a space. And Dourish (2004) argues that this is the more interesting aspect to look further at. The placement of artefacts in a space that defines the place can drastically alter perception, performance and emotions of an individual acting in it.

The concepts discussed within embodied interactions are interesting because they describe how an experiment can be situated in the best possible way. Technology and experiment content aside, embodied interaction discusses how an environment affects people. If the context is not considered carefully the results might show data and trends that would not be typical in an environment that was carefully chosen to work well and naturally with people.
3.4. **Frame analysis**

Frame analysis was first created by Erving Goffman (1974) and is a theory that explains how to interpret experiences and how they can be organised and structured. The term comes from his example of a picture frame. The frame represents a barrier in which an experience (picture) is represented and expressed. In the same way, a real-life experience can be “framed”. Goffman (1974) further explains the theory by “laminations”. Using the previous example of a picture frame, if there is a picture in that frame and a logo, label or explanation is added to it, a layer of “lamination” is added. This means that the picture has been re-framed and has gotten another dimension to it that changes the experience and interpretation from the initial frame. Goffman’s version of frames and laminations show an interesting way of how experiences and interpretations of the world can be changed or manipulated. Having this in mind when designing an exercise to test a group of participants is interesting because it enables the experiment to add new dimensions, re-framing experiences for participants during a test without the interruption or direct involvement of the researcher. Tasks that are given to some participants and not others can alter their current experience and force them to re-frame their thoughts and to challenge themselves as well as others.

Another use of the term framing can be found in Donald A. Schön’s book “The reflective practitioner”. The term frame is used in the context of how a situation is playing out. Schön (1983) talks about framing in his book the reflective practitioner which amongst many things discusses “Reflection-in-action”. A practitioner must reflect upon their case continuously and must “reframe” it if plays out in a way that is not desirable. If a practitioner designs a test that does not seem to work particularly well for a specific case, even if it is grounded in solid theories, they must be mended and expanded upon to fit their case. This is where the expression “frame” comes in. Any practitioner that wants to investigate a problem frame it in a way that they desire to conduct the research in. Schön (1983) argues that not all practitioners are aware that they are framing a problem, but the ones that do have the ability to reframe their case and study it from another angle that was not considered before. This theory is intertwined with participant observation. As a practitioner, it is important to be observant and understand what participants are doing, why and how.

Schön’s framing theory complements Goffman’s frame analysis in a way that fits the thesis quite nicely. As discussed earlier, Goffman’s theory is considered when presenting participants with information and have them discover new layers to the task at hand that changes their experience and forces them to re-think what they had in mind earlier. Schön’s theory will be adding another layer where the focus instead is on the person, the participant. His theory will be used in designing and improving the exercise so that it fits participants the best, not the practitioner. If a run of the exercise proves to be confusing and non-productive, it must be changed and shaped in a way that fits the participants the best.
4. Observation study

An observation study was designed and performed for this paper. The study was an exercise where three participants were to co-operate with each other to plan for a fictional holiday trip. Each participant got an area of responsibility with descriptions of days that had to be rescheduled. The exercise consisted of a pre-test questioner, an introduction to the task, the task itself, a post-test questioner and a quick focus group interview with the participants. The study will be explained in detail along with methodology that was applied to each part. The methodology was created from the concepts discussed in the theory earlier.

4.1. Pre-test questionnaire and consent form

Before each test, the participants were handed a pre-test questionnaire to gather information that might prove useful for the results and data analysis. Questions ranged from the participants age, gender, occupation and how comfortable they were with technology in general. With that questionnaire the participants also received a consent form with clear and precise descriptions on what kinds of data was gathered during the test, that it was voluntary, and that all data will be handled confidentially. All this to ensure that the experiment was conducted with high ethical standards. The consent form was based on a standardised form by usability.gov with additions to clarify that the test would be filmed, and that audio would be recorded.

4.2. Pilot study

A pilot study was performed to confirm that the test as viable. It was created with pen and paper with real sticky notes and arranged in the same way as it would appear on the touch screen. It was conducted as a real test with the questionnaires, introduction, experiment and interview. It was recorded as it would be in the later runs of the study. The goal of the pilot was not only to see if the test worked, but also to establish categories and codes that could be noted for the data collection.

Figure 3 The basic setup for the pilot study.
After the pilot, each part of the study was tweaked and shaped according to feedback from the participants during the interview and observations made. Having the focus on the participants and their experience was taken from how the participants were framed in the situation according to Schön’s frame analysis, how their interpretation of the tasks differed from mine and how I could improve upon them so that it would fit participants with no prior knowledge of the study. The location and space were also considered carefully. Using the theory behind embodied interaction a location was selected with plenty of room to move around, a table to lean on near the schedule with the sticky notes. The schedule was positioned in such a way that it would minimise the need of reaching long and uncomfortable distances to rearrange the sticky notes. With the pilot test and its results, the real test was finalised and tweaked. The test turned out to take approximately 20 minutes total. The test was then implemented into the digital visual planning tool and was ready for testing.

4.3. Experiment

4.3.1. The set-up

The place in which the experiment took place was not in the same location for each group. The space itself was, however, set in a way so that it would be consistent with the other locations. There was a comfortable amount of space for the participants to move around, a large screen was present and a table that could be used to lean on, stand by or discuss by. This was important as discussed earlier, the space between objects and the space between object and person can affect the usability and performance of people interacting in that environment (Dourish, 2004). The basic setup can be seen in figure 4. It depicts how the space was arranged and an example of how participants could be situated.

Figure 4 Sketch of the space used in the observation study.

Legend:

- Touch screen
- Participant
- Researcher
- Table
- Computer
For some of the tests conducted, a touch screen was not available. The solution instead was to organise a room the same way it would look in the following tests except a television was used with the same dimensions as the touch interface would be. A constant was to make sure that the sticky notes on the screen would be about 20 mm across as per Chen et al. (2013) and Colle & Hiszem (2004) findings on object size performance. As for the interaction, a “Wizard of Oz” technique was used. This technique is based on testing unimplemented or unavailable technology by emulating it in real time with a person or group (User Experience Professionals' Association, 2012). What this means is that the participants interacted with the screen as if it was a touch screen and the observer, me, would observe from the side and interact with the computer to match the participants intended interactions.

For the tests that were conducted with a touch screen, an interactive projector was used. The projector would create a large projection for a classroom. To keep the test as constant as possible, the browser window containing the visual planning tool was scaled to the same size as the television used in previous tests, 50 inches. A blank background was added in the space that was not used by the projector as to not confuse the participants. This setup enabled me as the observer to disconnect even further from the study as I was not interacting with the computer as previously.

### 4.3.2. Participants

Participants were chosen at random and were not required to be from a specific department or age. Most participants, however, were students at Uppsala University as most of the tests were performed at their facilities. Several participants found were from completely different backgrounds and age groups creating a diversity amongst participants.

### 4.3.3. Introduction to the study

Before the exercise, the task with its rules were introduced and explained to the group of participants. The introduction was not scripted but followed some key points. The reason for not scripting the introduction was that elements that could cause confusion found in previous runs of the experiments could be added for the next group to eliminate concerns and doubts during the test. As the test was quite clear and straightforward for the presenter, the same cannot be expected by the participants.

During the introduction each participant was given a piece of paper containing information on what their specific role was during the test. They were given the time they needed to go through their tasks and to raise any concerns they might have. A general walkthrough of how the touch screen worked as well as the visual planning tool worked was given. When the participants showed that they understood the study and their tasks they were instructed to start whenever they felt ready and communicate when they felt that they were finished with the study.

### 4.3.4. The exercise

The exercise was designed with some key factors in mind. It should promote collaboration with the other participants without having a pre-determined leader, it should be a challenge that would encourage discussions and that it should be fun. These factors were important because it would lower the chance of biased results, it would throw the participants a bit out of their comfort zone to promote natural reactions and to lower possibility of the task becoming a chore. These choices reflect Goffman’s (1974) theory discussed earlier. The additions of layers that laminate the participants view of the task again and again, forcing them to see new approaches and express new understandings of the current situation. What makes this even more interesting is how the current frame is changing differently for each participant as they not only have different information for their specific role that
constantly changes, they see how their co-participants change their understanding of the situation simultaneously. This seemingly chaotic stream of information is also planned through Glaser’s (1967) grounded theory. The hope is that the laminations on each participant current frame promotes natural behaviours, that the participants “forget” that they are in a study but instead act as if their task is real and happening live. This would enable me to find real and genuine interactions to observe and analyse.

The experiment was an exercise of planning a holiday trip with the other participants. The exercise was split into two parts with two phases each. A preliminary plan was first presented which was set up beforehand with a set of tasks. The plan consisted of one week of planning the trip and one week of holiday. The first week was called the planning week and was the first part of the exercise, followed by the holiday week that was the second part of the test. There was a maximum of one task per day and person. The first phase of each part was set to be an overview of the coming week. Imagining that they were at the day or weekend before the set week and making sure that the planed week ahead would work for each participant. The task was to go through each day and confirming with each other that they could perform the tasks. On the description of each role, the participants got a list of problematic days. That is, they would inform their group on the particular day that they had to reschedule and thusly would move their sticker to another day or person. When the whole week was examined by the group phase two was set to start. Phase two was set to be living through the week one day at a time, “live” so to speak. When there were no problems, the tasks would be marked completed and the group would move on to the next day. Just as in phase one, they might have to reschedule tasks during the week depending on new problematic scenarios that might occur. The schedule including both the planning week and the holiday week is shown below in a screen shot from the study.

![Figure 5 The initial screen of the study.](image)

The participants themselves had to agree on when a phase in a part of the test was starting and ending and when the exercise was done. Me (the practitioner) only introduced the task. It was set that the practitioner would not interfere or comment during the exercise to reduce as much bias as possible for the results. In the instances when a touch screen was not available, the practitioner (me) would only interact with the user interface according to how the participants wanted to manipulate objects on the screen.
4.3.5. Data gathering method

As previously stated, each session of the study was filmed with a camera. The reasoning is to be able to carefully observe the sessions with the ability to stop time and rewind. If all data was to be collected on the spot, a lot could be missed simply by concentrating at taking notes while the study was done. Besides the questionnaires filled in before the test, the video footage was to be analysed according to two angles. First one being coding of behaviours and the second one being their position in the space. Both were categorised according to the role the participant had. All data was then aggregated into one set of data each and is presented in the results.

For the coding of behaviours, the following table was used to collect data:

<table>
<thead>
<tr>
<th>Role of participant</th>
<th>Categories</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discussing</td>
<td>Passive</td>
</tr>
<tr>
<td>Accommodation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 1: Table used to code behaviours.*

The categories of codes chosen were determined by the most common behaviours observed during the study sessions as well as from the videos afterwards. The table and procedure are inspired by the methods described by Bell (2006). They represent the most common behaviours found and the ones that seem the most important in this context. “Discussing” means when the participants are discussing with each other, either helping one another or talking about how they should solve a particular task for example. “Passive” is used when a participant is seemingly not contributing or interacting with another participant. “Moving” is used when a person is moving around, either walking up to another participant, the screen or walking back to the table. “Confused” means when a participant or several show, either by body language or by talking, that they are unsure of what to do at the moment. The term also encompasses if the participant is agitated or annoyed. “Leading” is used when a participant shows signs of taking control of the situation, either by directing the others, showing that they are in control of the visual planning interface or simply being in charge at the moment. “Screen interaction” is a code used when a participant is actively interacting with the screen. The codes will be noted as a “1” each time they can be applied to a participant. If a participant for example is clearly passive for a prolonged period of time, a resolution of one notation per 15 seconds is used.

The second angle or data collection is a participant’s position over time. Just like discussed earlier, a resolution of one sample per 15 seconds will be used. The data will be put together and displayed on the diagram showed in section 5.3.1. It will be a heat-map of sorts where each participant will be represented as their respective role. This diagram will show how a person moves in this scenario and from this data conclusions can be drawn that might help further solidify findings and suggestions for improvements in the future.
4.3.6. Post-test focus group and questionnaire

When the participants decided that the test was done, and they were satisfied with their planning, the video recording was stopped, and the participants filled in a system usability scale (SUS) questionnaire that is based on a standardised set of questions with an analysis method for determining the usability of a user interface (Sauro, 2011). This questionnaire is not tied to the method of the test itself, it is used as another perspective that can strengthen the results and analysis. In this case it was done towards the visual planning tool. The questionnaire is composed of 10 predetermined questions where each question can be answered on a scale from 1 – 5. The questions in the form are as follows:

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

The answers are then analysed and converted according to a specific set of instructions that make up the SUS methodology that has been created from analysing hundreds of papers and has become a standard for testing the usability of a system (Sauro, 2011). The method of scoring SUS is to first interpret the scale on the questions as 0 – 4 instead of 1 – 5. For each odd numbered question one point is subtracted from what the participant’s answer. For each even-numbered question five is subtracted from the participants answer. The new score calculated from these rules are then multiplied by 2.5. By doing so, the total score is now between 0 – 100 and not 0 – 40. And according to Sauro (2011) a score of over 68 in the results indicates an overall positive usability score. This method was chosen to be used because it might prove to be a data set that solidifies other findings. The rest of the results are not concerned with the technology used, rather behaviours and interaction patterns. This method will give an insight to the technology itself, how it is perceived and if that could be a factor for behaviours displayed during a study session.

When the participants filled in the form, an audio recording was started, and some post-test questions were asked where the group was encouraged to discuss shortly how they felt about the exercise, how they experienced their co-operation as a team and how they felt towards this technologically enhanced way of creating and manipulating a plan. The questions were designed to promote discussion and to find attitudes towards the test, the environment and the visual planning tool (Nielsen, 2010). It was conducted immediately after the test so that the participants would still be in the moment and have all their thoughts and experiences fresh in mind. When the discussion was concluded the participants were thanked and were given a cup of coffee.
5. Results

The study resulted in 7 separate sessions with a total of 21 participants. One of the seven sessions was the pilot run. The average test lasted 19 minutes with 3 participants in each test. Except the pilot study, two sessions were conducted without a touch screen and four with a touch screen.

5.1. Pre-study questionnaire results

The results in this section are compiled from the pre-study questionnaire handed to the participants before the test started. They have been compiled to figures representing the data provided by the participants. These figures can be found in the appendix, chapter 10.6.

The age of the participants was dominant in the segments 18-25 and 26-35 which results in 16 of 21, or about 76%. The remaining participants were in the groups with an older age. The largest field of work between the participants was Informatics & media with 43% of the participants. The three following biggest fields where IT, Linguistics and Engineering with 14% each. Most participants felt comfortable with technology with 76% feeling very comfortable using and understanding every day technology. A smaller number of participants did not feel very comfortable but rather comfortable enough. This group was about 20% of the participants. No participant felt totally uncomfortable around technology.

5.2. System usability scale

The score of the system usability scale was calculated according to standardised instructions for this method (Sauro, 2011). The score is calculated for each participant of the study sessions conducted. The final score is measured between 0 – 100, where a score of 68 or higher is considered to point to a system with good usability (Sauro, 2011). In this study 19 out of 21, or about 90% of participants rated the visual planning tool as a system with good usability. The results can be seen below in figure 6.

![Figure 6: Results of the system usability scale questionnaire.](image-url)
5.3. **Real-time observation**

Behaviours were noted while observing the video footage of the 7 study sessions performed. They were categorised under the following terms: discussing, passive, confused, leading and screen interaction. When a behaviour was recognised it was added as a 1 to the specific cell in the table for the appropriate role the participant had. If a participant’s state did not change within 15 seconds, another 1 was added to the previous code. For example, if a participant stands still for 30 seconds not doing much, 2 was added to “passive” in the respective cell. Other patterns or observations that ties to the respective codes will be discussed in the analysis. These include attitudes, body language and comments made by the participants. The position of each participant was noted and interpreted into a top-down heatmap presented later.

5.4. **Behaviour observations**

All the data gathered from the observations in the form of codes will be presented below. The data will be divided into results from all observations and into individual participant results.

5.4.1. **Results from all observations**

All results from each study session was added together from each study session. The data is represented in table 2.

<table>
<thead>
<tr>
<th>Role of participant</th>
<th>Discussing</th>
<th>Passive</th>
<th>Moving</th>
<th>Confused</th>
<th>Leading</th>
<th>Screen interaction</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accommodation</td>
<td>92</td>
<td>66</td>
<td>79</td>
<td>34</td>
<td>75</td>
<td>91</td>
<td>437</td>
</tr>
<tr>
<td>Transportation</td>
<td>90</td>
<td>59</td>
<td>68</td>
<td>36</td>
<td>61</td>
<td>91</td>
<td>405</td>
</tr>
<tr>
<td>Activities</td>
<td>99</td>
<td>75</td>
<td>47</td>
<td>44</td>
<td>38</td>
<td>53</td>
<td>356</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>281</strong></td>
<td><strong>200</strong></td>
<td><strong>194</strong></td>
<td><strong>114</strong></td>
<td><strong>174</strong></td>
<td><strong>235</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Table 2: Behaviour coding result.*

The most coded for category is “discussing” and second most is “screen interaction”. The categories “passive” and “moving” had almost equal amounts of occurrences with an amount not much greater than “leading”. The least coded for behaviour was “Confused”. All data is presented in figure 7.
In five of the study sessions there was one participant that lead the task most of the time. This person also usually had most interaction with the screen. In the two other study sessions the leadership was mostly split evenly between the participants. In these two sessions the screen interaction was also evenly spread across those participants. The role did not seem to influence who became the leader.

Number of recorded behaviours differed between what role a participant had. Participants with the role “transportation” showed most coded for behaviours followed by “accommodation” and “Activities”. In the order described, the number of behaviours decrease with about 50 occurrences per role. The data is shown in figure 8.

Figure 7: Diagram of codes recorded per category.

Figure 8: Table of recorded behaviours per role.
5.4.2. Individual participant results

As mentioned earlier, in five of the study sessions there was one person showing significantly more leading tendencies than the other two participants in their respective study session. Examples of how the coding looked in two of those sessions can be seen in table 3 and 4. These tables represent all codes for two separate study sessions.

<table>
<thead>
<tr>
<th>Role of participant</th>
<th>Categories</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discussing</td>
<td>Passive</td>
<td>Moving</td>
<td>Confused</td>
<td>Leading</td>
<td>Screen interaction</td>
<td></td>
</tr>
<tr>
<td>Accommodation</td>
<td>11</td>
<td>5</td>
<td>4</td>
<td>8</td>
<td>14</td>
<td>26</td>
<td>68</td>
</tr>
<tr>
<td>Transportation</td>
<td>12</td>
<td>12</td>
<td>9</td>
<td>4</td>
<td>7</td>
<td>11</td>
<td>55</td>
</tr>
<tr>
<td>Activities</td>
<td>12</td>
<td>14</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>31</td>
<td>18</td>
<td>14</td>
<td>25</td>
<td>22</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 3: Coding results for one study session.

<table>
<thead>
<tr>
<th>Role of participant</th>
<th>Categories</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Discussing</td>
<td>Passive</td>
<td>Moving</td>
<td>Confused</td>
<td>Leading</td>
<td>Screen interaction</td>
<td></td>
</tr>
<tr>
<td>Accommodation</td>
<td>20</td>
<td>15</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>44</td>
</tr>
<tr>
<td>Transportation</td>
<td>15</td>
<td>6</td>
<td>11</td>
<td>3</td>
<td>19</td>
<td>19</td>
<td>73</td>
</tr>
<tr>
<td>Activities</td>
<td>19</td>
<td>16</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td>47</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>37</td>
<td>14</td>
<td>10</td>
<td>27</td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Coding results for one study session.

The rows that are coloured yellow in Table 3 and 4 show examples of participants that stood out as leaders. They showed the most occurrences of leading the group as well as interactions with the screen. Participants that show this kind of leading behaviour usually also move around the most and show the least amount of confusion amongst the group. The blue coloured rows show two examples of behaviours of passive participants. These participants usually engaged a lot in shorter discussions but did not move around or interact with the other participants or the screen that much. The amount of behaviours coded for during each test show that participants that are mostly passive have about half the amount of behaviours expressed compared to leaders.

5.4.3. Outliers

There were three participants in separate sessions in total from the 21 that did not show any sign of leadership at all during their session. They usually discussed a bit, showed little to no confusion but did not take any initiative to take over any task.
5.5. **Interviews and comments**

During the study sessions some interesting comments were made. For participants that mostly took the role of leader, many commands were given while the rest usually engaged in discussions. For example, “Maybe you can fix this then?”, “Move that one over there” and “Who is in charge of” following a task or role. These kinds of quotes came up a lot from these participants. The leaders also tended to explain the next step and task for the other participants if any doubt or confusion arose. And of course, a favourite comment made was “That was fun, I enjoyed that!” after one of the sessions.

From the post-test interviews, a bigger insight to how the participants perceived the task was noted. Most participants enjoyed the experiment and understood it well. The visual planning was welcomed and described as “easy to follow everyone’s tasks” and “The colours helped me understand what tasks were mine”. Some other comments about the tool where “I would like it to be a timeline top to bottom like a regular schedule” and “The contrast between the cells was bad”. When asked about their collaboration most agreed that they had a positive experience. Some quotes about how the visual planning tool affected collaboration: “I feel like everyone seeing the same page helped in solving the tasks together” and “If this was a list instead it would be way harder than just seeing these stickers”.

Overall, the participants in this study were quite positive about using the visual planning tool and how they collaborated with each other to solve the problems at hand. Most comments about improvements or difficulties were about how they saw the tool as a traditional schedule with early activities at the top and late ones at the bottom. Therefore, they were confused about placing the stickers and showed signs of confusion.
5.6. Position heat-maps

The position of each participant in the room of the study was recorded whenever they took a few steps. Slight adjustment of current stance or leaning was not recorded. If a participant was standing still for a longer period of time, the position was not recorded again. The participants were colour coded according to their respective role and their position was mapped using Adobe Photoshop on top of a diagram of the room. Coloured circles were used to make a marking of their position with an opacity of 25 %. Overlapping positions will therefore show double the intensity, making the position gradually opaquer. Figure 9 show an example of a heat map created for one of the study sessions. In this session, the participants with the roles accommodation and transport moved around the most, they also interacted with the touch screen the most. The participant responsible for activities was the most passive, mostly standing beside the screen observing. The rest of the heat maps created for each of the study sessions can be found in the appendix.

Figure 9: Heat map from one study session.
The movement of the participants was compiled from all participants separated by their respective role in the study. The paths of the participants movements were traced and layered with the same method as the previous heat map explained. In figure 10 the paths taken by the participants who had the role activities can be seen. These participants showed the least amount of movement and usually situated themselves around the rest of the participants on the sides of the screen or standing by the table.

Figure 10: Movement of participants with the role “Activities”.
In figure 11 the movement heat map of the participants with the role transport can be seen. This heat map shows the most amount of movement. These participants resided mostly in front of the screen but showed a lot of movement around the table and the screen area overall.

*Figure 11: Movement of participants with the role “Transport”.*
The last heat map, the one showing the movements of participants with the role accommodation, seen in figure 12, was in second place when it comes to overall movement. These participants were mostly either standing by the table or standing directly in front of the screen.

Figure 12: Movement of participants with the role “Accommodation”.
6. Analysis

In this chapter the results will be interpreted and analysed according to the methodology described in the theory (chapter 3) and used in chapter 4. The research question will be answered according to the findings. Some overall observations from the results are that there was no significant difference between the groups using the touch screen projector, from the groups using a regular television with the wizard of oz approach.

Using an observation method inspired by grounded theory did result in a rich data set. Overall, most groups showed a passive start that usually picked up the tempo when someone in the group took initiative to lead. The roles that each participant had did not seem to have a significant influence on what types of behaviours they expressed. When a participant started moving it was usually with the intention of either pointing at activities on the screen or directly moving activities. In these cases, the other two participants were standing beside the screen observing and adding to the discussion of how something was to be moved. In the cases of arguments breaking out, all participants usually engaged together besides the screen and sometimes interacted with the screen simultaneously while discussing or arguing. Much like in the findings by Peltonen et al. (2008)’s study. The most engaging situations between the participants was when they were discussing solutions that differed from one another. In some cases, this would break out between two participants. The remaining participant then usually stood by, passively while the two came to an agreement (no groups were showing aggressive behaviour, more discussing disagreements respectfully). Most tests ended with the participants standing in close proximity of each other in front of the screen.

Most noticeable differences were found on an individual level which is also why this division was made in the results chapter. The most leading participants usually were the most talkative and showed a personality that would indicate that they were not shy to take over. This person was not necessarily the person that was the dominant leader throughout the whole study, but they were often the most active participants. No role was designed to be a dominant one, rather natural behaviours where wanted when creating this research. The most coded for behaviour was discussions which usually were quite short but frequent. It was during these discussions when some would express confusion or take over the lead. The outliers described in the results section were kept in the data and are accounted for in the total. They were not removed or separated because these participants showed some unique behaviours that were interesting. Their behaviours seemed mostly fuelled by personality. They did not feel like they needed to intervene in the tasks or be the one person who leads. Though their data stands out to the rest, while observing they stood out as much as leaders did at times. They provide a nice contrast that further solidifies how personalities can alter how each individual in a small group can affect the whole dynamics of the group. An interesting take is that unlike the results in the study by Lanzilotti et al. (2015) where the children usually persuaded their passive peers to be more engaged, this did not happen in the study conducted in this thesis. What could happen though is that short lived groups could be formed between two participants during an argument much like in the study by Westendorf et al. (2017). This might explain why these outliers exist in the first place.
Looking closer at the behaviours expressed during the study sessions, most discussions and leading behaviours were expressed by also using their whole body to express themselves besides talking. Both body and spoken language played a big role in how participants explained themselves or described something to the rest of the participants. Most discussions and leadership changes took place when another participant expressed a problem that they had from their role description. The previous leader would show signs of confusion before reframing their context to fit the new reality of the task. The theories from frame analysis did show to have a prominent role and was further reinforced by the freedom of movement in the room. When the perspective changed, a participant could for example walk to the screen and point at the new reality, initiating a lamination of the other participants framing of the task.

As expressed by the participants and by the observation, the consideration of place and space as discussed by Dourish (2004) showed its significance. No participant showed signs of having trouble using the technology or situating themselves in the room. As the screen was positioned at a comfortable height and size. The only difficulties observed with the interface and stickers where in rare instances that the projector did not register touch or ignored input. Adding the table showed additional comfort for some as they could resort back to the table, lean on it and look at their tasks on the printed paper. Many discussions where preferred by the table while being situated so that they could refer to the screen when discussing a sticker.

For answering the research question:

“How is interaction between individuals affected by using large touch screens with a digital visual planning tool in a meeting?”

A lot of how the touch screen affected the interaction has been discussed earlier. There is no singular right answer, rather there are many. From the findings it would be suggested that the large touch screen invoked discussion, promoted movement that would enable individuals to express themselves not only by words but to point at the precise thing that they wanted to communicate. They could use their whole body to communicate to the other participants of their intentions. For example, while discussing how stickers should be moved, many participants would simply move to the screen, point at a sticker and show where they would like to put it. This would either help the other participants understand what a working solution would be or promote discussion on alternative solutions.
7. Discussion

The results did prove to provide a rich data set without a definitive answer as predicted. There were many strengths of using a mixed method approach, in this case grounded theory with frame analysis, real-time observation and embodied interaction. The main one being that no pre-determined interactions were expected. Hypothesis could be formulated beforehand and discussed here but seeing as the purpose essentially was to conduct studies and find the hypothesis and results during the tests and during analysis afterwards, those could prove to be redundant. Instead what was found were trends that can be linked to events during the study. The leadership aspect for example, was usually found in those who first saw a way to tackle the problem and were not shy to show it. The way that the leading turned out might also be a consequence of participants wanting to complete the study in the best way possible and be done. Not necessarily a weakness in the results, in a similar setting where a group is planning something one would like to finish the task as soon as possible. What might weaken the results in this aspect though is that something that the participants were not informed about or did not know is that I did not care how they solved the study or if they did it in a certain amount of time. They might have acted in a way that made them feel obliged to solve the tasks in the “correct” way and as quickly as possible to help my results. This is an aspect I cannot know for a fact, but it could be a factor. Another factor that could affect the results in this thesis is the relationship between each participant. How well they knew each other before the test. As McCarthy et al. (2008) pointed out, the work environment where they did the research was one were everyone knew each other from before. This was not considered in this thesis to any greater extent and could be a source of weaker results. Though many of the groups were made up of groups of friends, I am not sure all were. Another potential weakness is that a more clear and precise set of results could have been achieved if the RQ was approached from another point of view, one that was not as open ended.

When it comes to the touch screen itself, the study proved it to be effective and liked by the participants. This was confirmed both from the interviews and from the SUS score. Except a handful of brief technical issues with interaction, participants had no problem interacting with the touch screen or the visual planning tool. Taking the size of the screen and objects into account as described in the background section, each direct interaction was decisive and swift. Usually the participants would situate themselves in a way as to not block the view to other participants while interacting. Essentially standing sideways while using their hands to interact. Even with this unergonomic stance, there were no issues. Worth noting is that when someone showed that they were highly concentrated in the task, they would briefly stand directly in front of the screen until they were done, blocking the view for the others simultaneously.

The heatmaps created enabled an aggregated view of movement by the participants. They show clear data and are easy to follow. Their implication might not be clear. They do not show intention or direction. What they do show though, is how important it was to consider the space around the task. Using the theory of embodied interaction showed that the participants really took advantage of their space by moving themselves, situating themselves as comfortably as they wanted and were enabled to express themselves with their whole body. The results do not however explain why participants of different roles moved so differently. It might be argued that the number of tasks given to each role was slightly different and therefore participants with fewer tasks did not have to move around or take part as much. On the other hand, participants that did not have as many tasks could also be enabled to take charge, leading the rest of the participants to finish the task.
8. Conclusions

In conclusion, this thesis showed how important space can be in an interactive setting and how people would behave in a situation where they are planning a project. Using a large touch screen as a starting point was both interesting and gave a lot of insights. Mainly, it improved communication between people in a group and promoted natural discussion and leadership throughout the task. The theory and methodology used might be a bit unconventional but ultimately proved to be effective in showing natural behaviours in group interaction. The results were not precise in the sense that they did not give one type of answer. For future research, the approach could be modified to give different sets of results. The results could be studied further by creating variations of the test, using different roles and measuring data in multiple ways. Different ways of furnishing the room could be investigated. This would enable results that could be interpreted by finding correlations and causations. The observation study could also be modified in a way so that different groups could be compared to each other to further investigate the leadership phenomenon as well as movement patterns.
9. References


Bowden, Zac (2017), Retrieved from https://www.windowscentral.com/microsoft-surface-pixelsense-table


10. Appendix
10.1. **Study description and tasks**

**TIME TO PLAN THE TRIP!**

**GENERAL INFORMATION**

This exercise is about three people that plan their holiday trip. They first spend one week planning the trip then spend the next week going on that trip. Each person has their specific area of responsibility. The exercise is divided into two parts with two phases each. The first phase consists of looking through the planned week before it starts, and the second phase is starting the week where each day is executed in order, or “live”. This is true for both parts.

Part 1 involves you to together agree on the activities for each person during the planning week. You will have to adjust the schedule so that it aligns with every participant one day at a time.

Part 2 involves you to adjust the trip week after the planning is done according to any changes that might occur.

The three different areas of responsibility are transportation, accommodation and activities. Each participant will get their own instructions that accounts for their tasks and any deviations that might occur during your planning. During this part the activities are colour coded for the type of task.

**RULES**

- Maximum of one task per day.
- Part 1 can only be planed Monday through Friday. Part 2 can be planed Monday through Sunday.
- Each task and activity affect each participant. If one participant has to cancel one day during the trip, the rest must too.
- No activities planned can be removed.
- During Part 1 the activities can be moved around freely to any participant.
- During the second phase of each part tasks and activities can only be moved within the same day or forward.
- A task that occurs in the morning can be planned the same day as another task that is in the afternoon. And vice versa.
PART 1 – THE PLANNING WEEK

PHASE 1

Time to plan the trip! On the screen you will see the preliminary plan for both weeks. Go through the first week and check if any tasks need to be moved around. Do so one day at a time. If you can’t find a solution look at the next day, maybe there is a spot open? When you are done, make sure that each task is set to a slot where each person is free.

PHASE 2

Now the planning week begins! Start from Monday and go one day at a time making sure to complete each task for each person before going to the next. Make sure that there are no clashes in the schedule! When you feel that a day is finished, move on to the next day.
PART 2 – TIME FOR THE HOLIDAY

PHASE 1

Now, before going on the trip, your task is to make sure that all bookings and tasks are good to go. If there are any sudden changes, make sure to plan around those to make the trip schedule work and so that it becomes the dream trip you guys wanted!

PHASE 2

Now you are at the flight and the holiday is on! Make sure to mark tasks complete when they are completed. Watch out for anything that might force you to reschedule events each day. When you have a plan that works for the day move on to the next day.
RESPONSIBILITY: TRANSPORTATION – BLUE STICKERS

You are responsible for the transportation tasks during the trip. Remember that you can move all types of transportation activities to any other day without any problems. You booked through very generous companies! Below you will find any problematic days that you have during each part of this exercise. If a day is not written, assume it is problem-free.

PART 1

PHASE 1

Monday – You have an appointment at the barber shop! You can’t do any tasks this day.

Thursday – You can’t help today. You have planned to meet a friend this day.

PHASE 2

Thursday – Your friend cancelled which means you are free.

Friday – Laundry day. You have no time today.

PART 2

PHASE 1

Thursday – You accidentally booked the boat ride for Wednesday.

PHASE 2

Tuesday – You got the message that the flight home has been postponed one day to Sunday.

Wednesday – Stormy seas! The boat trip has to be moved one day forward. All activities related with the island trip has to be moved accordingly.
RESPONSIBILITY: ACCOMODATION – GREEN STICKERS

You are responsible for the accommodation tasks during the trip. Remember that you can move all types of accommodation activities to any other day without any problems. You booked through very generous companies! Below you will find any problematic days that you have during each part of this exercise. If a day is not written, assume it is problem-free.

PART 1

PHASE 1

Friday – You can’t help this day, you have to go to work.

PHASE 2

Tuesday – “I have to dust the carpet today”. Your task has to be moved, you obviously don’t have time today.

Friday – You took a day off from work so that you can help plan instead.

PART 2

PHASE 1

Thursday – The hotel called, they have to sanitize the rooms on the Thursday, but Wednesday is fine!

PHASE 2

Tuesday – “Shouldn’t have eaten that kebab..” You got food poisoning, the day must be cancelled.
Responsability: Activities – Red Stickers

You are responsible for the activity tasks during the trip. Remember that you can move all types of activities to any other day without any problems. You booked through very generous companies! Below you will find any problematic days that you have during each part of this exercise. If a day is not written, assume it is problem-free.

**PART 1**

**PHASE 1**

Tuesday – You must be at the office.

Wednesday – You have booked a spa, you can’t plan any activities this day.

**PHASE 2**

Tuesday – You are at work but cancelled the spa day on Wednesday so that you can take a task then.

Wednesday – free

Thursday – “Going out with the boys” You can’t help today!

**PART 2**

**PHASE 1**

Tuesday – The city tour has been cancelled by the organizer. The activity has to be moved to another day.

**PHASE 2**
10.2. **Interview questions**

**INTERVIEW QUESTIONS**

- How did you experience this exercise?
- What are your opinions on the visual planning tool during your cooperation with each other?
- What worked well?
- What did not work well?
- Do you see any strengths with using this visual planning tool?
- What weaknesses do you perceive with this tool?
- Did the visual planning tool help in your cooperation with one another?
10.3. **Consent form**

Participant: ______

The study will be recorded through video and audio, you can choose to quit at any time. All information about you and all recordings will be treated confidentially and will not be distributed outside of this thesis. Quotes from the recorded audio in the study might appear in the final thesis but will not be tied to any personal information.

I agree to participate in the study conducted by Martin Rutkowski at the department of Informatics & Media at Uppsala University.

I understand that participation in this study is voluntary and I agree to immediately raise any concerns or areas of discomfort during the session with the study administrator.

Please sign below to indicate that you have read, and you understand the information on this form and that any questions you might have about the session have been answered.

*Date: ________*

*Please print your name:___________________________________________________*

*Please sign your name:__________________________________________________*

Thank you!

I appreciate your participation.
10.4. *Pre-study questionnaire*

**Pre-study questioner**

Participant number: _____

1. How old are you?
   - younger than 18
   - 18 – 25
   - 26 – 35
   - 36 – 45
   - 46 – 55
   - older than 55

2. What is your gender?
   - Male
   - Female
   - Other

3. What is your field of study or work?
   - Informatics & media
   - Economics
   - Law
   - IT
   - Medicine or Pharmaceutics
   - Languages
   - Social Sciences or Humanities
   - Science
   - Engineering
   - Other, please state: __________________

4. How comfortable are you with computers and technology overall?
   - Very comfortable. I like to try new gadgets and tools whenever I can and enjoy working with computers and phones.
   - Comfortable. I get around, it is not my favorite thing, but I understand how computers and phones work.
   - A bit comfortable. I don’t like using computers or other technology. I can get tasks done with them, but I don’t understand everything.
   - Not comfortable. I do not like computers or similar at all. If I use them I probably need some help to perform basic tasks.
### System Usability Scale (SUS)

System Usability Scale

Participant number: ____

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10.6. Figures based data from the pre-study questionnaires

Figure 13: Participant age

Figure 14: Field of work between participants
Figure 15: Participants comfort with technology
10.7. *Heat maps from individual study sessions*

*Figure 16: heat map from one of the study sessions.*
Figure 17: heat map from one of the study sessions.
Figure 18: Heat map from one of the study sessions.
Figure 19: heat map from one of the study sessions.
Figure 20: heat map from one of the study sessions.
Figure 21: Heat map from one of the study sessions.
Figure 22: heat map from all study sessions combined.