Improving the Creative Processes in Remote Collaboration via Video Communication
Identifying Problems and Designing a Solution

IT 15048

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July 1, 2015
Abstract

When using video communication to collaborate with different parties in a creative process, several issues often arise that are due to the different locations of the participants. Limited research has been done on the use of video communication in a work environment. To research this area more closely, I have conducted an exploratory research using a case study approach. Issues were identified through observation and contextual interviews and then the identified issues were validated via a questionnaire. Based on these results I designed a solution to improve communication over distance. A whiteboard application provides the ability to working together to visualize ideas beyond the usual focus on written notes. Thoughts of different users can be better explained and combined through the possibility of drawing. This application was designed through conducting iterative tests to verify the build statements around the application.
Acknowledgments

This thesis would not exist without the useful help and insights from my supervisor Brendon Clark and reviewer Mats Lind. I would also like to thank all my colleagues (Sara, Jane and Helena) within the Interactive Institute that provided me with help, feedback and suggestions when needed. Without company X, who agreed to be observed during the case study, there would not have been realistic data. Besides them, there are also my old, and new friends, who helped motivate me and assisted with proofreading.
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Chapter 1

Introduction

With today’s fast developing technologies people have easier access to the internet, and people are getting more familiar with different devices. Communication is going faster and faster, collaborations are done all over the world, communicating with other people is not limited to a location. Technologies such as phones and video calls via the internet can be a good replacement for traveling since it is a cheaper, less time consuming and more environmentally friendly way of communicating [O’Connor et al., 2008]. Video communication is not limited to private conversations, today it is common that students can attend their lectures via video [Horton and Campbell, 2014], doctors have online consultations with patients [Glauser, 2011], and companies can conduct their business while being in geographically different places.

The Interactive Institute is one of many companies that use video communication to plan projects together with colleagues and companies in different parts of the world. They have discussions, workshops and brainstorm sessions using video communication to plan creative meetings. Having a remote meeting with colleagues is all about sharing information, knowledge and visions rather than casual communication. Being creative means creating new, innovating ideas and thoughts. This is mostly done by communicating with each other, combined with drawing and other techniques. Everyone has their own way to be creative. Although communication via video works, employees think that it has not yet reached its full potential. Therefore they are interested in ways to improve collaboration over distance, using video communication.

There are different technologies that make it possible to have a remote meeting using video. Some well-known examples are Skype and Google Hangout, but services like WebEx, join.me and Go2Meeting also support video communication. In this thesis I will research what the issues are when having a work related meeting via video. These issues will be found by observations, contextual interviews and questionnaires. Based on these
observed issues, I will design a solution and test this via an iterative process.

1.1 Background

1.1.1 The Company

The Interactive Institute Swedish ICT describes themselves as being “an experimental IT & design research institute that conducts world-class applied research and innovation.” [InteractiveInstitute,].

One year ago, two employees of the Interactive Institute had regular meetings with a company based in the USA, which we will call company X for confidentiality reasons. Company X agreed to participate in the study, as long as there was full confidentiality of the company’s name and business area. Company X is the lead client and has hired the Interactive Institute to assist in planning and creating a workshop to be held based in the USA. The purpose of this event was to develop different ideas, therefore company X and the Interactive Institute were planning and rehearsing different activities remotely in preparation for the workshop agenda. Based on the experience of organizing the event last year, they know that it is hard to conduct creative process planning via video.

1.1.2 Communication

Communicating with other people can be done in various ways. Johansen made a time/space Groupware Matrix for Computer Supported Cooperative Work (CSCW), shown in figure 1.1 where he discusses different combinations of times (same vs. different) and locations (same vs. different) of communication between people [Johansen, 1988]. In this table we can see that synchronous communication at different places can be achieved by the use of video conferencing or shared desktop views. Components like group size, individual or group sites and predictability of time and space component can influence the work [Johansen, 1988].

In real-life meetings there are multi modality interactions, meaning that people get input from each other via several ways (touch, hearing, vision). When using voice and video for remote meetings, two modalities are fulfilled (vision and sound), though vision might not be fully fulfilled due to poor cameras, camera positioning or bad network connections. Other modalities that we are used to in meeting when in reality (like tangibility or perception of body posture) are ignored while meeting over distance.

1.1.3 Working over Distance

Olson and Olson claim that it is complicated to successfully collaborate over distance [Olson and Olson, 2000], but O’Leary and Cummings respond to
that and point out, if the nature of the work is adapted, dispersed teams are possible. This means that one needs to change the way of working to achieve distance collaboration [O’Leary and Cummings, 2004]. Fussell et al. note that projects over distance are less successful, due to the phenomenon ‘out of sight, out of mind’ [Fussell et al., 2004] but this can be solved with the current technology of instant messaging within work groups [Majchrzak et al., 2004].

Before the usage of videos became common for meetings, companies communicated via e-mails and phones. Hyder et al. researched in 2010 that having a meeting via phone is hard, since one can experience issues identifying the current talker. This is because it is not possible to apply the so-called ‘cocktail-party effect’, where you can direct your attention to one speaker while you have multiple sound inputs [Hyder et al., 2010]. This effect would be improved if telephones used stereo headphones and spatial audio rendering, through which you would be able to focus on one person since every sound comes from a different direction. When using video in a remote meeting, Hyder’s problem occurs less since it is possible to see who is speaking.

1.2 Structure

In the next Chapter I discuss the purpose and goals and set out the research questions. In the following part, Chapter 3, I review theories that are needed for an understanding about how the research questions in focus in this thesis
relate to other research.

General methods are discussed in Chapter 4, with a more detailed discussion of specific methods in Chapter 5 and 6 separately. This is done because most methods are influenced by the previous results.

After identifying issues related to video communication in a work related atmosphere, I design a solution. As found in the literature, multiple solutions have already been developed and tested, though they mostly lack accessibility. In Chapter 6 you can also find the results and analysis of each step in the process.

In Chapter 7 the conclusions will be discussed together with the limitations and options for future research.
Chapter 2

Purpose and Research Questions

2.1 Purpose

The described background presented a variety of different observations. The conclusions from these observations were very diverse and sometimes even contradictory. Some concluded that collaboration over distance works and some concluded that it does not. It is possible that the different settings may have influenced the results. Using video for personal reasons might be different than for work-related conversations. On top of that it is possible that different people have a different conceptual model of a ‘working product’. Some people might accept the usage of video communications if the alternative is too costly or time consuming, no matter if the experience of video communication is positive or not.

The purpose of this thesis is firstly to identify the issues in distance collaboration where users in a work environment have creative processes, and secondly, to design a solution to target one of these identified issues.

2.2 Research Questions

At the Interactive Institute they experienced that communication over distance works but that it has not yet reached its full potential. Especially when they are focused on brainstorming or conducting workshops (for example when communicating with company X), they feel limited while using video-communication systems like Skype, as a medium for communication. They were not able to identify what was disruptive to their communication. Therefore I conducted research on why video communication between multiple colleagues limits brainstorm sessions and workshops.

The first research question is:
Which issues can be identified for users remotely collaborating via video communication, while working in a creative process?

After issues are identified there can be numerous solutions. Several solutions have already been thought of but the set up is hard to create, expensive devices need to be bought and calibration can take up a lot of time. The solution should be applicable within the Interactive Institute and its colleagues spread out over the world. This includes easy set-up, a fast learning curve and an easily transportable device. The Interactive Institute would like to only use technologies that already exist. They do not see any added value in developing a new device that people need to buy separately. The second research question then becomes:

*How can the use of video communication be improved, using currently available technologies?*

In the chapter 3 the theory and definitions of the words used in the research questions will be discussed.

### 2.3 Scope and Limitations

This research will be limited to video communication via Skype and Google Hangout, between two locations. On each side will be one or two people attending, and they will perform creative work. All meetings who do not fit this description will not be taken into account.

Some limitations were imposed during this study to answer the two research questions. One of them is the technology that will have its own characteristics and might limit the intention of the experiment. For example, when I decided to use Skype, the lay-out cannot be changed. During the testing of the design phase, I am also limited to the technologies available to test with.

Another limitation is the different devices available to test with. The tests will be conducted with private devices and therefore the tests are limited in the scope of devices.

The last limitation is the amount of observations that can be conducted. Real meetings will be observed, meaning I am dependent on the progress and planning of the Interactive Institute.
Chapter 3

Theory

In the first research question, the phrases remote collaboration, video communication and creative process appear. In this section these terms will be elaborated and previously conducted research will be included. This section ends with two examples from research carried out within interaction design that tried to improve remote collaboration over distance using video communication.

3.1 Remote Collaboration

Remote collaboration means that a group of people work together to achieve a goal, while they are dispersed over different areas. They work from different locations and time zones [Klitmøller and Lauring, 2013]. According to Pangil and Chan, remote teams rely significantly more on technology than teams at the same location. This is because remote teams need to be able to collaborate “across space, time, and organizational boundaries” [Pangil and Moi Chan, 2014].

Gullström argues that work-related collaborations rely more on “the potential exchange of knowledge, information transfer, direct access to the expertise and flow of ideas between individuals rather than on physical contact”. These knowledge and management processes have one qualifying factor: trust. Presence and trust are closely linked [Gullström, 2010]. Therefore it might be that one prefers to work in the same location, to create trust. I believe that supporting the building of trust via video communication is the key to improving work-related collaboration over distance.

Shared awareness is “the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future” [Wickens, 2008]. Shared awareness is more easily reached when the collaborators have a common ground, mutual knowledge, beliefs and assumptions [Clark and Brennan, 1991]. According to Endsley et al. this does not mean that all information
needs to be shared, only information useful to achieve their goals would be sufficient [Endsley, 1988].

3.2 Video Communication

Boyle defined three factors which can affect the usage of communication via video [Boyle et al., 2009]:

- **Solitude**, Where you do not want to be disturbed by an unexpected video call.
- **Confidentiality**, Where you do not want to expose confidential information or environment
- **Autonomy**, Where you are able to choose how you participate in the activity

Judge and Neutaedter claim that planning a video meeting (time, date, location and subjects), increases the solitude and autonomy. The solitude factor increases since there will not be an unexpected video call, and the autonomy increases since you have the opportunity to prepare your participation for this meeting. The user should be able to find a way to maintain confidentiality [Judge and Neustaedter, 2010]. In addition to those three points, privacy issues are also raised by Judge and Neutaedter [2010] and Madge and O’Connor et al. [2008].

Different researchers have tried to identify problems for communicating via video. One of the lists of identified factors contains the following items: “presence, location, identity, activity, availability, history of activity, viewpoint, action point, gesture, facial expression, voluntary versus involuntary expression, degree of presence, capabilities, physical properties, manipulating one’s view of others, multiple media, distributed bodies, truthfulness and efficiency.” [Benford et al., 1995].

Research has been done into differences between online and real-life interviews. Deakin and Wakefield assert that using Skype for interviews can produce the same reliable, in-depth information as real-life interviews [Deakin and Wakefield, 2013]. Teaching via videos is proved to be working for computer science students [Horton and Campbell, 2014]. Both interviewing and teaching are mainly forms of one-way communication, and focused on transferring (educational) information. Video meetings for companies can be focused on either transferring information in one direction, or transferring information in both directions. The two involved parties are focused on gaining information, visions and ideas from each other.
3.3 Creative Processes

Ken Robinson claims that “Creativity is the process of having original ideas that have value. It is a process; it’s not random”[Robinson,]. This process takes time, and everyone has their own technique to generate creative thoughts. The process mostly involves communicating and sparring with other people, using pen and paper to brainstorm. Larsson et al. say that most of the communication is lost when the conversation is online, since digital interfaces do not engage people as much as face-to-face communication[Larsson et al., 2002].

Nootenboom and Gilsing claim that creating new ideas is mostly done in the social and work networks of the employees. And in order to create innovation one needs a group that is linked via multiple channels. This means not limiting oneself to only communicating via video communication but extending communication to other channels, such as e-mail. That diversity seems to be an essential part of creating innovation [Nootenboom and Gilsing, 2004].

Distributed teams have to find new ways to ideate and create collaboratively. Bergström and Törlind argued in their study, that better collaborative tools and shared online platforms need to be developed, because the existing technology was not yet sufficiently advanced to fulfill the needs of designers [Bergström and Törlind, 2007].

3.4 Technologies to Improve Video Communication

Norris and Gullström are both researchers that tried to improve video communication, although their research was not specifically focused on creative processes, it was in a work environment.

Gullström discovered different issues in collaboration over distance in her doctoral thesis Presence design: Mediated spaces extending architecture. She tried to capture being together ‘in the same room’ while you actually collaborate over distance. One of her biggest concerns is mediated gaze, which is hard to achieve when using a normal set-up for video communication. While you watch the camera you are not able to look into the eye of your partner on the screen. She also pointed out that a shared space influences how knowledge is exchanged [Gullström, 2010]. There is no scientific evidence that an open plan layout creates more interaction than in a cell-office layout [Steen, 2009]. However, space syntax theory has shown that spatial features such as proximity, visibility and layout encourage interaction and collaboration [Hillier, 2007][Sailer, 2010]. Gullström developed a mediated sketchpad: a projector and webcam that are focused on a table that give both sides the opportunity to have the same visuals of the table. If there is
a pen on table A, this pen will then be projected on table B. This gives the users a chance to make drawing together. It functions quite well, but it is hard to set up due to adjusting and fine tuning of the devices.

Norris et al. discovered an inability to point and refer to different objects due to limited vision. They developed a lightweight collaboration tool which helps in scalability, speed and view reconciliation named CamBlend. “The study of CamBlend highlighted a number of successful examples of object referencing using the pointing tools provided. These included pointing implicitly, explicitly and referencing objects in either local or remote spaces” [Norris et al., 2012].
Chapter 4

General Methods

To find an answer to the two proposed questions, different techniques and methods were applied. The methods for research question one differed from the methods for research question two, therefore these will be discussed separately. In this chapter the general methods will be discussed, in chapter 5 the method for each part will be discussed in detail.

4.1 A Case Study

A case study approach was chosen to allow a deeper insight into how employees use video communication and why they are not satisfied while using it. “A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.” [Yin, 2013]

There are four reasons to choose a case study approach [Yin, 2013]:

- To explain a link in real-life events, which are too complex to capture in a survey or other methods
- To describe an intervention and the real-life context in which it occurred
- To illustrate topics within an evaluation
- To detail situations in which the behavior being evaluated does not have one clear set of outcomes

However there are also certain drawbacks associated with the use of case studies. There is a risk for biased results, due to the fact that only one person is processing the qualitative data. Another drawback is the limitation of generalization to a wider population. However, a case study allows a small sample size, and gives the ability to conduct exploratory
research which fits the timeframe and the scope of this research. Not much research has been conducted in the area of video communication in work environments, therefore no specific questions can be formalized and tested. This exploratory research provides a basis for future research to formalize hypotheses in the identified problem areas.

The case study was conducted at the Interactive Institute, which during the research period had a long distance collaboration with company X, as described in the introduction. They were organizing a similar event to the event described before, though with a different subject, resulting in the need of organizing from the beginning on. They contacted each other via different mediums: e-mail, phone, text message and video calls. Only the communication via video was taken into account, and the four people organizing this event (two at the Interactive Institute, two at company X) were observed for this research. Ethnographic research methods, field notes, photographs, film recordings and interviews, were used to identify the issues.

4.1.1 Initial Observations

To classify why employees at the Interactive Institute do not experience video communication as useful as they wish, observations were conducted. During three afternoons their video meetings were observed. These meetings were recorded with a GoPro and an Ipod, and were analyzed afterwards. A detailed understanding of their thoughts was gained by conducting contextual interviews, after the observations, in order to avoid disturbing the meeting. The second meeting had as an addition, written feedback from the users. The focus of the data collection was on neutral to negative experiences during the video meeting.

At this stage a list of issues was created from the three observations. To apply a structure in these observations, a colleague and I clustered them into themes. One of the drawbacks of a case study that was mentioned is that qualitative data is observed and analyzed by just one person. To minimize this bias, I gave the same task (clustering the observations) to three other colleagues. Both frameworks served as a base for the next part of the study.

4.1.2 Validating Initial Observations

After creating a framework, including the results from three observations, two more observations were conducted. These observations are conducted in the same way as the initial observations. The goal of these last two experiments was to verify that the issues found in the first three sessions occur consistently, and see if the built framework was useful to cluster the results.
4.1.3 Questionnaire

Another one of the aforementioned drawbacks of a case study is that it can only be applied to one specific group - in this case to employees of the Interactive Institute, and their colleagues at company X. To see if other people use the same practices and experience the same issues and benefits while using video communication, a questionnaire was conducted. The design of the questionnaire was based on the results of the experiments conducted previously. Four different identified problem areas in the use of video communication served as a base for groups of questions. Besides that, general questions were asked which could prove useful in the later design process. The questionnaires were distributed via e-mail to employees in SICS, Viktoria and the Interactive Institute (which are all part of Swedish ICT).

4.2 Designing a Solution

After identifying the issues in communication via video in a work environment, a solution to one of these problems was designed to answer the second research question: How can the use of video communication be improved, using currently available technologies? Designing a tool is something that is used purposefully to perform a procedure, like Jonas Lowgren defines interaction design as: “Shaping digital things for people’s use” [Löwgren, ]. The design process to create a meaningful experience for the user is called theory of use [Laaksoharju, 2014].

Besides the theory of use is the ISO 9241-10 definition of usability used: “The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.” The ISO 9241-10 definition is extracted from [Bevan, 2009].

4.2.1 Usability

Specified users To create a meaningful tool for the user, the user needed to be specified. This was done by creating personas, fictional users that have the characteristics of the people imagined to use the product to be designed.

Specified goals Goals were specified for the specified users. These goals are similar to the goals observed during the video meetings of the Interactive Institute.

Specified context of use The meetings observed at the Interactive Institute were all within a context. This context was also used as the specified context of use for designing a solution.
4.2.2 Theory of Use

After creating personas, goals and context, main issues were chosen from the answers to the first research question. This was concluded from the qualitative data from the observations, and the quantitative data from the distributed survey. From this list of issues, a solution needed to be designed. This could be focused on one issue, or a combination of multiple issues.

Development of ideas For several issues found in research question 1, and combination of these issues, design ideas were generated. These ideas developed via communicating with classmates and brainstorming with colleagues. From multiple ideas one solution was chosen that fit most of the desirable criteria for the solution. Purpose for the user, fitting to Human Computer Interaction theory, expectation in effectiveness, time and technical limitations and innovation were some examples of the criteria.

Iterative testing The following two steps were repeated in an iterative process:

- Theorize
- Testing
- Get feedback from the user

Theorize In the theorization part, falsifiable statements were made. Statements were built to gain the user’s opinion about the use of such a solution. This was done to optimize the usability fit to the user’s needs. During each iteration around one or two statements were tested.

Testing The created statements were tested as soon as possible, on participants fitting the personas. The subjects were requited in a university building. They were asked if they would like to participate in a 15 minute experiment, and in return receive a cup of coffee. They were asked to sign the consent form which can be found in appendix B. In each iteration the participants needed to have a Skype call with the other participant (their friend and colleague), and discuss the transportation of the future. They had to come to a common understanding within (around) 7 minutes. The subject transportation of the future was chosen since it is an easy subject that can develop in multiple directions. One could create a new design for a car, or brainstorm about the issues in general. It was up to the participants themselves to set the direction. During each iteration the conditions in the test were changed according to what was being tested.
**User Feedback**  Afterwards the participants were interviewed, using a semi-structured interview, to gain their insights about the experiment and falsifiable statements. The questions for the interviews were thought of before and during the observations. Standard questions were asked, concerning their age, job and relation to each other. Open ended questions were chosen to gain insight into the users thoughts, and give them the opportunity to elaborate. All interviews took less than 5 minutes, and were conducted in English.

**Hypotheses**  The last part of the *theory of use* is to propose a solution. The solution is built on the results from the iterative testing. A prototype is designed using PowerPoint and POP (see https://popapp.in/). In the last part of the designing phase a full storyboard is developed. The purpose of theory of use is to see artifacts more as hypotheses than solutions. To test if the designed solution actually improves the long distance collaboration, it should be developed and tested with several colleagues for a longer period of time and used as a base for hypothesis.
Chapter 5

Case Study

As mentioned in the general methods chapter [4] the theory on which the design of research question two is built, stems from the answers to research question one. Therefore firstly the specific methods of research question one will be discussed in this chapter, followed by the results and analysis.

During the initial observations a lot of issues are discovered and build the basis for a framework. The observations conducted after the initial observations confirm the frameworks, but do not validate the results. Therefore, a survey in the form of a questionnaire is conducted.

5.1 Initial Observations

5.1.1 Methods

During the case study, the Interactive Institute regularly had video communication sessions with company X. Company X works in collaboration with the Interactive Institute, but wanted to remain anonymous, including the subject that was discussed. Two Fridays and one Thursday afternoon sessions were used for observation, since these meetings took a longer time and always included creative thinking and brainstorming. At other times during the week video communication was used for checking in on each other. These shorter sessions were not taken into account.

The observations were done in such a way that the participants would notice as little as possible, namely using video recordings of the room. Before starting a video meeting I discussed with the participants in Stockholm what the plan was. Each time different set-ups were used to allow for creative thinking and behaviour. The basis was one connection between the two locations, but mostly another connection was added via a different device. The settings were initially proposed by me, but during the meetings the set-up was often changed due to technology issues, personal preferences or purposes of the meeting. The feedback from the observations resulted in a different set-up for the next observation.
For purposes of the readability of the results, the two participants in Sweden will be called Sandra and Bob, and the two participants in USA will be called Jane and Richard see also picture 5.1. Bob, Sandra and Jane already know each other which creates a friendly, relaxed atmosphere in the meetings. The language used in the observations was always English. Bob, Richard and Jane are native speakers, and Sandra is an advanced English speaker.

The first observation session was conducted on 30th of January, 14.00 in Stockholm, 8.00 in Ohio. The second observation was conducted 5th of February 14.00 in Stockholm, 8.00 in Ohio. The last of the initial observations was conducted on February 6th, 15.00 in Stockholm, 9.00 in Ohio. The set-ups of the meetings will be discussed in the results.

5.1.2 Results

**Observation One** Sandra (tablet) was connected with Richard (laptop), and Bob (laptop) with Jane (laptop), both connections via Skype. Sandra and Bob were seated together and Richard and Jane were sitting together. This is also visualized in figure 5.2. On both sides they had print outs of documentation. To show what is happening on the table, the laptop is turned around and tilted slightly downwards, visualized in picture 5.3.

There was a moment during the first observation when the tablet was used as a real-time camera. Bob filmed Sandra when she explained something, resulting in Sandra not being able to see the other people. Bob turned the front camera on when he wanted to talk. During the Skype session both sides sometimes wondered what was happening on the other side, especially when people started walking around, or picking up phones. They also doubted if the other side was actually listening when no feedback was given. When the camera froze people started waving to the camera and saying ‘You are frozen’. After this incident they often mentioned that they were frozen and repeated the last subject that was discussed. At the end of the meeting there was a brief summary, mainly focused on the technology
used and a small discussion about the next meeting, when it would happen and what would be discussed.

During this meeting two clear issues were recognized. Firstly Jane could not point to parts of the table on Bob and Sandra’s side. Instead she needed to use words to explain the specific item she meant while that would have been easily solved by pointing. Secondly, both Bob and Sandra looked only at one camera view at the same time, though they switched looking at a camera view when there was something happening in the other camera.

After the meeting Sandra expressed that she felt awkward while using her laptop for typing while the webcam is on. She argues that when there are multiple computers available, people still want to use their own computer for typing, but when the webcam is connected it creates an uncomfortable feeling. This is taken into account when the set-up for the next observation is decided.

**Observation Two**  The initial idea was to connect all four participants in a Google Hangout call - Sandra on an iPod, Bob on a Laptop, Richard on an iPod and Jane on a laptop, see picture 5.4a. The devices were chosen so as to give both sides an easy to move camera (on an iPod), and a bigger screen to see each others’ faces. Google Hangout was chosen to give the opportunity to show all four different views on the laptop. In reality there were three laptops connected via Google Hangout, one in Sweden and two in the USA, visualized in picture 5.4b. Both sides also had printed instructions, blank paper and markers.
Figure 5.5: What did the users like and not like during the video communication?

None of the participants were experts in using Google Hangout. This was seen clearly during the set-up when the participants chose to have a Skype call to plan how to connect via Google Hangout. It took a long time before they were actually ready to start. One of the issues that needed to be solved was the echo when two devices are in the same room and on the same connection. Unfortunately the volume of the iPod could not be switched off. Therefore the iPod was replaced by a iPad. On the USA side they decided to use two laptops, instead of the requested laptop and iPod. The connection from the iPad was poor and often fell away. This resulted in the use of only three laptops.

The printed instructions were often shown in front of the camera by team USA. Team Sweden had the instructions laid out on the table, and flipped the laptop towards the table (picture 5.3) to explain content. Though when Jane or Richard talked for a longer time, the laptop was flipped up again resulting in everyone being able to see each other again. Both sides also made notes on papers, but what they wrote was never discussed or exchanged.

Jane often wondered what Sandra and Bob were doing, while they had a private discussion or action, and asked ‘What are you doing?’

Afterwards I asked the users in Sweden to write what they liked and did not like in the meeting. In addition to this they could write what they would really like to change. These results can be seen in picture 5.5. The main point that they made is that they would like to have a camera positioned towards the table, so that Jane could see from her side what they were doing, this solution is applied in the next observation.

We also discussed the usage of Google Hangout. In Google Hangout the view of who you see is decided by sound. The person who makes the most sound is shown. This does not work when the microphone of a laptop is muted. If you want to see the muted microphone view, they should click specifically on it. Bob did not like that he had to click around to see differ-
ent views, he would prefer that it was automated. Bob and Sandra also had the feeling that they were using too many devices this time, that took too much space (a PC, two laptops, an iPod and iPad), and complained about interruptions in the internet connections. Both sides liked that they had the same printed material to work together.

**Observation Three** Sandra connected to Skype using an iPod (mounted on a lamp arm, picture 5.6a) to share a view of the table, with Jane’s laptop, this was decided upon the users suggestion. Bob used an Apple desktop PC to connect with Richard’s laptop using Skype (picture 5.6b). During this test the set-up changed by swapping an iPod for a laptop. Also notable is that Jane used her phone to read documentation while she could have used her laptop instead.

On the side of Bob and Sandra, both laptops were free to use since external webcams were used (one iPod and a webcam via a desktop PC), this was done because Sandra did not like to use her computer when the camera is on. Unfortunately the webcam from the desktop PC was very poor quality. The iPod camera was focused on the table, so that Jane and Richard could see Bob and Sandra’s notes. Communicating face to face was done via the webcam of the desktop PC. When Richard had to leave with his laptop for a moment, only the connection between Jane’s laptop and the iPod in Sweden remained. This meant that Bob and Sandra were standing and talking into the iPod, see picture 5.7. When Richard returned the normal set up was used again, until the whole internet connection was lost and the participants adopted an easier set-up - (laptop(SE)-laptop(USA) and desktop(SE)-laptop(USA)).

Both sides noted that setting up got faster as they practiced more. When a camera froze they go to ‘camera two’, which is always the camera which is not frozen. Jane once showed something in the other camera, and referred to it with: ‘Can you see this? It’s in camera two’. This also implies a routine in communication.

Other behavior that was observed was a Skype hug and a Skype high
five to celebrate achievements. Bob was quite easily distracted by his phone and what was happening in the office environment, and Jane often asked again what the other side was doing (especially when relocating laptops and cameras). Jane made private notes on her side that remained private. When Bob and Sandra gave Jane and Richard an assignment to focus on, they disconnected the sound to have a private conversation. Jane later mentioned that she did not like this, since she could see that they were talking, but could not hear them.

All users quite often switched which screen they were looking at. Jane did not like the camera view from the desktop PC due to the bad quality. Richard noted that he really appreciated eye-contact, even if this meant looking at a lower quality camera. Jane mentioned again that she wanted to point quite often, and suggested that a laser pointer that would go through the webcam would be useful. Finally Richard also explained that he had the feeling that Sandra and Bob were screaming towards him, due to the sound level. Sandra and Bob did indeed talk a little louder, but definitely did not scream.

General observations In all three conducted observations it appeared that time difference between the two locations could have influenced the flow of the meeting. Two observations were conducted at 14.00 (SE), 08.00 (USA), meaning that both teams just had a meal and were ready to start. One observation was conducted at 15.00 (SE), 09.00 (USA), here it was observed that the team in Sweden was more easily distracted and needed a coffee break. The team in USA did not show a difference in behavior when the meeting was one hour later.

During all the meetings devices, needed to be plugged in for charging. This often caused an unplanned pause in the whole conversation. Even when advised to have their devices charging, they forgot.

At the end of the meeting they often discussed what they were going to take up in the next meeting. From this we can also clearly see that there are different types of Skype meetings. It is possible to just have a shorter check-in or a longer brainstorm session, which requires more time and preparation.
5.1.3 Analysis

The observations were made by reviewing recordings rather than being in the room during a session, so as to influence the participants as little as possible. Unfortunately Sandra and Bob remained aware of the recording camera, which could be seen by them looking straight into the camera and addressing me! For example, one time Bob said: “See Kim, we need to change this the next time”.

All set-ups contained multiple cameras. This had quite a positive effect for the users and their tasks, though it was often difficult to set up. Each video communication software has its own limitations. In Skype one can only have a conversation with multiple people if a member has a premium account. On top of that it is not possible to have video communication with multiple devices using an iPod. In Google Hangout only the vision of the person who is speaking is shown, which is limited when some users mute their microphone to avoid echo. It was always hard to decide who would call who, on which device. This was enhanced by the fact that multiple people had multiple accounts (for example a private and work account) which easily got mixed up. Users expressed a wish to see the faces on a bigger screen, but also the view of the table on a bigger screen. This meant that the view of Bob and Sandra, and the view from their iPod both needed to be redirected to big screens in the USA. This was only possible with Google Hangout, and not with Skype.

Low quality of camera and camera positioning changed often during the three different meetings. If there is a camera a bit further away, it gives both the sides the opportunity to retain eye contact. Though, this means that it is hard to navigate on this computer, since it is positioned at a distance to allow an overview. This in turn means that an extra computer needs to be used only for having a video communication and for no other purposes. Another suggestion is that an external webcam is used, though this does not solve the issue of not having eye-contact.

The results obtained from the initial observations appeared very unorganized. Therefore a framework was built around the observations. To keep my personal bias as small as possible, two different frameworks were build. Framework one was built by me and my colleague, whilst framework two was built by three other colleagues. This resulted in clear themes emerging from the analysis.

Framework One
This framework clustered the observation into 5 five different themes:

- Feelings of the participants
- General working together, and its rituals
- The vision of the camera
Sound

Limitations

**Framework Two**

This framework is more focused on placing the issues in a specific place, and is also visualised in Picture 5.8. Problems can be distributed in different areas:

- Pre meet up, making the appointment
- Going into the meeting (includes printing print outs, starting computers and getting connected)
- Having the meeting which is separated in:
  - Visible part of the meeting (camera view)
  - Invisible items in the meeting (artifacts and movements that are not captured by the camera view)
  - The communication between the different locations
- The conclusion of the meeting, which is not always present.

### 5.2 Validating Initial Observations

#### 5.2.1 Methods

After identifying areas (as discussed in the analysis in the initial observations) where problems occurred, I conducted two follow-up observations,
Figure 5.9: Set-up created by the participants

5.2.2 Results

Results from these observations are among others: poor quality of the cameras, discussions about how to focus the camera, Bob leaving the room without giving a reason, having two cameras focusing on the same object.

One set up was created by the participants themselves (by trial and error), which they really appreciated and which functioned well. Bob and Sandra were seated together side by side, with an external webcam in between them (focused on the table). This external webcam was connected to a laptop, placed on the table. Here Bob and Sandra could see Jane. In addition, there was a tablet on the table which showed Jane the faces of Bob and Sandra, and which showed Bob and Sandra the view of Jane’s hands. This gave Jane the opportunity to point towards different parts of the table and participate in the workshop. The set-up is shown in picture 5.9.

5.2.3 Analysis

Besides the set-up described above, no other observations were made that could alter or add to the frameworks. Results from the first observations were often repeated, but this data unfortunately did not give the opportunity to validate the issues described before. They did not repeat certain issues more than others. Therefore another attempt to capture other people’s use of video communication was conducted by distributing a questionnaire.
5.3 Survey

5.3.1 Methods

I compared my observations of the participants with the experiences of other people using video communication. To do this, a survey was designed and distributed via email within the Swedish ICT Interactive Institute, SICS and Viktoria, giving me the option to gain results from random sampling. These people are all located in Sweden, but come from different places in the world, therefore the survey was written in English. Those e-mailed were asked to assist a colleague by filling in a five-minute questionnaire about their experiences of using video services for work meetings.

It is unknown exactly how many people received the email, but it is believed to have been around 300 people. The questionnaire got 45 responses in seven days. The questionnaire was fully anonymous. People who did not fill in the questionnaire were not using any video service for work related meetings, or decided to not answer the questionnaire.

The questionnaire contained three multiple choice questions, 17 statements with a five agree-disagree scale and 4 open questions. A five Likert scale was used since that would provide sufficiently detailed results [Dawes, 2008]. The questionnaire can be found in Appendix A. The questionnaire’s statements were built around four themes, extracted from the frameworks:

- The entry rituals of starting a video meeting
- Visibility of the users and work space when discussing non-spatially ordered information
- The general features of working together
- Visibility of the work space when discussing spatially ordered information

Each theme got four questions (except for ‘The general features of working together’, which contained five questions), half of the questions were negatively formulated, while the other half was positive formulated. A scale of five was used where number one meant totally agree, and number five totally disagree.

The Likert-scale questions were answered by all respondents. The three multiple choice questions were asked to gain basic information on how often, which devices and which service they use for video communication. The four open questions gave the respondent the ability to share extra opinions and experiences while using a video service for work meetings. These are only used for inspiration and therefore not extensively discussed in the results. All closed questions were answered by everyone, some open questions were left blank.
5.3.2 Results

From all the respondents, Skype is the most used service (95.6%) among Google Hangout, WebEx, GoToMeeting, Jabber, Join.me and Lync. Most people use their laptop for video communication (84.4%), and just 11.1% use an external webcam. Other used devices are, from often to less often used: PC, tablet, mobile phone, video communication equipment and a special meeting room. Video services for meetings are used at least once a week by 51.2% of the respondents. 28.9% use it less than once a month.

The entry rituals of starting up a video meeting: 31.1% prepare a similar amount for a video meeting as for a normal meeting, and 44.4% prepare more for a video meeting. 35.6% start a video meeting exactly on time, compared to 6.7% who never start a video meeting at the planned time. Only 8.9% of the respondents experienced no problems involving sound and view when setting up a video meeting. The statement It takes me less time to feel relaxed during a video meeting than a normal meeting was not able to falsify if people are in a less relaxed state while having a video meeting.

Visibility of the users and work space when discussing non-spatially ordered information: When in a video meeting, a similar amount feel comfortable (42.3%) as uncomfortable (40%), while 26.7% feel extremely comfortable compared to only 8.9% who feels very uncomfortable. 95.6% care to some extent what is visible behind them. The respondents feel slightly uncomfortable facing the webcam when using the computer. From the 7 respondents who do not feel uncomfortable at all, 3 respondents used an external webcam. 91.1% look at least once in a while to the preview video that is mostly shown in video meeting software, see picture 5.10.

The general features of working together: Over half of the respondents (62.2%) feel limited by the options available on Skype for structuring a meeting. To the statement if others pay less attention to the user people responded normally distributed, but slightly disagreeing. Compared to the
opposite statement where people think that they pay more attention to the user while communicating via video, which is more disagreeing normally distributed. This result is shown in Figure 5.11. 46.7% agreed to some extent that they get more easily distracted than in a normal meeting. In response to the statement that video meetings are more efficient than a normal meeting the responses were normally distributed with a slight disagreement.

Visibility of the work space when discussing spatially ordered information: 53.3% state that they never lift their laptop to show something in front of the webcam, meaning that 46.7% do it at least once. Most of the respondents (77.8%) think that showing print outs in front of the camera is harder than sharing files via the computer. 48.9% strongly agreed that it is useful to share documentation before you start a video meeting, nobody fully disagreed. 44.4% sometimes use a whiteboard or flipchart in a video meeting, but only 6.7% use it often. The respondents had the option to motivate why they (did not) use a whiteboard. Of those that answered, most of them wrote that they would like to use it but it is hardly visible, not practical and expressed the need for an extra camera.

As mentioned before, I do not intend to discuss the results of the open questions. However, one notable point should be made, some people mentioned that they do not use the camera in video communication. Online calls are a cheaper way of communicating than using the phone, and some only share their screen. They do not see any value in seeing the other person.

5.3.3 Analysis

From the four themes that were surveyed, the features of general working together seems to be the most important one. It is interesting to see how that could be combined with the visibility of spatially and non-spatially ordered information.
From the answers to this survey one might wonder if the lack of sharing documents influences the general advantages of working together.

People expressed that they are less focused in a video meeting. This is an interesting statement that could be researched in the future. Why are people less focused in video meetings? Two influences could be because there is no pressure from colleagues, or because there are too many devices around you to distract you.

5.4 Comparative Analysis

Looking at both my observations and the results from the survey, several issues arise in both parts. Technical issues like poor sound or view are often disruptive. Some people even prefer not to use the video because of the unacceptable quality. This issue is out of the scope of this project. People care about how they are shown in the camera, and what is visible behind them. In comparison to a normal meeting, respondents from the survey confirm the observation of unstructured working. They neither confirm nor unconfirm that they are more quickly distracted than in a real meeting, though in the observations this was clearly visible. Only half of the people say that they sometimes lift their laptop to show something. The respondents think it is useful to share documentation before the meeting, and prefer file sharing over showing items in front of the camera. This was mostly not observed during the observations, mainly because handwritten notes were shared via the camera. Respondents to the survey noted that they did not (often) use a whiteboard during video meetings, mostly due to visibility issues over video.

Combining the results of all observations and the survey pointed out a few main problems, which can serve as a base for the design iterations. To the question Which issues can be identified for users remotely collaborating via video communication, while working in a creative process?. I came up with the following list based on framework two.

**Before the meeting.** The moment where the meeting is scheduled

- Users prepare more for a video meeting then for a normal meeting
- Though people think it is useful to share documentation before starting, this does not always happen.

**Going into the meeting.** The moment where you start up the meeting

- Each location needs to be set up in time
- Have documentation, for example printouts, ready
- Unfamiliarity with Google Hangout creates uncertainty about how to start
- Empty batteries create undesirable pauses
People experience problems involving sound and vision when starting.

**Visible part of the meeting.** The visible parts of the meeting

- Eye contact is hard to reach in a video meeting
- People care what is visible behind them
- People check their own video preview during video communication
- People can only look at one screen at the same time
- Talking and looking in a inconvenient angle due to camera positioning
- Low quality cameras
- Switching cameras from front side to backside can provide trouble
- Squeezed faces in to a small screen
- Clicking between different cameras (only in Google Hangout)
- Show printouts in front of the camera
- Facing the camera is awkward when typing on the laptop
- Sometimes the visible becomes invisible by freezing of the screen.

**Invisible part of the meeting.** The hidden actions or comments of the meeting

- People need feedback from the under side to show that they understand and that they are listening
- Laptop flipped to show the table vision
- No ability to point
- Items on the table are not visible for the other side
- Private notes that are not shared
- People wonder what the other side is doing

**Communication between two locations.** Aspects connected to knowledge transfer

- Echo annoys the user and is complicated to get rid of
- People feel limited in how they can structure a video meeting
- Weakening attention from the other side
- People get more easily distracted
- Time difference can influence the meeting in a negative way

**After the meeting** Conclusion and preparation for the next meeting
• Often there is no summary from what is discussed in the meeting
• Discussions about what to discuss in the upcoming sessions, sometimes end up without conclusions
Chapter 6

Designing a Solution

In this chapter the development process of the solution, including the result, will be discussed. First the definitions of the usability will be specified to clarify the target group and context. Then the theory of use will be applied, this consists of identifying a problem, proposing a solution, and iterative testing of this prototype solution. Finally a hypothesis in the form of a solution will be proposed.

6.1 Usability

6.1.1 Personas

The fictive representation of the user, is Sven. Sven is a 38 year old man, happily married with two young children. Everyday he drives to work: a research institute. He is very social, talkative, and knowledgeable. He has a PhD in Social Science and is always looking for a challenge. His social skills are demonstrated in his positive way of communicating with friends, colleagues and new people, and his ability to explain a subject in detail so that everyone completely understands. Sven is on good, friendly terms with most of his colleagues. He likes technology and new devices, though he is definitely not an expert in using them.

6.1.2 Goal

The goal that should be achieved, in this experiment, is to come to a common understanding of the transportation of the future, between two different teams during a meeting. This could be a design for a new car, or a storyline about future developments. The users decide how they interpret the topic.
6.1.3 Context

The solution is going to be applied to improve communication over distance. Sven needs to communicate with colleagues living in Asia, who have medium affinity with technology. He knows these colleagues from a previous meeting in Asia. Video communication is used to reach its goal as described in section 6.1.2 and the solution. Although the context suggests communication between Sweden and Asia, the solution should work between any different time zones and cultures.

6.2 Theory of Use

6.2.1 The Problem and Development of Ideas

The answer to research question one, discussed in the previous chapter, shows there are multiple issues while working over distance using video. By communicating with colleagues and friends, different issues are clustered and solutions are thought of:

Make the invisible visible. This problem occurs often and can be solved by introducing two cameras. However, there is still an issue though of how the other side sees your environment while at the same time filming their environment. To solve this issue multiple devices are needed.

Talking indicator. People on the other side often feel that people are screaming towards them. During the observations it was noted that people speak louder when they are in a video meeting. What would happen if you would saw how loud you speak? Would this regulate your ‘screaming’?

Be engaged during the meeting. During the observations Bob and Sandra were easily distracted by their computers, phones and the environment. Is there a way to keep participants more focused and engaged during a video call?

Have a shared agenda. Structures in video meetings are not always clear, and as well prepared as a normal meeting. Could a tool help support a common understanding about the topics to be discussed?

Shared clock. When one is in a face-to-face meeting, there is usually a clock available. How could a clock be integrated with the agenda to indicate remaining time to meeting attendees?

Ability to point. During the observations it was often noted that the other side had no opportunity to point. Words need to be used to
refer to objects. One could be done to improve this aspect of the video meeting experience?

Make guidelines for the set up. A lot of time is wasted during the setup of a video meeting. Who will call whom, with which program, what to do when sound or video is not working, etc. How could a program present the set-up procedures for you, and give guidelines in case of technical issues during the video meeting?

These solutions were suggestions to serve as a basis for the rest of the design phase. Due to time limitations there was only the opportunity to focus on designing one solution. The problem space which was chosen is the following:

Multiple issues could be described as missing a common space, besides seeing each other’s faces. Space where the users can write, draw, and share thoughts easily, replacing the table space which would be in between users in a face-to-face meeting. The chat function of most video communication software is often not used, probably because it does not contain the requested functionality. There should be a place where users can come to a common understanding, without the hassle of multiple cameras focused on tables or walls.

6.2.2 The Solution

The solution brings the characteristics of a whiteboard into video communication, and gives the opportunity to write and draw thoughts for each other. Connect ideas by both having the opportunity to participate on the whiteboard. All participants have the chance to join the whiteboard, which will start empty and blank and white but develops into a place where information can be collected, shared and elaborated. People can build on ideas of others and make mind maps together. This is a artifact that can be used alongside the usual face-to-face view during communicating via video.

It makes an invisible part of the video communication visible, by having a shared artifact on both tables. It will also reduce the occurrence of having to show papers in front of the webcam, and makes written notes more readable by digitalising them. This idea could be connected to a tablet, which is a device that most companies have available. Having an extra device in a video meeting is not noted as an issue for users like Bob and Sandra - they already use multiple devices during a meeting.

6.2.3 Iterative Theorize and Testing

Iteration One

The idea of a shared whiteboard sounds promising, but one could wonder if people actually would prefer to write and draw to each other when they can
already communicate verbally. With this statement, test number one was conducted.

**Methods**  One participant (male) was placed in the hallway, the other participant (female) in the office, they were colleagues and both around 27. Between them there was a window. On the window white sheets were taped, representing a frame of video communication. They could only see each others face. Next to this window, a door was opened so that the participant could hear each other. This set-up is also visualized in picture 6.1.

The participants were asked to discuss the transportation of the future, while they were holding a pen. Halfway during the experiment I told them that they could write on the window, with the pen, if they preferred.

After the experiment a small interview was conducted to capture their thoughts on the experiment.

**Results**  While receiving the pen in the beginning of the experiment the participants looked confused. Right after the start, the conversation had no specific direction. After telling them that they were allowed to use the pen to write on the window, the male participant started immediately summarizing their conversation on the window (using written language). After this phenomenon the conversation had a stronger direction towards one common understanding. Text was added (by the male) to the window, and the female often referred to the text by pointing towards it.

After the experiment they were asked about their thoughts on the writing functionality in addition to video communication. They are of the opinion that using a shared whiteboard would improve the communication. The female did not write on the board, since she knew it would be mirrored for him. She mentioned the text was hard to read, because, for her, it was mirrored but knew that it would be an easy fix for a computer. We discussed the fact that they were writing in the zone of their head, and not in a separate field. They reacted that it does not matter where you draw, unless you really want to see the other person.
Analysis From the observation and interview we can derive that having the opportunity to draw and write to each other could improve the communication. This couple used it to summarize their thoughts, which enhanced direction of their conversation.

The area regarding where to draw was discussed in the interview. The participants did not have a strong opinion about whether it should be laid over the video vision or in a separate part of the screen. Drawing in the zone of the head gives the user the ability to point by marking something in their field, which solves one of the identified issues. Nevertheless, an arising issue could be that different colours might fall away against the background while drawing in an not uniform coloured area.

Iteration Two

The second iteration was focused on devices: should the application be on the computer where the user can draw with a mouse, or on a tablet where the user can draw using their fingers. Attention was also brought to the colour use of the users: should they use similar or different colours?

Methods To check the first statement, two tests were conducted. One test where the participants used Skype on a laptop for video communication and a tablet for a shared whiteboard. In the other test, participants used a laptop for both the video call on Skype and the shared whiteboard. Skype was chosen because most people are familiar with this software.

Whiteboard tool awwapp.com was used. This is a tool to make collective drawings on different computers. It is hard to set up the connection (especially for tablets), but once that is organized, the program is fairly straightforward in its use. It has no option to replace, the user can only draw in the area that is visible for himself, meaning that if the other person has a bigger screen, his drawing could exceed the limits of the shared whiteboard. This application was chosen since it is the most usable current technology available for the purposes of this test.

The participants were placed in two different rooms, in the same building. Both teams got around 7 minutes to come to a common understanding for the transportation of the future. For test one and test two different participants were chosen, because then they would not have any previous knowledge about each others ideas. All participants were in their twenties, and friends and classmates with the other participant. Test one was conducted in the afternoon, test two late in the morning. These time slots were chosen so they would fit the participants’ schedule.

Test one The experiment using video communication on a laptop and a tablet with the awwapp application to mimic a whiteboard, was conducted with two men (Matty and Johan), around 20 years of age, who are friends
and classmates. They were in different rooms where the laptop and tablets were already set up when they arrived. They had the opportunity to familiarise themselves with the awapp tool. After this, they were asked to discuss the same topic as in the other experiment: to discuss the transportation of the future.

Test two In the second part of this experiment two different male participants (Mart and Ted), around 24 years of age, classmates and friends, were asked to discuss the transportation of the future while half of the laptop screen was filled with Skype, and the other half of the screen had the awapp open. They were also both placed in different rooms with the set-up ready, prepared in advance.

Results

Test one Matty started drawing instantly when he wanted to explain his vision. Johan was quite hesitant in drawing. Johan was more focused on the Skype meeting and only looked at the tablet when silences occurred, while Matty focused more on the tablet and drew while talking simultaneously. They experienced that one tablet was smaller then the other, and that half of the drawing is out of vision for the smaller tablet. The result on both devices can be found in picture 6.2.

During the interview, after the experiment, they expressed their appreciation for the opportunity to draw to each other. Johan stated that, “I have done it before, but then I just drew it on a piece of paper and showed it in front of the camera. But when the quality of the camera or internet was bad, it is hard to see.” Matty adds that it is “pretty cool” that you can edit each others pictures and “it would make a business meetings more productive, just because of the whiteboard”. Also the choice of colour was asked: if it was on purpose that they had different colours. Matty said that he knew his friend would choose black, therefore he chose another one.
They had no opinion about a pre set of colours. Both participants liked the use of the tablet, since it is easier then drawing on the computer. If the laptop had a touchscreen they did not know what they would have preferred.

**Test two** Mart and Ted did not use the awwapp application at all, and they still came to a common understanding. Notable is that this common understanding was not as clear as during the first experiment. This conclusion is drawn from the way they explained their thoughts and how they helped each other out, they did not have a common understanding and filled each others ideas. Mart considered drawing, but he did not feel like using it. He said that if he had a tablet, he would have definitely had drawn something, drawing on a computer is difficult, according to him. Ted added: “it really depends on the kind of meeting that you are having, now we were just talking instead, and it is hard to draw a car. . . . If someone does not understand it you maybe need a pen. . . . for another topic it would be useful, but not for this topic.”

**Analysis** More tests should be conducted to create a significant result. Still it has been decided to base an analysis on just these two observations. It can be concluded that people prefer drawing on a tablet rather than using a mouse on a computer. In the second test the participants did not use the mouse at all, even though one participant obviously attempted to draw showing by the hand movements towards the mouse. Concerning the colours no obvious conclusions can be drawn.

6.2.4 **Hypotheses**

From the second iteration it can be derived that a tablet is easier to use for drawing, compared to a laptop and computer mouse. Because of this reason it was decided that an application for a tablet would create an opportunity where both parties can draw in, that is easy in use. There were no tests conducted with a touchscreen laptop, and therefore it is impossible to make any statements about this.

During one of the observations it was noted that one of the participants had a bigger tablet screen, which resulted in the fact that one participant went outside the scope of the others participant’s screen. Besides that, the screen was filled rather quickly, and drawings were not very detailed. To solve both these issues, it was chosen to use the tablet as an input device for a larger space which can be found on the computer screen. On the tablet it is possible to zoom, draw and drag through the whole whiteboard, while on the computer screen the whiteboard has a fixed size so everything (also what your colleague writes) is visible. See Figure 6.3 for the layout, Figure 6.4 for the zoom functionality and Figure 6.5 for dragging.
Though some people might have mentioned (in the survey) that they do not perceive the need to be able to see each other during a video meeting, during the observations it was clear that it is important to see the other participants. By including a whiteboard, we do not want to lose the vision

1Icons from [www.thenounproject.com](http://www.thenounproject.com) for more see Appendix C
of the colleagues. Consequently, it was decided to keep the two camera views (one of yourself, one of the other) in the whiteboard, similar to how this functions in screen sharing. It might occur that someone draws behind the vision of the video, but this can be solved: the video vision can easily be replaced by dragging and the ability to be re-sized, see Figure 6.6.

Figure 6.6: By click and drag one can resize and replace the video.

To focus on the usability and functionality, rather than the background synchronization of the application, it was decided to build the whiteboard into Skype. Skype was chosen due to the fact that a vast majority of respondents to the questionnaire (95.6%) use this service. The tablet will have an application that is connected to your Skype login. When starting a Skype meeting on the computer, and opening the option to use a shared whiteboard, your tablet will react by opening a shared whiteboard with the other participants in the meeting. When drawing something on the tablet, it will instantly be synced to the PC and the other users tablet. Opening the whiteboard functionality in Skype on the PC is similar to opening a chat or shared screen, see Picture 6.7.

 Icons from www.thenounproject.com for more see Appendix C.
There was also a statement made regarding the use of colour. It was debated to give all users different colours, so one could easily distinguish who draws what. During the experiments, we saw that one couple used different colours. During the interviews it was established that there were no common opinions about the usage of similar or different colours. Therefore, it was decided to leave the users free in their choice of colour. There will be no tag to show who drew and wrote specific items, since this application is focused on communication between two places, and one can easily recall what is drawn by him/herself and what was not. In the future, colour use and tagging can be researched more in depth.

To promote the communication, the application should be as simple as possible, it was preferred to use a prefix painting method. This is a “what you draw is what you get”-method. You need to choose your colour and place before you start drawing. There is no possibility to re-size, replace or change the colour once it is drawn. When one of the users needs to change any of their drawings, there is the option to use the eraser and to draw again. This keeps the application as easy as possible, and close to a real whiteboard functionality. The drawing functionality is shown in figure 6.8 and the removing functionality is shown in figure 6.9. In figure 6.10 you can see how one can change the thickness of the line, the colour of the line can be changed by performing a similar action on the colour panel.

Icons from [www.thenounproject.com](http://www.thenounproject.com) for more see Appendix C
In the logos in 6.11, the design for different options are represented. Logo 6.11b gives the opportunity to share the full whiteboard directly with someone via Skype or e-mail. The receiving participant can only see the

4Icons from www.thenounproject.com for more see Appendix C
whiteboard, and not adapt it. Logo 6.11c give the user the opportunity to save the file to the device that is currently used. The blank sheet represented in logo 6.11d will remove everything on the current whiteboard. All other options, like importing whiteboards are reached by clicking logo 6.11a.

![Different options](https://via.placeholder.com/150)

(a) Settings  (b) Share  (c) Safe file  (d) New file

Figure 6.11: Different options

This design is based on just a few experiments with users, using a different application to reach a common drawing. For user testing with a working application this design should be implemented and tested on multiple users, for a longer period of time. This more elaborate test could have two different focus points. Firstly, it focuses on how the program is used and how the design can be improved. Secondly, it focuses on how the program is used to improve the collaboration over distance.

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5Icons from [www.thenounproject.com](http://www.thenounproject.com), for more see Appendix C
Chapter 7
Conclusion and Discussion

This thesis has examined two questions:

*Which issues can be identified for users remotely collaborating via video communication, while working in a creative process?*

*How can the use of video communication be improved, using currently available technologies?*

Key strengths of the present study were the holistic and exploratory approach, obtained results can serve as a basis for future research. The first question is answered by conducting a case study using observations and a survey. The issues found in the observations are presented in a framework to show what the problem areas are. It starts from *planning the meeting*, when it might be complicated to agree on a date and time that suits everyone, especially when the work is conducted in different time zones. Also to be decided is what is going to be discussed, so that everyone can be prepared. *Going into the meeting* is the next part where obstacles occur. People need to be connected via a special program (such as Skype or Google Hangout) and through a specific account. Cameras and microphones need to work and printouts need to be printed. The whole process of getting started is often cumbersome. During the meeting there are three different areas where issues are located. *The visible part of the meeting* presents issues - such as when seeing each other is adversely affected by bad quality cameras, poor camera positioning or poor internet quality. *The invisible part of the meeting* also influences (and limits) the communication. Notes on a piece of paper are unseen, and objects like a whiteboard stay unused since they are not visible to the other participant. The function of body language in communication and social interaction may also be lost. During the meeting there is also the *actual communication* which can be disrupted by bad microphones, speakers and background noise. Also people tend to speak louder in a video call than normal. Communication is not limited to speaking, as users simultaneously use other programs like Google docs, e-mail, chat functions and
phones. After the meeting it is useful to summarize the discussion and make a structured plan for the future. This is often ignored resulting in the loss of exchanged information.

The issues were identified from a case study, in which only one pair of people were observed. A survey was distributed to validate the issues identified during the observations of this pair. The questionnaire was built around four themes: Starting a video meeting; visibility of the users and workspace when discussing non-spatially ordered information and when discussing spatially ordered information; and general features of working together. From the questionnaire it can be concluded that people are limited in working together when communicating via video communication. At least half of the people use a video communication service at least once a week. Most people prepare more for a video meeting than a normal meeting. During the meeting people are aware of what is visible in the camera behind them. Half of the people occasionally lift their computer to show something specific. Whiteboard and flip charts are hardly used because they are difficult to make visible through a webcam.

From combining the observations and survey can be concluded that there are a lot of different points that could improve the collaboration for work related tasks, over distance. The answer on research question one provides a good basis for future research. Techniques used in Human Computer Interaction can be used to design solutions, this is also done to provide a solution for one of the found issues.

The focus of the design, to improve collaboration over distance, was on creating a collaborative space to complement video and to make visible invisible aspects when meetings occur in multiple locations. A shared whiteboard would give the opportunity of creating ideas together by allowing both parties to draw in the same place. Techniques such as mind mapping, drawing and brainstorming can also be incorporated. The application is designed while conducting iterative tests. This resulted in a tablet application that is connected to Skype on a laptop or PC. The tablet gives you the opportunity to zoom, drag and write on the whiteboard, with the whiteboard on the PC being automatically updated, giving you a full view of the board. The main advantages of the use of such an application are: users have a shared space, users can both participate in this space, users do not need to show handwritten notes in front of the camera to explain their vision, and users can build upon the vision of the other user, this all while the users still have the ability to see each other.
7.1 Discussion

While formulating research question one, I knew that issues would arise, just not what kind of issues. There was only one issue that I was sure would arise: problems with cameras and microphones. During the observations I was therefore positively surprised to see more issues in behavior and from the devices of the participants. When all the issues were collected, it was a very complicated task to make sense out of them. They seemed very random and unorganized. However, after a lot of brainstorming and use of post-its and whiteboards two frameworks were created.

The proposed solution in the answer of research question two could be very useful to implement for services like Skype and Google Hangout. Implementing such a solution could lead to a higher frequency of use of their programs, especially when it comes down to work related creative sessions. Google Hangout already implemented a similar solution, though this geared more towards reaching a fun factor then a useful tool for a work environment. The user has the opportunity to draw and use stamps in the camera view of the other participant. This function can hardly be used to share notes with each other or to create mind maps. Both companies could do more research in how to implement such a solution, and test if it actually improves distance collaboration.

One of the key points of the proposed solution is that both teams have control over a device that has the same functionality as a whiteboard. Multiple devices are already used during video communication, but by including this solution the devices will be used in a way that more results can be achieved.

7.2 Limitations

The scope of this study was limited in terms of group size and purpose. The research was focused on brainstorming sessions between two different locations with one or two people on either side. It is possible that if the purpose and context were varied, different results would be found. An uncontrolled factor is the possibility that the participants gave biased behavior, since they were the ones who would like to improve the collaboration. They already had an opinion about the issues involved in using video communication and this could have influenced the case study. Besides this, as the observations were of real business meetings, there was always a pressure to set up the tests on time, and ensure that the services and devices functioned for the meetings.

Another limitation was that it was not possible to assess the number of employees who received the survey. It remains unknown to what extent the results could be seen to be representative. Still, with almost 50 respondents, it was decided to accept them as representative.
The small sample size in the design iteration did not allow significant results. Ideally for each test at least four couples would have been tested. Unfortunately there were limits to time and in finding participants. Therefore the results were generalized and accepted as plausible. The study did not evaluate the use of the application due to technical and time constrains.

7.3 Future Research

The answers on research question one offer directions for future research. Limited research has been done on the issues in collaboration over distance via video communication. Therefore this exploratory research provides interesting new insights into what actually happens when using video communication services in a work environment. This research provides a framework for the exploration of different aspects of video communication.

During this research we often worked with multiple camera connections with participants in other locations. One of the questions that arises is: Does having multiple cameras improve the interaction? Another observation showed that using an unfamiliar service creates uncertainty for the users. One could wonder how much a video meeting is dependent on expertise in certain services. During this research, problems occurred when describing video meetings. An easy face-to-face video meeting with one other person is easy to describe and visualize, but as soon as multiple people and devices are involved, communication and visualization of what happened becomes complicated. There are no definitions about different purposes for different meetings, and there are no common visualizations that are easy understandable. It would be useful if definitions for different purposes of meetings would be made, and a general visualization would be developed. With this tools it will be easier to communicate observations from video communication.

The second part of the research, the design of an application to improve communication over distance, also gives opportunities for future research. There are two clear directions to focus on. The first is usability testing of the application. Is the application working as expected? What is the learning curve? Are all the options easily understood by users? The second direction is to consider the addition of other functionality, such as pictures, websites and the option to import information from different documentation. A complement to these directions, is considering how the functionality is used when there are more than two people “at the whiteboard”. How would this be visualized with video frames, colours, and synchronization? Future research could more deeply determine in what ways the application improves collaboration over distance in work settings. To research this, multiple participants should use this application for a longer period. From this, researchers could make more interesting observations in how different subjects are communicated in different ways.
Chapter 8

Bibliography


[Dawes, 2008] Dawes, J. G. (2008). Do data characteristics change according to the number of scale points used? an experiment using 5 point, 7 point and 10 point scales. International journal of market research, 51(1).


Appendix A

Questionnaire

Usage and Experience of Video Communication for Work Related Tasks

Skype and Google Hangout among others are often used to meet with colleagues in other places. If you ever use video calling services for work related tasks, I would appreciate it if you would fill out this survey. For my master thesis in Human Computer Interaction at Uppsala Universitet, in combination with Interactive Institute Stockholm, I am exploring remote collaboration experiences. Please notice that this survey is focusing on video communication, and not telephone communication. The results will be anonymously processed.

If you have any comments or questions you can reach me at kfk@tii.se, Kim Feenstra Kuiper

Which software do you use within your company for video calling?

☐ Skype
☐ Google Hangout
☐ WebEx
☐ Other namely . . .

On which devices do you use for a video meetings service?

☐ PC
☐ Laptop
☐ iPad
☐ External Webcam
☐ Other namely . . .

How often do you use a video conference service for work?

☐ Less than once a month
☐ 2-3 times a month
○ Every week
○ 2-4 times a week
○ Other namely . . .

I prepare less for a video meeting than for a normal meeting.
Take for both meetings the full preparation in account
Totally agree ○ ○ ○ ○ ○ Totally disagree

I always start video meetings exactly on time
Totally agree ○ ○ ○ ○ ○ Totally disagree

I often experience issues setting up video and sound when starting a video meeting
Totally agree ○ ○ ○ ○ ○ Totally disagree

It takes me less time to feel relaxed during a video meeting than a normal meeting
Totally agree ○ ○ ○ ○ ○ Totally disagree

I feel comfortable facing the camera while being in a video meeting
Totally agree ○ ○ ○ ○ ○ Totally disagree

I often look at the picture of myself when using video in a meeting
Programs like Skype and Google Hangout often show a preview of how the other people can see you
Totally agree ○ ○ ○ ○ ○ Totally disagree

I do not care about what is visible behind me, via my webcam
Totally agree ○ ○ ○ ○ ○ Totally disagree

While my webcam is on for a video meeting, I feel uncomfortable using my computer (like typing or browsing)
Totally agree ○ ○ ○ ○ ○ Totally disagree

I feel that programs like Skype and Google Hangout limit me in how I can structure my meeting
Totally agree ○ ○ ○ ○ ○ Totally disagree

I find that other people pay more attention to me in a video meeting than in a normal meeting
Totally agree ○ ○ ○ ○ ○ Totally disagree

I find that other people pay less attention to me in a video meeting than in a normal meeting
Totally agree ☐ ☐ ☐ ☐ Totally disagree

I get more easily distracted in a video meeting than in a normal meeting
Totally agree ☐ ☐ ☐ ☐ Totally disagree

A video meeting is more efficient than a normal meeting
Totally agree ☐ ☐ ☐ ☐ Totally disagree

While having a video meeting, I often lift my laptop to show people something via the webcam
Totally agree ☐ ☐ ☐ ☐ Totally disagree

Showing print outs in front of the camera is harder than sharing the file via the computer
Totally agree ☐ ☐ ☐ ☐ Totally disagree

It is useful to share documentation before you start a video meeting
Totally agree ☐ ☐ ☐ ☐ Totally disagree

I do not use my physical whiteboard/flipboard in a video meeting
Totally agree ☐ ☐ ☐ ☐ Totally disagree

(Optional) Motivation to the previous question
Why do you (not) use a whiteboard? Would you like to change it?

General
What kind of meetings would be optimal for a video meeting?
For what kind of meetings would you never use a video meeting?
What are the advantages and disadvantages while using video for a meeting?
Appendix B

Consent Form

The purpose of this experiment is to see how people work together. After the experiment you will be asked a few questions.

Please note that none of the tasks is a test of your personal intelligence or ability. The objective is to test the usability of our research system.

All movements and sounds will be recorded with 2 camera’s. This data will be analyzed and afterwards destroyed. If we would like to use video data from this session we will reproduce your actions with colleagues to keep you anonymous.

Your signature below indicates that you have understood the information about the experiment and consent to your participation. The participation is voluntary and you may refuse to answer certain questions on the questionnaire and withdraw from the study at any time with no penalty. This does not waive your legal rights. You should have received a copy of the consent form for your own record. If you have further questions related to this research, please contact the researcher.

<table>
<thead>
<tr>
<th>Name Participant</th>
<th>Name Researcher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature Participant</td>
<td>Signature Researcher</td>
</tr>
<tr>
<td>Date</td>
<td>Date</td>
</tr>
</tbody>
</table>
Appendix C

Icons

Figure C.1: Designed by Jeff Portaro, the Noun Project

Figure C.2: Designed by Edward Boatman, the Noun Project

Figure C.3: Designed by Ivan Colic, the Noun Project

Figure C.4: Designed by Henrique Sales, the Noun Project
Figure C.5: Designed by Iconoci, the Noun Project

Figure C.6: Designed by Michael Zenaty, the Noun Project

Figure C.7: Designed by Roman J Sokolov, the Noun Project

Figure C.8: Designed by Hatayas, the Noun Project

Figure C.9: Designed by Justin Alexander, the Noun Project