

# Video Conferencing - User Interface with a Remote Control for TV-sets

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## **Abstract**

By using Axis pan/tilt/zoom cameras it is possible to create a simple, high quality video conference system, without the need for a separate computer to control the system. This can be achieved by connecting the camera to a standard television set and utilize open standards like the HDMI feature Consumer Electronics Control (CEC). With CEC it should be possible to control the system using a standard TV remote control, thus moving a major part of the user interaction to an external device. Though this approach has its benefits by removing the need for Axis to provide a separate remote control, it also sets higher requirements on the user interface. Especially with regards to the usability since TV remote controls differ in many ways depending on the manufacturer.

A user interface with a TV remote control solution has been prototyped and implemented demonstrating a peer-to-peer video conference system. This was done through the use of on-screen displays, an iterative design process with multiple usability tests and an evaluation of similar video conference products as a basis. The test results shows that a prototype with high usability was created which the users felt confident using.

**Keywords:** Video Conference, Remote Control, Usability, Interaction design, CEC



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# Terminology

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## Abbreviations

<b>API</b>	Application Protocol Interface
<b>CEC</b>	Consumer Electronic Control
<b>HDMI</b>	High-Definition Multimedia Interface
<b>HI-FI</b>	High-fidelity
<b>LO-FI</b>	Low-fidelity
<b>PTZ</b>	Pan-Tilt-Zoom
<b>OSD</b>	On Screen Display

## Concepts

**Local camera** A video conferencing camera that is present and captures the user.

**Remote camera** A video conferencing camera which is on a different location, capturing the other participants in the video conference.

**Daemon** In multitasking computer operating systems, a daemon is a computer program that runs as a background process, rather than being under the direct control of an interactive user [1].

**Vapix** VAPIX is an open API created by Axis that uses standard protocols to enable integration into a wide range of solutions on different platforms. Almost all functionality available in Axis products can be controlled using VAPIX. [2]

**Test Person** The test person is the person who are performing a usability test.

# Chapter 1

## Introduction

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### 1.1 Background

Axis Communications AB is a company that primary develops network cameras, the company's origin is in Sweden with the headquarter in Lund. The company is at the moment the market leader in network based video surveillance, Axis is also a driving force in the transition from analog to digital video surveillance. The number of employees at Axis is around 1600 worldwide and the headquarter hosts around 1000 of them [3].

AXIS cameras contain a processor chip and can be used for much more areas than just surveillance, without complementing hardware it could be possible to make video conference calls and therefore entering on a new market with this desirable feature. For example, connecting the camera directly to a screen and holding a video conference should work well without the need of a computer which many of the solutions on the market require. In our thesis we will use a standard TV remote control to a HDMI compliant TV, use on overlays to configure the cameras through CEC.

### 1.2 Similar work

Three master's theses regarding video conferencing were conducted simultaneously on Axis Communications, this master's thesis was one of them. Marcus Carlberg and Christoffer Stengren (not yet published) investigated different approaches to varying bandwidth, explored different algorithms for optimized bandwidth usage and investigated H.264 error resilience. More closely they implemented and evaluated three TCP congestion control algorithms to achieve this. Michael Sköldegren and Christoffer Timelius (not yet published) wrote the other master's thesis were they investigated the video conference market.

## 1.3 Purpose

The purpose of this masters thesis was to investigate how CEC, TV remote control user interaction and a high usability GUI can be introduced to and prototyped on an Axis PTZ camera. The purpose was to make it easier to have video conferencing sessions with no need for a separate computer to control the system and where all configurations are made with a standard TV remote control. By using open standards the user should only need an Axis PTZ camera along with standard television set thus having a plug-and-play experience. By prototyping this it will be easier to take the next step and in the future make the prototype into a real product.

The main goal of the thesis is to design and prototype an intuitive interface combined with a standard TV remote control for a video conferencing system using Axis hardware and software and standard AV equipment. To achieve this a set of goals has been set up.

- Make a usability evaluation of similar products to identify good and bad video conference interfaces and designs to get a better understanding of how to make a good user interface for a video conference system.
- Make a working code prototype that shall demonstrate a bidirectional system where it is possible to install the product, initiate a video conference and remotely control the other camera's pan/tilt/zoom functions, without the use of a computer.
- The design of the prototype shall focus on usability and ease of use. The prototype shall be efficient to use, easy to learn and satisfactory to use. The user shall feel confident in using the prototype.

## 1.4 Approach

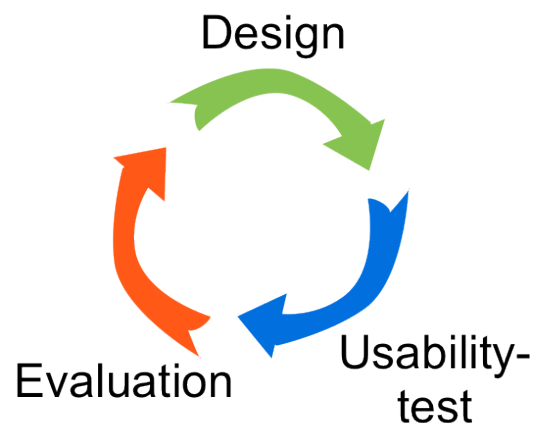
A literature study was performed to find relevant theories within the area of usability and also to find relevant technical information regarding HDMI and CEC.

### 1.4.1 Market overview

To get a basic understanding about the products on the market we evaluated some video conference competitors. The result from the evaluation where used to base our product on the good design choices we found. See section 4.3 Methods for evaluation for more on this.

### 1.4.2 Iterative design process

The design process was divided into three phases. The first two phases consisted of design, testing and evaluation, see figure 1.1, the third and last step consisted of design with the creation of the final Hi-Fi prototype. See sections 5.1 Method, 6.1 Method and 7.1 Method for more.



**Figure 1.1:** The design process circle which illustrates one iteration.

### 1.4.3 Implementation

The implementation of the prototype was done parallel with the iterations. Initially a set of minor programs was made to get a better understanding of how the camera works and its different features. In the second and third iteration phase a Hi-Fi prototype was implemented. Since the camera is Linux based, the implementation was made in the C programming language. See chapter 8 Implementation for more on this.

## 1.5 Contribution

Following section describes the writers contribution to the thesis and how the work was divided.

### 1.5.1 Development

Both Alexander and Catarina planned and did the exploratory testing and assessment testing together along with most of the design of interfaces for the prototypes. Alexander was responsible for the technical parts of the thesis.

#### Alexander

Alexander evaluated set-tops and their remote controls as a part of the evaluation of similar products. Also wrote all code for the prototypes and configured them and made the overlays for the prototype in the second iteration.

#### Catarina

Catarina evaluated software based systems as a part of the evaluation of similar products. Also did the heuristic evaluation of the first iteration and made the overlays for the proto-

type in the third iteration.

## 1.5.2 Report

The report was initially written together by both Alexander and Catarina and later on responsibilities for the different chapters was divided between the two. Alexander wrote the abstract and was responsible for chapter 1, 2, 5 and 8 while Catarina was responsible for chapter 3, 4, 6 and 7. Both were responsible for chapter 9. The chapters were mostly written by the person who was responsible for them.

## 1.6 Overview of thesis

The thesis consists of two main parts. The first part, chapter 4, describes a market overview of similar video conference products which were evaluated. The second main part is the development of the video conference prototype which is divided into three iterations, chapter 5, 6 and 7. For these chapters we go through the methods used, results and conclusions drawn from the results. The implementation of the prototype is explained in chapter 8 which is followed by a discussion in chapter 9. Chapter 2 and 3 goes through relevant technical and theoretical background where the used protocols, methods and other theory are described briefly.



# Chapter 2

## Technical background

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*The Technical background chapter introduces the reader to the protocols and technologies which were used throughout the thesis. The chapters' purpose is to give the reader a better understanding of the thesis' technical aspects.*

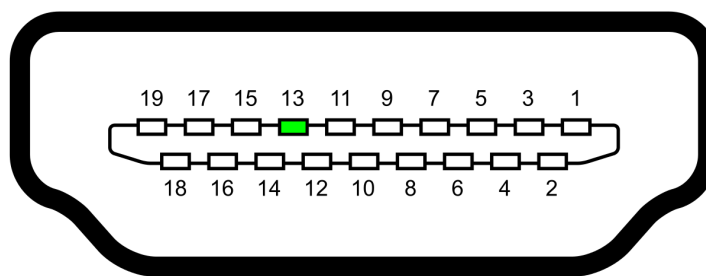
### 2.1 High Definition Multimedia Interface

HDMI is a digital audio/video interface for transferring video and audio from a HDMI-compliant source device, known as a HDMI Source to a HDMI-compliant audio/video receiver, also known as a HDMI Sink. HDMI Sources include DVD players, Blu-ray Disc players, video game consoles, VCRs and cameras which can be linked together with HDMI Sinks like TVs, projectors or monitors, or just about any other device capable of sending or receiving an high-definition (HD) signal to create a HDMI system, such as a home theater system. HDMI has become a modern replacement for previous standards such as composite video, Separate Video (S-Video), Video Graphics Array (VGA) and Digital Visual Interface (DVI). HDMI transmits all HDTV standards and supports up to 8 channels uncompressed audio. HDMI is basically the same as the interface standard DVI for PCs and displays but with the addition of audio, smaller connector and CEC [4].

The HDMI founders are Hitachi, Panasonic, Philips, Silicon Image, Sony, Thomson and Toshiba [5]. With over two billion HDMI-enabled products shipped since the start of the HDMI standard in 2003 it is the industry leading standard for audiovisual equipment and has extended to a vast array of applications, devices and industries [6].

## 2.2 Consumer Electronic Control

Consumer Electronics Control (CEC) is a protocol used in HDMI to provide high-level control functions between various audiovisual products. It is based on the AV.link protocol on the SCART standard and carries control data on a single wire bidirectional bus known as the CEC line on the HDMI, see figure 2.1. This allows for transmission of audio, video and control signal through a single cable. CEC was first utilized to carry remote control data between TVs and DVD players. When a user inserts a DVD into the DVD-player, the DVD-player starts playing and, using CEC, turns on the TV and switch the TV input to the DVD-player. If a separate sound system is available it is also possible to reroute the the sound from the DVD-player to the sound system via the TV. CEC makes it possible to control all products in a home theatre system using only one remote control.



**Figure 2.1:** The HDMI connector pinout where the CEC pin (13) is marked.

Even though CEC has been included in the HDMI standard since its start in 2002, only the wiring is mandatory, the implementation of CEC in products is optional. This means that all HDMI-compliant products does not allow for high-level control functions. Many companies who choose to adapt CEC have their own trade names for CEC, see table 2.1.

**Table 2.1:** Companies and their trade name for CEC

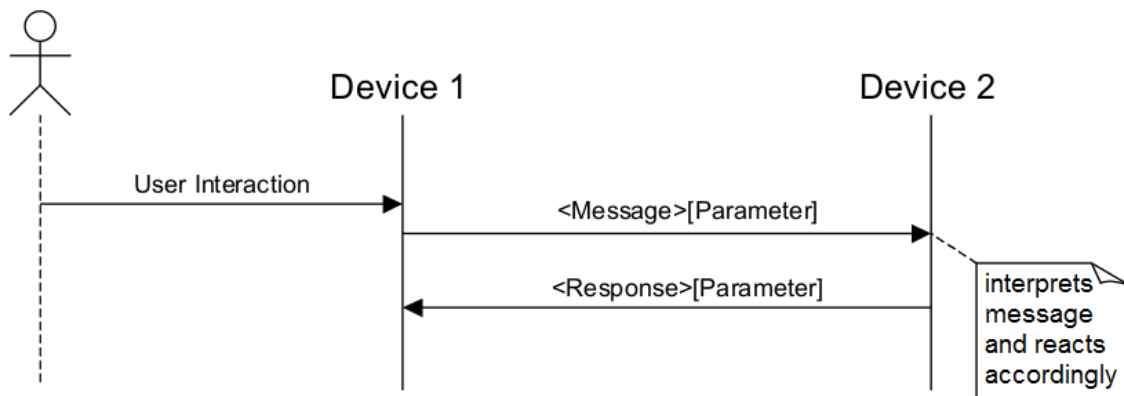
Company	Trade name
Insignia	INlink
LG	SimpLink
Onkyo	RIHD
Panasonic	VIERA Link
Philips	EasyLink
Pioneer	Kuro Link
Runco	RuncoLink
Samsung	Anynet+
Sharp	Aquos Link
Sony	BRAVIA Link
Toshiba	REGZA-Link

The companies use different trade names partly due to vendor specific implementations which often only guarantees full support of high-level control functions between products

from the same company, though in theory products supporting different trade names should be able to work together and be able to communicate entirely using the standardized CEC commands. See section 2.2.3 Vendor Specific Commands for more on vendor specific implementations.

## 2.2.1 Communication

The CEC communication is bidirectional which allows for both the HDMI Source and the HDMI Sink to send and receive CEC messages. Since the control data is carried over a single wire bus, the connected HDMI devices can not send messages simultaneously. The device that receives a CEC message is called a Follower and is required to respond to the message. The device that has just sent the CEC message is called an Initiator and, if appropriate, waits for the Follower to respond to the message[7]. Both the HDMI Source and HDMI Sink can take the roles as Initiator and Follower and will likely switch between these roles multiple times during the communication session. In figure 2.2 Device 1 is the Initiator and Device 2 is the Follower.



**Figure 2.2:** Sequence diagram of a sequence of directly addressed CEC messages between two devices.

## 2.2.2 Messages

### Frames and blocks

A CEC message, also called a frame, consists of a number of blocks. A block is always 10 bits long, where the first 8 are information bits followed by an end of message bit (EOM) and an acknowledge bit (ACK) see table 2.2. The information bits differ depending on which type of block it is. For header blocks information bits are the destination address, bit 0 - 3, and the initiator address, bit 4 - 7. For data blocks they are opcodes or operands, more on this under Data blocks in section 2.2.2. The end of message bit indicates if the block is the final block of the frame, 1 meaning that it is the final block and 0 meaning that one or more data blocks follow. The acknowledge bit is used by the Follower to acknowledge the block. It is always set to 1 by the Initiator and set to 0 by the Follower if it reads its own address in the destination address. The block is then sent back to the Initiator.

Therefore an ACK read 0 by the Initiator indicates a successful transmission of the block. The control bits, EOM and ACK, are always present and always have the same usage. The first block of a frame is always a header block and it is also always the only header block in the frame. The number of data blocks differs depending on the type of message, e.g. a ping message to ascertain that other devices are turned on contains only a header block and no data blocks. The maximum frame size is 16 blocks,  $16 \times 10$  bits. [8]

**Table 2.2:** Generic CEC block structure

Header/Data Block									
7	6	5	4	3	2	1	0	-	-
Information bits								EOM	ACK

## Data blocks

There are two different types of data blocks. The first type is opcode (operation code) blocks that has the purpose of describing what type of message is being sent. The 8 information bits in opcode blocks are unique message identifiers, e.g. User Control Pressed, which indicates that the user has pressed a button on the remote control, has the unique value of 0x44, see section 2.2.3 Remote Control Pass Through for more on this. The other type is operand blocks which contains parameters used by the message.

**Table 2.3:** CEC block structure of a message sent from the TV to a recording device reporting that the Select button has been pressed on the remote control.

Header Block									
0	0	0	0	0	0	0	1	0	1
Initiator				Destination				EOM	ACK

Opcode Block									
0	1	0	0	0	1	0	0	0	1
User Control Pressed (0x44)								EOM	ACK

Operand Block									
0	0	0	0	0	0	0	0	1	1
Select (0x00)								EOM	ACK

Table 2.3 shows an example of a message sent from the TV to a recording device. The message contains three blocks sent in the order of header, opcode and operand block. The header block contains the initiator address 0, which is the logical address of the TV, and the destination address 1 which is the logical address for Recording device 1. Since a message can only contain one header block and a opcode block must precede operand blocks, the recording device knows that second block is an opcode block. By reading the unique id of

0x44 the recording device knows that the user has pressed a button on the remote control and awaits a operand block describing which button it is. The information bits for the operand block is 0x00 which is the unique id for the Select button. The recording device now knows that the user has pressed the Select button on the remote control. Note that the EOM of the operand block is set to 1 indicating the end of the message. Also not illustrated in the table is the acknowledgements for each block sent from the recording device to the TV.

### 2.2.3 Features

CEC provides a number of features designed to enhance the interoperability and functionality of devices within a HDMI system. Implementation of these features are optional but if a CEC feature is supported, the feature has to be completely supported with all messages and their behaviour implemented. Not all feature are covered in this section, only the features relevant for this theis.

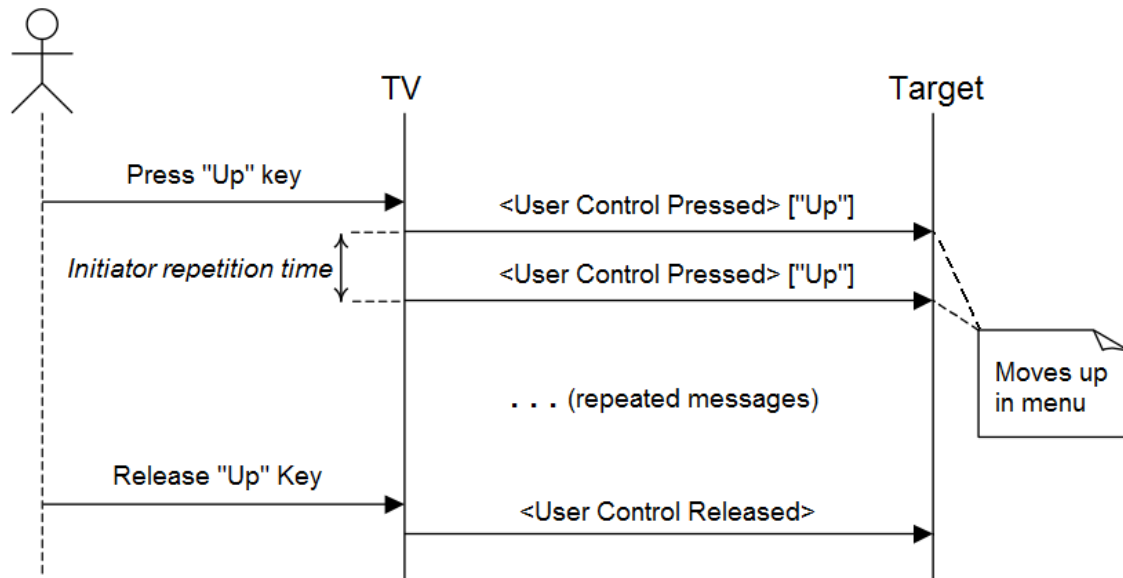
#### Remote Control Pass Through

Remote Control Pass Through is a CEC feature which allow for HDMI devices to communicate within the HDMI system for when a user press and release a specific remote control button. The feature enables a device, typically the TV, to pass through received remote control commands to other devices within the system. Remote Control Pass Through include two types of messages, User Control Pressed which indicates when a specific button has been pressed and User Control Released to inform that a button has been released. User Control Pressed include one parameter, an id mapped to a specific button. User Control Released has no parameters and instead refer to the latest pressed button. The feature is not restricted to only sending messages as a direct result of user interaction, thus not always directly mapped to button on the remote control (or on the TV). For example, a TV can offer a way to access a connected HDMI device's root menu from a menu in the TV UI.

When the user press and hold a remote control button for a period of time, the Initiator repeatedly sends the same User Control Pressed message until the user releases the button. The frequency of these messages are determined by the Initiator repetition time which is a value between 200 ms and 500 ms, see figure 2.3 for an example on this behaviour . [9]

#### Vendor Specific Commands

This feature allows vendors to specify their own CEC messages to communicate between devices. For this to be possible a device that support this feature must store a Vendor ID. The Vendor ID is an id that is unique for that vendor, i.e. each trade name in table 2.1 corresponds to one Vendor ID. A communication with Vendor Specific Commands must be initiated by an exchange of the devices' Vendor IDs. If, and only if, the other device's Vendor ID matches a Vendor ID on the internal list of acceptable Vendor IDs, the communication may continue. If the Vendor ID is not recognized then the incoming messages will be ignored. With this feature it is possible for companies to add new messages and functionality to CEC and tailor the communication for their devices. A common use of



**Figure 2.3:** Sequence diagram for when a user presses and holds down the Up key on the remote control for a period of time before releasing the key.

the feature is to send messages about button presses which are not supported in Remote Control Pass Through.

It is important to note that if a device supports a CEC feature it is not obliged to use that feature before Vendor Specific Commands. For example, a device may support Remote Control Pass Through but choose to send Vendor Specific Commands instead for communicating about remote control button presses for certain remote control buttons, even if they are supported in Remote Control Pass Through. [10]

With the use of the open source Pulse-Eight project libCEC [11] along with hardware like the credit card-sized single-board computer Raspberry Pi [12], it should be possible to listen to Vendor Specific Commands messages and interpret them.

## 2.3 Overlay

Overlays is put on the picture from the camera block in the chip module. Overlay images are converted from bitmap file format to a ovl file format and later on added. The overlays can be in different sizes and there can be more than one at the same time. It is also possible to make parts of an overlay transparent.

## 2.4 PTZ

PTZ is an abbreviation for Pan Tilt Zoom and is a term used for cameras. A PTZ camera is capable of pan, tilt and zoom movements not available to stationary cameras.



**Figure 2.4:** Illustration of pan (horizontal) and tilt (vertical) movement.





# Chapter 3

## Theoretical background

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*The Theoretical background chapter introduces the reader to some important usability and design concepts which is important for the coming chapters.*

### 3.1 Interaction Design

Interaction design is about creating interfaces that that are completely elaborated. With the understanding about how humans reason around navigating in different interfaces the interface developer can partly invent new methods to do things and partly fix problems early in the developing phase.

Interaction design (abbreviated IxD) is the knowledge about shaping digital products for people's use. IxD fills the design needs of digital products with dynamic behavior and changing user interfaces.

Designing interactive products to support the way people communicate and interact in their everyday and working lives [13].

*Once we know something, we find it hard to imagine what it was like not to know it. Our knowledge has "cursed" us [13].*

### 3.2 User-centered Design

User-centered design (UCD) is a process where there is a strict and early focus on the end user. The purpose is to evaluate often and continuously improve the design. A Iterative design processes is a big part of the User-central design. An iterative design process was chosen since it is suits user-centered design well. The usability expert Jakob Nielsen recommends at least two iterations which we adapted in our approach [14]. Nielsen has also

measured that the usability can be improved by 38% per iteration. [15]

### 3.3 Cognitive graphical design

Cognitive graphical design is the knowledge about designing interfaces with concern of how the brain works. By increasing the visibility, give good affordance, support mapping and by giving relevant feedback a user interface can be improved.

There are some cognitive laws according to the cognitive graphical design. The laws are called the law about proximity, similarity, closure, symmetry, common fate, continuity and past experience. [16]

When creating graphical user interfaces the choose of color is very relevant. The brain connects different colors to different feelings and therefore the choice of color is important.

**Blue** often feels distant, peaceful and cold.

**Green** often perceived as distant and peaceful as well.

**Yellow** is on the other hand closer than more stimulating.

**Red** feels warm just like yellow but stronger.

The brain works faster when it recognises a picture and uses its passive memory instead of processing letters to a word with the active memory which gives that icons should be used. Icons shall in general be simple pictures and be based on nouns. [17]

### 3.4 Designing the user interface

*“Anything that can go wrong, will go wrong.”*

— Murphy’s law

When designing a user interface there are some well known researchers and experts who have created some guidelines that is suitable to assume from. Shneiderman’s Eight Golden Rules of Interface Design are a good base together with Jakob Nielsens ten usability guidelines for interaction design. Jakob Nielsens guidelines can be seen in appendix A and the Eight Golden Rules of Interface Design are presented below.

1. Strive for consistency
2. Cater to universal usability
3. Offer informative feedback
4. Design dialogs to yield closure
5. Prevent errors
6. Permit easy reversal of actions
7. Support internal locus of control
8. Reduce short-term memory load [13]

There are some important concepts that are relevant when designing the user interface. These concepts are learnability, efficiency, attitude, flexibility and relevance. They are important due to the fact that the concepts together contains all the important characteristics from a smooth user interface.

<b>Learnability</b>	The relation of performance to training and frequency of use, i.e. the novice user's learning time, and relearning on the part of casual users. How easy it is to learn, and well the users can remember their skills. [18]
<b>Efficiency</b>	The results of interaction in terms of speed and errors. How efficiently the users carry out their tasks and recover mistakes. [18]
<b>Attitude</b>	The acceptable levels of tiredness, discomfort, frustration and personal effort. Subjective feelings towards the product. [18]
<b>Flexibility</b>	Allowing adaptation to tasks and environments beyond those first specified. [18]
<b>Relevance</b>	How well the product serves the functions needed by the user. [18]

### 3.4.1 Card sorting method

This method is used to explore the general structure of an application. The system user often got a mental image that can be discovered with card sorting. By using this method in the design process all the categorization will be thought through. Every function in a system is put on a piece of paper like a memory card, after that everything is sorted based on the logical groupings the participant prefers. [13]

## 3.5 Prototypes

A prototype is the manifestation of a design suggestions for you to interact with in any way. There are two kind of prototypes, horizontal and vertical. The horizontal has many functions and few details, the vertical in opposite has few functions but is more detailed. [19]

### 3.5.1 LO-FI

A LO-FI prototype equals to a low fidelity prototype and is often drawn by hand. LO-FI prototypes are cheap and quick to make. Another advantage is that it can be easier to give constructive feedback on a prototype that does not look polished. Some disadvantages are that usability tests becomes harder and the navigation is quite limited. [19]

## 3.5.2 HI-FI

A HI-FI prototype equals to a high fidelity prototype and is often computer made. It takes a lot of time to create a HI-FI prototype. Adobe Photoshop or Microsoft Power Point is two common programs that can be used for HI-FI prototyping. HI-FI prototypes can preferably be used when usability test must be performed and therefore a click-able prototype is needed. It can in most cases be more cost effective to first create HI-FI prototypes because changes are easier done in non implemented prototypes. [19]

## 3.6 Usability evaluation methods

A program that is hard to use is a poorly designed program no matter how great the different features may be. When performing usability tests the lack of usability can be discovered and any problem with the usability requirements. Not only the fact that the product will sell more if it is usable, the support costs will drastically be reduced as well. When discussing usability evaluation there are some key words that must be explained. [20]

### 3.6.1 Use cases

A use case is a written description of how a user will perform a certain task on the software while striving for a particular goal. A use case is from the user's point of view, each use case is a collection of steps to complete the task. A reason to use use cases is because they add value in explaining and describing the systems behaviour. To create use cases can also be a way to brainstorm what can go wrong in the system. [21]

### 3.6.2 Scenarios

Good scenarios are concise and answer the following key questions:

*Who is the user ? Why does the user come to the site/view? What goals does he or she have?*

With **Goal- or Task-Based Scenarios** it is only stated what the user wants to do. Any information on how the user would complete the scenario should not be included. These scenarios are useful in helping to define your site architecture and content. This type is suited for usability test scenarios. It gives them a reason and a goal for going to the site, but it lets them show you how they would use the site to accomplish that goal.

**Elaborated Scenarios** give more user story details. These details give the Web team a deeper understanding of the users and users' characteristics that may help or hinder site interaction. Knowing this information, the team is more likely to develop content, functionality, and site behavior that users find comfortable and easy to work with.

When identifying scenarios for usability testing, you should limit your test to 10 to 12 tasks due to time constraints. Additionally, in a usability test, you can ask users for their own scenarios.

## Debriefing

The main goal of having a written post questionnaire is to clarify and deepen your understanding of the test person. Every question in a written debriefing must be asked to the test person in the same way but in an oral debriefing the questions can be adopted depending on the test results. The questions shall be subjective, not performance based.

### 3.6.3 Usability inspection

A usability inspection is a way to find usability problems in a interface design. Usability problems in the whole system and also system difficulty can be found. Inspections can be performed early in the design due to the fact that the specification can be reviewed. [22] One type of Usability Evaluation is Heuristic Evaluation which is the most informal usability inspection method. By going through usability guidelines and apply them on the design and later on evaluate.

### 3.6.4 Usability testing

Usability testing refers to evaluating a product or service by testing it with representative users. Typically, during a test, participants will try to complete typical tasks while observers watch, listen and takes notes. The goal is to identify any usability problems, collect qualitative and quantitative data and determine the participant's satisfaction with the product. The desired number of testers in a usability study differs depending on the type of study, but according to Nielsen [23, 24] for most cases 5 test users is preferable. [25]

#### Pilot test

A pilot test is a preliminary study performed to validate the study itself. The pilot test is partly used to confirm that the questions are correctly formulated, it can also be a time and cost test and there is a possibility to change the arrangement of the study post pilot test. [26]

#### Before and after usability testing

When planing a usability test one of the first step is to create a test plan. The things that should be included in a test plan is scope, purpose, equipment, session description, metrics and roles. After the usability test the result is supposed to be reported and analysed. The things that needs to be reported is error and success rates and tast time. Recommendations and other comments must be presented as well as the note takers observations. [27][28]

#### Exploratory testing

This testing technique is cheap and perfect for discovering the interface. The design is not yet decided and the result from the test will affect the future design work. This method is used early in the design phase and the goal is to validate how the design works. This

method can be applied on paper prototypes which makes it cheap to make radical changes. The test leader interacts very much with the test person for example ask questions and start discussions.

### **Assessment testing**

This testing method is in contrast to Exploratory testing a way to test a ready design and perhaps a completed prototype. This test method can be used either in the end of the design phase or in a early implementation phase and the main purpose of this is the localise design issues. [29]

# Chapter 4

## Video conference systems

### *A market overview of similar products*

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*The market overview is done to take inspiration from similar products and this chapter explains the method used and the pros and cons with the similar products.*

In this chapter different video conference systems has been compared and evaluated. To introduce the reader to the chapter the first section will cover the video conference camera this master thesis is based on, followed by an introduction of the existing products on the market which were chosen for evaluation. The purpose of the evaluation is not to identify the market or to find and compare possible main competitors but to evaluate the usability of similar products to identify good and poor design choices. The evaluation and the conclusions drawn will serve as a helpful basis in the design process of the prototype. The evaluation is based on four different use cases which are described in section 4.3 Methods for evaluation. Video conference remote controls are also covered and evaluated in this chapter.

#### **4.1 Axis UtilityCam**

Axis UtilityCam is the camera the thesis is based on. It is the first camera in the V-line series that is not intended for surveillance use. Non-surveillance cameras still have wide use areas, for example video conferencing and broadcasting. Axis UtilityCam will be produced both for 720p and 1080p, there will be a HDMI and SDI outputs and support PTZ with up to 30 times zoom. What makes UtilityCam unique in the non-surveillance field is that the products only consists of a camera and that the user interaction is relied on a separate product. In the case of video conferencing the user completely controls the system with the connected TVs remote control. In many ways it is similar to surveillance cameras but intended for other multi-purpose use.

## 4.2 Different products on the market

There are a lot of different video conference products on the market which means that all categories and types will not be covered in this evaluation. To get the most out of the analysis it is preferred to compare and evaluate video conference products that are similar or have similar features to UtilityCam but also products with unique or different interface solutions to get a broader view on the area.

The four most common types of videoconferencing systems are telepresence videoconferencing systems, integrated videoconferencing rooms, set-top or appliance videoconferencing systems and desktop videoconferencing systems. Telepresence systems give the appearance of being present in an actual meeting even though the participants are geographically dispersed. They usually consist of higher quality video and audio, often with several large displays. This is the most expensive type of the four. Integrated room videoconferencing systems are most often used in conference rooms and board rooms and are designed for larger groups. These systems are usually permanently mounted with customized configurations and are normally equipped with multiple features which allow the room to be used for other functions besides videoconferencing. Telepresence and integrated videoconferencing systems will not be covered in the evaluation, due to their limitations in availability and high cost. Set-tops and appliance videoconferencing systems are non-stationary systems that are most useful in small conference rooms and for smaller groups of participants. UtilityCam falls under this type of videoconferencing system. Desktop systems are often completely software based and requires a computer and separate camera to use. These products are often designed for non-business use. [30]

### 4.2.1 Set-tops and other dedicated systems

This category includes set-tops and other dedicated video conference system that were chosen for evaluation. Set-tops are information appliance devices that displays the output on a display, normally a television set. To get a closer similarity between the evaluated systems and the Axis camera, only portable devices designed for smaller groups were chosen. The systems were selected for their relevance, interesting features and interfaces and their availability.

#### Logitech TV Cam HD

The Logitech TV Cam HD is a set-top video conferencing system that connects to a television set with HDMI. The product has its own remote control and is integrated with Skype. The product is described as a *"living room Skype approved all-in-one TV cam"*[31]. Though the system is not designed for a business environment there are some similarities worth looking into, PTZ control is supported along with a 10-foot user interface.

#### Google Chromebox for meetings

Chromebox for meetings is a Chromebox with additional video conference equipment; a HD camera, microphone/speaker and remote control. The Chromebox is a personal com-



puter running Google's Chrome OS operating system. Chromebox for meetings connects to a display using DisplayPort++ or HDMI with no support for CEC [32]. The interface is similar to Google+ Hangout but designed for a larger screen. [33]

### **Lifesize Icon 600**

The Lifesize Icon series is a series of video conferencing products that has more emphasis on the ease of use than their other series. Michael Helmbrecht, Vice President of Product Marketing on LifeSize Communications said that *"The idea behind the icon series is to simplify the video conferencing for individuals, one of the things that we've heard over and over is [...] that many users are still intimidated by it [their products], it is still too difficult to use versus competing technologies that people are more familiar with, like audio conferencing or web conferencing"* [34]. The Lifesize Icon 600 is HDMI enabled and supports up to 1080p. It consist of a remote control, which is covered in section 4.4.2, a camera along with other accessories.[35][36]

## **4.2.2 Software based systems**

There are products on the market that only provides the graphical interface between two end users, the hardware can differ which makes the system more dynamic.

### **Blue Jeans**

Blue Jeans offers a cloud-based video conferencing service that can connects different users with no requirements on the hardware which makes Blue Jeans to a very dynamic video conference client. The main purpose of Blue Jeans is to bring together business conferencing solutions. [37]

### **Hookflash**

Hookflash is a application for smart phones which offers text messaging, telephoning and video conferencing over a peer-to-peer network. The system also offer features like call transfer. [38]

### **Palbee**

Palbee is a Video Conference system that is used mainly for sharing knowledge. The system offers limited talking hours and participants but unlimited amount of sessions. The interface is flash based and evry kind of computer with an internet access can use it. [39]

### **ParkSlide**

ParkSlide is a system for video conferencing that from the beginning where designed around social networking. ParkSlide has since the beginning developed into an enterprise direction. ParkSlides vision is to change the common overly complicated systems and software in video conferencing. [40]

## 4.3 Methods for evaluation

This section is important for Axis who want to launch a competitive product on the market in the near future. The market analysis is also important for the master thesis project itself because what functionality is needed and what we can do can be inspired from other similar products as well as what we should not do, mainly concerning the graphical user interface. The focus of this section will mainly lie on the menu systems, ease of use and installation and setup.

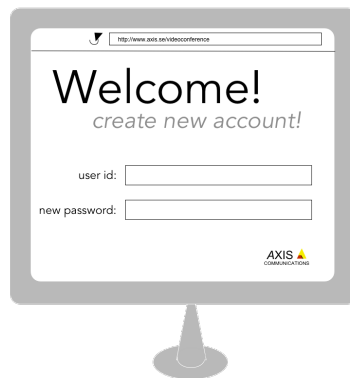
### 4.3.1 Use cases

To be able to compare and evaluate different video conference systems from the usability point of view we started with creating four use cases which reflects the need of a typical video conference user.

#### Use case 1: Installation and setup

The installation and setup of the system is often the first impression the user gets with the product. As it is commonly known that first impressions could have a large impact on the users overall experience with the product, it is important that the installation and setup has a welcoming design that doesn't scare the user away or make him or her hesitant to use the product.

The purpose of this use case is partly to capture the first time the user is introduced to the system and how well it is introduced to the user. It includes the necessary, and possibly unnecessary, steps before the product can be used for video conference call from when the system is turned on for the first time after all cables has been correctly connected.

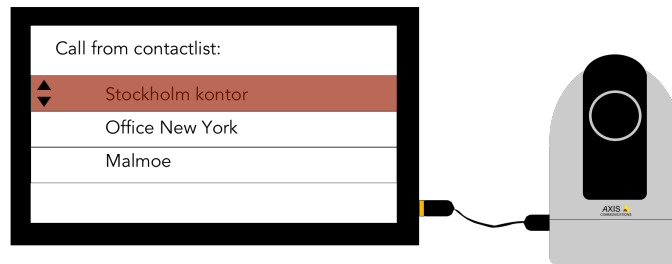


**Figure 4.1:** Example of use case for installation and setup.

#### Use case 2: Initiate a call

One of the core functions of a video conference system, which should be an easily accessed and intuitive process. This use case include adding the address of the receiver, both from

a preconfigured contact or manually adding the address. Most of the systems have the call camera symbol in direct connection to person the user want to call which prevent errors due to the fact that the user sees the picture at the same time as calling. One thing that increased the user experience were in Hookflash when calling somebody a spinning circle and a timer of how long the user have waited occurred on the screen. Many of the initiate calls is by pressing a button with a camera symbol. This symbol is a bit miss leading, a telephone might would be better as dialing symbol because the user will not mistake the dialing button for watch the camera.



**Figure 4.2:** Example of use case for initiating a call.

### Use case 3: Answer a call

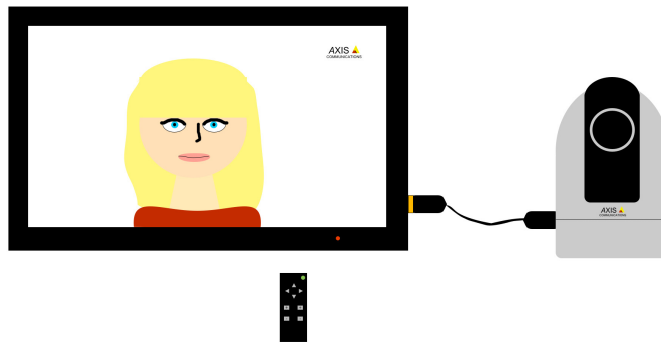
Often completed with just a press of a button but includes more than that. The user should get notified of incoming calls, from who it is and how to answer without other unnecessary information which might confuse.



**Figure 4.3:** Example of use case for answering call.

### Use case 4: PTZ Control

Controlling the Pan-Tilt-Zoom features during a video conference call. What the differences are there in the design when controlling the local cameras PTZ and controlling the remote cameras PTZ. What symbols should be used to get the most usable remote control. This is the only use case which takes place during a video conference call. It was chosen as a use case because of the feature's high importance and how it might distract the user from the video conference call if poorly designed.



**Figure 4.4:** Example of use case for controlling PTZ functionality.

## 4.4 Evaluation

The analyse includes to interpret the information given from the use case evaluation of the video conference systems described above. In this section we will discuss pros and cons from different graphical interfaces and the effects it will cause for the user as well. The analytic evaluation will be grounded of what expectations is held on a video conference system interface which is a subjective form of evaluation and the functionality performance which is the objective form of a evaluation. Except for the mentioned evaluation methods, a combination of heuristic evaluation and comparison testing is performed as well. The video conference cameras compared in this section are described above 4.2 as well as the testing methods and techniques 3.6.

### 4.4.1 Menu system

Lifesize Icon are video conference products which are based on one principle, simplicity. The design revolves around presenting the same user experience which we commonly get from todays smartphones[35]. This is seen in the menu system where the icons swipes back and forward when the user navigates through the menus. As expected from the name, the icons play a very important part of their design, it is what their design stand or fall by. Google's Chromebox for meetings goes for a more minimalist look, a winning concept which they have used since the start of their search engine. In contrast to Lifesize Icons interface this makes the other participants visible at all times.

### Installation and setup

The criteria on the interface in this use case is the simpleness. This step is only done once and therefore it should be quite straight forward. In some products the installation were simple because all the wireless cameras connected where shown in a straight forward list and it was very easy to find and install the camera intended. In other systems the camera could only be found when entering the correct IP number which in many cases where hard to find and not very adopted for persons without it knowledge. Other problem in other systems where for instance that it was possible to video call persons without first installing the camera which were not that logical in contrast to, for example Parkslide which focused

a lot on the design and had a intuitive tab for installing the camera, the interface were overall very clean and easy to find in. Parkslides slogan is "Get started in seconds, talk for hours". Chromebox for meetings had a fast and straight forward setup process, the user did not get overwhelmed with unnecessary configuration steps since the setup only consisted of picture, sound and microphone checking. Easy as it might seem there are some prerequisites, Chromebox has to be setup and running and the user needs a Google account. Bluejeans is a video conference client that is compatible with a bunch of different cameras which makes it easier for a company to have meeting without the same type of hardware. The functionality is also implemented in other VoIP system such as Skype, Skype is usually not used for video conference calls, although for example Logitech have a Skype integration for their video conference camera.

### **Initiate a call**

Most of the product that where evaluated by us had tried to make this step intuitive and logical. A problem with Hookflash were that to initiate a call the user had to manually type in the number to be able to make a call. Parkslide has a smooth drag and drop system to add people in the conversation. This is showed for the user with a text and a box where you can drop the pictures of the one you want to talk with. For example Blue Jeans also uses the color mapping with red to end call which the human mind connects with stop.

### **Answer a call**

Hookflash has a very simple and good way to answer a call, the buttons are color mapped to make it more logical for the user. Accept is green, ignore is orange and decline is red.

### **PTZ Control**

In the different PTZ remote controls there are some different approaches of how to control the pan tilt and zoom. The pan and tilt is often remote controlled with arrows, see figure 4.5, it is logical that the panorama view is navigated by left and right arrow and the tilt with up and down arrows. The zoom in some remote controls are logical with mapping to magnifying glass with a plus or a minus. Both 4.5 and 4.6 with a W and T which not are that intuitive. The W and T refers to a word that does not work cross languages, a symbol is better. In some cases there are two different speeds for zoom which could be useful in some cases but in general there could be too many buttons as in 4.5. Depending on what the remote control should be used for sometimes less is more.

## **4.4.2 Remote controls**

Most video conference systems are designed to be controlled with a remote control, the exception being software products that are made to be used on a desktop computer and are thereby controlled using a standard mouse and keyboard. Many of the products which rely on a remote control solution design their own remote control which is included with the camera. For some systems the remote control is not mandatory but can be bought



**Figure 4.5:** Agent remote control for controlling PTZ functionality.



**Figure 4.6:** Sony remote control for controlling PTZ functionality.

separately. The design and complexity of these remote controls can vary a lot depending on which aspects the manufacturers have decided to focus on.



**Figure 4.7:** From the left, remote control for the Icon series and remote control for the 220 series.

Lifesize chose two very different approaches in their remote control designs for their series, 220 and Icon, see figure 4.7. For their older 220 series the remote control is very similar to a standard TV remote control with many buttons and a higher learning curve. For their newer Icon series they took a complete u-turn and made their remote control as simple as possible with only the most essential buttons: a mute button, navigation buttons and a select button. That is a total of 6 buttons compared to 33 buttons in the 220 series. Lifesize says that with their new remote control for the Icon series they *"want the users to never have to look down at the remote"*[41], this way the user can focus on the display instead of trying to figure out which buttons do what. For the user to be able to control the system with only 6 buttons, down from 33, they also had to revamp the navigation and menu system, see Menu system in section 4.4.

Google's remote control for Chromebox for meetings has also tried to adopt the same simplicity as Lifesize Icon remote control, at least partly. The front look very similar to the Icon remote control with the only additions of an end call button and a menu button, see figure 4.8.



**Figure 4.8:** Front side of remote control for Chromebox for meetings.



**Figure 4.9:** Rare side of remote control for Chromebox for meetings.



# Chapter 5

## First iteration : *Requirements & concepts*

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*In this chapter the early development of the prototype is described. The chapter is divided into three main parts: Method, Results and Conclusions. Method covers the work process and the methods used, Results describes the results from the tests and Conclusions consist of the conclusions drawn from the results.*

The goals for the first iteration with a horizontal paper prototype were the following. Decide what functions that would be included and decide what steps that should be included. There was no focus on in-dept details in this iteration, just proof of concepts. The things that were prioritized in this step were the terminology, the conceptual design and the categorisation and grouping of features. The goals were fulfilled by creating prototypes that are based on the conclusion from the evaluation of similar products in the previous chapter.

### 5.1 Method

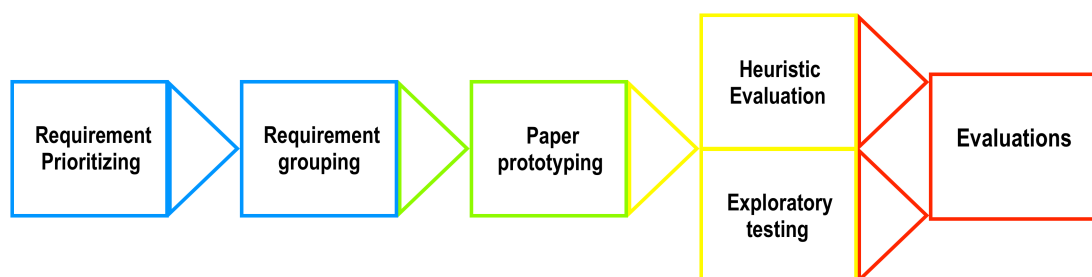


Figure 5.1: Iteration 1 work process

Figure 5.1 illustrates the work process for the first iteration. Initially requirement prioritisation and grouping was performed using the card sorting method. Based on the results from the card sorting and the conclusions from the previous chapter a paper prototype was made which was tested and evaluated. The conclusions from the evaluations was later used to improve the prototype in the second iteration.

## 5.1.1 Design

### Prioritizing

Every function from the current function analysis where included in a prioritization session and where given number with the the numeral assignment technique. The 13 functions where categorized from 1 to 13 where 1 equals the function that is most prioritized.

### Grouping with Card sorting method

The categorization between the different sub views is decided with the card sorting method. The technique is described in 3.4.1. The result from the card sorting session turned out in the four views "installation, settings, before call and during call. This can be viewed in figure 5.2. The functions from the functional analysis where divided into logical groups which represent what view in the menu system the function will be in.

### Paper prototyping

The prototypes in the first iteration were hand drawn on paper so usability testing and usability inspection could be performed. The prototypes where inspired by conclusions from the evaluation of similar product in 4.4.

## 5.1.2 Exploratory testing

This type of testing is described in section 3.6.4. The test consisted of note taker, test person and a test leader. The usability test was a minor formative usability test with focus on qualitative data. The purpose of this test was to test and evaluate how the preliminary conceptual design works, also to test if the terminology was fitting. The test could also be seen as a pilot test for future testing and as training for the test leader and the note taker.

The test was performed on three master students that has specialised in usability and design at LTH. The reason we chose these test persons, which are not in the target group, is because we wanted to get a lot of feedback regarding the usability. The students did a combination of both a form of expert judgment due to their academic background and a form of personas due to the fact that they getting a scenario they have to adopt to.

Six different scenarios were created which all contained a task for the test person to perform. The test leader tried to introduce a discussion for every scenario while the note taker described the scenarios and recorded what the test person expressed. The test started with

a short description of the master thesis and picture 4.4 where shown for the test person. For more on the presentation and scenarios, see appendix B.

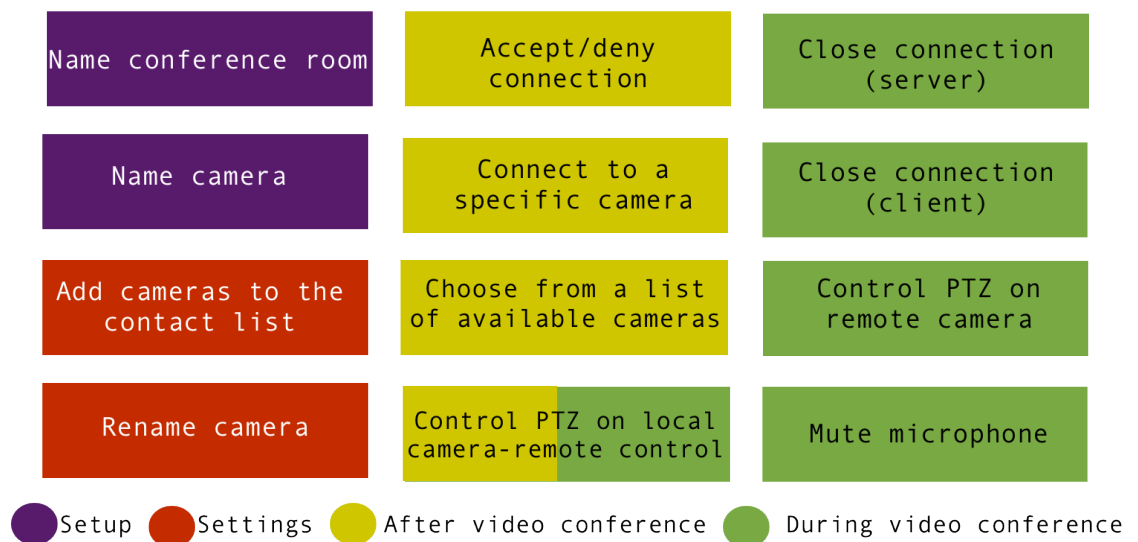
### 5.1.3 Heuristic evaluation

Usability inspection of iteration 1 where done with Heuristic evaluation that was based on Jakob Niensens 10 Usability Heuristics in appendix A.

## 5.2 Result

### 5.2.1 Design

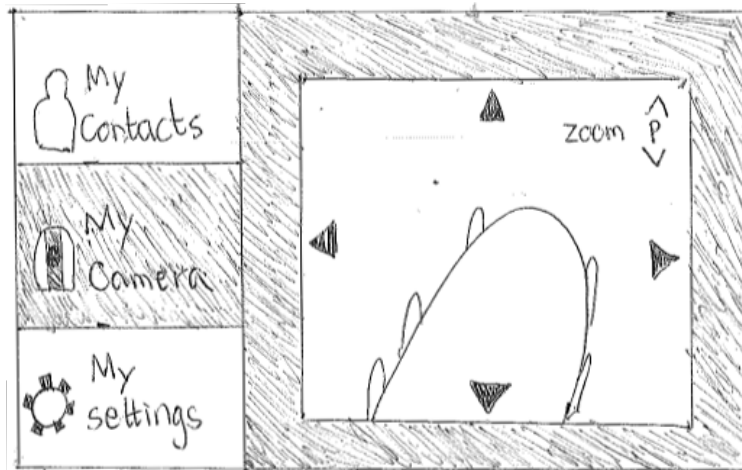
The results from the prioritizing and grouping of functions can be seen in figure 5.2.



**Figure 5.2:** Grouped and prioritized functions. Functions closer to the top is have a higher priority. The color mapping corresponds to the different views of the menus.

### 5.2.2 Exploratory testing

In scenario 1 the test participant were suppose to type in the name of the conference room they were currently sitting in as a part of the setup of the video conference system. Two of the test participants failed this test by typing their own name. During the retrospective probing (RP) they both said that the reason why they failed was because they were eager to get through the setup process as soon as possible and because of this they only read the word "name" and assumed they were suppose to type their own name.

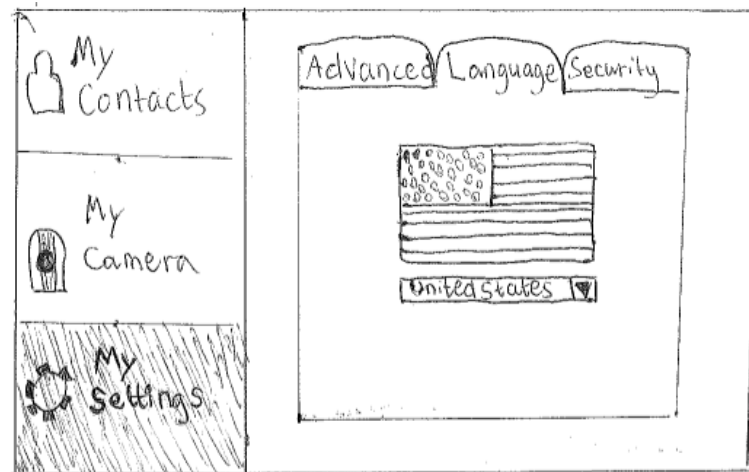


**Figure 5.3:** The view in the first iteration prototype for controlling the PTZ values of the local camera.

All three test participants had issues with the menu navigation. They expressed uncertainty for what the navigation buttons did in different situations. Most notable was during scenario 2 where the test participants wanted to pan, tilt and zoom the camera, and scenario 3 and 4 where the test participant wanted to change the settings. During scenario 2, when the test participants had reached the view shown in figure 5.3, two of the test participants expressed that they were uncertain if pressing the arrow buttons on the remote control would pan and tilt the camera or would continue to navigate through the menu.

Similar comments were made for the settings view, figure 5.4, where the test participants had issues determining if their action would affect the left or right panel. It was also stated that not enough feedback was given regarding if tabs or menus were selected or not, though one test participant thought that it was because the test was made on a paper prototype. The same test participant suggested an alternative way for changing settings in a list such as language by using the numpad or the channel up or down buttons. During the RP, one test participant said that there were some inconsistency for menus layout and how they worked. One test participant did not understand the term picture-in-picture in the advanced tab under My Settings.

It was also made clear that in the right panel of figure 5.3 it was found intuitive and easy to understand how to pan, tilt and zoom the camera, none of the participants failed this task on their first try. During the test one participant was asked about the zoom icon in the upper right corner and if it would've been better to use perspective arrows. The test participant thought it was much better as it was in the test because that icon was recognized from the remote control. With different icons for the button on the remote control and for the screen it would be more difficult to map these together. The purpose of being able to control the remote camera and not the local camera during a video conference call perplexed a test participant, as a user he wanted to be in control of his own product, not anyone else. It was also expressed that it deprives the purpose of configuring the local cameras pan, tilt and zoom if the user on the other end of the video conference call can change it freely. Overall the test participant thought that PTZ control was a "luxurious feature" which isn't



**Figure 5.4:** The view in the first iteration prototype for changing system language.

necessary.

Some spontaneous thoughts of changes from the test participants:

- Strive for more consistency in the navigation.
- Use the numbers as presets in the contact list.
- It is enough to only control your own cameras PTZ according to one test participant.

### 5.2.3 Heuristic evaluation

The main menu gives good information of where the user is because the whole view is visible and there are clear indications in the view which helps the navigation. The introducing installation should give a hint of how many steps are left of the installation, for example "2/3" in the right corner. The "My Settings" view got some issues about the navigation, due to the fact that there are nested tabs inside of the menu the interface must be very clear of the navigation status.

According to Jakob Niensens second rule, see appendix A, the system should be designed for its target group with for example terminology which the prototype is. The headlines in the main menu could have more professional headlines instead of MyContacts, MyCamera and MySetting but on the other hand the names indicates precisely what the view is aimed for which is good.

The third rule is fulfilled because the user can always navigate to another state in the main menu. During a call the user can press the menu button to end the call. If it is to hard to end call, a mistake call could be embarrassing but on the other hand if it is very easy to end call the user might end calls by mistake.

The navigation should always be straight forward and in the MyCamera and MySettings views there is need for clearer navigation possibilities and indications of where the user are. The interface is indeed flexible for both new and advanced users, by default there is a lot of help views and the views are design for not that technical users. Even though there is a help view during the minimalistic call view, the order of the functions must be thought through.

## 5.3 Conclusions

### Terminology

Picture in picture is a technical term which is hard to understand, a better way could be to use self explanatory images or icons. My Contacts, My Camera and My Settings should be changed into something more professional, it can also give the user the false impression that the user interface is personal, even tough it is room based. In the Language tab, United States should be changed to English. It is not clear what the Security tab means, Privacy could be a better term. The zoom indicator in the PTZ view, figure 5.3, is easy to understand and maps to the remote control button well. A reason for why two of the test participants failed scenario 1 could be the lack of background information. Inexperienced video conference users often associate video conference systems with Skype, which is a personalized product unlike the prototype which were tested. During the setup it should be made more clear that the user is asked to insert the name of the conference room.

### Conceptual model and navigation

Drop down menus is mostly a computer oriented design and is not optimal for interfaces designed for television sets, it should be made clear how to open the drop down menu if they are kept in the design. The setup should have a clear indication on where the user is in the setup process and how many step there are. The general conceptual model and navigation routes needs a lot of work and might have to be completely remade. The testing showed that the current design for the main menu is a poor design. With two menus shown at the same time, right and left panel, it is difficult to navigate. The design of the menus is most confusing when the user is presented with multiple horizontal and vertical menus, e.g. see figure 5.4, this should be avoided.

### Features

*“The hardest part of design, especially consumer electronics, is keeping features out.”* — Donald A Norman

Since a goal of this thesis is to develop an initial prototype which focus on the ease of use, the scope for included features should be reduced in upcoming iterations. This is especially relevant for features which can not be fully implemented due to technical limitations and would only serve as a placeholder and not a proof of concept of how such feature could

or should work. Since the feature can not be fully implemented it would not be correctly tested in upcoming iterations which is planned to be done on the implemented prototype. Picture in picture is one such feature that also was found to be a technical term that might be difficult to understand. The feature picture in picture does not necessarily have to be removed in upcoming iterations but the option of enabling and disabling picture in picture should. Advanced settings and features which would primarily be used by advanced users will thereby be reduced in upcoming iterations.





# Chapter 6

## Second iteration : *Design & prototyping*

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*This chapter contains information about the method used in iteration 2 and the results which is half way into the design. The results are presented in form of digital prototypes. The chapter is formed in the same way as chapter 1.*

The goals for the second iteration included creating a HIFI-prototype. In contrast to iteration one where it was decided what functions should be in what view, this iteration focused instead on how to interact with the different functions in a natural and useful way. The second iteration is more detailed than the previous one. what was most important in this step, was to get feedback about how well the user understand the hidden functions and also feedback on the use of color et cetera.

### 6.1 Method



**Figure 6.1:** Iteration 2 method overview

The goals and test method from the second iteration can be found in appendix C. The iteration started with a complete redesign from iteration 1 that were based on the conclusions from iteration 1. Digital prototypes were created and usability tests was made. Each test included a debriefing, the results were used to draw conclusions.

## 6.1.1 Design

This was still quite early in the design phase and it was therefore decided to rethink the design from iteration 1 to be find a better solution. The main menu was completely re-designed and the main goal was that less is more. Even though the old design in 5.3 kept the user aware of where they were and how they could navigate to other view, the new design seen in 6.2 is a better design for TV interfaces.

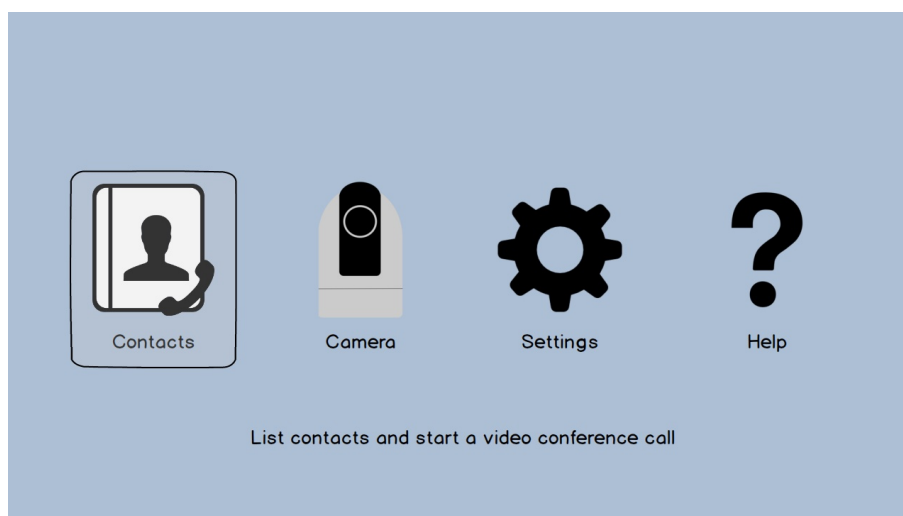
## 6.1.2 Assessment testing

The usability test was performed on seven test persons that work on Axis Communication AB. They were chosen because they fit the target group, since the prototype is meant for business use. The complete test plan can be found in appendix C. One goal with the usability test was to get suggestions for improvement. The whole system is tested in a real video conference environment. The sessions were all together about 45 minutes long an contained six different scenarios with a debriefing afterwards. The data collected is both subjective and objective information we received from the tests. The test leader interacted if needed with the test person and the note taker collected all valuable information.

Techniques used for the assessment testing were concurrent think aloud and retrospective probing which are technique where the test person talk loud what they think and how they resonate while retrospective probing means that there is a discussion after the test session. [42] [43]. The data collected during the test were both quantitative and qualitative data.

## 6.2 Result

### 6.2.1 Design



**Figure 6.2:** Iteration 2 main menu



**Figure 6.3:** Iteration 2 language view



**Figure 6.4:** Iteration 2 remote camera view

## 6.2.2 Assessment testing

### Quantitative data

**Table 6.1:** The 1 - 5 scale questionnaire statements used in the assessment test.

Q1	I feel confident that I used this system correctly
Q2	I think that I would need to ask questions to know how to use this system
Q3	I think that most people would figure out how to use this system very quickly
Q4	Figuring out how to navigate in this system was difficult
Q5	I think that this system was easy to use
Q6	I think the amount of information where adequate
Q7	I think the use of color where appropriate

The data presented in table 6.2 shows the results from seven questions, seen in table 6.1, from the seven test persons and two pilot testers. The debriefing survey can be found in appendix D. The table shows that question three and question seven got the lowest points for the questions where high points were preferred, which are all except question two and four. With the low mean value of Q7 of 3.78, it should be noted that the choice of colors not optimal and can be improved to next iteration. Figure 6.6 shows a bar diagram for these values.

**Table 6.2:** Debriefing results for question (Q) one to seven with test person (TP) one to seven and pilot tester (P) one and two. 1 means strongly disagree which scales up to 5 which means strongly agree.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7
TP1	5	3	3	3	4	3	4
TP2	2	4	2	4	3	4	5
TP3	5	2	4	1	5	2	2
TP4	5	1	4	2	4	4	4
TP5	5	1	4	2	4	4	1
TP6	4	4	5	2	5	5	5
TP7	4	2	4	1	5	5	4
P1	5	2	4	2	5	4	4
P2	5	2	4	2	5	4	5
<b>Mean</b>	<b>4.44</b>	<b>2.33</b>	<b>3.78</b>	<b>2.11</b>	<b>4.44</b>	<b>3.89</b>	<b>3.78</b>

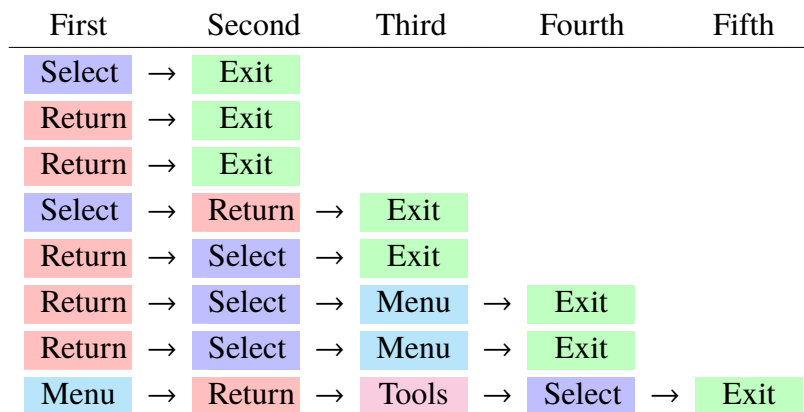
## Navigation

All users understood right away that they had to use the arrow buttons to navigate through the menus and used them correctly. Several users commented during the testing that the navigation through the menus felt fast and smooth. The first time the users came across that they had to go back a step in the menus was in scenario 1 where they wanted to go back from the Camera menu to the Main menu. None of the users pressed the correct button (*Exit*) on the remote control on their first try. Three users pressed the correct button on their second try, two on their third, two on their fourth and one on the fifth, see figure 6.5. In the Camera menu a few test persons expressed that they felt that it would be suitable with more hints for how to go back to the Main menu. One test person said that the *Select* button should send back to Main menu from the Camera menu because the test person felt that *Return* or *Exit* would exit the menu without saving the cameras PTZ configurations that were made.

After scenario 1, once the users had found that *Exit* was the correct button, the users continued the usability test by going back a step in the menus in a correct way. During the retrospective probing the users were asked why they think they failed to go back to the main menu from the camera menu in scenario 1.

## Information

The information that was not existing in the prototypes was how to return. There were also missing information about who you are connected to during call. Other things that were missing were the Axis look n' feel in the design. When muting the call it was not clear if it was the local or the remote microphone (the microphone on the other side of the call) that was muted.



**Figure 6.5:** The buttons pressed by the users in their first encounter of having to go back a step in the menus. Each row represents the series of buttons pressed by a user in chronological order from left to right.

## Feedback

Many test persons found the prototype to be lacking feedback when changing language, the only thing that changed were the language symbol in the top left corner which switched to the selected language. Two test persons said that they were expected to be sent back to the settings menu when they changed language which the prototype did not do. More feedback where desired regarding the mute function during a video conference session, especially when the menu was not present.

## Terminology

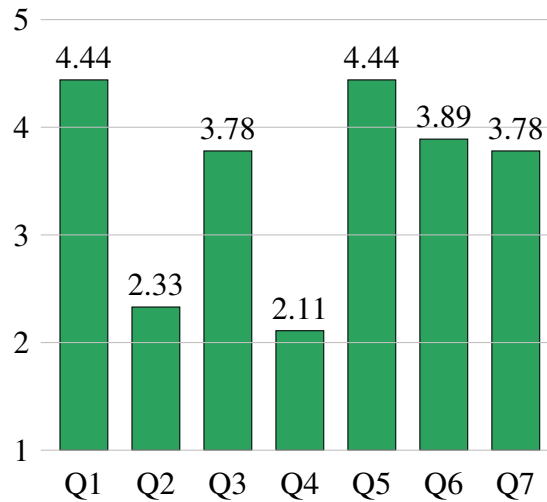
Generally the users did not find the terminology confusing and felt that the sentences was of appropriate length. One user found it unclear if the mute function in a video conference call muted their own microphone or the microphone on the other side of the conference call.

### 6.2.3 Results from open discussion

In the contacts menu some test persons wanted to be able to go directly from A to Z as well as directly from Beige to Yellow which was not possible in the current design. Beige and Yellow are conference rooms from the usability test session. It was new for some test persons that you can configure the PTZ for both local and remote camera. This was said to be unnecessary and some wanted to have the opportunity to turn this feature of.

Colors should be more, exciting, modern and warm. A problem that occurred was that the help menu was not present when it was felt that it was needed. It was never used for during the tests. One test person commented on the Camera view that it is not clear if the changes are saved. The mute/unmute icon and text were contradictory.

## 6.3 Conclusions



**Figure 6.6:** Mean value of the results from the 1 (strongly disagree) to 5 (strongly agree) scale questionnaire in appendix D, these are the same results as in table 6.2. Higher value is better except for Q2 and Q4 where lower is better.

### Navigation

One recurring error that was found in the assessment testing regarded the users ability to go back a step in the menus. As seen in figure 6.5 all users tried the *Return* button on their first or second try except one user which pressed the correct button on the second try. Based on the result it is clear that the correct button should be the *Return* button. The reason why the *Return* button has not been used previously is due to technical limitations. *Return* does not map to a CEC UI Command Code like *Exit* does but is a vendor specific implementation which falls outside of the scope for this thesis.

### Information

The results showed that all users had trouble knowing how to return, see figure 6.5. There were also missing information about who you are connected to during a call. Other things that can be improved was to give the prototype a more Axis look n' feel, by fonts and colors that are typically used in Axis products.

### Terminology

The terminology in the prototype is good and does not need to be changed for the next iteration.

### **6.3.1 Error sources**

Some things could affect the result in a negative way, this is for example that two of the debriefing questions were designed in a way that low number is preferred while in the other five questions a high score is preferred. Another error source is that the test persons all had different experience of similar systems, some had experience with HDMI-CEC and XBMC before which were helpful because the navigation is similar. XBMC is an open source media and entertainment center.





# Chapter 7

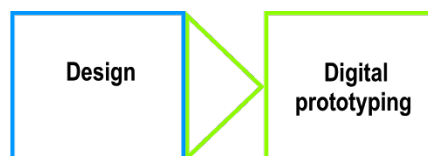
## Third iteration : *Graphic design & high level prototypes*

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*This chapter contains information about the method used in iteration 3 and the final design results. The results are presented in form of digital prototypes. The chapter is formed in the same way as chapter 1 and 2.*

The third iteration is the last iteration in the design process for this master thesis. The goal for this iteration was to create a HI-FI prototype with Axis look and feel. All the results and conclusions from the usability tests in iteration 2 were considered.

### 7.1 Method



**Figure 7.1:** Iteration 3 method overview.

#### 7.1.1 Design

Important for this iteration was to not change anything that we did not have any base to change because there is a chance to introduce new usability problems. The changes for this iteration was based on previous usability test results and conclusions from iteration 1 and 2.

## 7.2 Result

The main view from iteration 3 seen in figure 7.2 is the interface with Axis look n' feel, only three menu selections and a gray text that explains the marked menu choice. The help menu has been removed. The intuitive icon that shows that the sound is muted can be seen in figure 7.4, which is a view that is shown during call, gives its information without being in the way for the user. The indicator in right top side of the view is the same as in iteration 2 but the colors has been changed. The left indication about how the user navigates back to the main menu is complimented by a symbol which is the same as the button that is supposed to be pressed on the remote control. This symbol may differ depending on TV model but information about the TV brand can be fetched with CEC and the displayed symbol can be adjusted to fit the remote control. The main difference in the Settings language view figure 7.5 is that the user is moved to the previous view when selecting language, this is to give the user feedback. An interaction design advantage we added to the contact list view figure 7.6 were that there are two items showing down or up except when the scroll reaches the end of the list. The intuitive scheme in the top of the view with all the letters shows in what letters there is conference rooms and what letter is in focus right now. This scheme is a short cut for faster navigating when there is a lot of conference room.



List contacts and start a video conference call



**Figure 7.2:** Iteration 3 main view

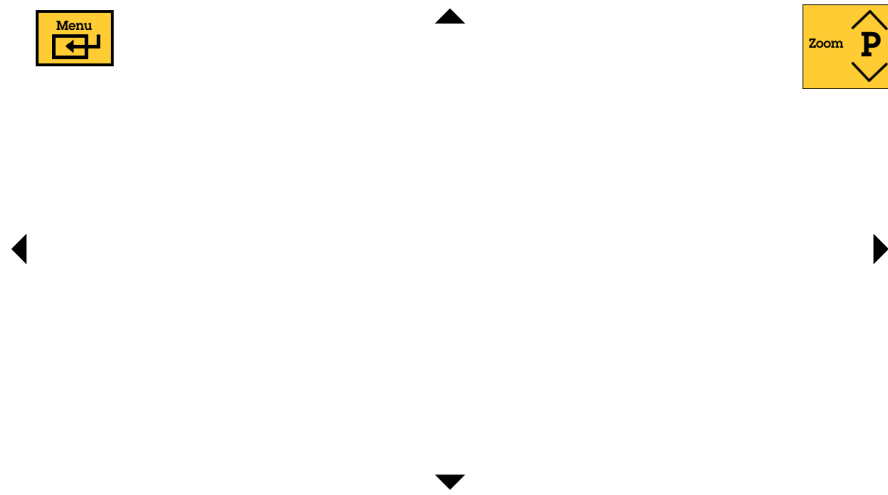


Figure 7.3: Iteration 3 during call

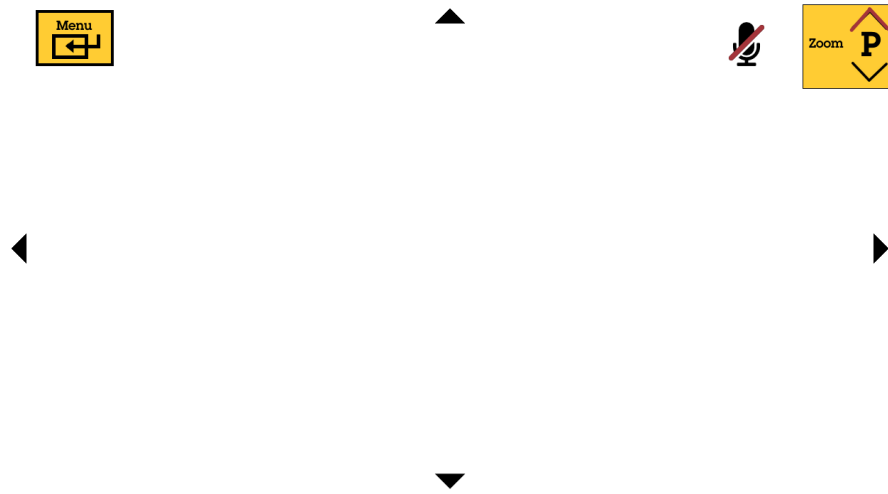


Figure 7.4: Iteration 3 during call with mute and zoom

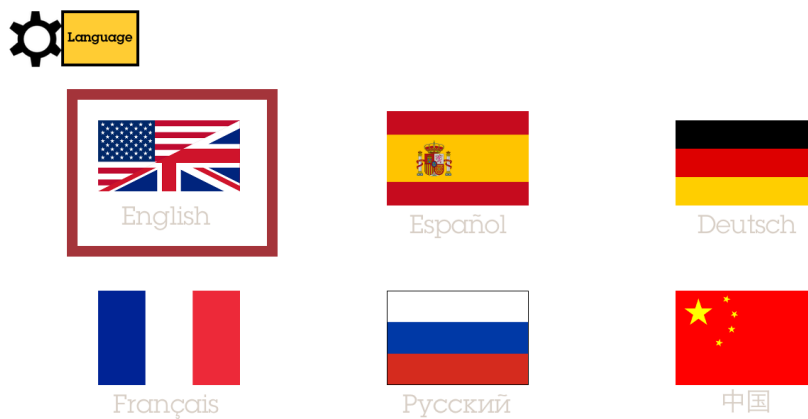
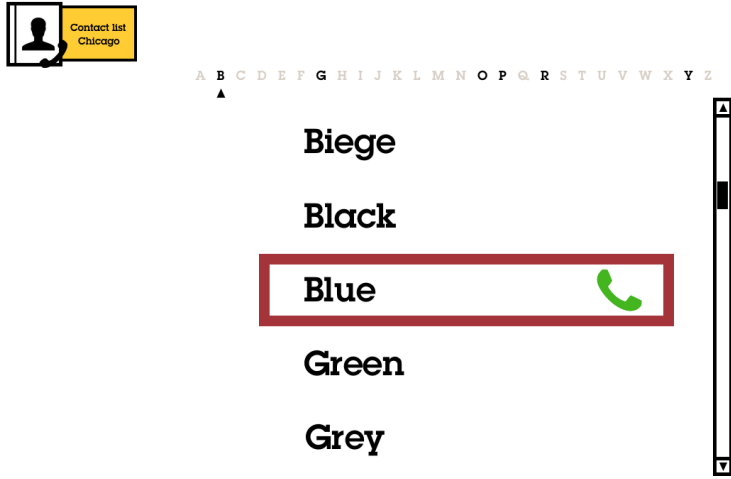


Figure 7.5: Iteration 3 language view



**Figure 7.6:** Iteration 3 contact view

# Chapter 8

## Implementation

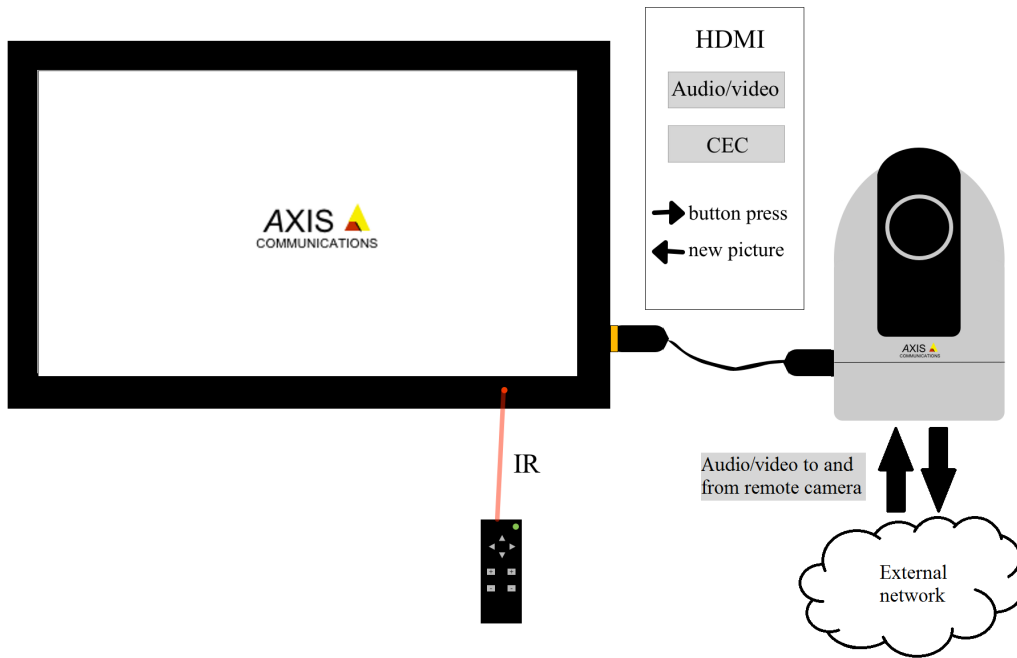
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*The implementation chapter describes the setup and implementation of the final prototype. This chapter also covers technical restrictions.*

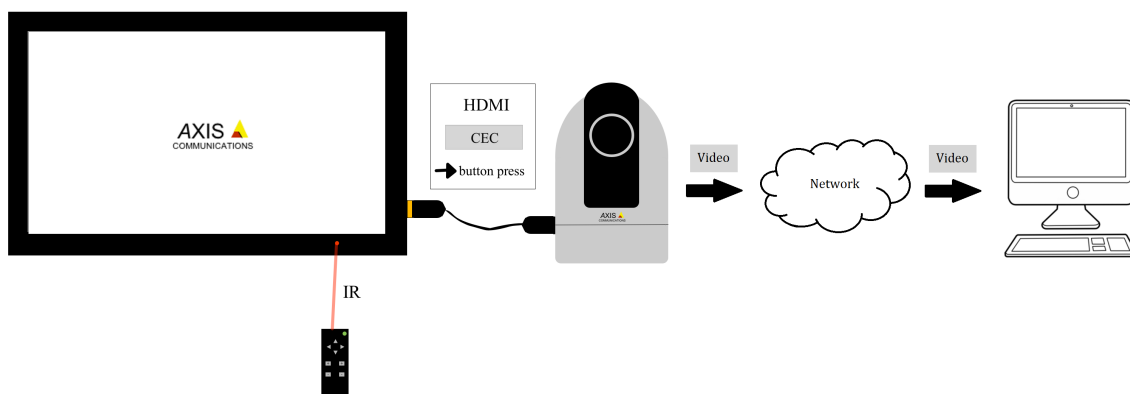
### 8.1 Overview of the setup

The communication between the different artifacts for one end of the system is shown in figure 8.1. The same configuration is taking place in another remote conference room and the external communication is through an ethernet port on the camera over the external network. The figure illustrates which data is sent from the different artifacts in the system. The user navigates in the menu system with a remote control and the signals are passed through HDMI to the camera. This was the initial setup, the end setup is illustrated in figure 8.2. The differences between these are due to technical limitations which were found through the course of the thesis. In the initial setup the video stream is displayed on the TV but in the end setup the video stream is displayed on a computer monitor. The switch of monitors was made because the communication from ARTPEC 5 to FPGA was not yet fully implemented when this thesis was conducted, see 8.4 Technical Limitations. The computations are still being made on the camera, the computer only displays the image from a GStreamer pipeline sent from the camera, for this we used the gst-launch tool [44]. A Samsung TV was used for the setup.

The basic architecture of the program is made up by different states and in them different views. The program listens to CEC messages and when received changes the states and views accordingly which alters the GUI. For PTZ control Axis' own open API, VAPIX, was used.



**Figure 8.1:** Overview of the initial setup for one end of the system.



**Figure 8.2:** Overview of the end setup for one end of the system.

## 8.2 CEC

The Remote Control Pass Through feature was used when communicating between the TV and the camera. The reason for not utilizing the Vendor Specific Commands feature was that a solution which would work on any HDMI-CEC TV was desired. Initially a LG TV was used in the setup but was later switched to a Samsung TV since the SimpLink (LG CEC trade name) seemed to be using Vendor Specific Commands more for button presses while Anynet+ (Samsung CEC trade name) used Remote Control Pass Through. Some Samsung remote control buttons were still not supported in Remote Control Pass Through. The Exit button is one example and was therefor not used which was found to be the source of the navigation problem in the second iteration, shown in figure 6.5.

## 8.3 Overlays

The process of generating an image in the Axis camera basically consists of four steps, seen in figure 8.3. These steps are made in the ARTPEC 5 module, (2) in figure 8.4. In the first two steps the image is captured and processed to enhance quality. In the third step the overlays are added to the video stream over the captured image and in the last step the data is encoded. Since the scaling is made before the encoding, the overlay images can not be in a compressed file format, instead 24 bit BMP was used.



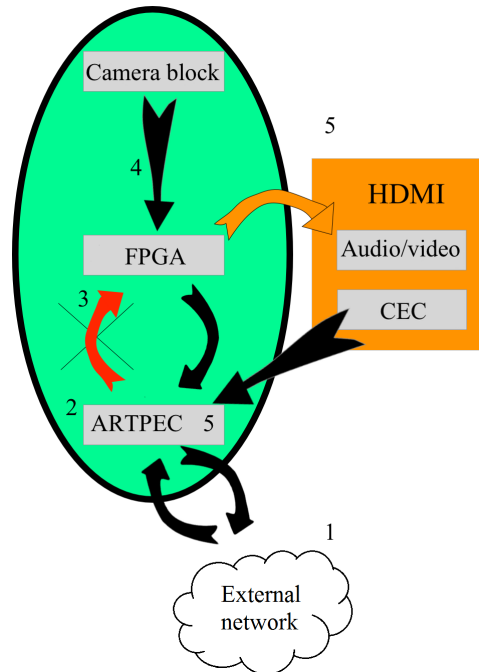
**Figure 8.3:** The four steps of generating an image. Overlays are added in the third step, Scale, before the image is encoded.

Along with the captured image, the video stream can be seen as three layers. The other two layers are the overlay image and the overlay alpha. The overlay alpha determines which part of the overlay image that will be transparent and show the captured image underneath. The alpha is determined by a unique color in the overlay image, in figure 7.3 the white color is the alpha. Not all overlays overlays had transparency, e.g. Main menu, figure 7.2, where the overlay image completely covered the image captured by the camera.

## 8.4 Technical Limitations

The chip, ARTPEC 5, in the camera has limited graphical processing power. There is no GPU, Graphical Processing Unit, in the chip which put constraints on animations and dynamic overlays which could increase the user experience and give a more modern look to the interface. Due to the graphical processing restriction, the overlays were pre-generated. Because of this, the prototype only supports one resolution,  $1920 \times 1080$ . The prototype is not technically limited to only one resolution but the overlays would lose quality if scaled

to other resolutions than the pre-generated overlay image, especially for text which could become unreadable. An alternative solution for this could of course be to have multiple overlays for multiple resolutions for each view, but this would require a lot more overlays.



**Figure 8.4:** The different parts in the camera (oval) and how they are connected.

As previously mentioned, the communication from ARTPEC 5 to FPGA is not yet fully implemented at the time of this thesis. It is still possible to send the captured image from the local camera to the TV via HDMI, (4 → 5) in figure 8.4, but not with the added overlays since that part is done in ARPTEC 5. By sending the video stream to a separate computer through the ethernet port (1), this solution circumvents the issue. As the Axis camera was still in development during this thesis, technical limitations like these should be expected and should not be considered a bug.



# Chapter 9

## Conclusion and discussion

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*This chapter presents different aspects of the project, future perspective, alternative solutions and general discussion.*

We have in this project created a video conference prototype with an intuitive interface combined with a standard TV remote control for a video conferencing system using Axis hardware and software and standard AV equipment. We also did a market overview where we compared similar products which were included in the first goal. The market overview could be done in a more effective way but due to the fact that some equipment were hard to test without buying we read about some systems instead of testing them ourselves. The second goal about creating a bidirectional system was not fulfilled completely. Due to technical limitations some functionalities were simulated with a computer in the middle but these problems were outside of our project and will eventually be fixed. Also the installation of the camera was excluded and put in a fictive cloud solution. After the usability test we can be quite positive that a huge majority of the target group will feel confident using the video conference system.

The CEC solution in this thesis has some major benefits, the two biggest being not having to provide additional equipment, like a separate remote control, and the use of a standardized protocol that, in theory, should make the system interoperable. We found however some drawbacks to this approach regarding both design and implementation. The CEC feature does not provide for as much interoperability as we first hoped for. With different CEC trade names using different vendor specific commands, vendor specific implementation might be required by Axis as well. How many TV brands must a CEC based video conference product support to be sufficient? Do all vendors use their own unique commands? The different implementations of CEC from different vendors was only briefly looked into during this thesis, a more thorough study on this will be required to be able to answer these questions certainly. Is it possible to design a user interface good enough to work well with high usability, regardless of the layout of the remote control? With no real

influence on the design of the remote control, this is basically the task. Most TV remote controls are similar and we can of course expect that the companies strive to design remote controls with high usability. But even when this succeeds, it is still a TV remote control, not a video conference remote control. Can we expect a product with high usability for its intended field to still be intuitive to use outside of the field? During our testing we did not find any correlation between a better result for experienced Samsung users who has the same type of remote control at home compared to the other testers. With CEC it is possible to find the brand of the TV and tailor the user interface for that company's remote control. Could a dynamic interface which adapts to the TV and its remote control be the solution? That is possible, in our design we believe we achieved better results by restricting and adapting to a specific TV remote control as many testers justified their choices of button presses by the icon mapping between the remote control and the GUI. Note that the user isn't actually restricted to the standard TV remote control though, a generic remote control could be used. Even though higher usability might be achieved for the individual case, a user of multiple products connected to different TV brands, might find it confusing if the user interface differs since it is same video conference product.

The amount of testing we did was sufficient according to usability experts, such as J. Nielsen. We even tested on more test users than suggested (5) [24]. When determining the suggested number of testers, Nielsen not only looked to find as many usability issues as possible but also took the test budget regard. The test budget in our case can be seen as the time we spent on the testing, the preparation and the evaluation of the test results. We felt that we gained a lot from our elaborated tests with many test participants, but according to Nielsen it is more favorable to test on fewer users if it leads to more tests. A rule of thumb here might be to strive for many tests and on a few testers rather than a few tests on many testers. For our testing we felt that we wanted to be well prepared, and if possible test on more users to get as many different views and thoughts on our prototype as we could, which we think we did successfully. In hindsight, testing more scenarios or adding other types of tests instead of more testers when we had spare time could have given us a better result. That said, we are still satisfied with our result.

## 9.1 Technical restrictions

The design were constraint by the camera hardware, with no GPU and a limited memory the design had to be quite simple. No visual effects could be used so the views are not dynamical, no input text or similar can be used, in our prototype all views are unique pictures. Sound is a central thing during video conference, both for the sake of video but also for the usability part. This were excluded from this project due to time limit.

## 9.2 Alternative solutions

The system is implemented with a TV remote control which has its pros and cons. In some peoples opinion the TV remote control feels limited and old meanwhile the pros is

that you do not need one more new unique remote control. There is a possibility to both skip using the TV remote control and also not have a own unique camera remote control by having a application in your smart phone where you can sign in and control the camera. It is also a opportunity to both have a smart phone application and the TV remote control. The TV remote control limits the video conference user to only use an TV screen while in fact there often is need for a bigger screen than that.

Usually meetings are setup on/added to the participants digital calendars. There are already standards for exporting and importing such appointments, this can be an possible extension of the project. When a user comes to a conference room it could already know which other conference room the user is going to call and provide the user the option to call that conference room with one button press.

There is a opportunity to create a personal interface which requires sign in. The guidance that is should be very easy to get started made us go for a solution without a personal touch but there is of course pros with personal views. First of all there will be possibility to configure the settings and save it depending on the users own requirements.

The contact list is design so you first have to choose a country then city and last a conference room all in alphabetic order. One can imagine a solution where the contact list gets less steps and the contacts instead are grouped by geographical orientation or by starred contacts.

## **9.3 Suggestions for future development**

The future from this project is quite unknown. Many parts of this project is simulated for the demonstration. To make a product out of this is a large step. In this thesis we have showed that it is possible but there is still a lot of improvements that must be done. As discussed above, the artpec5 chip is quite limited for graphical things and the graphical part must indeed be improved before the video conference camera is market ready.



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# Appendices



# Appendix A

## 10 Usability Heuristics for User Interface Design

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Below is Jakob Nielsen's 10 general principles for interaction design. He calls them "heuristics" because they are broad rules of thumb and not specific usability guidelines [45]:

### **Visibility of system status**

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

### **Match between system and the real world**

The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

### **User control and freedom**

Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

### **Consistency and standards**

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

### **Error prevention**

Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

### **Recognition rather than recall**

Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

### **Flexibility and efficiency of use**

Accelerators – unseen by the novice user – may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

### **Aesthetic and minimalist design**

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

### **Help users recognize, diagnose, and recover from errors**

Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

### **Help and documentation**

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

# Appendix B

## Script for usability testing iteration 1

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### Presentation

- You work at a company.
- You are about to use this conference camera for the first time.
- You are in a conference room where the camera will be permanently placed.
- The camera is connected to the TV with a HDMI cable and connected to the internet with an ethernet cable.
- In your hand you are holding the remote control for the TV, in this test you will be interacting with the video conference system using this remote control.

**Scenario 1** You have recently bought a new conference camera and want to start using it by getting to the main menu after you have plugged in all the cables needed.

**Scenario 2** You have the camera on the shelf and you want to change the cameras PTZ position using the remote control.

**Scenario 3** Your conference system is by default used with English and you want to change it to Swedish.

**Scenario 4** You want to customize your video conference experience by becoming an advanced user. Remove the nestled window in you view that shows yourself.

**Scenario 5** You want to initiate a video conference call with the persons that are located in the room "Axis Herkules".

**Scenario 6** You are in your conference room and are waiting for a call from "Axis Hippodromen". Answer the call.

# Appendix C

## Test plan iteration 2

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### **Purpose**

The purpose of the usability test in iteration 2 is to receive useful feedback from the real target group on computer made prototypes. The questions we want to get answers to is for example: By fixing issues from iteration 1 have we introduced new problems? Is there a difference now when we are doing a computer made prototypes instead of paper prototypes? Is it something that the real target group finds good or bad in contrast to the master students in usability and design from iteration 1? Is the interface easy to use for the whole intended target group? Is there any part of the interface where the user becomes uncertain or cannot understand how to follow?

### **Scope**

The testing will be performed on computer made prototypes of the Axis Communications Utility cameras video conference mode. The prototypes are from iteration 2 of 3 and will consist of the whole overlay interface system, the cloud service will not be included.

### **Environment**

The test will be executed 2014 week 45 and 46 at Axis Communications buildings at Emdalavägen in Lund. The number of test participants and sessions that will be held depends on how many that can volunteer their time for us. The vision is to held the test in conference rooms in the H building.

### **Session**

The test will be 20 minutes long each and afterwards it will be free discussion for 10 minutes and here is it after that it will be possible for for the test leader to reset the test

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environment for the next test person. Every test session will be 30 minutes long and the test persons will come every forty fifth minute which means 15 minutes for resetting the environment and briefly review the session.

## Equipment

The test will contain of table with room for at least four seatings, laptop preferably 15 inches and the operating system should be Linux, camera that can document the test, time-keeper, paper and pencils for the note taker.

## Participants

The test persons will be recruited mainly by our supervisor at Axis Communications and everybody will be from our target group. Our target group is employees at Axis Communications who might want to have video conference. For the test we would prefer to have eight test persons but five is the minimum number we want to test to get the most out of the usability test.

## Scenarios:

- 1 Ändra kameran så du är i bild och gå därefter tillbaka till huvudmenyn.
- 2 Ring konferensrummet Yellow i Chicago.
- 3 Ändra så att personen i andra änden av videokonferenssamtalet är i bild.
- 4 Stäng av mikrofonen så att personen i andra änden av samtalet inte kan höra vad du säger.
- 5 Avsluta videokonferenssamtalet med konferensrummet Yellow.
- 6 Zooma in på din kamera och gå därefter tillbaka till huvudmenyn.
- 7 Ändra språk till Spanska.

## Method

The test will be held in the environment described above, it is the real video conference environment that is pursued. The test leader brings all the necessary equipment for the test. First the test person will be greeted welcome and the outline will be described. Afterwards the test will start and proceed scenario for scenario. Afterwards a debriefing will be held.

## Roles

The test will be held by the test leader who will integrate with the testperson but only if necessary, afterwards a short discussion will occur. The test also contains a note taker that will write down everything said during the test. The test leader will as well take time if so needed.



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## **Data collection**

The primary data collection will be qualitative data that the note taker wrote down and later analysed. Every test session will be taped which means that the analysis can be done on that material as well. Another form of data is from the debriefing when the test person with his or her own words can give suggestions for improvement in either a interview or a survey.



# Appendix D

## Debriefing survey iteration 2

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### Post test questionnaire - Video Conference System

*Answer the following questions with a number between 1 to 5, 1 means strongly disagree and 5 means strongly agree.*

**I feel confident that I used this system correctly.**

1      2      3      4      5

**I think that I would need to ask questions to know how to use this system.**

1      2      3      4      5

**I think that most people would figure out how to use this system very quickly.**

1      2      3      4      5

**Figuring out how to navigate in this system was difficult.**

1      2      3      4      5

**I think that this system was easy to use.**

1      2      3      4      5

**I think the amount of information where adequate.**

1      2      3      4      5

**I think the use of color where appropriate.**

1      2      3      4      5

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*Answer the following questions with free text.*

**Problems with navigation?**

**Problems with losing your place in the system?**

**Too much or too little information?**

**Both experienced and novice users accommodated?**

**Terminology confusing?**

**Adequate feedback after completing actions?**

**Sentences appropriate length?**