Interface Design – a User-Centered Design Process

A STUDY HOW TO IMPROVE THE USABILITY OF A WEB-BASED CONSUMER TOOL THAT MEASURING THE QUALITY OF STREAMED VIDEOS

INGRID LARSSON
Gränssnittsdesign - en användarcentrerad designprocess

En kvalitativ studie hur man kan förbättra användbarheten av ett webbaserat konsumentverktyg som mäter kvaliteten på streamad video

Syftet med denna undersökning var att studera hur man skapar ett användarvänligt gränssnitt till en webbsida. Forskningen har gjorts i samarbete med forskningsinstitutet Acreo och projektet Streamingkollen; ett konsumentverktyg som syftar till att förbättra användarens upplevelse av streaming videos genom att mäta video streaming kvaliteten.

I denna studie har fokus lagts på användarna av tjänsten för att optimera deras upplevelse av webbplatsen och gränssnittet.

För att uppnå en hög nivå av användbarhet, har en användarcentrerad designprocess använts. En användaranalys, en heuristisk utvädering och användartester på prototyper har använts som metoder i designprocessen och utvecklingen av gränssnittet.

Resultatet från användartesterna visar att den huvudsakliga anledningen till att användaren ogillade, kände sig frustrerad eller inte kunde hantera tjänsten var när gränssnittets design inte var konsekvent och minimalistisk, när ord, fraser och begrepp på webbplatsen inte var bekant för användaren, och när tjänsten inte gav användaren informativ feedback till navigation.

Den användarcentrerad design processen gav goda resultat; många av de potentiella användarbhetsproblemen kunde identifieras och undvikas.
INTRODUCTION AND BACKGROUND ........................................................................................................3
DEFINITION OF SCOPE AND RESEARCH QUESTIONS ...........................................................................4
THEORY ..................................................................................................................................................4
METHODS ...............................................................................................................................................8
RESULTS .................................................................................................................................................10
ANALYSIS & DISCUSSION .......................................................................................................................14
CONCLUSION .......................................................................................................................................16
REFERENCES ........................................................................................................................................16
Interface Design – a User-Centered Design Process
A qualitative study how to improve the Usability of a web-based consumer tool that measuring the quality of streamed videos

Ingrid Larsson
Media technology and Interaction design, School of Computer Science and Communication, KTH Royal Institute of Technology Stockholm, Sweden inglar@kth.se

Abstract—The purpose of this examination is to study how to create a user-friendly interface to a new non-released website. The research has been done in collaboration with the research institute Acreo and a project named Streamingkollen; a consumer tool that aims to improve the customer’s quality of experience (QoE) of streamed videos by measuring the video streaming quality.

In this study the focus has consequently been placed on the users of the service, in order to optimize their experience of the website and the interface.

In order to achieve a high level of usability, a user centered design process has been used. A user analysis, a heuristic evaluation and user tests on prototypes have been used as methods in the design process and the development of the interface.

The result from the user tests shows that the major reason why the user disliked, felt frustrated or couldn’t manage the service was when the design of the site was not consistent and minimal, when words, phrases and concepts on the site were not familiar and communicated in the same language as the users and when they lacked informative feedback of the operations made on the site.

The user-centered development in the study gave good results; many of the potential usability problems were identified and avoided.

Index Terms—Interface design, Human Computer Interaction, Usability, User Experience Design, Usability testing, Design Guidelines, Prototypes.

I. INTRODUCTION AND BACKGROUND
Developing new products requires planning and a lot of work. When developing technologically complex products and services the demands are even higher. The human should meet the technology, and a working interaction must be achieved. Human Computer Interaction (HCI) has moved from evaluation of interfaces of systems into evaluation of the users. HCI is no longer about teaching the users how to use the product, but rather to learn how the users work. As a designer you need to understand what your users want and need, and design a product according to their requirements. This transition has led to new concepts and methods [1].

How well the system serves the user’s needs includes many factors. Of course the information about the service needs to be relevant for the user, but also aspects like how efficiently the user can get this information, what is the user’s subjective feelings towards the service interface, how easy it is to understand the information that the service provides and how easy it is to learn how to use the service. The terms Usability and User Experience have become key concepts in this area [1].

This thesis is a concrete example of how the user experience is used in the development of a technically complex service.

Outsourcer - Acreo Swedish ICT AB
Acreo Swedish ICT AB was established in 1999 and is a Swedish research institute in electronics, optics, and related communication technologies. The company is a subsidiary of Swedish ICT Research AB, and together, they have the vision “ICT for a sustainable and better life for everyone”.

The head office is located in Kista, but Acreo has a total of about 140 employees in Gothenburg, Norrköping and Hudiksvall. Acreo has partners from around the world and have managed extensive projects in hardware oriented ICT and solved problems in a variety of application areas within electronics, optics and communication technologies [2].

Streamingkollen
In this thesis the research is done in collaboration with Acreo and a project named Streamingkollen. Streamingkollen is a new non-released consumer tool available on the web. The service aims to measure the customer's experiences, known as QoE (Quality-of-Experience), of the streaming video content received of “over-the-top” (OTT) service providers. The service analyzes a clip from the video that the user is
watching, and presenting a value of the videos QoE. The user’s QoE in this case is based on occurring pauses, the duration of the pauses and how the video changes bitrate quality during playback. In present state there is only a demo of Streamingkollen available. The functions are programmed but the interface is not ultimate.

Creating a new service with high-tech features is a challenge, but I believe that the biggest challenge is to create a service that users understand. Streamingkollen will provide complex information to a target group including non-skilled and low technology skilled users. To meet the user needs and provide a service with value, a priority is an interface that is easy to understand and use, an interface based on a User Experience Design Process.

II. DEFINITION OF SCOPE AND RESEARCH QUESTIONS

The purpose of my examination is to study how to create a user-friendly interface design for a service that aims to measure the quality of the streaming video content received of "over-the-top" (OTT) service providers.

My study will be focusing on the users of the service. Instead of forcing users to change their behavior in order to manage the service, my work will be to optimize the interface design. And in the end present a well-defined, simple to use and understand solution of an interface design from a user's perspective.

The key questions of my work will be to analyze how the information on the site in the best way could be presented to the user in a human computer interaction point of view.

My problem definition is:

How should the interface of the consumer tool streamingkollen.se be designed in order to improve the Usability of the service?

To be able to answer this question, I have four belonging issues that I will highlight in my essay. All issues are based on usability, and evaluated by qualitative studies using usability inspection methods, user tests and interviews.

- How to make streamingkollen.se easy-to-learn for the first time users?
- How to make the information that streamingkollen.se provides, easy to understand?
- How to make the task operations at streamingkollen.se efficient and effective to carry out?
- How to make an interface for streamingkollen.se that it pleasant and satisfying to use?

Limitations

I will focus on the user and the human-computer interaction, and not the technical aspects of the service, therefore I am not going to analyze the website's functionality, and examine how to optimize the utility of the website design. My paper will therefore not answer questions about if the website does what it should do, and if the website offers the tools that the user will expect from the service.

The focus of my study is the interface and in order to give the user a hint of how the service will look like and work in practice, I will demonstrate the interaction by a clickable mockup on the computer.

The target group for my study will be the same target group as for the site streamingkollen.se; computer and video-streaming users.

III. THEORY

User Experience Design

Designing a product or in this case an interface may seem like a simple task. Many people would probably without further reflection answer that it is about developing many great new features and ensure that the design looks cool. And yes that design will surely be a good service in a technical and visual standpoint, but something is missing here. How does this service react when a person interacts with it?

This is where the concept 'User Experience' must be given attention. All products or services that are used by someone create a user experience. A bad user experience can be the reason why a product or service becomes a failure instead of a success. User experience can be defined as; the experience the product creates for the people who use it in the real world [1].

Why is the user experience important? Because it is important to the users. If the users do not get a positive experience of using the service, they might not use it. And a high-tech and cool website without users is not worth much [1].

An interface with good user experience is too often neglected, because of the simple reason; no one gives attention to it. Something that users however will notice is a site with bad user experience. Errors and shortcomings are reasons why users won’t be able to carry out the intended purpose without becoming frustrated [3].

How to design an interface that achieves good user experience? The method “listening to the users” and let them be the guide in the developing of a new product was first presented in the 1950s in the industrial design. In the 1980s also designers and computer scientists in the area of human-computer interaction began to realize the important of include the users in the design process of interfaces [4]. This method is called 'User-Centered Design Process', and it simply means that you listen to and focus on the users throughout the whole design process. By following the motto “Users know best”, it’s a great change to get a successful process and final solution [4].

Of course, the interface designer has to compromise with the solutions, designing an interface is a complex process that requires time and money to find the best solution. But a user-center design process ensures that these compromises do not happen by accident, but is based on studies with emphasis on users. An important thing to remember is that the designer is not the user, just at translator of user needs and goals [1].

Usability

Before you can try to measure user experience and look at the
individual's entire interaction with the service, we need to scale it down and examine the term Usability. There are different definitions of usability: in this study I have chosen to use the international standard, ISO 9241-11, definition: 

_The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use_ [5].

Effectiveness, efficiency and satisfaction is in this case measuring:

- Effectiveness: Can users complete tasks and achieve specified goals with the service?
- Efficiency: Which time, effort, or cost requires managing tasks and achieving the specified goals?
- Satisfaction: How pleasant is it to use the interface? [6].

The author and consultant in computer and web usability Jakob Nielsen and the computer science professor Ben Shneiderman, both prominent researchers in the HCI area, use a definition that also includes the quality components:

- Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- Memorability: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
- Errors: How many errors do users make, how severe are these errors, and how easily can they recover from the errors? [7] [8].

Why is usability especially important in website interface design? Websites are unlike other products complicated pieces of technology without instruction books or manuals. The user should alone be mastering the site with only their own experience and knowledge as guides. If the users don't understand how the service works, they only have themselves to blame. This can results in a feeling of stupidity, they lose their confidence and the solution becomes in many cases that they leave the site [1].

According to (Nielsen 2012) studies have shown that users have much lower tolerance with poor design of a service online than with products in the real world. They have less patience to wait on a slow site. They don't want to learn how the page works, because they expect to understand it after scanning it for a few seconds.

**Design Guidelines**

A useful tool in a user-centered design process and the development of an interface is guidelines and principles. Design principles are a set of rules to help make design decisions and form the design of a specific component of interaction, and have been developed after extensive studies [9].

There are many different principles and guidelines, in this study I will use two of the most common used guidelines in interface design, specifically designed for computer interfaces, as the tool to help me make the first design decisions. Nielsen's *The 10 Usability Heuristics for Interface Design* and Shneiderman’s *Eight Golden Rules of Interface Design* [10] [11].

**The 10 Usability Heuristics for User Interface Design**

One of the most common used principles is “10 Usability Heuristics”, which was developed after several years of experience and studies [10].

**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.

Eight Golden Rules of Interface Design
The Eight Golden Rules of Interface Design is often used as guidelines in design processes [11].

Strive for consistency
Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout.

Enable frequent users to use shortcuts.
As the frequency of use increases, so do the user's desires to reduce the number of interactions and to increase the pace of interaction. Abbreviations, function keys, hidden commands, and macro facilities are very helpful to an expert user.

Offer informative feedback
For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial.

Design dialog to yield closure
Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions.

Offer simple error handling
As much as possible, design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error.

Permit easy reversal of actions
This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions.

Support internal locus of control
Experienced operators strongly desire the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions rather than the responders.

Reduce short-term memory load
The limitation of human information processing in short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes, mnemonics, and sequences of actions.

Usability testing
The purpose of a user-centered design process is to listen to the users. Usability testing is therefore a key activity in the process. Depending on whether you want to gather information to establish design requirements for a new product, or evaluating an existing product, there are different methods to use.

Number of test participants and the extent of the tests vary. If you want qualitative data from the survey, it is recommended to keep the number of participants low. Five people may be enough if the tests are performed in detail [12].

Usability Requirements
The first phase in the software development and user-center design process is to define a set of requirements for the new interface. The compilation of requirements consists of collecting and concretizes a number of requirements to be achieved in the new design. A requirements specification is created to easily get an overview of what is requested by the user. Compiling usability requirements should be implemented early in the process to obtain formal guidelines for the development of the service [13].

User Analysis
A user-centered design process is about constantly listening to the user, and to work according to the philosophy that the user always knows best. It is the users who will use the final product, which means that they are the most important source for the investigation.

Before the users expectations and requests of the interface can be examined, information about who the users are and which tasks the service will provide must be clarified. It is therefore important to implement a user analysis in the beginning of the design process. Through a user analysis you can gather information about the users and determine their properties [14].

Heuristic Evaluation
A common used method when determining usability
requirements for interfaces is a Heuristic Evaluation. A heuristic evaluation is an inspection method where an inspector evaluates and identifies usability problems in the interface. By analyzing a website's interface through the various principles, errors and deficiencies in the design can be found quickly and efficiently. The method doesn't require any participants, only a user experience-expert in the role of evaluator, which makes it a simple and inexpensive method [15].

User Observations
A useful method for obtain qualitative data is user observations. Observation is classified as one of the most rewarding method of all design research methods. The method entails to observe how people interact with a system in a precise manner, to be able to detect errors and shortcomings in the design [4].

“Pay attention to what users do, not what they say” [16] is an important statement to have in mind through an interface design process. This is the reason why observations are a better choice of technique for data collection, instead of for example a questionnaire. A questionnaire is in many cases an effective and inexpensive way to get a lot of information within a short period, but may result in self-reporting errors, where users forget to mention information that may be useful for the investigation. [17]

There are various methods to use when performing observations. One common used method for analyzing the interface is Task Analysis. The participant is prompted to complete some tasks on the website, while the observer takes notes and analysis how the person navigate on the site [4].

To collect data the observer can use the techniques Critical Incident and Think-Aloud. In a critical incident evaluation the observer note the hesitations, problems, and errors that occur during the participants navigation on the website [9]. The Think-Aloud Technique is a qualitative data collection technique in where participants explain what they think about during the navigation. This technology enables the observer to take part of the underlying information and understanding of the participant's actions. Participants are also encouraged to show what they feel when they navigate on the site, which give the observer the possibility to note what’s in the design and interaction they feel satisfying or dislike [9].

To collect data in a task analysis, the best way is to complement the observation with interviews during and after the test. To be able to obtain correct information it is important that the interview questions are concern the actual moment, not about how they think they would do or how others might solve the problem [4].

Prototypes
To be able to develop and receive feedback on the new interface, a good way is to create and evaluate prototypes of the ideas early in the design process. The idea of using prototypes is to be able to change and improve the design before implementing the code or other work that takes time and resources. The earlier the prototypes are implemented the easier it is to do these changes. Fake it before you build it is a vision in interaction design [18].

When testing the ideas, the prototypes shall communicate the message of something that is not finished. Just a suggestion of how the final product or service might look like and work, to be able to get as much feedback as possible from the user. In a prototype test it is the experience, not the fidelity of the prototype or technology that should be tested. A too developed prototype can make the user think that the product is finished and that all design decisions has already been taken, which can lead to reduced feedback. One of the most important things to keep in mind before designing a prototype is, therefore, you don't have to prototype everything, choose the parts that you want to highlight [4].

To take advantage of the benefits of a prototype, and make it easier and faster to build than the final product, it requires to either containing fewer functions or less advanced features. A prototype is therefor often a horizontal design (many but less detailed functions) or a vertical design (fewer but more detailed functions). A useful method is to combine horizontal and vertical design, named T-prototypes. Where many of the functions of the interface is realized (horizontal design), but only a few are developed in detail (vertical design).

Prototype can also have different credibility and fall somewhere between a low to high level. The fidelity depends on in which stage in the design process you are, and what you want to find out by your test [9].

Lo-fi Prototypes
To evaluate the overall functionality and interaction at an early stage, a lo-fi prototyping is preferable. These prototypes are put together quickly and will be a first hint to the user, and the base for the first user test to track the overall faults and error in the design. Here you have the chance to make changes to the interface by replace and add functionality as you test on un-coded material [19].

Lo-fi prototypes can be present with the help of paper, or simple digital solutions. The key is to make it clear that it is far from the final solution in order to get feedback from users.

To test a lo-fi prototype without real interaction you need to fake the interactions somehow. This can be done with the help of a person, usually the designer or an assistant, "standing behind” and make the interaction. This method is called Wizard of Oz manipulation, because the man behind the curtain control the interaction by swap pages in the paper prototype or control the digital screen when the user interacts with the prototype [4].

Medium & High-fidelity Prototypes
When overall decisions about the functions and the design of the service are set, it is time to create a more developed prototype, a medium-fidelity prototype or high-fidelity prototype. These require more work, time and resources do the result should be a closer imitation of the final product. These prototypes should be programmed on a computer to get them alive, and to give the user a sense of how the finished service
will look like. The prototype should not need the Wizard of Oz-method to make it interactive.

A risk with hi-fi prototypes and their similarity with the final product is that the user can experience the prototype as a complete service, and provide less feedback. It is therefore a good thing to implement a medium-fi prototype between a lo-fi and a high-fi prototype in the design process. A medium-fi prototype is often presented by a wireframing and mock up tool on the web [4].

IV. METHODS
The design process has consisted of three phases:
1. Defining usability requirements
2. Design of prototypes
3. Usability tests

In the first phase ‘Defining usability requirements’; data were collected through a user analysis, a heuristic evaluation and user tests on an existing service. This was done to establish requirements that could form the basis for phase two, where the design of the first prototype was implemented. In phase three the first prototype was tested in a user test. The result formed the basis for the second prototype, which also were exposed to a user test. The data from the test resulted in a solution for the interface presented by a high-fi prototype to the participants for the final feedback.

Through continuous usability tests, users have played a central role through the whole process.

Defining Usability Requirements
There are different techniques to formulate usability requirements and the best way, which is also used in this investigation, is to combine different kind of techniques [20].

In this study, three methods for specifying requirements and guidance for the interface has been used:
• A user analysis
• A heuristic evaluation on the existing demo of Streamingkollen.
• User tests on a service similar to Streamingkollen.

User Analysis
As a basis for the requirement specification a user analysis was implemented. The analysis were conducted to identify the target group of the service, and the tasks that the website will support.

In order to collect information for the user analysis an interview with Kjell Brunnström, manager for the project Streamingkollen, was conducted. The interview was carried out in connection to the start for the study in January 2015.

From the discussion, the purpose of the service and the expected target group were clarified. The user analysis has been a basis for the recruitment of participants for the future user tests in this study.

Heuristic Evaluation on the existing demo
The second step in the compilation of the design decisions and guidance for the creation of prototypes was a heuristic evaluation. The evaluation was performed on the demo of Streamingkollen that was available at the start of the study.

The interface was evaluated by using the Heuristic principles. The principles and the evaluation are described in detail in the Theory chapter.

The reason why the demo was used in the evaluation was that it hasn't enough content to be evaluated by a user test. There were not enough functions available and the interface was too undeveloped. The test would have needed speculations on future use of the service, and questions like “How do you think the service should look like and behave?” Getting users envision something that does not exist is a bad way of gathering information in a user test. The users should never act as designers, it can produce misleading answers [21].

In this study the heuristic evaluations was only used as a supplement method to the user tests, since the purpose of the study was to include users in all stages of the process. In the evaluation, I took the role as evaluator and the evaluation was done in my home, the 17th of February, and took about 45 minutes. The evaluation started with list Nielsen's 10 heuristic principles [10]. During the navigation on the demo of the webpage, me in the role of evaluator search for usability problems in the design by comparing the interface with the principles one by one. Design and functions that didn’t fulfill one or more of the principles were noted. In a document the shortcomings were ranked according to how serious they were perceived. And proposed solutions to the problems, based on theory of usability, were added.

User observation
When designing a new product or in this case a new interface, it is important to start analyzing an existing service and examine what could be better before start thinking about and focus on the new design [9]. The currently most similar service to Streamingkollen is bredbandskollen.se. Bredbandskollen is a consumer tool that helps broadband customers to evaluate their broadband connection. Using the tool, consumers can obtain a measurement value and an indication of how well this measurement match the expected capacity of their internet connection [22].

Recruitment of participants
Five persons were collected and participated in a usability test with bredbandskollen.se as investigation platform.

The choice of five persons is based on an early research by Jakob Nielsen and Tom Landauer showing that the ultimate number of participants in a user test where the goal is to find usability problems, is five persons. The research show that less then five persons don't give you enough information, and by adding more than five participants you will observe the same problems and not learning much new with your study [12].

With the help of the user analysis a picture of the future users could be determined and provide the basis for the recruitment of participants. People with different gender, age and professions were chosen to achieve a large part of the target group.
The five participants:
1. Female, 25, Police
2. Male, 77, Retired person
3. Male, 35, Librarian
4. Female, 28, Transport planner
5. Female, 29, Account manager

All participants had use streaming services at least a few times a month, which fits into the future target group for Streamingkollen. The target group generated in the user analysis includes people with different computer skills. Therefore the choice of participants resulted in people who use computers every day in their profession and in their spare time and people who don't use computers in their work, and more rarely at their leisure.

The test
The tests were performed at different times during a period of one week, 18th February - 25th February 2015, and took about 45 minutes each. In order to imagine how the interface will be used in real life the observation should analyze users doing their own work in their own work context. And the observation tests should take place in the user's actual place for the use of the service or product [9]. The five user tests were therefore performed at the place that most possible would be the location for the use of Streamingkollen. All the five tests were localized to the home of the participant.

Before each test an instruction to how the test would be performed was prepared. Before the start the instructions and the background for the test, was explained to the attendants. The fact that it is the website that will be tested and not you and your computer skills was carefully clarified to the participant.

There are various methods to use when performing observations. To this study, Task Analysis has been used as method. The test began with presenting the first of four tasks that should be solved. The test person was given one task at a time to avoid being confused or start thinking about other tasks instead of concentrating on the mission for the moment.

In the task analysis the evaluation methods Critical Incident was used as techniques for collecting the data. Everything that leads to difficulties for the participant in completing the task and the possible UX problems that may have caused the problem was noted on a paper.

To gather more information the Think-Aloud Technique was used. Participants were encouraged to explain what they were thinking about during the navigation on the website. The test persons expressed dissatisfaction and positivity of the website was also recorded. The instructions stated that the participant should avoid asking me as an observer for help when problem of solving tasks occurred. Instead they were encouraged to explain what they don’t understand and why the task is difficult to perceive.

After each task, questions about the person's attitude toward the interface were asked. The interview was implement to get an idea of the subjects' feelings to the service and the interface. To catch the first impression the questions were treated one task at a time. When the test was finished an interview with general questions was conducted to get an overall impression of the service. What was good/bad in the design? Which tasks were difficult to complete and why? Was there something in the design you did not find or missing?

The interview worked as a complement to the future analysis to clarify anything non obvious in the observation.

Design and test of prototypes
In the study three prototypes has been created: a low-fidelity prototype of paper, a medium-fidelity prototype presented by an interactive wireframe, and a high-fidelity prototype of a visual mockup. User tests on the lo-fi and medium-fi prototypes resulted in data that were analyzed and become basis for the final design and hi-fi prototype.

Prototype 1 - The Lo-fi prototype
Based on the requirements that establish by the heuristic evaluation and user tests on an existing product, the lo-fi prototype was created. By using paper a design proposal of the user interface was presented. With the choice of using a paper prototype, I wanted the users to feel that the design was far from complete. And by that get them to feel open to comment and criticize the design so I could get the change to collect more useful data from the user tests [4].

The prototype was designed on paper and created as a T-prototype; many of the functions of the interface were realized (horizontal design), but only a few were developed in detail (vertical design). The text was handwritten and the objects were paper printed via a computer.

Recruitment of participants
The participants were collected in the same way as for the user test on the existing service; people in the target group, based on the user analysis of Streamingkollen whit different ages, genders, professions, and computer skills. The prototype test was also conducted on five participants at five different times [12].

The five participants:
1. Male, 24, Film worker
2. Female, 27, Art teacher
3. Woman, 60, Dentist
4. Male, 58, Integration Coordinator
5. Female, 30, Phd student in cultural studies

The user tests were conducted during a period of 6th March - 20th March 2015 and were performed at locations that most possible will be the location for the use of Streamingkollen. Two of the tests were conducted at a cafe and three tests in the homes of the participant.

In order to get as much information as possible from the prototype test, I chose to develop two processes in the service and associated steps and interactions; 'Test the video quality’ and 'Presentation of the result’. I wanted by the test get an overview of how easy the task 'Test the video quality’ is
to carry out, and how easy it is to understand the subsequent results that are presented. I wanted to find faults and shortcomings in the design and interaction that affects these aspects.

The participants interact with the prototype and the interaction was carried out with the help of the Wizard of Oz manipulation method, which is based on that me as a designer accomplish the interaction and make it seem alive even though the prototype isn't digital [18].

Depending on how the users choose to navigate, I switched sides and parts among the papers. All buttons and links on the papers led to a new scenario in the prototype in order to give the user the sensation of that all the choices are possible and make them get a real feeling about the prototype.

In many lo-fi prototypes testing, the designer has an assistant who play “computer” and has the task of moving parts in the prototype. In this way the observer is able to put all the focus on observing and taking notes during the test [9]. I made the assessment that my prototype not require excessively rapid interaction and therefore I chose to both take notes and play the computer without help from an assistant. Not being dependent on a third part also facilitated the booking of the test sessions.

Before each test, I explained to the participant what a paper prototype is and how a prototype test works in practice. The test was just like the first user test a task analysis with the belonging data collection methods Critical Incident and Thinking-out-Load. During the test they were encouraged to comment and provide feedback on what was good with the prototype, when they experienced something that was unclear, and when they missing buttons, functions or instructions.

When the test was finished an interview with general questions about the test and the total impression about the service was conducted. All comments, complaints and ideas from the user were recorded on a paper.

Prototype 2 and 3 - The Medium-fi & Hi-fi Prototype

Based on the results from the user tests on the lo-fi prototype a more developed prototype was created. By using the wireframing tool Balsamiq Mockups [23] the interface was presented on a computer. Using the program the ideas could reproduce the experience of sketches on a whiteboard, but on a computer. This made the prototype still indicated that the interface is under development, which could lead to more feedback from the users, and in the same time the computer could make it looks more similar to the final result and the interactions could easily be tested.

This prototype was tested in the same way as the lo-fi prototype, by observe five participants completing five tasks and using data collection methods Critical Incident and Thinking-out-Load. This user test also contained an interview whit related questions after the test.

Recruitment of participants

The user tests were conducted during a period of 30th of March to 5th of April 2015. The tests were conducted in the homes of the participant.

The five participants:
1. Male, 75, Retired
2. Female, 15, Student
3. Female, 47, Employment Officer
4. Male, 49, Microbiologist
5. Male, 30, Construction Engineering

Based on the result from the medium-fi prototype test, a final solution was created. The hi-fi prototype was presented with the wireframe tool Justinmind Prototyper [24].

To increase credibility and ensure that the user experience was improved, some more user tests with the people that had been participants through the design process were conducted. Problems were noted and the interface was refined until the user interface problems were solved.

V. RESULTS

In order to be able to answer my problem definition and present an interface with improved user experience, one heuristic evaluation and three user tests, with five participants in each have been implemented in this study. The user tests have been performed on the already existing service Bredbandskollen, a lo-fi prototype (prototype 1) and a medium-fi prototype (prototype 2). The result from the last user test led to a high-fi prototype (prototype 3) that also was presented to the users for feedback. The feedback was then used to do the last improvements and to solve the user interface problems. The people who participated in the usability tests, and the tasks that the tests contained, was established by a user analysis.

The User Analysis

In order to collect information for the user analysis, to identify the target group of the service and the tasks that the website will support, an interview with Kjell Brunnström, manager for the project Streamingkollen, was conducted.

From the discussion it was clarified that the service should support the tasks:
- Test the quality of the TV-program the user are watching.
- Present a result based on the video's quality.
- Present information about the test and the measurement.

The expected target group for the service was people of all ages, gender and professions, with the common property that they use streaming services.

Prototype 1 - The Lo-fi Prototype

Based on the heuristics evaluation on the existing demo of Streamingkollen and the observations test on the existing service Bredbandskollen the first prototype was developed. Theories about user experience and usability, and the design guidelines presented in the Theory chapter also formed the basis for the design decisions.

Prototype 2 and 3 - The Medium-fi & Hi-fi Prototype

Based on the results from the user tests on the lo-fi prototype a more developed prototype was created. By using the wireframing tool Balsamiq Mockups [23] the interface was presented on a computer. Using the program the ideas could reproduce the experience of sketches on a whiteboard, but on a computer. This made the prototype still indicated that the interface is under development, which could lead to more feedback from the users, and in the same time the computer could make it looks more similar to the final result and the interactions could easily be tested.

This prototype was tested in the same way as the lo-fi prototype, by observe five participants completing five tasks and using data collection methods Critical Incident and Thinking-out-Load. This user test also contained an interview whit related questions after the test.

Recruitment of participants

The user tests were conducted during a period of 30th of March to 5th of April 2015. The tests were conducted in the homes of the participant.
The people who participated in the user tests were people of the target group formulated from the user analysis.

Prototype 1 is demonstrating the three tasks mentioned above: “Test the video quality of the TV-program the user are watching”, “Present a result based on the video's quality”, “Present information about the test and the measurement”.

The Design
There is a header on every page on the site, showing Streamingkollens logotype. In the top right corner there is a “FAQ”-link and an “About Streamingkollen”-link, where the user can find information about the company as well as contact information. All pages also have a tab menu with links to pages on the site consisted relevant information about the test: “Test the video quality”, “How does the test work?”, “How do I interpret the results?”, “How do I improve the quality?”. A tab menu makes it easy for the users to understand where at the website they are. This menu should be a guide to the test and how it works and not create more questions and insecurity for the user [3].

The user should be able to return to the start page by clicking on the Streamingkullen logo or on the first tab in the heading menu called “Test the video quality”. It is important that the user can “find home” on the site. The knowledge about being able to start over if something goes wrong creates a feeling of control to the user [3].

Page 1: The start page
At the top of the start page there is a process bar with 3 steps that show where in the process the user is, and the next step in the process. In this stage the user is on “Test your Video Quality”. The step in the process where the user is has a yellow process-icon, and all process-icons have a different design than the buttons and links on the site to clarify the difference between these and the clickable links and headings.

On the first page the user is presented an introduction to the test, what Streamingkollen is and what the test is measuring. The user is prompted to fill in which streaming service they use and which program they are watching by predetermined choices in alphabetical order in a drop down menu. A yellow cursor shows which menu the user should start with. To prevent that the user do it wrong, the second menu is dimmed and unclickable until the user has filled in the information about the streaming service in menu 1.

The results from the observations test on Bredbandskollen showed that the users became confused when the information did not appear in a natural and logical order as well as when the result was not presented directly after the test had run. In the prototype the user was prompted to fill in the information already at the start page in order to present the results immediately after the test had run, without the need of more details from the user.

At Bredbandskollen some users missed the information about the test and the information about what the test is measuring. The tests start button take up too much space on the page. It is placed in the middle of the page, which take away attention from other relevant information, such as information text and instructions video. To not cause uncertainty on how to get to the next step, or to take away focus from other information on the start page, the prototype is designed in the way that the user automatically is moved to step two after the information in the menus have been completed. In that way a start button that takes all the attention can be avoided.

On the start page I also implanted a “My previous test”-link, to reduce the number of interactions and facilitate the navigation for returning users. This link is only available if a previous test has been run (Figure 1 shows the design of the start page).

Page 2: The video is being analyzed
On page number 2, the user has moved to stage 2 in the process, this is indicated by ”The test analyzes” is highlighted in yellow in the process bar.

In conjunction with that the user is automatically moved from the start page, to page number 2, a media player including a clip from the users selected program pop up. The user starts the clip by pressing a large play button in the middle of the media player or the play button in the media player's timeline. In this way the user has control over the site and has the opportunity to go back and change information before the test is running. The clip is then played for 20 seconds. The reason for the 20 seconds play time is because it's the same time as the test is running at Bredbandskollen which the participants in the observation test considered to be a suitably playtime.

Page 3: The result
After the video has been played, the user automatically moves to the Results page where the result of the video's total QoE is presented. An image of an indicator with the range Bad, OK, and Good, show the QoE. The image also has an explanatory text below. The prototype has clear words and images to present the results. Images on a web site get in most case more attention then words, and considered to be easier to interpret by the users [3]. The indicator is displayed in the middle of the page to avoid user focusing on wrong information. On this page the data and other information about the result is not shown, with the reason that it can distract the user and move
the focus from the relevant result about whether the quality is good or bad. In order to avoid too much information at one page a “detailed information”-link where the information about the measurements instead is implemented. This link and a link to the “Step by step guide to how to improve the quality” are placed under the indicator.

Page 4: The guide to how to improve the quality
Three instructional videos show step-by-step what the user should do to improve the quality. Bredbandsbolaget had the same instruction manner, which received positive feedback from the users.

Page 5: Detailed information about the test result
The user tests on Bredbandsbolaget showed that too much and too complicated information about the result wasn’t appreciated by the participants. It was especially numbers and the term “Bit rate” that confused the users. The prototype has therefore detailed information gathered in a link instead of being presented on the result-page.

Prototype 2 - The Medium-fi Prototype
The evaluation of the first prototype resulted in an amount of data to base the development of the second prototype upon. Prototype 2 was created by using the web-based mockup tool Balsamiq Mockups [23].

The fact that the prototype was presented on a computer facilitated the presentation of the ideas and contributed to some of the changes. However most of the improvements are based on the results from the user tests on the lo-fi prototype.

Page 1: The start page
One user found it confusing that the links in the tab-menu contained questions. “How does the test work?”, “How do I interpret the results?” etc. These were therefore renamed to “Start”, “This is how Streamingkollen works”, “This is how you interpret the results”, “Guide to how to improve the quality”. Some of the users also wished the link “FAQ” to be more visible. The link was therefore moved to the main menu instead of being placed on the upper right corner.

Many of the participants found it unclear if the progress bar was clickable or not, as well as how to move backward in the progress. It was in the new prototype therefore clarified that the progress bar wasn’t clickable. This was done by designing the progress icons less like clickable buttons.

The user did perceive the instructions “Select the streaming service” and “Select Video” as unclear instructions, mainly because the word “video” was unclear in this context. The user doesn’t interconnect it with “TV-programs”. The sentence “Select streaming service” was replaced to “Which Streaming Service do you use?” and the sentence “Select Video” was replace to “What program do you watch?”

“Enter your information” in the process indicator also perceived as unclear instructions. Three of the participant misinterpreted it as personal identification. In Prototype 2 the sentence “Enter your information” was replaced with “Start”.

Some of the participants didn’t realize that the page with the name “Test the video quality” was the home page. An example of unclear connection between the name and the function, and the page was therefore renamed “Start”.

I noticed that some of the users did not read the introductory text; they did put to much focus on starting the test and the dropdown menus because they were placed in the center of the page. In prototype 2 the introductory text was therefore placed above the dropdown-menus, to ensure that the user understands what the test measures before they fill in the data. (Figure 2 shows the design of the start page).

Page 2: The video is being analyzed
No mistakes or comments from the participants were provided on this page in prototype 1 so nothing in the design was modified. One user proposed that information about the test could be presented on this page, because it’s a page for killing time and the users are therefore more willing to read information text. It was a good proposal so this was implemented in the new design.

Page 3: The result
To make the result page more visually enjoyable the indicator with the range Bad, OK, and Good was replaced with a smiley with the facial expressions Sad, Natural, or Happy.

One user found it confusing when the link “Guide to how to improve the quality” wasn’t named exactly the same as the link in the main menu “How do I improve the quality.” On the result page, the links were therefore renamed to the same as the buttons in the main menu.

Almost all participants thought that it was too much text on the result page. In prototype 2 the text was removed and replaced with related links (with the same text as the buttons in the main menu). One user gave the proposal to place the guide on the side of the performance indicator instead of below so that this link would become even more visible. I thought the proposal was good and I also implemented an arrow next to the link to clearly show that this is the next step in the process.

Almost all users had difficulties understanding how to get back to previous pages, this because there wasn’t back-buttons on all pages. To get back to the previous page, the user must know the name of the page that he/she wants to visit, and then
press this tab in the header menu. This was a mistake, and a back-button was therefore implemented at all pages in prototype 2 to allow the user to always be able to return to the previous page, without need to know which name this page have. A “Back to my results”-button was also implemented on the pages that were visited by the user after the result had been presented. (Figure 3 shows the design of the result page).

**Prototype 3 - The Hi-fi Prototype**

After the user test on the medium-fi prototype, some corrections in the design were made and the final result was presented by using the wireframe tool Justinmind Prototyper [24].

**Page 1: The start page**

All participants understood how to start the test, as well as where in the process they were at, therefore the start page design remained the same.

Some of the participants, however, had comments on the icon named “Start” in the progress indicator. They argued that an arrow with the name “Start” could easily be misunderstood of being a button to start the test. This icon was therefore renamed “Step 1: Enter streaming service”. The other two icons were also named Step 2 and Step 3, to make sure that the user understands that they are indications of the process and not clickable buttons.

**Page 2: The video is being analyzed**

A user gave the suggestion that instead of starting the analysis of the video on page 2, a button called “Analyzing clip” will pop up on the start page when the information about the streaming services and TV-programs has been completed. This makes it easier to understand what’s happening in process and the user don’t need to start the video on page 2, because it occurs automatically when the user moves to the “The clip is being analyzed”-page.

This also lead to that the name “The clip is being analyzed” in the progress indicator get a more logical connection to what is happening on the page, when the clip actually starts analyzes when the user enter the page. I also implanted a progress indicator that shows the percentage status of clip that has been analyzed (See figure 5).

**Page 3: The result**

The Result page received positive feedback from the participants and was considered easy to understand; therefore
just minor adjustments concerning the visual design were made in the design.

Page 4: The guide to how to improve the quality
This page did not get any negative feedback, which resulted in that no changes regarding the interaction were made for the final prototype, just visual enhancements for a more pleasing design.

Page 5: Detailed information about the test result
This page was still considered too cluttered and presenting too much information. In the final prototype the design was scaled down little and some text was removed to be able to get the graphs appearing simpler and not to scare the users with too much and too small text.

Four out of the five participants also wanted an information box about the QoE on this page. They meant that this information box just needs to appear the first time they use Streamingkollen. Two small boxes with information about Pause Intensity and Bit-rate and why these values affect the final value of the quality was therefore implemented on the Detailed Information-page.

VI. ANALYSIS AND DISCUSSION
Method discussion
The first step in the process to improve the user experience of the interface of Streamingkollen was to clarify the terms ‘User Experience’ and ‘Usability’. I chose methods to use in my investigation based on research and recommendations from the theories. I concluded the choice of methods to be the best approach in order to answer my problem definition would be; a heuristic evaluation, user tests on a similar existing service and user test on three prototypes with different levels.

With regard to the literature study I concluded that five people are an appropriate number of participants in observation tests. In retrospect it seems to be a reasonable number, five people per prototype test provided the data I needed. Of course I would have preferred more tests to identify user problems, but because of the survey scope five people were an appropriate number.

In my examination I wanted to put the user in focus throughout the whole design process, and I therefore used the heuristic evaluation and the design guidelines just as a method to create a foundation to build upon. The user tests have also been the most rewarding method for my result.

I quickly discovered a connection between the mistakes done in the user tests and the design principles retrieved from the theory. The mistakes and shortcomings noted during the prototype tests were almost all design decisions where the design principles had not been fully achieved. Therefore, I think that my choice of methods complemented each other well and together worked as a good procedure in a user-centered design process and in the development of a user-friendly interface.

The choice of four different user tests also proved to be a good decision. The navigation mistakes noted in user test 1 (the lo-fi prototype) was the same kind of mistakes discovered in the other two tests (the medium-fi prototype and the high-fi prototype), although the number of mistakes was reduced. I realized that it took some design attempts before the errors could be remedied completely. In the last test the response from users was overall positive, which led to the decision of a
less detailed performed user test on the last high-fi prototype. This proved to be a wise decision since I didn’t have to change much from the last high-fi prototype to the final prototype.

The fact that all participants in the user test were users of streaming services and therefore might have high, or at least basic technology and computer skills may have influenced the positive outcome of the third and final user test. However, I don’t think this have had a bad influence on the result, considering that the website should be designed for streaming users.

**Problem Discussion**

This report has been conducted with the purpose to answer the following question: *How should the interface of the consumer tool Streamingkollen.se be designed in order to improve the usability of the service?*

With my research I have concluded some design decisions that have been important in the development of the interface in a user experience perspective. These corrections are based on the mistake and feedback users made and gave during the user tests. I have observed a connection between these adjustments and the design guidelines derived from Nielsen’s “10 Usability Heuristics for User Interface Design” [10] and Shneiderman’s “Eight Golden Rules of Interface Design” [11].

The errors and mistakes that led to these adjustments were all design decisions in which one or more principles weren’t met. I therefore believe that the outcome accuracy is enhanced when the result both are based on theoretical guidelines and usability tests.

**The most important design decisions and related fulfilled guidelines**

Here is a description of the key design decisions, and below the fulfilled guidelines/principles.

1. **Feedback**

What led to most frustration and disapproval among the users in user test 1 (the observation test on Bredbandskollen), was when the users felt that they didn’t had control over the service. This could for example be when they clicked on a button and didn’t get the response they expected, or when they ended up in a place at the site without understanding why and how to get back. I also noticed that the users felt this lack of control when the next step in the process to complete the contemplated task was unknown to them.

I realized that the lack of localization had a great impact on this, and I put major focus on creating a clear and distinct design that would show were the user is and what the next step in the process is. A design proposal was given in prototype 1, a tab menu and a process indicator were included already in the first prototype and the design solution was improved after feedback from the users which led to a final draft in the last prototype.

The design principles that were highlighted and achieved by the corrections based on the user tests were:

**Visibility of system status**

*The system should always keep users informed about what is going on, through appropriate feedback within reasonable time* [10].

**Offer informative feedback**

*For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial* [11].

**Support internal locus of control**

*Experienced operators strongly desire the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions rather than the responders* [11].

**Design dialog to yield closure**

*Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions* [11].

2. **Speak the users' language**

Too difficult words and terms were the reason for why many users became frustrated and got a bad impression of Bredbandskollen, which was exposed in the first user test. Users felt stupid when they couldn’t manage the site, and that feeling was one of the biggest reasons why users became disinterested in the site. Because of this I used easy words and terms in my prototypes. However, I noticed an interesting result from my study, the fact that the language used at the site needed to be simplified much more than I first thought. This also proved that several prototypes and tests are required to obtain the best results as possible.

The design principle that were highlighted and achieved by the corrections based on the user tests were:

**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* [10].

3. **Consistency**

A non-consistent design was the reason that users clicked on un-clickable buttons in the user test on Bredbandskollen. The fact that the users didn’t get the response they expected was, as I explained earlier, a major reason for frustration and negative experience of the website. During the investigation I realized that this clarity was something I must focus on, and to achieve a user-friendly design it requires that links and buttons has right color and shape for each activity.

The design principles that were highlighted and achieved by
the corrections based on the user tests were:

**Consistency and standards**
Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions [10].

**Strive for consistency**
Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout [11].

4. **Minimalistic design**
The main challenge when improving the user experience of an interface is that the interaction between the features and user are working optimally. Difficulties to navigate on a site may lead to users giving up and moving to another site. But I realized that another important aspect in the design process is the first impression of the site. It is crucial to if the user even choose to navigate on the service or not.

It appeared in user test 1 that many users were intimidated by too many and cluttered details. Excessive and irrelevant information on both Bredbandskollen and the first prototype also had the effect that other more relevant information on the pages was missed by the users.

Information should be easily accessible, and the user shouldn’t need to seek for the information. To make it easier for the user I chose a minimalist design. This might not attract the user visually. But at the same time it does not cause usability problems, which was my purpose to avoid with this study.

The design principle that were highlighted and achieved by the corrections based on the user tests were:

**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 [10].

VI. **CONCLUSIONS**
In this study, I have tried to answer the following questions: How should the interface of the consumer tool Streamingkollen.se be designed in order to improve the Usability of the service?

I see this study as successful. Since I got more and more informative feedback from the users in every test made I can conclude that the investigation took the right direction.

Nielsen’s “10 Heuristic Principles” and Shneiderman’s “Eight Golden Rules of Interface Design” formed the basis for the prototypes. The prototypes were exposed to user tests that had the greatest impact on the final result.

The shortcomings in the interface identified in the user tests that affected the users experience the most proved to be failures regarding lack of feedback from the service, non-minimalistic and consistent design and unfamiliar language including system-oriented terms.

The lack of feedback was perceived when the service provided no, minor or wrong response to the action made by the user. Also minor information about the user's location at the site led to questions like “where am I?”, “what is the next step?” and "how do I get there?, and resulted in a feeling of lost control among the users.

A non-consistency design with different design on buttons, text and links with the same purpose, or in the other cases the same design for buttons, text and links with different purpose, and a non-minimalistic design including too much and cluttered information also proved to affect the user experience.

The design process also showed that the unfamiliar language used at the site needed to be simplified much more to adapt to the user's level than I first thought.

These shortcomings were all design decisions in which one or more of Nielsen’s and Shneiderman’s principles and guidelines were not met.

**Suggestions for further research**
To be able to identify defects and mistakes in the final prototype more user tests needs to be done. To find out how the service is experienced by people with continual use of the service, a long-term study may also need to be implemented.

**ACKNOWLEDGEMENTS**
I would like to thank all participating in this study. I would also like to thank my supervisor Kjell Brunström at Acreo and my supervisor Malin Picha Edwardsson at KTH.

**REFERENCES**
[12] Nielsen, J; Landauer, T.K. A mathematical model of the finding


