

User-Centered Design and Eyetracking Evaluation of a Generic Product Specification at IKEA

Rikard Lundberg

DEPARTMENT OF DESIGN SCIENCES
LUND UNIVERSITY
2016

MASTER THESIS



Abstract

The company IKEA utilizes traditional methods of communicating requirements to their subcontractors. IKEA has started a project to update their specifications and this thesis details the first draft of their new system. The draft was created by utilizing several methods in interactive design. The considerations to design and implementation was taken from ideas generated by interviews with IKEA and their subcontractors after which a prototype in form of an interactive website was produced. This was then tested to verify improved efficiency compared to the specification IKEA uses today. In order to further increase efficiency in communications between IKEA and its subcontractors this thesis will serve as a basis for which directions any future works will take. The design solutions proposed in this thesis showed promising results during testing. As the project continues, the design solutions proposed will serve as a good foundation for future work.

Contents

1	Acknowledgements	4
2	Introduction	5
2.1	Background	5
2.2	Purpose	5
2.3	Goals and contributions	5
3	Theoretical background	6
3.1	Interaction design	6
3.1.1	Eye tracking	7
3.2	Previous works with usability in product specifications	8
3.2.1	Product specifications	8
3.2.2	Guides & specifications at IKEA	8
4	Materials	10
4.1	Existing system at IKEA	10
4.1.1	Formaldehyde requirements of wood-based materials and products	10
4.2	Interactive solution	11
4.3	Gathering of information	12
4.3.1	Interview with subcontractor	13
4.3.2	Design principles and general design propositions	14
5	Method	15
5.1	First iteration of creating a prototype	16
5.2	Generic IKEA Product Specification	17
5.2.1	Designing the prototype	17
5.2.2	Programming the prototype	20
5.3	User testing	20
5.3.1	Research questions for user testing	21
5.3.2	Which type of data will be collected	22
5.3.3	Tasks	22
5.3.4	Task relations to research questions	22
5.3.5	Selection of test persons	23
5.3.6	Test sessions	23
5.4	Tool to analyze data	24
6	Testing results	26
6.1	Data obtained through analyzing the test data	26
6.2	Data obtained through analyzing the survey	27

6.3	Eye tracking data	30
6.3.1	Heatmap	31
6.3.2	Average fixation duration	32
6.3.3	Mean saccade amplitude	33
6.3.4	Blink rate	35
6.4	Findings to the research questions	36
6.4.1	Is it easier to navigate correctly in the prototype in comparison to the live specification?	36
6.4.2	Is it easier to find nationality-specific requirements for materials or processes and then navigate correctly in the prototype in comparison to the live specification?	36
6.4.3	Is it easier to find which documentation is necessary for a specific material or process in the prototype in comparison to the live specification?	37
6.4.4	Is it easier to determine what a specific documentation must contain in the prototype in comparison to the live specification?	37
6.4.5	Is it easier to determine how often a specific documentation must be written in the prototype in comparison to the live specification?	37
6.4.6	Is the prototype perceived as user-friendly?	37
6.4.7	Is the live specification perceived as user-friendly?	37
6.4.8	Is the prototype perceived as more user-friendly in comparison with the live specification?	38
6.4.9	Do the test persons believe it is reasonably easy to perform the tasks?	38
6.4.10	Is the user looking at irrelevant information more commonly in either the specification or the prototype?	38
7	Discussion	39
7.1	Eye tracking data	39
7.2	Identified problems	40
8	Conclusions	42
	Appendix A	45
	Appendix B	53

1 Acknowledgements

I would like to acknowledge and thank the following persons and entities:

- Mikael Blomé for guiding me through the project and helping me with deciding what to do and how.
- Nils Holmberg for helping me with using the eye tracker device and analyzing the data collected from it.
- Humlab for letting me use their eye tracking devices and their facilities.
- Torbjörn Svensson for helping me keeping a dialogue with IKEA and gathering information from the users.
- Joakim Eriksson for helping me finding this project and giving support in times of need.
- Laura Björck for not letting me give up.

2 Introduction

2.1 Background

IKEA utilizes specifications to communicate requirements concerning their products to their subcontractors. As these product specifications must contain both national and international requirements and are used for about 100 000 different products it is important that they are easy for the subcontractors to understand. Unfortunately, the product specifications are difficult to interpret for many users, and IKEA struggles with improving the communication with their subcontractors. This has led to many misinterpretations and delays during delivery, which in many cases has led to even further delays down the line all due to unstable communication. After careful consideration IKEA realized the potential increase in efficiency if these specifications were to be made more easily understood by the subcontractors. Eventually a project was started in which a prototype for a more user-friendly environment was created. However, 10 years later IKEA still struggles with the very same issue. In order to determine the complexity of this project a first draft of a solution is required.

2.2 Purpose

The solution to IKEA's problem is supposed to be found during a project in cooperation with Faculty of Engineering, Lund University. This thesis was written in order to provide a solution to IKEA's problem and to create a basis for future works.

2.3 Goals and contributions

This thesis will serve as an initial transition to a more user-friendly communication system between IKEA and its subcontractors. It might eventually be followed up by other, more specified projects and will be used as a basis for future work. As the thesis designs the general approach to the problem at hand, IKEA will also use its results to determine whether or not they believe the approach would be suitable for them. As this might be a problem at other companies than IKEA, the thesis might also serve as a basis for working with communications concerning requirement specifications in general.

The main goal of this thesis is to prove the efficiency in the chosen design solutions and give a recommendation for future works.

3 Theoretical background

This chapter lists all theory needed to properly understand this thesis and other references such as previous work with usability within product specifications.

3.1 Interaction design

Because of the need of a user-friendly interactive system the main focus of the work concerned in this thesis is the Human-computer interaction (HMI). One design method commonly used during HMI is User-centered design (UCD), which puts the user in centrum rather than the designed system [1][2]. For example, a system developed with a UCD-method should be intuitive to a standard user rather than too complex. In other words, the users abilities and knowledge prior to using the system should be reflected in the system.

Fitts' law determines the time which it takes to reach a target with a pointing device [1]. While it can be used to calculate exact values to compare the time to reach targets in different systems, no calculations are used in this thesis. However, it still provides a theoretical basis for analyzing in a broader sense.

As a way to analyze how using the system affects the user, cognitive load can be used. Cognitive load is how much information a user can process at any one time. This is further divided into three separate types:

- **Intrinsic** - The complexity of information currently being processed.
- **Extraneous** - Any extra data that the user inadvertently processes while processing the information.
- **Germane** - A cognitive load that helps the user to learn the information currently being processed more efficiently.

While germane and extraneous cognitive load can be affected, intrinsic is more dependent on the user. Any system with a lot of extraneous cognitive load is generally bad design as it means that the user has to process a lot of irrelevant information in order to solve a problem [3].

Hierarchical task analysis is a way to analyze the problem as whole. The basic principle is to divide a task into a subset of tasks. These

tasks may in turn be divided further into subsets of task until simple tasks are found and then solved separately in order to complete the first task [1].

3.1.1 Eye tracking

Eye tracking is a way to collect data of exactly what the user is looking at while using a system [4]. This provides useful information in cases where a lot of information is shown at any specific time. This information can be used in order to determine whether or not the user is looking at information which would help the user to complete a task or if the user is reading a lot of unnecessary information.

The data collected through eye tracking are the basic types of eye movement recognized by the eye tracking device; Fixation, Saccade and Blink. Fixation, as suggested by the name, is when the eyes are focusing at one specific area for a relatively long duration. This is recognized as reading or analyzing information. Saccades are quick movements of the eyes from one fixation point to another [5]. Blink is, also as suggested by the name, when the eyes are blinking for a relatively long duration.

Both average fixation duration (the average amount of time elapsed during each fixation) and mean saccade amplitude (the average length of a saccade measured in degrees from the point of view of the user's left eye) have been proved to be related to increased cognitive load. The blink rate (the rate at which the user is blinking) is related to task difficulty [6].

While reading web content most users tend to read in an F pattern as a mean to scan the whole text for relevant information rather than reading it thoroughly. Heatmap examples of the F pattern can be seen below in Figure 1. This pattern shows that users usually read the first two headers and then scans vertically on the left side of the content [7].



Figure 1: Heatmap examples of the F pattern.

3.2 Previous works with usability in product specifications

3.2.1 Product specifications

Product specifications, or in some cases more known as product design specifications (PDS), are commonly used as guides to create specific products. There are several guides that describes how to create a PDS, but these tend to highlight which content should be included and why [8] [9]. I have failed to find more details concerning how to create a user-friendly PDS which perhaps should be a big concern for any large PDS.

This gives an indication of the relevance of this project, as it is reasonable to assume that not only IKEA is faced with this problem.

3.2.2 Guides & specifications at IKEA

The problem IKEA has with their product specifications has previously been analyzed by Mikael Blomé which resulted in the creation of several interactive guides. He noted that IKEA's specifications mostly consisted of written text, and focused heavily on visualization as a mean of clarifying the contents to users. A screen dump from one of the interactive guides can be seen in Figure 2.

The project was divided into two separate evaluation steps in order to ensure that the right approach was taken. The short-term evaluation was performed shortly after the creation of the interactive

guides and showed promising results. The participants of the evaluation thought the visual guides were extremely helpful and thus the project was continued. Six years afterwards a long-term evaluation took place. While some guides were still used as introduction material for new personnel, other guides were completely obsolete [10].

While the project yielded promising results, the idea of increased visualization for the specifications was ultimately dismissed due to being hard to update [11].

◀ back

EN 717-1 Chamber method and EN 717-2 Gas analysis method

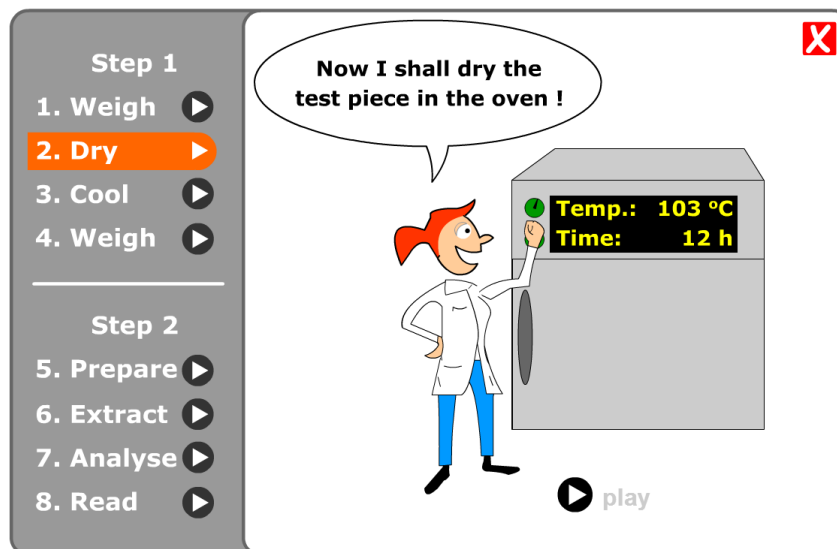


Figure 2: Screen dump from the formaldehyde guide developed in 2005 [10].

4 Materials

4.1 Existing system at IKEA

Currently IKEA has all their specifications on a website available for download to certified users. When a subcontractor signs a deal with IKEA it gets access to appropriate specifications via the website. When these specifications are updated it is up to the subcontractor to renew its specifications by downloading them once again through the website.

As was the case with the interviewee in "4.3.1 Interview with subcontractor", the specifications may or may not be used as intended. Instead, it was thoroughly scanned for vital information which was then added in an Excel document. The specification was subsequently dismissed as the Excel document proved far more easy to use in comparison with the specification.

4.1.1 Formaldehyde requirements of wood-based materials and products

The specification is written as a PDF and describes the IKEA requirements for limitations of formaldehyde in products made of wood-based materials. It contains overall requirements depending on material, how to test that the requirements are fulfilled and information about how to document performed testing.

The specification mainly consists of tables, as can be seen in Figure 3 and again in Figure 4. This makes sure they can include as much information with as few words as possible. These tables are in turn filled with different materials and processes in which one would have to consider the usage of formaldehyde, and relevant information about requirements surrounding them. The specifications are today in PDF-format [11].

Material (uncoated)	Test method	Limit	Documentation
Particle-board	ASTM E 1333 or ASTM D 6007 (ppm)	0.09	For all IKEA Suppliers: <ul style="list-style-type: none"> All boards shall be TPC-certified at the level for CARB Phase 2 by an IKEA approved TPC or have an approved exemption from TPC-certification. Plywood shall be certified for CARB Phase 2 or be PS 1-certified. Note: The material shall comply with both limits (ASTM and EN) which are to be verified at the inspection audits. ³ <ul style="list-style-type: none"> Marking: each bundle/pallet of board, each pallet or box of components shall be marked throughout the supply chain (from board producer to IKEA supplier). Marking: Each finished product using TPC-certified board or board with approved exemption from TPC-certification shall be marked. A Statement of compliance on invoice or bill of lading shall accompany each sale or delivery of board, components or finished product. Each board, component and IKEA producer shall have a general statement of compliance.
	EN 120, Perforator (mg/100 g)	4.0 ⁴	
Dry process fibreboard excluding for flooring, e.g.: MDF, HDF, LMDF	EN 120, Perforator (mg/100 g)	5.0 ⁴	
	ASTM E 1333 or ASTM D 6007 (ppm)	0.11	

Figure 3: Part of a table in the specification. There is much information for every type of material.

Documentation	Document or marking required
Approved exemption from TPC-certification (NAF, ULEF)	To be handed over to the IKEA supplier <ul style="list-style-type: none"> Copy of Approval for exemption from TPC-certificate (Application for exemption is to be made together with an IKEA approved TPC), not older than 2 years from date of issue. To be handed over to the IKEA supplier before first delivery and at each update. Additional for ULEF production: <ul style="list-style-type: none"> Proof of continued ULEF production issued by a TPC based on the half yearly review of result. Sampling for 6 month test for ULEF is to be made by an approved TPC. Not older than 8 months, to be handed over to the IKEA supplier To be available for IKEA on request for minimum 5 years <ul style="list-style-type: none"> TR from the TPC-audits Test result from board production
PS 1 Certification	To be handed over to the IKEA supplier <ul style="list-style-type: none"> PS 1 certificate issued by an independent laboratory as stated in Voluntary Product Standard PS 1-07, Structural Plywood – to be handed over to the IKEA supplier before first delivery and at every change of certification. The certification shall include level of compliance (i.e. type of wood). The certification can apply to a batch or to a production line. The certification for a production line shall be less than 12 months old. TR for formaldehyde issued by an IKEA approved laboratory, less than 12 months old. A statement from the board producer describing the gluing system used, less than 12 months old.

Figure 4: Part of a table in the specification depicting documentation.

4.2 Interactive solution

There are numerous approaches that can be considered while creating a more user-friendly specification environment for subcontractors to IKEA. However, IKEA has three requirements for the approach which must be taken into consideration [11].

- 1 Maintain accessibility** - The finished environment must be easy for subcontractors to access on a regularly basis. The current specification is a PDF-file and is accessed by a website from which the subcontractors can download the latest iteration. Any new environment must be as easy to access.
- 2 Maintain flexibility** - The finished environment must be easy for IKEA to update, which limits the usage of descriptive images.
- 3 Avoid interactivity unless necessary** - An interactive solution would only be accepted if IKEA can be assured that it is absolutely necessary in order to streamline the environment.

The proposed solution to the problem with above requirements taken into consideration was an interactive environment utilizing a content management system which could be available as a website. This would both maintain accessibility, as it could be accessed at the same place any PDF is today, and flexibility, with a user-friendly content management system. Furthermore, in order to satisfy the third requirement mentioned above, the new system underwent usability testing and was compared to current specification in means of usability to ensure that it is more user-friendly.

It should also be noted that IKEA have many specifications, and that these interact at certain points. Thus, the flexibility can already be considered low as updating one PDF-specification may result in another one needing updating. Without automatic updates for all affected specifications, this becomes a tedious handwork [11].

As a way to prove that the proposed solution is a good way to deal with the stated problem, a prototype was created. This prototype aimed to simulate the proposed system, and was then tested against the current specification.

4.3 Gathering of information

So far only IKEA's own requirements had been taken into consideration, which does not really promote any change to the specifications. So in order to make the system more user-friendly more requirements would have to be made.

4.3.1 Interview with subcontractor

The major contribution of user perspectives came with an interview with a subcontractor to IKEA [12]. The interview was mostly performed in order to ensure that the prototype is the right way to go. The interviewee showed how they used the specification and to which scenarios it was relevant for them. This was later used as the basis for the usability tests to make them as realistic as possible. As the interviewee was introduced to the different design propositions he subsequently provided information as to which ones seemed interesting for his everyday work.

He maintained that the specifications from IKEA have been a problem for quite some time, mostly due to their user-unfriendly nature. As to get around this problem the interviewee's company had made a document using the program Excel, in which they put all relevant information from the specification. This would later serve as a model for the prototype created in this project. He also stated that he could see himself using the prototype if it was not so tedious and time-consuming to use.

Both visualization and print-out friendly version of the specification were dismissed by the interviewee as he could not see a proper use for it. Apparently, these features are currently handled in another application by the name Connect.

During the interview it turned out that the interviewee had a lot of additional information to provide, and lots of own thoughts of how to proceed. His greatest concern was that IKEA does not clearly state what they want according to his point of view. He works as a subcontractor creating a specific type of board for IKEA, and they might in turn have other subcontractors connected with them. There might also be middle men between IKEA and this specific subcontractor. Every company in this process needs to perform tests and provide documentation up in the hierarchy. This might lead to a lot of confusion, since a middle man might or might not be sure as to whether or not their subcontractor hands them fibreboard made from a wet or dry process. If other companies who use this middle man would not care about this, but IKEA does, then it is essentially extra work for the middle man because IKEA did not clearly state which product they want and the specification handed to them by IKEA mentions both and, for that matter, many others. This can also cause confusion as the specification mentions many test meth-

ods, but not necessary test methods used by every subcontractor under other circumstances.

4.3.2 Design principles and general design propositions

A lot of information in the specification must be accessed in order to access other information. For example, if one would wish to read about specifics in the required documentation surrounding handling of Plywood, one would first have to locate Plywood in one part of the specification and then re-direct manually to another part of the specification. This puts some cognitive load on the user, as he or she must remember previously read parts in order to fully understand what he or she is currently reading [13]. If we were to apply Fitts' law to this scenario it would also show that the specification is not easy to use at any efficient speed. This would, of course, apply to any specification which utilizes a PDF-format. Even more cognitive load is put on the user in form of extraneous cognitive load due to the extra data the user inadvertently processes.

Another thing that I considered for a long time was visualization. This causes some trouble since any visual aid for the user would damage the system's flexibility. While this was considered for a long time it was ultimately dropped due to lack of interest from every found user perspective and deemed too difficult to use in any efficient way. Among the things considered for improving visualization was:

- Pictures clarifying the information contained in tables
- Different color scheme to emphasize different information
- Animations in order to describe processes
- The ability for users to include and save their own color scheme in order to give them a clear overview over things they want to emphasize
- Images given to the user as feedback for using the system correctly

Some parts of the documentation were originally meant to be printed out, filled in and sent to IKEA upon request. While this would explain the usage of a PDF-file, it is yet an ineffective output. This would easily be solved by using a small print-out friendly version containing the parts of the specification that needs to be printed

The general approach used to the problem stated was according to the ISO standard "ISO 9241-210:2010 - Ergonomics of human-system interaction – Part 210: Human-centered design for interactive systems" as depicted in Figure 5 [14]. This standard can be somewhat simplified to detecting problems with the current live specification and correct them. The detection of problems was done by thoroughly studies of the specification, the appliance of interactive design principles and through an interview with a subcontractor who had experience working with the specification.

Every found problem was then estimated how important it was to correct. After this short process, solutions to the main problems found were considered and it ultimately resulted in the decision of creating a prototype to simulate the specification working without the found problems. This would lead up to a new version of the specification which would work more efficiently.

As a final measure, test sessions were held at the end of the project in order to test and prove that the prototype handles everyday tasks better than the live specification and that it thus is more efficient.

5.1 First iteration of creating a prototype



Figure 6: The first iteration of prototype creation

The first iteration of creating a prototype was done by using the program MS Flash, mirroring the work performed in the project "Guides & specifications at IKEA". A screen dump taken of the prototype can be seen in Figure 6. However, this iteration was quickly dropped due to it being difficult to update. As the specification contains a lot of information, it also proved to be difficult to fully create in the first place.

5.2 Generic IKEA Product Specification

The second iteration of creating a prototype proved to be more successful. The new prototype was called Generic IKEA Product Specification (GIPS) and will henceforth be referred to as the prototype. The process of creating the prototype is described in the following two sections (divided into design and programming).

5.2.1 Designing the prototype

While the main idea behind this project is fairly simple, it can be done in several ways. However, as some sort of database is the best way to achieve a necessary level of flexibility, creating a database seemed to be a logical first step [15]. Furthermore, in order to simulate a high level of accessibility of this database, a webpage was hosted on the free web hosting service 000webhost which included access to two databases [16].

In order to avoid the problems mentioned under "3.2.2 - Design principles and general design propositions" a different design solution was proposed. As a mean to reduce cognitive load and having to look at many different parts of the specification a different categorization was introduced. The new categorization mainly focus on giving the user a few select choices of materials and processes as can be seen in Figure 7. After choosing appropriate material or process the user is forwarded to a screen which include everything in the specification he or she needs for chosen material/process as can be seen in Figure 8, which solves the problem with high amounts of extraneous cognitive load being put on the user. The user does not need to return to a previous screen to get more information on chosen material/process once appropriate material/process has been found. This is in contrast to the categorization present in the original specification, which is based on the assumption that the user wants every material and process but instead divided among different types of information. For example, if one would wish to

read about specifications surrounding the material particleboard, one would have to find particleboard under the requirements-header shown in Figure 3 in order to know which information to look at under the documentations-header shown in Figure 4. This forces the user to go back and forth in the specification in order to find a small amount of information. The categorization in the prototype solves this problem, as all information is shown under a specific material or process. The categorization in the prototype is also based on the way the subcontractor interviewed in chapter 3.2.1 - "Interview with subcontractor" utilized an Excel-file to store important information that concerned his company.

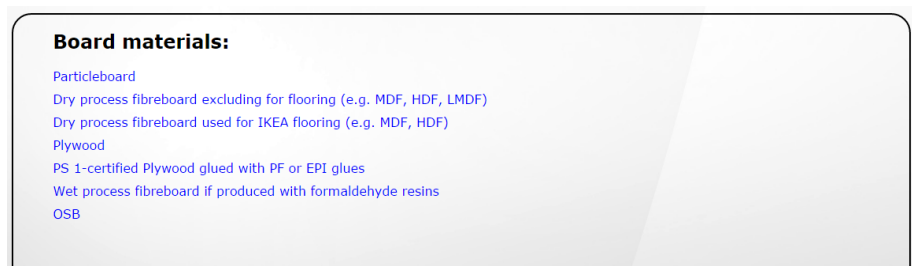


Figure 7: A screenshot from the prototype. The user gets a few select choices of materials and/or processes.

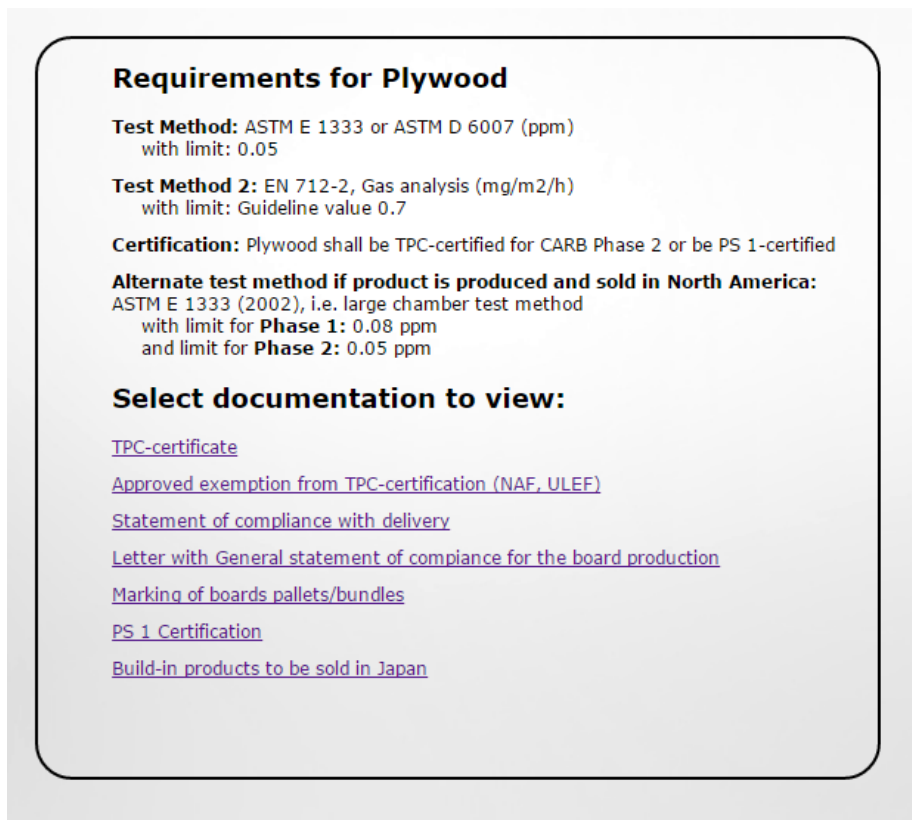


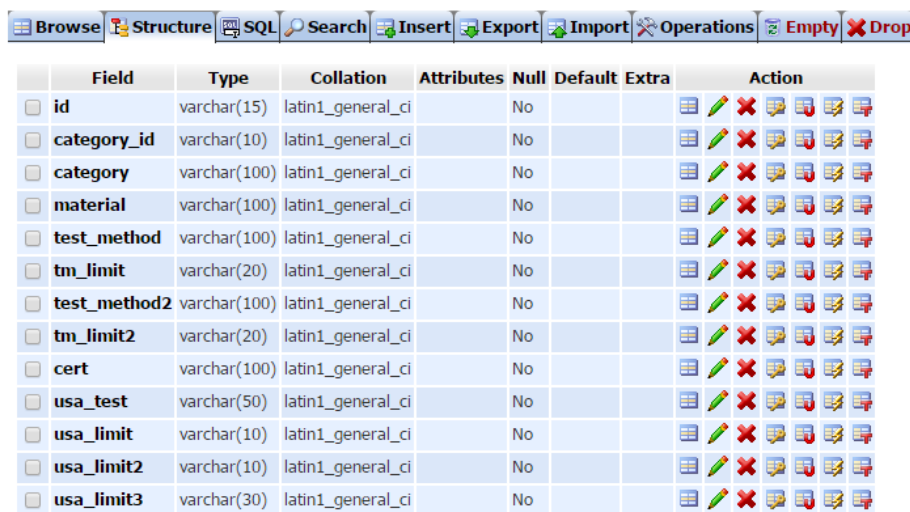
Figure 8: A screenshot from the prototype. The user does not have to return back to a previous screen in order to find other information on Plywood.

As visualization was not something that the user perspectives seemed to care much for, and also as it does not provide solid flexibility, basically all concepts concerning it were scrapped. This, as mentioned previously, also goes for any print-outs that could have been available.

5.2.2 Programming the prototype

The prototype is mostly written using PHP, which in many ways is a programming language well suited to work with MySQL [17]. The database management system chosen was, for this very reason, based on MySQL and the database handler tool phpMyAdmin was utilized as can be seen in Figure 9. All visual effects were created using HTML and CSS, which are commonly used together with PHP [18]. Most of the PHP code are basically queries to MySQL and storing of variables for further depth in the specification. While it is a tedious overall design, it is mainly created to prove the efficiency with a different categorization.

The programming code itself can at first glance seem poorly written as most variables are passed on in the URL. It was, however, taken into account that the eye-tracking device, which was used during testing, runs through software designed to detect different URLs while testing via a website [19]. This made the device considerably more easy to use.



	Field	Type	Collation	Attributes	Null	Default	Extra	Action
<input type="checkbox"/>	id	varchar(15)	latin1_general_ci		No			
<input type="checkbox"/>	category_id	varchar(10)	latin1_general_ci		No			
<input type="checkbox"/>	category	varchar(100)	latin1_general_ci		No			
<input type="checkbox"/>	material	varchar(100)	latin1_general_ci		No			
<input type="checkbox"/>	test_method	varchar(100)	latin1_general_ci		No			
<input type="checkbox"/>	tm_limit	varchar(20)	latin1_general_ci		No			
<input type="checkbox"/>	test_method2	varchar(100)	latin1_general_ci		No			
<input type="checkbox"/>	tm_limit2	varchar(20)	latin1_general_ci		No			
<input type="checkbox"/>	cert	varchar(100)	latin1_general_ci		No			
<input type="checkbox"/>	usa_test	varchar(50)	latin1_general_ci		No			
<input type="checkbox"/>	usa_limit	varchar(10)	latin1_general_ci		No			
<input type="checkbox"/>	usa_limit2	varchar(10)	latin1_general_ci		No			
<input type="checkbox"/>	usa_limit3	varchar(30)	latin1_general_ci		No			

Figure 9: A screenshot from the database handler phpMyAdmin which was used while creating the database to the prototype.

5.3 User testing

As a way to prove that the prototype is more efficient to use in comparison to the specification, a comparison test between the specification and the prototype was proposed. This was performed with the aid of an eye-tracking device.

In order to understand what good efficiency meant in this case, a number of common tasks were gathered from the subcontractor interviewed [12]. Ten research questions relevant for determining comparative efficiency were then derived from these tasks. After finding ten research questions it was determined how to find answers to each one respectively.

5.3.1 Research questions for user testing

The created prototype can be proven to be more efficient and user-friendly in comparison with the specification in a number of ways. This was mainly done by choosing a few key areas based on some typical tasks the subcontractors are faced with while using the specification [12]. If tests would show that people who are unfamiliar with the system can solve the problems more efficiently by using the prototype than by using the specification it would also prove the efficiency of the proposed design solutions in the prototype.

1. Is it easier to navigate correctly in the prototype in comparison to the live specification?
2. Is it easier to find nationality-specific requirements for materials or processes and then navigate correctly in the prototype in comparison to the live specification?
3. Is it easier to find which documentation is necessary for a specific material or process in the prototype in comparison to the live specification?
4. Is it easier to determine what a specific documentation must contain in the prototype in comparison to the live specification?
5. Is it easier to determine how often a specific documentation must be written in the prototype in comparison to the live specification?
6. Is the prototype perceived as user-friendly?
7. Is the live specification perceived as user-friendly?
8. Is the prototype perceived as more user-friendly in comparison with the live specification?
9. Do the test persons believe it is reasonably easy to perform the tasks?
10. Is the user looking at irrelevant information more commonly in either the specification or the prototype?

5.3.2 Which type of data will be collected

1. Objective-Quantitative: User tests
2. Objective-Quantitative: User tests
3. Objective-Quantitative: User tests
4. Objective-Quantitative: User tests
5. Objective-Quantitative: User tests
6. Subjective-Qualitative: Survey question
7. Subjective-Qualitative: Survey question
8. Subjective-Qualitative: Survey question
9. Subjective-Qualitative: Survey question
10. Objective-Quantitative: User tests

5.3.3 Tasks

1. Navigate to "Gluing of edge-band (non-board production) (uncoated material)" and find appropriate test method and limit.
2. Navigate to TPC-certified Plywood with composite core which is produced and sold in the USA and find both ordinary test method and specially allowed test method for USA (and their respective limits).
3. Find which information that shall be included in the marking of a TPC-certified MDF-board used for flooring (only board, not finished product).
4. Your company makes TPC-certified MDF-boards used for flooring. Find out how often you are required to hand in an update for each of the specified documentations (for any certification frequency). Your MDF-boards will be produced and sold in Sweden.

5.3.4 Task relations to research questions

Task 1 investigated research questions 1 and 10.

Task 2 investigated research questions 1, 2 and 10.

Task 3 investigated research questions 1, 3, 4 and 10.

Task 4 investigated research questions 1, 3, 4, 5 and 10.

Research questions 6 through 9 were investigated with the help of a survey which the test persons filled in after their test session. The survey questions were formulated accordingly after the research questions and can be seen under "6.2 Data obtained through analyzing the survey".

5.3.5 Selection of test persons

As two different things were compared with each other, an even number of test persons were required for the tests. It is also important that the test persons had approximately the same background, since different background could provide the test person with knowledge which would make his or her tests easier [20].

The number of test persons was eventually set to 10. The test persons consisted mostly of men, only one out of ten was a woman. The required background was set to engineering students as it is a likely background for a normal user of the specification. No other backgrounds (such as ethnicity or religion) were taken into consideration. Most of the test persons were acquaintances to me.

5.3.6 Test sessions

The test persons used a computer to complete each of the tasks mentioned under "5.3.3 Tasks" and the whole test session was recorded using an eye tracker. Five of them tested the prototype first and then the specification. The other five did the tests but in opposite order. Since test persons can learn some relevant information for problem solving the first time they see the specification or the prototype it could potentially help them in the other part of the test.

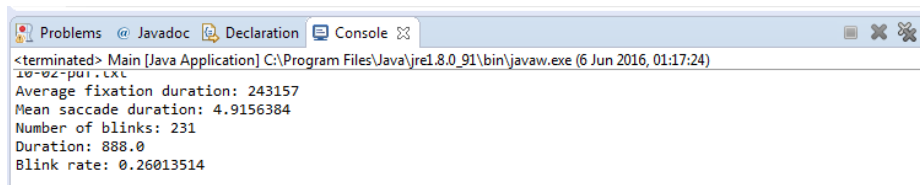
After the tasks had been performed with both specification and prototype the user was informed to fill out a survey with related questions. The survey was conducted through the Google service Google Survey. The following five questions were asked with the multiple choices as possible answers written below the questions:

1. Do you perceive the prototype as user-friendly?
 - (a) Very user-friendly
 - (b) User-friendly
 - (c) User-hostile
 - (d) Very user-hostile

2. Do you perceive the live specification as user-friendly?
 - (a) Very user-friendly
 - (b) User-friendly
 - (c) User-hostile
 - (d) Very user-hostile
3. Did you find the prototype more user-friendly in comparison with the live specification?
 - (a) The prototype is a lot more user-friendly
 - (b) The prototype is more user-friendly
 - (c) They are about equally user-friendly (/user-hostile)
 - (d) The live specification is more user-friendly
 - (e) The live specification is a lot more user-friendly
4. Did you think the tasks were reasonably easy to perform while using the live specification?
 - (a) The tasks were ridiculously hard to find proper answers to
 - (b) The tasks were a bit hard to find proper answers to
 - (c) The tasks were reasonably easy to find proper answers to
5. Did you think the tasks were reasonably easy to perform while using the prototype?
 - (a) The tasks were ridiculously hard to find proper answers to
 - (b) The tasks were a bit hard to find proper answers to
 - (c) The tasks were reasonably easy to find proper answers to

5.4 Tool to analyze data

In order to analyze the data collected from the eye tracking device I created a program called Eye Tracker Analyzer, of which a screen dump can be seen in Figure 10. Eye Tracker Analyzer was created using Java and the integrated development environment Eclipse. The program scanned through the files generated from the eye tracking device and calculated the mean saccade amplitude, the blink rate and the average fixation duration.



The screenshot shows a console window with the following text:

```
<terminated> Main [Java Application] C:\Program Files\Java\jre1.8.0_91\bin\javaw.exe (6 Jun 2016, 01:17:24)
IO-02-p01.txt
Average fixation duration: 243157
Mean saccade duration: 4.9156384
Number of blinks: 231
Duration: 888.0
Blink rate: 0.26013514
```

Figure 10: Eye Tracker Analyzer

6 Testing results

6.1 Data obtained through analyzing the test data

When the test persons performed the tests the time they spent on each task was measured . The average time spent on each of the tasks by the five test persons who used the specification first can be seen in Figure 11, while the average time spent on each of the tasks by the five test persons who used the prototype first can be seen in Figure 12.

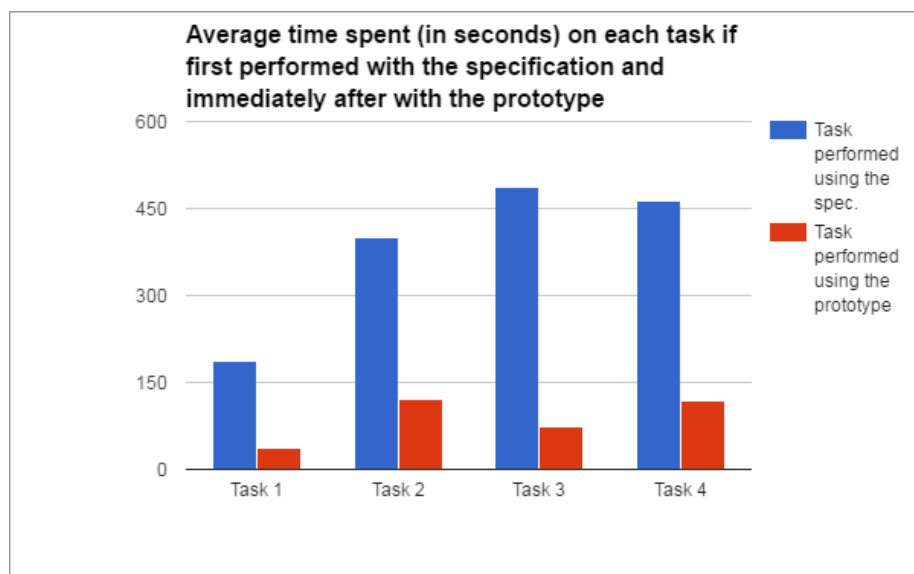


Figure 11: Average time spent in seconds on each of the tasks in "5.3.3 Tasks". These test persons started with using the specification, then performed the same tasks using the prototype.

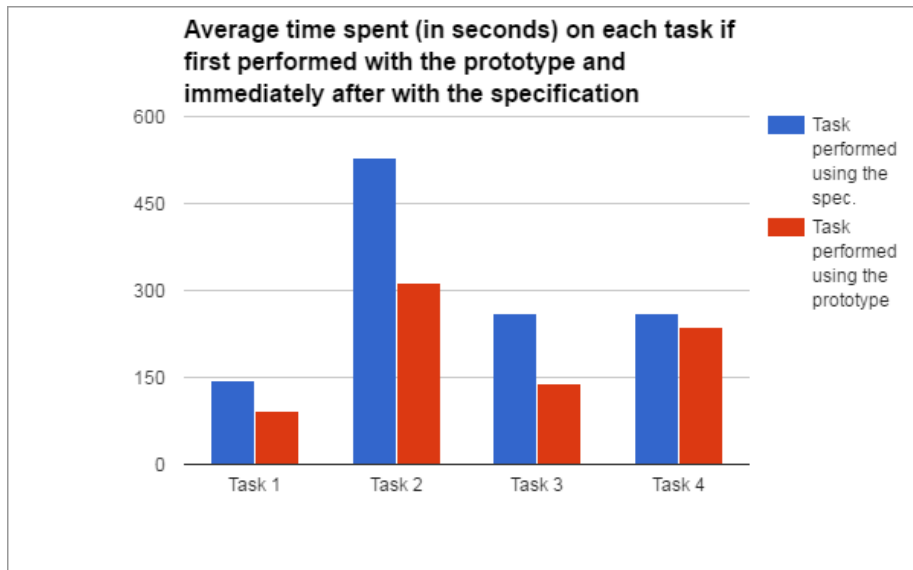


Figure 12: Average time spent in seconds on each of the tasks in "5.3.3 Tasks". These test persons started with using the prototype, then performed the same tasks using the specification.

6.2 Data obtained through analyzing the survey

The results from the survey questions were obtained directly from Google Survey. The distribution of the answers to how user-friendly the test persons perceived the prototype can be seen in Figure 13. Figure 14 depicts the distribution of the answers to how user-friendly the test persons perceived the specification. How user-friendly the test persons perceived the prototype in comparison to the specification is showed in Figure 15.

Whether or not the test persons found the tasks easy to perform while using the prototype and the specification are shown in Figure 16 and Figure 17 respectively.

Do you perceive the prototype as user-friendly?

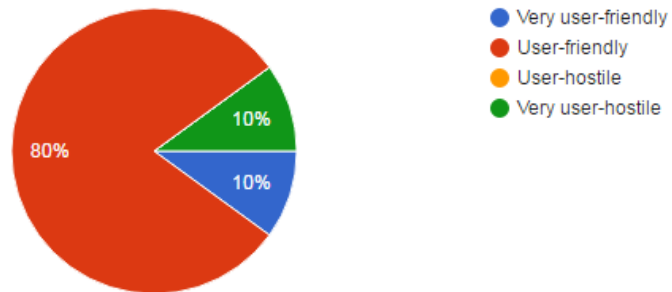


Figure 13: How user-friendly the test persons perceived the prototype.

Do you perceive the live specification as user-friendly?

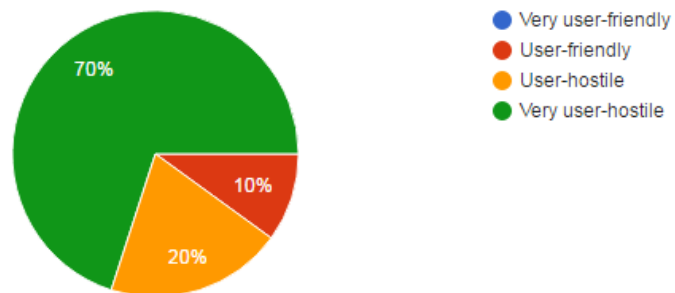


Figure 14: How user-friendly the test persons perceived the specification.

Did you find the prototype more user-friendly in comparison with the live specification?

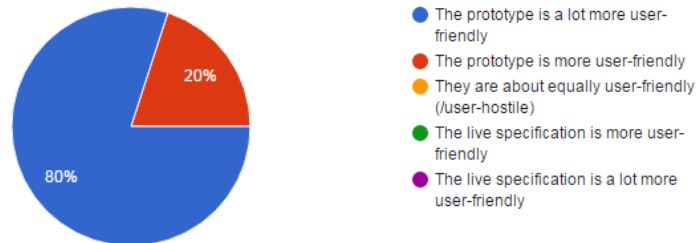


Figure 15: How user-friendly the test persons perceived the prototype in comparison with the specification.

Did you think the tasks were reasonably easy to perform while using the live specification?



Figure 16: Whether or not the test persons thought the tasks were reasonably easy to perform while using the specification.

Did you think the tasks were reasonably easy to perform while using the prototype?

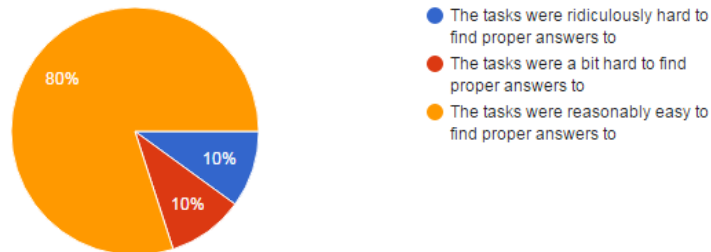


Figure 17: Whether or not the test persons thought the tasks were reasonably easy to perform while using the specification.

6.3 Eye tracking data

The eye tracking device provided a lot of data, as can be seen in Figure 18. This data was generated through a software called SMI BeGaze and depicts a user using either the specification or the prototype, totaling 20 of these data files. The data shown in Figure 18 is not complete, the data continues for about 10.000 lines. There are also further information in additional columns not depicted in the figure.

The information used in these data files are the duration times of fixations in order to calculate average fixation duration and amplitude of saccades in order to calculate mean saccade amplitude. The number of blinks and the total time of the test are also used in order to calculate the blink rate.

It should be noted that the headers depend on the event type, as can be seen in Figure 18.

Table Header for Fixations:								
Event Type	Trial	Number	Start	End	Duration	Location X	Location Y	
Table Header for Saccades:								
Event Type	Trial	Number	Start	End	Duration	Start Loc.X	Start Loc.Y	
Table Header for Blinks:								
Event Type	Trial	Number	Start	End	Duration			
Table Header for User Events:								
Event Type	User Trial	Events Number	Start	Description				
UserEvent	1	0	6866364322	# UTC: 1463717044 830				
UserEvent	1	1	6976387669	# Message: AcroRd32.exe				
Saccade L	1	1	6976387802	6976595412	7610	828.21	280.47	789.15
Saccade R	1	1	6976387802	6976595412	7610	828.21	280.47	789.15
Fixation L	1	1	6976595412	6976795668	200256	783.77	225.34	57
Fixation R	1	1	6976595412	6976795668	200256	783.77	225.34	57
Saccade L	1	2	6976795668	6976828958	33290	776.73	233.66	670.42
Saccade R	1	2	6976795668	6976828958	33290	776.73	233.66	670.42
Fixation L	1	2	6976828958	6977070878	241920	701.92	298.40	64
Fixation R	1	2	6976828958	6977070878	241920	701.92	298.40	64
Saccade L	1	3	6977070878	6977095863	24985	694.13	314.13	513.03
Saccade R	1	3	6977070878	6977095863	24985	694.13	314.13	513.03
Fixation L	1	3	6977095863	6977220991	125128	536.95	351.22	34
Fixation R	1	3	6977095863	6977220991	125128	536.95	351.22	34
Saccade L	1	4	6977220991	6977337768	116777	540.32	376.83	453.63
Saccade R	1	4	6977220991	6977337768	116777	540.32	376.83	453.63
Fixation L	1	4	6977337768	6977479605	141837	466.63	532.11	27
Fixation R	1	4	6977337768	6977479605	141837	466.63	532.11	27
Saccade L	1	5	6977479605	6977679854	200249	470.80	546.75	395.63
Saccade R	1	5	6977479605	6977679854	200249	470.80	546.75	395.63
Fixation L	1	5	6977679854	6977788803	108949	372.05	400.47	59
Fixation R	1	5	6977679854	6977788803	108949	372.05	400.47	59
Saccade L	1	6	6977788803	6977829948	41145	384.87	397.65	355.36
Saccade R	1	6	6977788803	6977980079	191276	384.87	397.65	509.41
Saccade L	1	7	6977846561	6977905061	58500	375.89	349.52	374.32
Saccade L	1	8	6977921719	6977938890	17171	490.32	475.05	445.63
Saccade L	1	9	6977955054	6978038855	83801	499.10	459.04	467.19
Saccade L	1	10	6978055185	6978188534	133349	410.39	443.91	839.08
Saccade R	1	7	6978114521	6978188534	74013	674.16	410.53	839.08
Fixation L	1	6	6978188534	6978305854	117320	851.04	523.06	38
Fixation R	1	6	6978188534	6978305854	117320	851.04	523.06	38
Saccade L	1	11	6978305854	6978455787	149933	856.73	516.37	898.04
Saccade R	1	8	6978305854	6978455787	149933	856.73	516.37	898.04
Fixation L	1	7	6978455787	6978563960	108173	940.28	346.41	57
Fixation R	1	7	6978455787	6978563960	108173	940.28	346.41	57
Saccade R	1	9	6978580832	6978747535	166703	955.21	344.79	969.10

Figure 18: Part of one of the data files generated by SMI BeGaze.

A heatmap was generated from the average fixation from all test persons while looking at a certain part of the prototype. This is depicted in Figure 19. As can be seen, it almost follows a typical F Pattern.

6.3.1 Heatmap

The recordings of all test persons were put together to show the average fixations for all test persons while looking at one particular part of the prototype as depicted in Figure 19. The red shows the highest intensity of fixations, followed by yellow and then green. The blue shows low amounts of fixations and none-colored areas contains very few or no fixations.

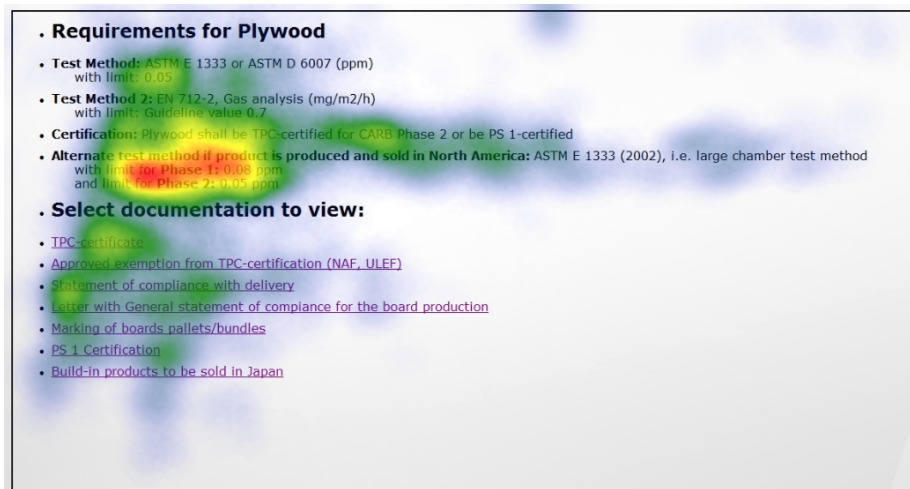


Figure 19: An heatmap showing the average fixations for all test persons while looking at this part of the prototype

6.3.2 Average fixation duration

The average fixation durations for each test person are shown in Figure 20 and Figure 21. Figure 20 shows the five test persons who used the specification first and Figure 21 the test persons who used the prototype first. In both figures, the blue bars depicts the measurements for the specification while the red bars depicts the measurements for the prototype.

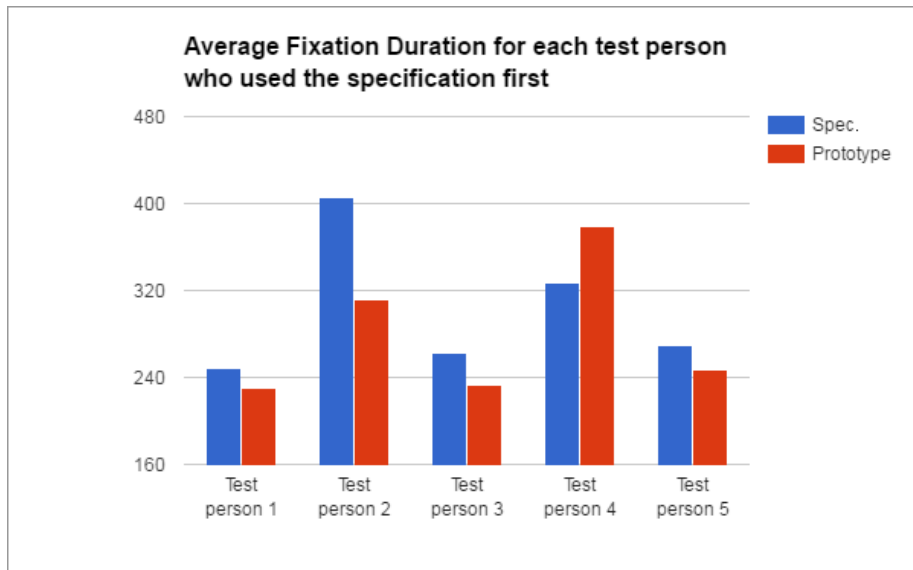


Figure 20: The average fixation duration (in milliseconds) for those test persons who first performed the test using the specification

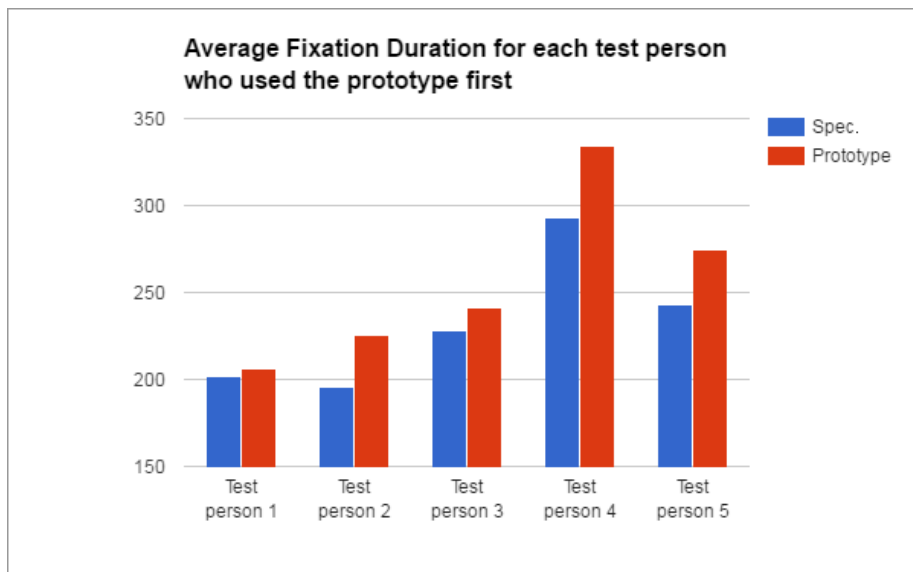


Figure 21: The average fixation duration (in milliseconds) for those test persons who first performed the test using the prototype

6.3.3 Mean saccade amplitude

The mean saccade amplitudes for each test person are shown in Figure 22 and Figure 23. Figure 22 shows the five test persons

who used the specification first and Figure 23 the test persons who used the prototype first. In both figures, the blue bars depicts the measurements for the specification while the red bars depicts the measurements for the prototype.

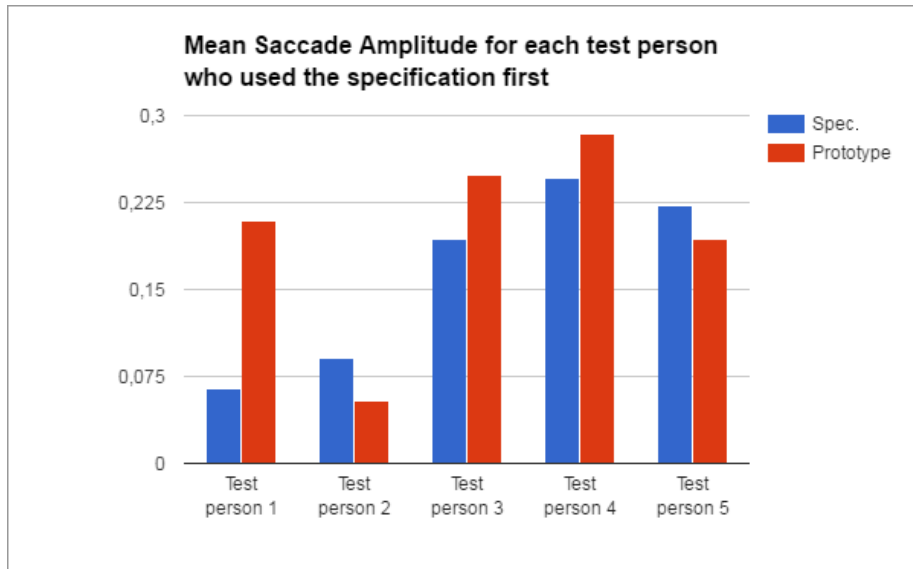


Figure 22: The mean saccade amplitude for those test persons who first performed the test using the specification

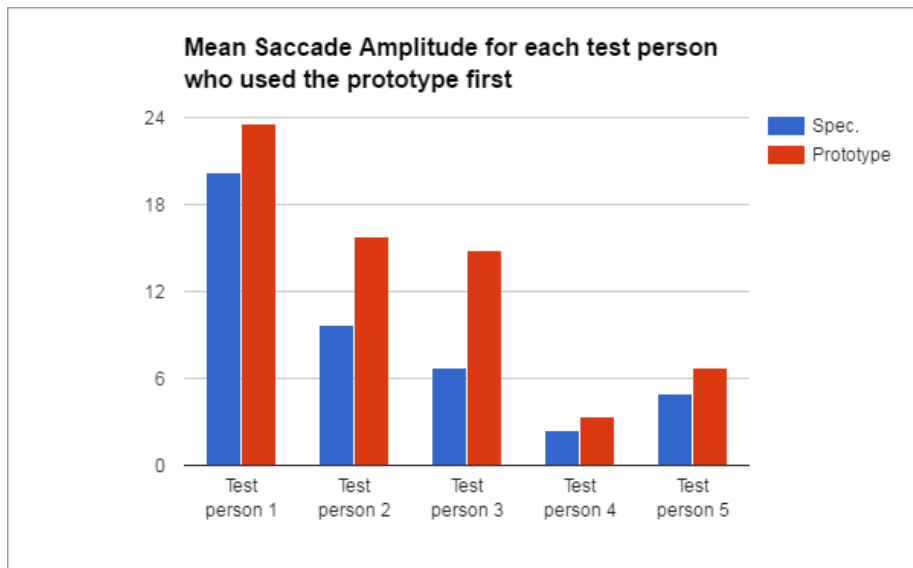


Figure 23: The mean saccade amplitude for those test persons who first performed the test using the prototype

6.3.4 Blink rate

The blink rate for each test person are shown in Figure 24 and Figure 25. Figure 24 shows the five test persons who used the specification first and Figure 25 the test persons who used the prototype first. In both figures, the blue bars depicts the measurements for the specification while the red bars depicts the measurements for the prototype.

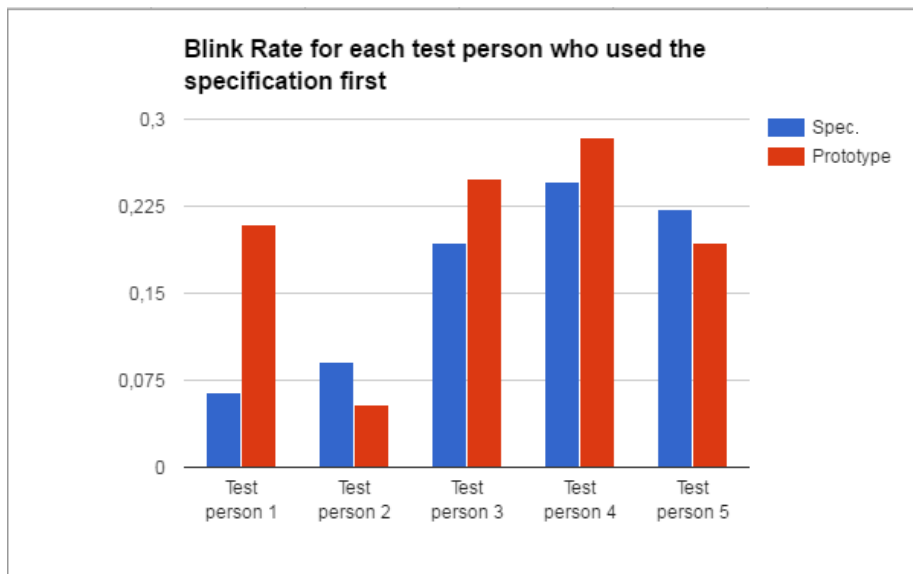


Figure 24: The blink rate for those test persons who first performed the test using the specification

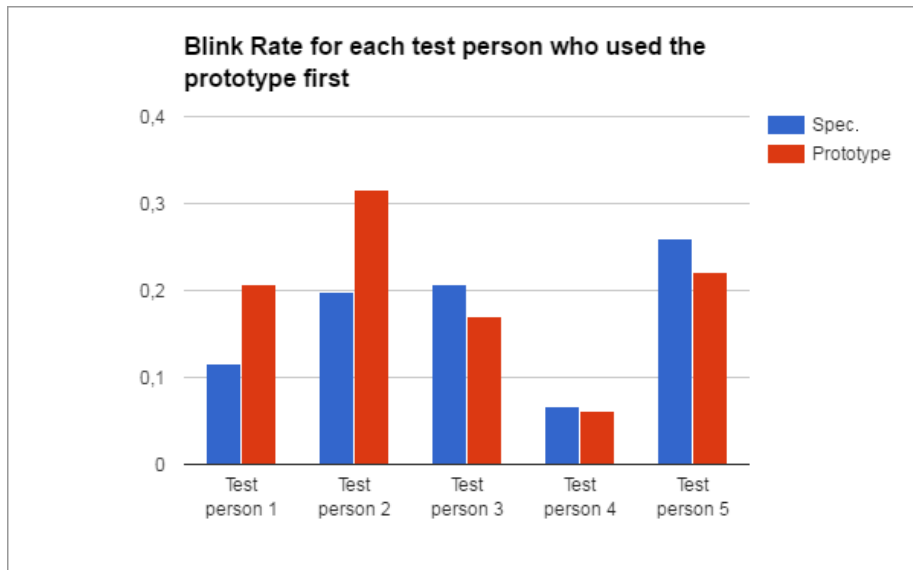


Figure 25: The blink rate for those test persons who first performed the test using the prototype

6.4 Findings to the research questions

The answers to research questions 1 through 5 and 10 utilizes the data from Figure 11, Figure 12 and Figure 20 through 25.

The answers to research questions 6 through 9 utilizes the data from Figure 13, Figure 14, Figure 15, Figure 16 and Figure 17.

6.4.1 Is it easier to navigate correctly in the prototype in comparison to the live specification?

The first task is specifically designed to be a pure navigating problem, and the test persons performed this task slightly faster with the prototype if using the prototype first and significantly faster with the prototype if using the specification first. It is hence concluded that it is easier to navigate correctly in the prototype in comparison to the live specification.

6.4.2 Is it easier to find nationality-specific requirements for materials or processes and then navigate correctly in the prototype in comparison to the live specification?

The second task focused on nationality-specific requirements and was solved a lot faster by using the prototype in both cases. It is worth notifying that the time spent on this task with the prototype

was cut in half if the test person had used the specification first and that solving this task with the specification took the test persons longer time if they had used the prototype first. This might be explained in different ways. For example, the test persons can at first have thought the task to be very complex and may have missed the easy solution the prototype provides. Then, while using the specification, the test persons could anticipate an easy solution where none was provided. With a rather low number of test persons it is of course also possible that this specific task simply suited the five test persons who used the specification first better.

6.4.3 Is it easier to find which documentation is necessary for a specific material or process in the prototype in comparison to the live specification?

This was examined in both task 3 and task 4. If using the specification first it was obvious that it was significantly easier to find appropriate documentation in the prototype. However, even when using the prototype first, it was slightly easier for the test persons to find appropriate documentation in the prototype.

6.4.4 Is it easier to determine what a specific documentation must contain in the prototype in comparison to the live specification?

This was examined together with the previous research question and reached the same answer.

6.4.5 Is it easier to determine how often a specific documentation must be written in the prototype in comparison to the live specification?

This was examined in task 4. It reaches the same answer as stated in the previous two research questions.

6.4.6 Is the prototype perceived as user-friendly?

The prototype was perceived as user-friendly by almost all test persons. Only 10% (one test person) thought it to be user-hostile.

6.4.7 Is the live specification perceived as user-friendly?

The specification was perceived as very user-hostile by almost all test persons. 20% (two test persons) found it user-hostile and 10% (one test person) found it user-friendly. It is however rather evident that the test persons found the specification generally user-hostile.

6.4.8 Is the prototype perceived as more user-friendly in comparison with the live specification?

Every single test person thought the prototype to be more user-friendly than the specification.

6.4.9 Do the test persons believe it is reasonably easy to perform the tasks?

While using the specification the test persons gave very different answers to this question. However, the very same test persons found the tasks more reasonably easy to perform while using the prototype. It should be noted that the test persons do not necessary have a proper frame of reference to what is reasonably easy with this type of tasks. It is however clear that they believed the tasks to be relatively easier to perform in the prototype in comparison with the specification.

6.4.10 Is the user looking at irrelevant information more commonly in either the specification or the prototype?

The calculations shown from mean saccade amplitude in Figure 22 and Figure 23 suggests that the test persons looked at more irrelevant information. This is due to the amplitudes being generally greater while using the prototype which is connected with a lower cognitive load.

7 Discussion

7.1 Eye tracking data

Most of the test persons who used the specification first showed a longer average fixation duration while using the specification in comparison to while using the prototype. However, all test persons who used the prototype first showed a longer average fixation duration while using the the prototype in comparison to while using the prototype.

As longer average fixation duration is strongly connected with higher cognitive load, it suggests that the tasks themselves provided a high amount of cognitive load for the test persons rather than the prototype or the specification as the test persons were familiar with the tasks while performing them a second time. It also suggests that the sheer complexity of the information (as the test persons are assumed to be previously unfamiliar with the information content) provides more cognitive load than the designs of the specification and the prototype.

The data collected by measuring the mean saccade amplitude strongly shows that the amplitude is greater while using the prototype no matter which one the test person was first introduced to. This suggests that using the specification in fact gives the users more cognitive load.

The data collected by measuring the blink rate did not show any specific connections between blinking and which system is used. This is however not unexpected; As blink rate is not necessarily connected with cognitive load but rather the difficulty of the task (and the tasks being the same no matter which system the test persons used) it is highly individual.

It is possible to delve further into the data provided by the eye tracking device. The author would suggest to look more carefully at small lapses of time, for example between mouse clicks, to really see a difference in how the specification is used in comparison to how the prototype is used. This is however beyond the scope of this thesis.

7.2 Identified problems

Some of the content in the specification and the prototype were hard for the test persons to grasp. A lot of this was due to lack of knowledge within the given field. The test persons were, for example, not expected to know a lot of different certifications or general testing methods for formaldehyde. This might however be expected by most real users to the specification. The lack of this knowledge did cause some confusion for most, if not all, test persons.

Most test persons used search functions for finding information in the specification. This led to a lot of extra confusion as they never fully understood the structure of the document. It further led to the test persons missing relevant information for the task at hand. For example, most test persons never read which of the documentations that were required to be handed in and instead simply read through all documentations and tried to figure out which of the documentations that seemed to be likely subjects for handing in. This further strengthens how meaningful a different structure is.

The heatmap generated shows that users scan a lot of the information rather than reading it. This should be investigated further in future projects as it might mean that the prototype contains too much content on each screen.

Although the survey questions strongly suggests that the prototype is way more user-friendly than the specification it should be noted that the test persons might have been biased as most were acquaintances with me. It is however unlikely that this would have any effect on their performances while using the prototype and the specification respectively.

As identified by the subcontractor, communication is another problem with the product specifications. This is a problem that needs to be further investigated and is out of the scope of this report, but it would seem it is difficult for subcontractors to understand what IKEA really wants if they are handed a specification detailing other products. For example, if IKEA would order a board made out of plywood, the specification does detail test methods and documentations for plywood, but also for many other materials and processes.

It should also be noted that all interactivity provided by the prototype is it giving information to the user based on the users action.

For future research it could also be interesting to test cases where the user can provide information to it, for example put in strategic color patterns visible only for this specific user in order to more easily navigate in it.

8 Conclusions

Already at this early stage in IKEA's project a lot of progress can be shown. The test results speaks for themselves as the interactive website is used with much more efficiency in comparison with the specification. Even when the test persons had familiarized themselves with the content of the prototype (which is virtually the same as the content in the specification), the new abbreviations and words, and the tasks themselves they struggled more with using the specification. This is a huge step forward, and it definitely shows this is the correct direction for the project.

References

- [1] Preece, J., Rogers, Y. and Sharp, H., *Interaction Design: Beyond Human-Computer Interaction*
- [2] **Wikipedia. User-centered Design**
https://en.wikipedia.org/wiki/User-centered_design (2016-05-22)
- [3] **Guyan, M. - 5 Ways To Reduce Cognitive Load In eLearning** <http://elearningindustry.com/5-ways-to-reduce-cognitive-load-in-elearning> (2016-05-12)
- [4] **Eyetracking, Inc.** <http://www.eyetracking.com/About-Us/What-Is-Eye-Tracking> (2016-06-07)
- [5] Purves, D., Augustine, GJ., Fitzpatrick, D. et al., *Neuroscience. 2nd Edition*
- [6] **Dehue, N., van de Leemput, C.** *What does germane load mean? An empirical contribution to the cognitive load theory. Front Psychol. 2014;5:1099. doi: 10.3389/fpsyg.2014.01099.*
- [7] **Nielsen, J. - F-shaped Pattern For Reading Web Content** <https://www.nngroup.com/articles/f-shaped-pattern-reading-web-content/> (2016-06-12)
- [8] **Jensen Consulting - Writing a Product Design Specification** www.jensen-consulting.co.uk/blog/writing-a-product-design-specification (2016-06-23)
- [9] **The Open University - Manufacturing: 1.5 Product design specification (PDS)** www.open.edu/openlearn/science-maths-technology/engineering-and-technology/design-and-innovation/design/manufacturing/content-section-1.5 (2016-06-23)
- [10] **Blomé, M.** *"Visualization and establishment of product design regulations as interactive modules", Journal of Systems and Information Technology, Vol. 17 Iss 1 pp. 20 - 34 (2015)*
- [11] **Svensson, T. (2016, February 22).** Personal interview.
- [12] **Andreasson, B. (2016, April 19).** Personal interview.
- [13] **Malamed, C. - What is cognitive load?** <http://thelearningcoach.com/learning/what-is-cognitive-load/> (2016-06-07)

- [14] **International Organization for Standardization, Geneva, Switzerland.** *ISO 9241-210:2010 - Ergonomics of human-system interaction – Part 210: Human-centred design for interactive systems*
- [15] **Burns, J. - To Use or Not to Use a Database? That is the Question**
<http://www.htmlgoodies.com/primers/database/article.php/3478121>
(2016-06-07)
- [16] **000webhost - Free web hosting service**
<https://www.000webhost.com/> (2016-05-12)
- [17] **w3schools - PHP MySQL Database**
http://www.w3schools.com/php/php_mysql_intro.asp (2016-05-12)
- [18] **Kunskapsbanken - Skapa en webbsida med HTML, CSS och PHP** <http://dbwebb.se/kunskap/skapa-en-webbsida-med-html-css-och-php> (2016-05-12)
- [19] **Holmberg, N. (2016, May 3). Personal interview.**
- [20] **Rubin, J. and Chisnell, D,** *Handbook of Usability Testing, Second Edition p.121-122*

Appendix A

This Appendix contains the source code for the prototype made. It consists of seven files; index.html, item.html, doc.html, final.html, boards.html, login.php and style.css.

index.html:

```
<?php
session_start();
if (empty($_SESSION["Namn"])){
    header('Location:_login.php');
    exit;
}

?>
<html><head>
<link rel="stylesheet" href="style.css" type="text/css"/>
<script type="text/javascript" src="scripts.js"></script>
</head>
<body>
<section>

<div id="home">
<a href="index.html">Home</a>
</div>

<div id="surround">
<div id="text">

<ul id="avmenu">

<li><h2>Requirements:</h2></li>

<?php

    $oppnadb = mysql_connect("*****", "*****", "*****") or die (mysql_error());
    mysql_select_db("*****") or die(mysql_error());

    $result = mysql_query("SELECT
DISTINCT_category,_category_id_FROM_requirements");
    while($row=mysql_fetch_array($result))
    {
        $category=$row["category"];
        $cat_id=$row["category_id"];

        ?><li><a href="item.html?cat=<?echo_ $cat_id?>">
        <? echo $category; ?></a></li><?
    }
?>

</ul></div></div>
```

```

</section>
</body>
</html>

```

item.html:

```

<?php
session_start();
if (empty($_SESSION["Namn"])){
    header('Location:_login.php');
    exit;
}
?>
<html><head>
<link rel="stylesheet" href="style.css" type="text/css"/>
<script type="text/javascript" src="scripts.js"></script>
</head>
<body>

<div id="home">
<a href="index.html">Home</a>
</div>

<div id="surround">
<div id="text">

<?php
$radio = "";
$oppnadb = mysql_connect("*****", "*****", "*****") or die (mysql_error());
mysql_select_db("*****") or die(mysql_error());

$Frust = $_GET["cat"];

$result = mysql_query("SELECT_*_FROM
.....requirements_WHERE_category_id=_ '$Frust'");
$row=mysql_fetch_array($result);

$currCat=$row["category"];
?>

<ul id="avmenu">

<li><h2><? echo $currCat ?>:</h2></li>
<?php

    $result = mysql_query("SELECT_*_FROM
.....requirements_WHERE_category_id=_ '$Frust'");
    while($row=mysql_fetch_array($result))
    {
        $namn=$row["material"];
        $id=$row["id"];
        if($Frust == "boards"){
            ?><li><a href="boards.html?id=<?echo_$id?>"><? echo $namn; ?></a></li><?

```

```

    } else {
        ?><li><a href="final.html?id=<?echo_$id?>"><? echo $namn; ?></a></li><?
    }
}
?>

```

```

</ul></div></div>
</body>
</html>

```

doc.html:

```

<?php
session_start();
if (empty($_SESSION["Namn"])){
    header('Location:_login.php');
    exit;
}
?>
<html><head>
<link rel="stylesheet" href="style.css" type="text/css"/>
<script type="text/javascript" src="scripts.js"></script>
</head>
<body>
<section>

<div id="home">
<a href="index.html">Home</a>
</div>

<div id="surround">
<div id="text">

<ul id="avmenu">

<li><h2>Documentation:</h2></li>

<?php

    $lvl=$_GET["lvl"];
    $docn=$_GET["docn"];

    $oppnadb = mysql_connect("*****", "*****", "*****") or die (mysql_error());
    mysql_select_db("*****") or die(mysql_error());

    $result = mysql_query("SELECT_doc_name,_documentation,_level_id
    FROM_documentation_WHERE_level_id=' $lvl' _AND_doc_id=' $docn'");
    while($row=mysql_fetch_array($result)){

        $docu=$row["documentation"];

        echo $docu;
    }

```



```
?>
</ul></div></div>

</section>
</body>
</html>
```

final.html:

```
<?php
session_start();
if (empty($_SESSION["Namn"])){
    header('Location:_login.php');
    exit;
}
?>
<html><head>
<link rel="stylesheet" href="style.css" type="text/css"/>
<script type="text/javascript" src="scripts.js"></script>
</head>
<section>
<body>

<div id="home">
<a href="index.html">Home</a>
</div>

<div id="documentation"></div>
<div id="surround">

<?php

$oppnadb = mysql_connect("*****", "*****", "*****") or die (mysql_error());
mysql_select_db("*****") or die(mysql_error());

$Frust = $_GET["id"];

$result = mysql_query("SELECT_*_FROM_requirements_WHERE_id=_'$Frust'_");
$row=mysql_fetch_array($result);

$namn=$row["material"];
$test_method=$row["test_method"];
$tm_limit=$row["tm_limit"];
$test_method2=$row["test_method2"];
$tm_limit2=$row["tm_limit2"];
$cat_id=$row["category_id"];
$cert=$row["cert"];
$sustest=$row["usa_test"];
$us1=$row["usa_limit"];
$us2=$row["usa_limit2"];
$us3=$row["usa_limit3"];

?>
```



```
</body></section>
</html>
```

boards.html:

```
<?php
session_start();
if (empty($_SESSION["Namn"])){
    header('Location:_login.php');
    exit;
}
?>
<html><head>
<link rel="stylesheet" href="style.css" type="text/css"/>
<script type="text/javascript" src="scripts.js"></script>
</head>
<body>

<div id="home">
<a href="index.html">Home</a>
</div>

<div id="surround">
<div id="text">

<?php
    $oppnadb = mysql_connect("*****", "*****", "*****") or die (mysql_error());
    mysql_select_db("*****") or die(mysql_error());

    $Frust = $_GET["id"];

    $result = mysql_query("SELECT_*_FROM_requirements_WHERE_id=_'$Frust'");
    $row=mysql_fetch_array($result);

    $currCat=$row["material"];
    $cat=$row["category_id"];
?>

<ul id="avmenu">

<li><h2><? echo $currCat ?>:</h2></li>
<li><h3>Select level:</h3></li>

<?
    $result2 = mysql_query("SELECT_DISTINCT_category,
level_name, _level_id_FROM_documentation_WHERE_category=_'$cat'");
    while($row2=mysql_fetch_array($result2)) {

        $level_id=$row2['level_id'];
        $level_name=$row2['level_name'];

?>

        <li><a href="final.html?lvl=<?_echo_$level_id_?>&id=
.....<?echo_$Frust?>"><? echo $level_name; ?></a></li>
```

```
<? } ?>
```

```
</ul></div></div>  
</body>  
</html>
```

login.php:

```
<?php
```

```
session_start();
```

```
?>
```

```
<form action = "login.php" method = "post">  
<p>Log in as user:</p>      User:  
<input type="text" name="anv" />      Password:  
<input type="password" name="loosen" />      <input type="submit" value="Log_in" />  
</form>
```

```
<?
```

```
$anv=$_POST[anv];
```

```
$loosen=$_POST[loosen];
```

```
if (($anv != "") && ($loosen != ""))
```

```
{
```

```
    $oppnadb = mysql_connect("*****", "*****", "*****") or die (mysql_error());  
    mysql_select_db("*****") or die(mysql_error());
```

```
    $result=mysql_query("SELECT_*_FROM_users_WHERE_anv=' $anv'")  
    or die(mysql_error());
```

```
    if ($rad = mysql_fetch_array($result))
```

```
    {
```

```
        if ($rad['loosen'] == $loosen)
```

```
        {
```

```
            $_SESSION['Namn'] = $anv;
```

```
            header("location:_index.html");
```

```
        }
```

```
        else
```

```
        {
```

```
            print"<FONT_COLOR=_#FF0000>Wrong_password!</FONT>";
```

```
        }
```

```
    }
```

```
    else
```

```
    {
```

```
        print"<FONT_COLOR=_#FF0000>Wrong_username!</FONT>";
```

```
    }
```

```
    mysql_close($oppnadb);
```

```
}
```

```
?>
```

style.css:

```
body {
    background-image: url(white.jpg);
    background-repeat: no-repeat;
    background-size: cover;
}

.section {
    width: 100%;
    height: 100%;
    margin: auto;
    padding: 30px;
    background-color: blue;
}

#home {
    margin-top: 2%;
}

#home a {
    text-decoration: none;
    font: 32px Verdana;
    color: blue;
    margin-left: 45%;
    border: 2px solid #000000;
}

#home a:hover {
    color: purple;
}

#surround {
    border-radius: 25px;
    border: 2px solid #000000;
    margin-left: 5%;
    margin: 2% 5%;
    font: 16px Verdana;
    height: 750px;
    width: 90%;
    float: left;
}

ul#avmenu li a {
    text-decoration: none;
    color:blue;
}

ul#avmenu li a:hover {
    color: purple;
}
```

```

ul#avmenu li{
    display: block;
    margin: 10px 10px 10px 10px;
}

ul#avmenu {

}

ul#offmenu li{
    display: block;
    margin: 10px 10px 10px 10px;
}

ul#offmenu li:hover{
    cursor: pointer;
    color: blue;
}

```

Appendix B

This appendix contains the source code for the Eye Tracker Analyzer created as a tool to analyze eye tracking data according to section "5.4 Tool to analyze data". It contains three classes; Main.java, Counter.java and GUI.java.

Main.java:

```

package fixCount;

public class Main {

    public static void main(String[] args) {
        GUI gui = new GUI();
    }

}

```

Counter.java:

```

package fixCount;

import java.io.File;
import java.io.FileNotFoundException;
import java.util.Locale;
import java.util.Scanner;

public class Counter {

    private Scanner scan;
    private File file;
}

```

```

private int countFix;
private int totalFix;
private int countSacc;
private float totalAmp;
private int countBlink;
private String temp;
private long first;
private long last;
private float dur;
private boolean sacc, fixDur, blink;

public Counter(File file, boolean sacc, boolean fixDur, boolean blink) {
    this.file = file;
    countFix = 0;
    countSacc = 0;
    countBlink = 0;
    totalAmp = 0;
    totalFix = 0;
    first = 0;
    last = 0;
    dur = 0;
    this.sacc = sacc;
    this.fixDur = fixDur;
    this.blink = blink;
}

public String count() {
    try {
        scan = new Scanner(file);

        scan.useLocale(Locale.US);

        while (scan.hasNext()) {

            temp = scan.next();

            if (temp.equals("Fixation")) {
                if (scan.next().equals("L")) {
                    countFix++;
                    scan.next();
                    scan.next();
                    scan.next();
                    last = scan.nextLong();
                    totalFix += scan.nextInt();
                }
            }

            if (temp.equals("Saccade")) {
                if (scan.next().equals("L")) {
                    countSacc++;
                    scan.next();
                    scan.next();
                    scan.next();
                    last = scan.nextLong();
                }
            }
        }
    }
}

```

```

        scan.next();
        scan.next();
        scan.next();
        scan.next();
        scan.next();
        scan.next();
        totalAmp += scan.nextFloat();
    }
}

if (temp.equals("Blink")) {
    if (scan.next().equals("L")) {
        countBlink++;
        scan.next();
        scan.next();
        scan.next();
        last = scan.nextLong();
    }
}

if (temp.equals("UserEvent")) {
    scan.next();
    scan.next();
    if(first == 0){
        first = 1;
    }
    else if (first == 1) {
        first = scan.nextLong();
    }
}

scan.nextLine();
}

} catch (FileNotFoundException e) {
    // TODO Auto-generated catch block
    e.printStackTrace();
}

dur = (last - first)/1000000;

StringBuilder s = new StringBuilder();

if(fixDur){
    s.append("Average_fixation_duration:_" + totalFix / countFix);
    s.append("\n");
}

if(sacc){
    s.append("Mean_saccade_duration:_" + totalAmp / countSacc);
    s.append("\n");
}

if(blink){

```



```

        s.append("Blink_rate:_" + countBlink / dur);
        s.append("\n");
    }

    return s.toString();
}
}

```

GUI.java:

```

package fixCount;

import java.awt.event.ActionEvent;
import java.awt.event.ActionListener;
import java.io.File;
import java.util.ArrayList;
import java.util.Scanner;

import javax.swing.JButton;
import javax.swing.JCheckBox;
import javax.swing.JComboBox;
import javax.swing.JFileChooser;
import javax.swing.JFrame;
import javax.swing.JLabel;
import javax.swing.JOptionPane;
import javax.swing.JPanel;

public class GUI implements ActionListener {
    ArrayList<String> array;
    JFrame frame;
    JLabel label, infoLabel;
    JButton button, choiceButton, resultButton;
    File f;
    Scanner scan;
    JComboBox<String> chapterList;
    JCheckBox saccButton, fixDurButton, blinkButton;
    String[] chapters;
    Counter c;
    String currentChoice;
    final JFileChooser fc = new JFileChooser();
    boolean isChosen;

    public GUI() {

        frame = new JFrame("Eye_Tracker_Analyzer");

        frame.setContentPane(choose());
        frame.setLocationRelativeTo(null);
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.setSize(360, 330);
        frame.setVisible(true);
        isChosen = false;
    }
}

```

```

public JPanel choose() {
    JPanel panel = new JPanel();
    panel.setLayout(null);

    choiceButton = new JButton("Choose_file");
    choiceButton.setLocation(20, 20);
    choiceButton.setSize(100, 30);
    choiceButton.addActionListener(this);
    panel.add(choiceButton);

    label = new JLabel("No_file_chosen");
    label.setLocation(140, 20);
    label.setSize(290, 30);
    panel.add(label);

    infoLabel = new JLabel("Choose_which_data_to_show:");
    infoLabel.setLocation(50, 60);
    infoLabel.setSize(290, 30);
    panel.add(infoLabel);

    fixDurButton = new JCheckBox("Average_Fixation_Duration");
    fixDurButton.setLocation(70, 90);
    fixDurButton.setSize(200, 30);
    fixDurButton.addActionListener(this);
    panel.add(fixDurButton);

    saccButton = new JCheckBox("Mean_Saccade_Amplitude");
    saccButton.setLocation(70, 120);
    saccButton.setSize(200, 30);
    saccButton.addActionListener(this);
    panel.add(saccButton);

    blinkButton = new JCheckBox("Blink_Rate");
    blinkButton.setLocation(70, 150);
    blinkButton.setSize(200, 30);
    blinkButton.addActionListener(this);
    panel.add(blinkButton);

    resultButton = new JButton("Show_results!");
    resultButton.setLocation(20, 200);
    resultButton.setSize(160, 30);
    resultButton.addActionListener(this);
    panel.add(resultButton);

    return panel;
}

public void actionPerformed(ActionEvent e) {

    if (e.getSource() == choiceButton) {

        File workingDirectory = new File(System.getProperty("user.dir"));
        fc.setCurrentDirectory(workingDirectory);
    }
}

```

