

Usability, User Experience and Aesthetics

- A Case Study at Toyota Material Handling

*Användarbarhet, användarupplevelse och estetik - En fallstudie
hos Toyota Material Handling*

Ingrid Sintorn
Mathilda Knöös Franzén

Supervisor : Pontus Haglund
Examiner : Filip Strömbäck

Upphovsrätt

Detta dokument hålls tillgängligt på Internet - eller dess framtida ersättare - under 25 år från publiceringsdatum under förutsättning att inga extraordinära omständigheter uppstår.

Tillgång till dokumentet innebär tillstånd för var och en att läsa, ladda ner, skriva ut enstaka kopior för enskilt bruk och att använda det oförändrat för ickekommersiell forskning och för undervisning. Överföring av upphovsrätten vid en senare tidpunkt kan inte upphäva detta tillstånd. All annan användning av dokumentet kräver upphovsmannens medgivande. För att garantera äktheten, säkerheten och tillgängligheten finns lösningar av teknisk och administrativ art.

Upphovsmannens ideella rätt innefattar rätt att bli nämnd som upphovsman i den omfattning som god sed kräver vid användning av dokumentet på ovan beskrivna sätt samt skydd mot att dokumentet ändras eller presenteras i sådan form eller i sådant sammanhang som är kränkande för upphovsmannens litterära eller konstnärliga anseende eller egenart.

För ytterligare information om Linköping University Electronic Press se förlagets hemsida <http://www.ep.liu.se/>.

Copyright

The publishers will keep this document online on the Internet - or its possible replacement - for a period of 25 years starting from the date of publication barring exceptional circumstances.

The online availability of the document implies permanent permission for anyone to read, to download, or to print out single copies for his/hers own use and to use it unchanged for non-commercial research and educational purpose. Subsequent transfers of copyright cannot revoke this permission. All other uses of the document are conditional upon the consent of the copyright owner. The publisher has taken technical and administrative measures to assure authenticity, security and accessibility.

According to intellectual property law the author has the right to be mentioned when his/her work is accessed as described above and to be protected against infringement.

For additional information about the Linköping University Electronic Press and its procedures for publication and for assurance of document integrity, please refer to its www home page: <http://www.ep.liu.se/>.

Abstract

Usability and User Experience are two important aspects in the design and development of software systems and websites. One part of this is the visual design, or aesthetics, of the system i.e., how does the product look to the user?

In this study, it was investigated if adapting a website to a graphic profile would increase the overall user experience, and if changes to the visual design would affect how other areas of usability were experienced. The system that was studied was the web interface of a documentation server that was used by software developers at *Toyota Material Handling Manufacturing Sweden AB* (TMHMS) in Mjölby. To evaluate the research questions, two surveys based on the *User Experience Questionnaire* (UEQ) were conducted. The first survey was done before making changes to the website and the second survey after, as to be able to compare the experience of the users. Changes to the website, such as changing fonts and colors, were made in accordance to the graphic profile of TMHMS and the results showed that the overall experience of using the website improved after these changes. The results also showed that aesthetic improvements had a positive impact on the perceived usability of other areas. The results are consistent with previous studies made and provides a good stepping stone for continued research into how visual design and consistent themes may affect the user experience of websites and systems.

Acknowledgments

We would like to thank our supervisor Pontus Haglund and our examiner Filip Strömbäck. We would also like to thank our supervisors at Toyota: Carl Westman and Jacob Olausson for the opportunity and help with this project. Lastly, we would like to thank our dogs Olivia and Wille for their unconditional love and support.

Contents

Abstract	iii
Acknowledgments	iv
Contents	v
List of Figures	vii
1 Introduction	1
1.1 Motivation	1
1.2 Aim	2
1.3 Research Questions	2
1.4 Delimitations	2
2 Background	3
2.1 Webservers and Host the Docs	3
2.2 Bootstrap	3
2.3 Usability	4
2.4 User Experience	5
2.5 Evaluation Methods for Usability and User Experience	5
2.5.1 Quantitative vs. Qualitative Measurements	5
2.5.2 Usability Evaluation	5
2.5.3 User Experience Evaluation	6
3 Related Work	7
3.1 Usability and User Experience	7
3.2 Aesthetics and Visual design	7
3.3 Evaluation Methods	8
4 Method	9
4.1 User Experience Questionnaire	9
4.2 Surveys	10
4.3 Data Evaluation	10
4.4 Website Design	11
5 Results	13
5.1 Theme Adaptation	13
5.2 User Experience Questionnaire	14
5.3 Usage Analytics	14
6 Discussion	16
6.1 Results	16

6.1.1	RQ1: How does adjusting the design of a software documentation web-page to better reflect a company’s graphic profile affect the user experience?	16
6.1.2	RQ2: How does improvements in visual aesthetics affect other subcategories of user experience?	17
6.1.3	Final Thoughts	17
6.2	Method	17
6.3	Source Criticism	18
6.4	The Work in a Wider Context	18
7	Conclusion	19
7.1	Further Research	19
	Bibliography	20
A	Appendix A: UEQ word pairs	24

List of Figures

2.1	The subattributes of the Efficiency attribute from Alonso-Ríos et al. taxonomy . . .	4
4.1	An example of an adjective pair from UEQ including the seven point grading scale	10
4.2	An excerpt of the styling of the original Host the Docs website, showing the bug of overflowing button text	11
4.3	The styling of the updated version of the website, with the added tab menu on the top	12
5.1	Results of how well the website design conformed to the TMHMS graphic profile before and after the changes, where 1 is "not at all" and 5 is "very consistent". . . .	13
5.2	Results from the UEQ, where blue corresponds to the results of the first survey and red to the second survey. Each value is ranked between -3 and 3, where -3 corresponds to the most negative user experience and 3 to the most positive. . . .	14
5.3	How often the users interact with the website	15
A.1	All the word pairs from the UEQ, with their respective categories.	24



1 Introduction

Modern days software developers interact with dozens of different systems and applications every single day, and each one of these systems and applications have their own User Interface (UI). It makes sense that the design of these UIs has the ability to affect the efficiency of the development workflow. If developers have to spend extra time figuring out how to interact with a system due to its sub-optimal UI, that time is lost and can not be used for other work tasks.

This thesis is written in cooperation with the globally recognized company *Toyota Material Handling Manufacturing Sweden AB* (TMHMS) on the UI of their documentation website. The goal is to evaluate the perception of the UI in its current state, and to measure the possible change in perception once certain improvements are implemented. TMHMS is a manufacturer of manual and autonomous trucks, with one site based in Mjölby, Sweden. They have over 2500 employees, of which about 100 are software developers working on various systems surrounding the trucks. One important part of this work is the software documentation. As of now, all of the internal documentation is stored on a website hosted on a private server, using an open-source project called Host the Docs ¹. While the current solution is functional, it has several graphical downsides that negatively impact the experience of using it.

1.1 Motivation

Many developers consider documenting software to be a dreary process, but the importance is understood by most (if not all) who work on bigger projects. Good software documentation prevents misunderstandings about how to use an application, what the requirements for the application are, how changes are to be implemented and so on. It also limits the need for person-to-person explanations, which is very useful when the members in a team are exchanged or for communication between different development teams. Laitinen [22] suggests that software development should be documentation-oriented, and that the software documentation is one of the most important parts of the development process. Cook and Visconti [10] mentions documentation products and processes as very important components of good software quality. Even though the actual process of documentation is out of scope of this thesis, the website for organizing documentation is not. Different studies indicate a

¹<https://github.com/rgalanakis/hostthedocs>

relationship between the aesthetics of an application and its perceived usability [44, 33], and as stated earlier in this chapter, the current solution is functional but it is lacking aesthetically. There are several bugs affecting the appearance of the website. For example, there is a reoccurring problem with text overflowing its designated container.

Another downside that has been expressed by the users of the website is the lack of thematic aesthetics. TMHMS has a graphic profile that their sites conform to, creating a uniform look and experience. Currently, Host the Docs does not allow for customization of the colors of the website, nor does it allow for the use of logos and images. It is hard to say anything specific about how important it is to conform to a graphic profile within the company, Clark [9] suggests that it can create stronger feelings of commitment towards the company.

There is currently no proven connection between these visual downsides and the effect they have on the overall perception of the website, and these uncertainties are the main reason for this study.

1.2 Aim

The aim of this thesis is to explore the connections between certain graphical alterations and the perception of the website's usability. To reach these goals, the website will be evaluated both before and after alterations, and the results will be compared to each other. The alterations will focus on adjusting the current aesthetics to the point where the UI fits the graphic profile at TMHMS. With this in mind, two research questions were formed, as stated in the paragraph below.

1.3 Research Questions

- **RQ1:** How does adjusting the design of a software documentation webpage to better reflect a company's graphic profile affect the user experience?
- **RQ2:** How does improvements in visual aesthetics affect other subcategories of user experience?

1.4 Delimitations

This study is conducted in collaboration with TMHMS and the users of the system are mainly software developers. Additionally, the webpage that is affected is only used internally. With this in mind, the results of the study will be somewhat limited in their generalizability overall, since the sample group may not be representative of the general public.



2 Background

This chapter covers the background knowledge needed for the thesis, bringing up some of the different technical solutions related to the study and its implementation.

2.1 Webservers and Host the Docs

The current solution for storing the software documentation at TMHMS is based on an open-source project called Host the Docs¹. It is developed as a simple way to host internal software documentation for private users or organizations that do not develop open-source software, which means that all documentation will be kept private. The Host the Docs web server hosting the documentation webpage is developed using the Python programming language and a web application framework called Flask². While Host the Docs only hosts static webpages, Flask has the possibility to host dynamic pages as well.

For browsers and servers to communicate with each other, there are a number of specified HTTP request methods that are used. For example, the GET method is used for the browser to request and retrieve data from a server and the POST method may be used to submit something to the server, often causing some change or effect to the server [14]. One thing to note is that Host the Docs does not generate any documentation, it only hosts it. When using Host the Docs, users must generate and compress their own documentation files before uploading them to the server using the POST HTTP method via a terminal. The user must provide the name, description and version of the documentation, there is no automatic version handling. To remove files, a DELETE request is sent to the server by the user. All file handling is done via the terminal, no UI exists for uploading or deleting the files. Currently, no security methods exist and only some basic validation, making it important to have external security measures, such as firewalls and only giving access to trusted users.

2.2 Bootstrap

Host the Docs is stylized using Bootstrap³, which is an open-source framework for front end work. It contains design templates for HTML, CSS and JavaScript that facilitate the devel-

¹<https://github.com/rgalanakis/hostthedocs>

²<https://flask.palletsprojects.com/en/2.0.x/>

³<https://getbootstrap.com>

opment of responsive sites. There are pre-built components for typography, forms, buttons, and other useful parts for interface design. Since its launch in 2010 there have been several updates and rewrites to the library and the most current version is Bootstrap 5, although the version used for Host the Docs is Bootstrap 3.

2.3 Usability

The word *usability* first started to appear in early 1980s when personal computers were becoming more and more common [39]. Previously, computers were not intended for everyday users, and they could oftentimes be unintuitive and complicated to use. As a way of increasing the reach of personal computers, achieving an easily accessible software became a key goal. This was especially true for software that did not target educated specialists. One early and highly regarded article describing usability is that of Gould and Lewis: 'Designing for usability: key principles and what designers think' [17]. In this paper published in 1985, three key principles are presented: Early Focus on Users and Tasks, Empirical Measurement, and Iterative Design. While these principles may seem intuitive now, when the study was written empirical data showed that it was not obvious to follow all or even some of these three fundamental ideas.

Nowadays, usability is a central term in software design, but the word itself has many definitions. The standards ISO 9241-11 (Ergonomics of human-system interaction — Usability: Definitions and concepts) and ISO/IEC 25010 (System and software quality models) of the International Organization for Standardization (ISO) both define usability as "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" [40, 42]. There are however many ad hoc definitions made by researchers and in an attempt to clarify the definitions along with the ascribed attributes, Alonso-Ríos et al. have created a usability taxonomy [2]. The taxonomy covers six major areas: *Knowability*, *Operability*, *Efficiency*, *Robustness*, *Safety* and *Subjective Satisfaction*, and every category is then further divided into sub-attributes (see Figure 2.1).

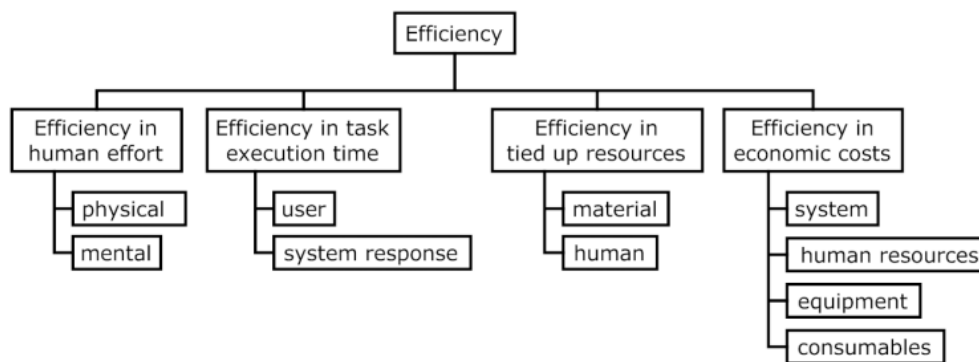


Figure 2.1: The subattributes of the Efficiency attribute from Alonso-Ríos et al. taxonomy

Knowability is how well a user can learn and remember how to operate the system, how easily understandable it is. Operability covers the system's capacity to provide the user with necessary functions and how adapted it is to users with varying needs. Efficiency, as seen in Figure 2.1, is how well the system uses different resources allocated and how much effort is required of the user to complete tasks. Robustness is how resistant the system is to errors and issues. Safety describes how well the system avoids risks and damage that could come from using it and lastly, Subjective Satisfaction is how pleasing the system is to the user in regard to interest and aesthetics. All these attributes are important when creating a system

with high usability, but their relevance may vary depending on the goal for the system and its intended users.

2.4 User Experience

The term user experience, or UX, was coined in early 1990s by cognitive psychologist Don Norman. He was employed as User Experience Architect at Apple and according to himself, the term UX was invented because the concepts of usability and human interface were too narrow. He wanted something that would cover all aspects of a user's experience, not only ease of use but encompassing industrial and graphical design, interface, physical interaction and more [7]. During the approximately same time, Lauralee Alben released a paper on how to define the criteria for effective interaction design [1]. Her paper focused on how users understood and sensed a system, what their feelings were during usage and to what extent they felt they achieved their goals in using the system, also taking the overall interaction context into consideration. However, the concept of user experience is older than that. Bell Laboratories adopted two traditions in the 1940s and 50s: Human factors, which focused on customer-oriented practices, and Human performance technologies, focusing on employee-oriented development [19]. Both these concepts resulted in much social psychological research, investigating how humans interact and want to interact with different systems.

As with usability, user experience is still not an easily defined phenomenon. An international survey exploring developers understanding of user experience showed that a majority consider UX as a central part of their work, but there was no general consensus on how to define the term [23]. In this thesis, the term will be used in light of the standard definition similarly to usability. So, while usability is defined in light of a specific task or context of user, user experience is defined by ISO 9241 as "person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service" [41]. It is a broader experience, also including any preconceived notions and lingering feelings about the system. However, usability and user experience often include similar aspects and many attributes of usability can be used to evaluate user experience as well.

2.5 Evaluation Methods for Usability and User Experience

As with the definitions, there are many different methods of evaluating the usability or user experience of a system or webpage. There are several similarities, but also differences in how the two subjects are measured.

2.5.1 Quantitative vs. Qualitative Measurements

In usability and user experience testing, there are multiple different types of evaluation methods with a mixture of gathering quantitative and qualitative results. Quantitative results refer to a quantity of something i.e. numeric variables, while qualitative results are more categorical in nature. For example, an interview asking participants to account for their subjective feelings about a system is qualitative in manner, while an evaluation of how long it took different users to perform a task is quantitative [43]. There are other definitions of these terms, however these are the ones that will be used for this thesis.

2.5.2 Usability Evaluation

Most usability evaluation methods employed involves some sort of user testing [16], however there are some methods which only make use of usability experts to analyse the system. When it comes to user involved studies, Bowman et al. [5] mentions the following categories: *Formative evaluation*, *Summative evaluation*, *Interviews* and *Questionnaires*. Formative evaluation describes an empirical evaluation where users are observed while performing task-based

scenarios, gathering data such as critical incidents, task timing and amount of errors. They may be formal, gathering both qualitative or quantitative results, or informal, focusing more on qualitative results. Summative evaluation is similar but focuses on statistical comparisons of multiple configurations of the system. They may also be formal or informal. The main difference is that formative evaluations are mainly done during a user test, while summative evaluations are performed after a task has been completed. In interviews, participants are directly questioned about the system they have tested, the interviews may be structured and have a set previously determined questions, or be more open-ended using broad questions and relying on the user to speak more freely. Lastly, questionnaires also investigate the user's experience after testing a system, via a written set of questions that participants answer on their own. Bowman et al. states that questionnaires typically work well for gathering subjective data and are easier to implement than interviews which may gather similar data. Many of the used methods focus much on the technical part of the system, looking at how the actual performance is in contrast to more subjective values [16].

2.5.3 User Experience Evaluation

While usability testing mainly focuses on effectiveness and efficiency, as can be deduced from the definition presented earlier, user experience contains more subjective variables [11]. So where usability evaluation methods may focus on pragmatic measurements such as task execution time and number of errors, user experience testing has to create an understanding of a user's motivations, feelings and expectations [28].

Roto et al. have described 30 different evaluation methods for user experience that were gathered during group discussions conducted together with multiple participants from both academia and industry. These different methods can be grouped together in five major categories, which are as follows: *Lab studies*, *Field studies*, *Surveys*, *Expert evaluations* and *Mixed methods* [36]. In traditional lab studies, individuals or groups are tasked with certain objectives to carry out and encouraged to think aloud while they complete them. The analysts observes their interactions and thoughts while using the systems. This may be done in various ways, where one way is to closely examine a participants facial expressions during the test. Another way is the Tracking Realtime User Experience (TRUE) method [21] that combines attitudinal data with behavioral data. Roto et al. continue with describing field studies. They are similar to lab studies, but instead of creating a controlled environment they investigate the system in real life situations. These studies can be done on a short-term basis in a more observational way, or a longer-term basis where users may explore the system during an extended period of time. Field studies for evaluation differ from exploratory user research, where no specific system is being studied. Another evaluation method brought up by Roto et al. is surveys. Surveys are an effective tool to gather data from many users, especially if an online version is used. Those surveys may also reach a wider audience, allowing researchers to gather data from many different countries. Some examples of survey methods include AttrakDiff⁴ and the *User Experience Questionnaire (UEQ)*⁵, both consisting of *Likert scales* where participants may rate how well the system conforms to several different adjective pairs, such as good or bad, or creative and dull. Further on, expert evaluation is usually used as a first step in the evaluation process. In early developmental stages when it is still quite hard to use the system, usability experts may be brought in and examine the prototype using some usability heuristics [32]. Lastly, mixed methods are just that: a mix of several of the previously mentioned approaches.

⁴<http://attrakdiff.de/index-en.html>

⁵<https://www.ueq-online.org/>



3 Related Work

This section covers some of the previous research relating to this project, looking at subjects such as usability as a concept in software design and how the visual design of a system may affect other characteristics and the users perception of them.

3.1 Usability and User Experience

Investigating the usability of a system may give important insight in how well a system is adapted to its users and what can be done to improve that system further. Hussain et al. [20] evaluated the usability of an online shopping app and found users were overall positive, but some changes could be made to the design to further increase the attitudes of the users. The authors state that the study will be helpful for the application developers when designing an improved version. User experience evaluation can also be useful when doing market research, such as in a study by Biader Ceipidor et al. [8]. In their paper they use qualitative and quantitative measures to capture the views of users in regard to Mobile Proximate Payments, finding several areas where improvements can be made to increase the use of such solutions. Brata and Brata [6] use user experience evaluation to investigate different language learning applications to see if a certain type of application will improve the learning experience. Overall, usability and user experience testing have many useful areas of application.

3.2 Aesthetics and Visual design

This thesis focuses mainly on how the layout and visual perception of the software documentation website affects the user experience. There has been many studies looking at how the design of a website, especially the aesthetics, influence the perceived usability and the overall user experience. Multiple studies have shown some correlation between aesthetics and other perceived characteristics of different systems. In a review paper by Lindgaard [27], several study results are summarized and examined. The concluding analysis of all these papers indicates that users may be more satisfied with a product that is beautiful but performs sub-optimally, than a product that performs well but is less appealing. Diving deeper, strong correlations between a system's perceived aesthetics and its perceived usability has been found. In a study by Tractinsky et al. [44] they concluded that the *perceived* usability of

the system was more affected by the aesthetic of the interface, rather than the actual usability of the system. Similarly, Robins and Holmes [35] found a connection between a site's aesthetic rating and another important feature: credibility. Their results showed that content that had a higher aesthetic treatment was also rated as having a higher credibility. Robins and Holmes do however suggest that aesthetics would be less impactful in regard to the perceived usability when having interacted with the site longer. The same correlation between aesthetics and usability has also been found in a study by O'Brien and Toms [33]. They investigated several different characteristics of a system, and their findings show that the aesthetic trait could successfully predict perceived usability, as well as focused attention and felt involvement.

Aesthetics contains multiple different areas, one of which is color and color themes. Color has been linked to different emotional responses, and a paper by Manning and Amare [29] investigates how different color schemes may affect the user experience. In the study, the emotional response to different colors and patterns are modeled and the results show that certain colors would consistently evoke similar emotional responses. Since the emotions of the users when interacting with a system is a critical part of user experience evaluation, the colors of a website may directly affect the user experience. Design principles is another area that may affect usability. Grudniewicz et al. [18] found that when using design principles and user preferences in the redesign of printed educational material, the usability improved and the updated material was chosen more often.

3.3 Evaluation Methods

As mentioned in previous chapters, there are many various methods to evaluate usability and user design. Here some applied examples will be highlighted. For evaluating the user experience of adaptive mobile application prototypes, Arhippainen and Tähti [3] used interviews and video recordings to gather information of the users' thoughts and emotions about the systems.

Moizer et al. [31] developed a survey to evaluate the user experience of a serious game, gathering the user's opinion on several aspects in the game and its surrounding framework before and after testing several features. They gathered both quantitative and qualitative data and found that the quantitative data showed clear indications of where the system faltered, while the qualitative aspects gave them more information on how those faults may be improved. When studying the user experience of a digital library, Barifah et al. [4] also used questionnaires, along with screen recordings and other tools. As in the Moizer et al. study, users filled in a survey before and after interacting with the system.

Both the above-mentioned studies have developed their own questions for their questionnaires, but there are some pre-constructed surveys that have been developed and validated through multiple studies. One of those is the UEQ¹. It is used by Schrepp et al. [37] in their study examining different evaluation scenarios. They found that the UEQ had simple and fast data collection, but the drawback of that efficiency was that only shallow data was collected. The measurement gave no further information on why a system was considered a certain way. Devy et al. [12] uses the UEQ to evaluate an interface for learning English, with a goal to conclude how multimedia should be presented to best serve the users. The authors also used another widely used questionnaire, the System Usability Scale². It is an even more compact survey than the UEQ, containing only ten questions compared to the UEQ's 26 questions.

¹<https://www.ueq-online.org/>

²<https://digital.gov/2014/08/29/system-usability-scale-improving-products-since-1986/>



4 Method

This section describes the method choices in this study as to be able to answer the research questions, along the changes made to the system as mean to improve it

4.1 User Experience Questionnaire

For the user experience evaluation a tool called the *User Experience Questionnaire* (UEQ) was used. UEQ¹ is a survey developed to measure user experience of websites and other interactive products. It is a well established tool, validated and used in multiple studies [24, 15, 26, 34]. The survey covers six different major aspects of usability and user experience:

- Efficiency (*Can users finish their tasks in an quick and easy way?*)
- Perspicuity (*Is the product easily used and understood?*)
- Dependability (*Is the product safe and trustworthy when used?*)
- Novelty (*How creative and innovative is the product?*)
- Stimulation (*Is the product exiting and stimulating to use?*)
- Attractiveness (*Is the product nice to use and look at?*)

The questionnaire consists of 26 pairs of contrasting attributes and each pair has seven corresponding choices, ranging from one extreme to the other in regards to the two opposing adjectives (see Figure 4.1). The full questionnaire can be seen in Appendix A. Since the results are numerical, it allows for easy statistical evaluation, making it simple to compare the different attributes between one another and also between two or more set occasions.

The original version of the questionnaire was developed in Germany in 2005 and at the time of writing it has been translated into 21 different languages, making it an accessible tool. The estimated time to fill in the entire questionnaire is 3–5 minutes and there is also a short version, containing only eight items if needed. However, the short version does not cover all of the aspects mentioned above and will not give as clear result as the full version. It is recommended to have a minimum amount of participants around 20–30 persons, but this is

¹<https://www.ueq-online.org>

dependent on the standard deviation of the answers. A more agreeing group may be smaller and still give reliable results.



Figure 4.1: An example of an adjective pair from UEQ including the seven point grading scale

In addition to the pre-constructed questionnaire, the UEQ also provides two data analysis tools that can be used to study the results of the survey: one for single point surveys and one for comparing two measurements. In the data analysis tools, information about the data such as mean values, standard deviation, variance and distribution can be found, along with some bar charts for visualizing the data in a simple way. In the two-point measurement tool, a statistical test is included to examine if the two samples differ significantly between the six different areas.

4.2 Surveys

Two online surveys were conducted in order to evaluate how the website was perceived before and after the implementation of the UI improvements. The surveys first included a part where the users filled in the UEQ, as described above. The first survey was extended with some open-ended questions where participants could describe in their own words their opinions on the current website. The purpose of these questions were mainly to confirm that the problems of the website identified in the beginning of the project were consistent with the problems that the actual users experienced. However, the answers were not used in the later evaluation analysis. No answers from open-ended questions were included in the second survey. For the first survey, users were also asked how often they use the website (Less than once a month, several times a month, several times a week or more often). Lastly, the users were asked to rank (choosing between 1 and 5, where 1 = “not at all” and 5 = “very consistent”) how well they thought the site matched the overall graphic profile of TMHMS. This question was included in both surveys. The questionnaires were created using Google Forms² and distributed to the software developers at the TMHMS site in Mjölby via their internal workplace chat. The chat reaches around 100 software developers. The invited developers were informed about the purpose of the survey, and the fact that the survey would be anonymous. The first survey was active for two weeks, while the second one was active for one week. Both surveys were answered by 23 people.

4.3 Data Evaluation

The data evaluation of the questions from the UEQ was made using the complementary data analysis tool for two-point measurements that is available on their website³. The tool allows for entering two data sets and then calculates the mean values of each of the sets along with the standard deviation, confidence, and confidence interval. A bar chart comparing the mean values is created, where the 26 original values are summed in their corresponding categories (see list in section 4.1). A two sample t-test [13] is used for discerning any significant ($p < 0.05$) differences between the two data sets, this is also using the values summed in their respective categories. The analysis of the question about overall compliance to the graphic profile was done in a similar way, but since this was not included in the data analysis tool of the UEQ it had to be done manually. As mentioned earlier, the free text answers of the first survey were

²<https://www.google.com/forms/about/>

³<https://www.ueq-online.org>

not analyzed and included in the final results, instead they were only used as indications to what could be changed to improve the design of the website.

4.4 Website Design

One of the issues with the website that was brought up in initial meetings with the client was the lack of branding. To make sure the updated site properly conformed to the company graphic profile, the re-design was based on the design guidelines of Toyota. The style guide provides a set of rules and guides about how and when to use specific typography choices, colors, and other design elements, creating a uniform experience for all applications it is used for. To be able to override the default themes of Bootstrap used for the original Host the Docs project, a custom CSS file was used to which all changes were applied. This allowed us to only apply changes to the necessary components, while still benefiting from the templates provided by Bootstrap.

The major changes made were the following: the font of the entire webpage was changed into Toyota's official font, Titillium Web⁴. Colors and sizes of buttons were changed to the official colors of the Toyota graphic profile, and the issue with text overflowing the buttons (see Figure 4.2) was fixed. One of the suggested improvements that was reported in the first survey was that the instructions on top of the page were overwhelming and unnecessary after some time of use of the website, so a menu was added to the top of the page and the instructional text that previously was placed at the top of the home page was moved under a tab called About (see Figure 4.3). The logo of Toyota Material Handling was added to the top right corner of the page as to further cement the graphic profile.

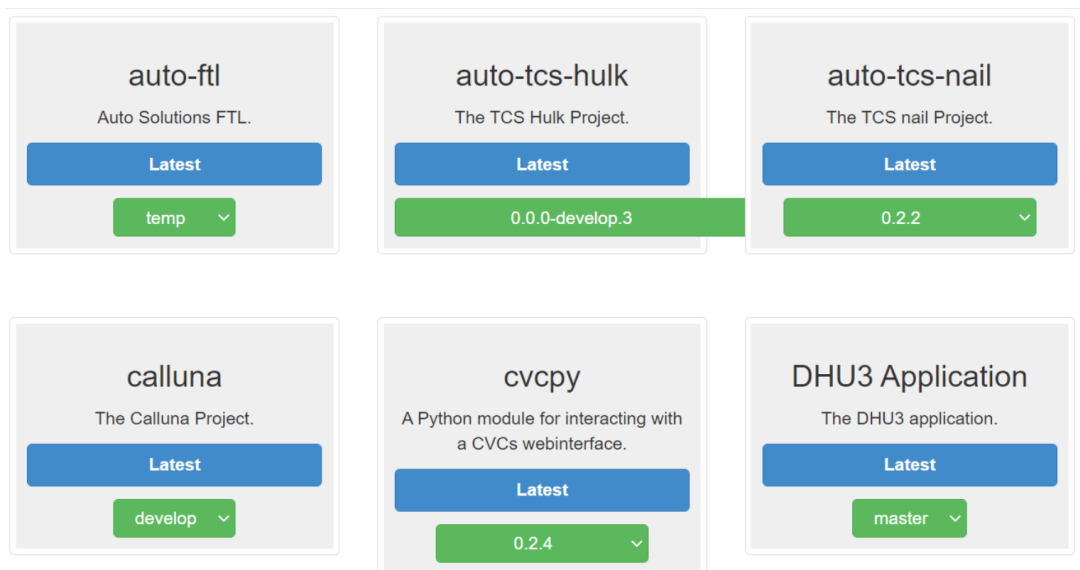


Figure 4.2: An excerpt of the styling of the original Host the Docs website, showing the bug of overflowing button text

⁴<https://fonts.google.com/specimen/Titillium+Web>

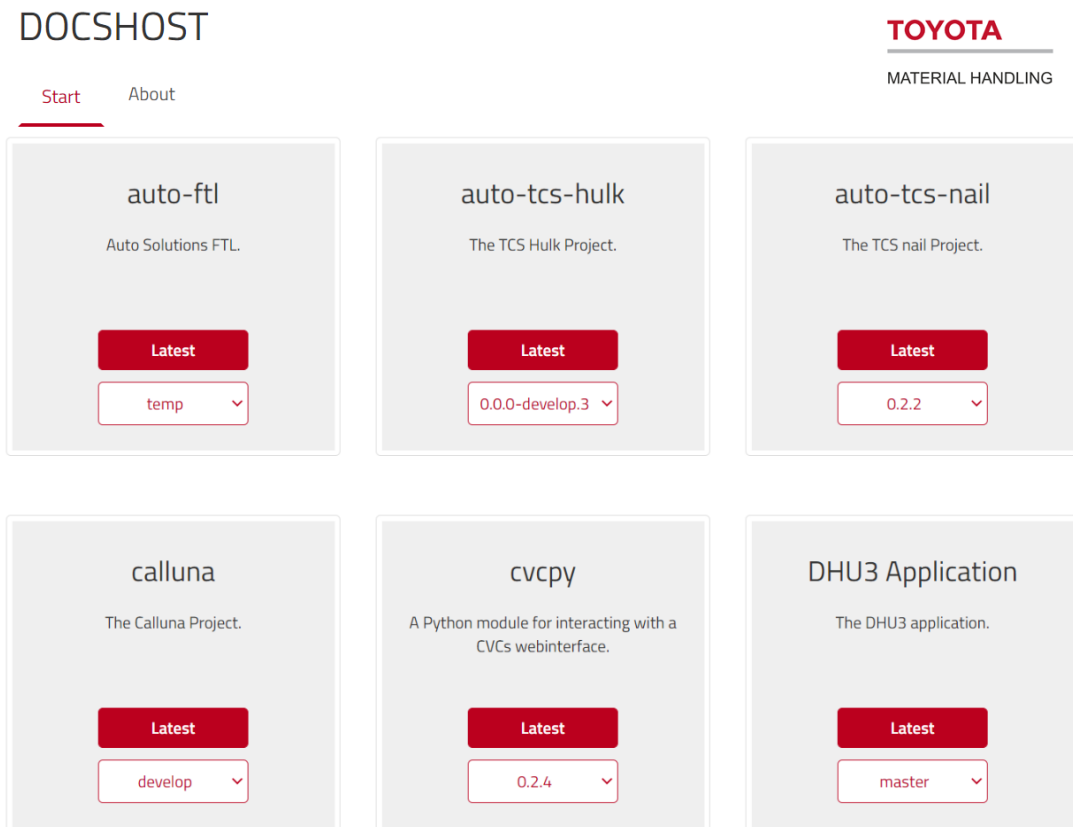


Figure 4.3: The styling of the updated version of the website, with the added tab menu on the top



5 Results

In this chapter the results and analysis of the two surveys are presented to give a clear view over how the changes to the system have affected the user experience.

5.1 Theme Adaptation

To verify that the changes made to the website more accurately reflected the TMHMS graphic profile, a question about this was included in the survey, and the results can be seen in Figure 5.1. The participants were asked to rate how well they thought the design of the website conformed to the graphic profile using a five-point scale, 5 being "very consistent" and 1 being "not consistent at all". A clear improvement was found: the mean value in the first survey was 1.52 and in the second survey it was 4.23 ($p < 0.001$).

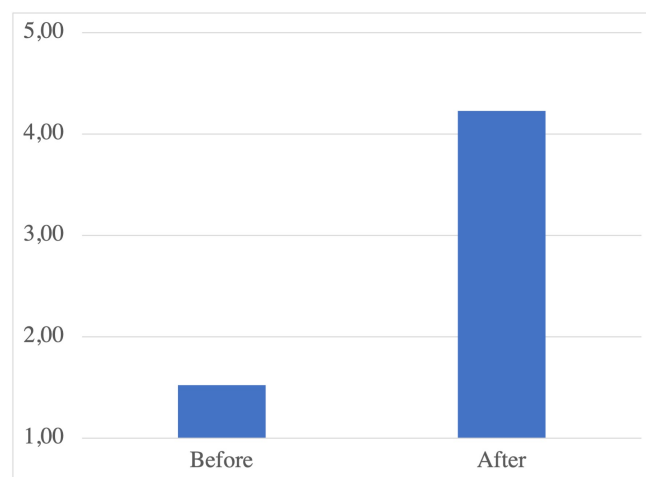


Figure 5.1: Results of how well the website design conformed to the TMHMS graphic profile before and after the changes, where 1 is "not at all" and 5 is "very consistent".

5.2 User Experience Questionnaire

The results from the UEQ are presented here. The scale used is a seven-point Likert scale and each measurement point can have a value between -3 (most negative experience) and 3 (most positive experience), where 0 would be neutral. The overall mean value for the first survey was -0.13, indicating a slightly negative experience overall. For the second survey, the overall mean value was 1.23 which is an improvement of 1.1 units.

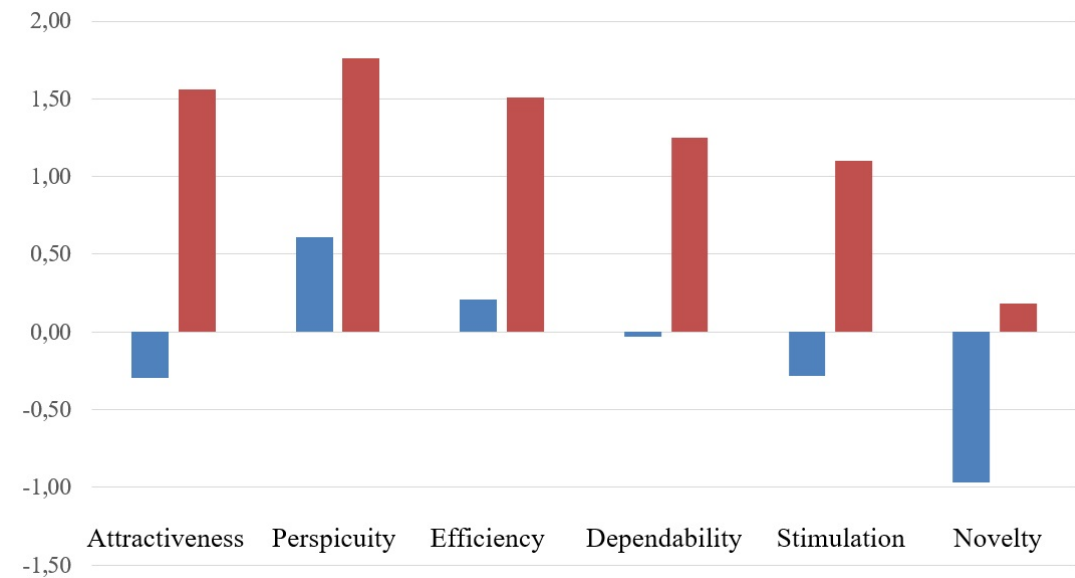


Figure 5.2: Results from the UEQ, where blue corresponds to the results of the first survey and red to the second survey. Each value is ranked between -3 and 3, where -3 corresponds to the most negative user experience and 3 to the most positive.

The mean values for each of the categories for the two studies can be seen in Figure 5.2. Each category showed an increase: Attractiveness from -0.13 to 1.56 ($p < 0.001$), perspicuity from 0.61 to 1.76 ($p < 0.001$), efficiency from 0.21 to 1.51 ($p < 0.001$), dependability from -0.03 to 1.25 ($p < 0.001$), Stimulation from -0.28 to 1.10 ($p < 0.001$) and lastly novelty from -0.97 to 0.18 ($p < 0.001$). The increases in all of the six categories were all statistically significant.

5.3 Usage Analytics

To give more insight on how the system is used, a question on how often the user interacts with the website was included in the first survey. The results, as seen in Figure 5.3, show that users exclusively interact with the website several times a month or less, with a majority of users interacting with the site less than once a month. None of the respondents used the website several times a week or more. The consensus is thus that the website is used quite seldom and not something that is part of a regular workflow.

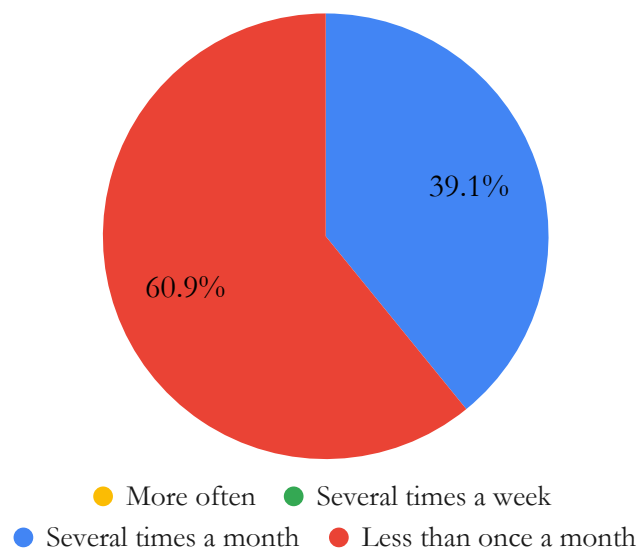


Figure 5.3: How often the users interact with the website



6 Discussion

In this chapter the results from the two surveys will be discussed and analyzed, along with the method choices and their effect on the study. Lastly the sources used in the study will be discussed and the work will be put into a wider perspective.

6.1 Results

In this section, the discussion is categorized by the two research questions.

6.1.1 RQ1: How does adjusting the design of a software documentation webpage to better reflect a company's graphic profile affect the user experience?

The results of this study shows that in this specific context, there is a strong correlation between adjusting the design and an increase in perceived user experience. The results in Figure 5.1 show that the users find that the new version of the website more accurately reflect the TMHMS graphic profile, which is a prerequisite for answering this research question. Looking at the overall mean value from the UEQ part of the two surveys, there has been a significant increase of the user experience after the adjustments to the graphics. This was the expected result since it is in line with previous research, as can be seen in section 3. Lindgaard et al. [27] found that more beautifully designed systems were also considered to be more usable, and Manning and Amare [29] saw strong correlations between different colors and certain emotional responses that also may affect the user experience. A graphic profile, together with the colors and design choices that comes with it, is an important part of a company's visual identity [30] and such profiles are designed for the purpose of improving the perception of the brand. It is therefore reasonable to believe that a site that conforms more to the company's graphic profile also would be experienced as better. With all this considered, it can be concluded that conforming to a graphic profile does affect the overall user experience in a positive way.

6.1.2 RQ2: How does improvements in visual aesthetics affect other subcategories of user experience?

Looking at the results of the individual areas, every category had a significant increase in rating after the changes were made to the website (see Figure 5.2). An increase in Attractiveness is to be somewhat expected since the focus of the changes has been mainly aesthetic. When it comes to the other categories, such as Efficiency and Dependability, it was less clear that the changes would have an effect on them. Previous research does indicate a correlation between aesthetics and other aspects of usability. Robins and Holmes [35] found a connection between aesthetics rating and the credibility rating, and O'Brien and Toms [33] showed that the aesthetic trait could predict usability, focused attention and felt involvement. Our results do fall in line with these other studies, however, they are quite extreme considering no changes has been made to the actual functionality of the website. For example, Dependability increased from -0.3 to 1.25, even though the changes were purely aesthetic. The explanation for this could be the fact that there are no clear indicators for Dependability on the website, which would make it hard to rate. It is possible that if a user experiences the aesthetic changes as positive, they rate everything unknown as positive as well. If the website would have been more complex, with more indicators of Dependability, it would be possible for the user to distinguish the changes of aesthetics from the changes of functionality.

6.1.3 Final Thoughts

While this study shows quite a large increase in the user experience in this context. The changes may have had less impact on a larger system that is more complex. Small changes on a simple site might make a big difference while the same changes to a larger system may not affect the user experience as much. Since this website is used quite infrequently (less than once a month, as seen in Figure 5.3), the changes made might also make a bigger difference since the visual aspects are more impactful in the beginnings of using a system, much like a first impression. This is something that Robins and Holmes discussed in their study on aesthetics and perceived credibility [35]. When a system is used more often, the user is more acquainted with it and the actual functionality is more important than the first impression.

6.2 Method

The method chosen for the evaluation was a survey based on the UEQ. The results from this questionnaire are a numerical, which means that it would be considered a quantitative study [43]. The motivation for choosing a quantitative method was simplicity and ease of analysis, since having numerical values would allow for simple statistical analysis of the two questionnaire results and would give easily comparable results. Another choice could have been conducting interviews with a small number of users. While oftentimes producing more information and more detailed data than questionnaires, interviews are more inconvenient and can be more inconsistent [5].

Surveys are a well used tool for usability and user experience testing, especially when testing a system before and after a change such as in the work by Moizer et al. [31] and Bari-fah et al. [4]. Surveys are also useful in studies with a short time frame [36], which applied to this project. The choice of using an already existing questionnaire, the UEQ, was made with the validity of the study in mind. Since the UEQ is already constructed and validated [25] beforehand, it is more certain that the method is valid. The questionnaire has also been shown to work in multiple different scenarios [38] [37] [12], which further confirms the validity of the method. Using a pre-constructed evaluation method also allows for easier replicability of the study and the time aspect is crucial as well, since developing and validating a questionnaire would require much more time. Another positive aspect of the UEQ is the fact that it comes with a tool for the data analysis. It automatically calculates mean values, standard

deviation, creates charts and for the two point measurement it also performs a two sample T-test comparing the two data sets.

6.3 Source Criticism

The sources chosen in this work are mainly from peer-reviewed journals and conference proceedings, where the quality and validity of the studies have been assessed by independent researchers. This ensures that the provided information is sound and trustworthy. In addition to this, multiple sources of the studied area have been reviewed as to find consistencies and inconsistencies of information. Some information have no easily obtainable peer-reviewed source. In most of those cases, certain websites have been used. The websites have mainly been from governmental agencies or well-established industry organizations, which are regarded to be trustworthy. Information about certain specific systems and softwares are gathered from the source websites, which should have the most accurate and up-to-date material.

6.4 The Work in a Wider Context

To the knowledge of the authors, no direct ethical aspects are related to this study and the general societal aspect is limited. As stated in the delimitations section in the introduction chapter, the generalizability of this study is somewhat impaired. The study focuses on a specific group of users, that is software developers working at TMHMS. The changes made are also very specific to TMHMS, since they have been made with their graphic profile in mind. However, the changes were overall highly appreciated and the result do give an indication on how visual design and an overall harmonizing theme can affect the user experience of a system. This can be used as a stepping stone for future works to further investigate the effects in a more general context.



7

Conclusion

The purpose of this study was to see how changes to a websites visual design can affect the usability and user experience. It has shown that having more consistency towards a graphic profile will increase the user experience overall and that changes in the aesthetics of a website can also affect other aspects, such as perceived efficiency and dependability. The overall conclusion is thus that having an overall harmonizing theme will positively affect the user experience of using a website. Previous research has shown that a more beautiful design may affect other areas as well, however they have not looked into the effect of conforming to a graphic profile for a company's website. It is to be noted that the results are mainly applicable in the specific context of this study, which is that the users of the website are software developers, all working within the same company and the changes to the website are done to better reflect that company's brand. While this study is limited to this particular background, it provides a good basis for further research into the subject.

7.1 Further Research

If further research is to be done on this subject, one suggestion is to broaden the context to make the results more generally applicable. For example, one could study a publicly available website and conduct the surveys with a larger number of participants from different backgrounds, rather than a group of only software developers. One could also investigate the relationship between aesthetics and usability on a much more complex system, where functionality probably would be a more important factor. Lastly, one could also study the same concept as in this thesis, but with a qualitative approach where interviews would be the main method of investigation.



Bibliography

- [1] Lauralee Alben. "Quality of experience: defining the criteria for effective interaction design". In: *interactions* 3.3 (1996), pp. 11–15.
- [2] D. Alonso-Ríos, A. Vázquez-García, E. Mosqueira-Rey, and V. Moret-Bonillo. "Usability: A Critical Analysis and a Taxonomy". In: *International Journal of Human–Computer Interaction* 26.1 (2009), pp. 53–74. DOI: 10.1080/10447310903025552.
- [3] Leena Arhipainen and Marika Tähti. "Empirical evaluation of user experience in two adaptive mobile application prototypes". In: *Mum 2003. proceedings of the 2nd international conference on mobile and ubiquitous multimedia*. 011. Citeseer. 2003, pp. 27–34.
- [4] Maram Barifah, Monica Landoni, and Ayman Eddakrouri. "Evaluating the user experience in a digital library". In: *Proceedings of the Association for Information Science and Technology* 57.1 (2020), e280. DOI: <https://doi.org/10.1002/pra2.280>. eprint: <https://asistdl.onlinelibrary.wiley.com/doi/pdf/10.1002/pra2.280>. URL: <https://asistdl.onlinelibrary.wiley.com/doi/abs/10.1002/pra2.280>.
- [5] Doug A Bowman, Joseph L Gabbard, and Deborah Hix. "A survey of usability evaluation in virtual environments: classification and comparison of methods". In: *Presence: Teleoperators and Virtual Environments* 11.4 (2002), pp. 404–424.
- [6] Komang Candra Brata and Adam Hendra Brata. "User experience improvement of japanese language mobile learning application through mental model and A/B testing". In: *International Journal of Electrical and Computer Engineering* 10.3 (2020), p. 2659.
- [7] Leah Buley. *The User Experience Team of One*. New York, USA: Rosenfeld Media, 2013.
- [8] U. Biader Ceipidor, C. M. Medaglia, A. Opromolla, V. Volpi, A. Moroni, and S. Sposato. "A Survey about User Experience Improvement in Mobile Proximity Payment". In: *2012 4th International Workshop on Near Field Communication*. 2012, pp. 51–56. DOI: 10.1109/NFC.2012.18.
- [9] Clancy Clark. *6 Reasons Graphic Design is More Important to Your Business Than You Think*. <https://www.business2community.com/branding/6-reasons-graphic-design-important-business-think-0928602>. [Accessed 2022-05-11].
- [10] Curtis R Cook and Marcello Visconti. *New and improved documentation process model*. Citeseer, 1996.

- [11] Pieter Desmet. *Designing emotions*. Delft University of Technology, Department of Industrial Design, 2002.
- [12] Ni Putu Indah Rosita Devy, Sunu Wibirama, and Paulus Insap Santosa. "Evaluating user experience of english learning interface using User Experience Questionnaire and System Usability Scale". In: *2017 1st International Conference on Informatics and Computational Sciences (ICICoS)*. 2017, pp. 101–106. DOI: 10.1109/ICICoS.2017.8276345.
- [13] JMP Statistical Discovery. *The Two-Sample t-Test*. https://www.jmp.com/en_ch/statistics-knowledge-portal/t-test/two-sample-t-test.html. [Accessed 2022-05-10].
- [14] MDN Web Docs. *HTTP request methods*. <https://developer.mozilla.org/en-US/docs/Web/HTTP/Methods>. [Accessed 2022-05-06].
- [15] Erlangga, Yaya Wihardi, and Eki Nugraha. "User Experience Evaluation by Using a User Experience Questionnaire (UEQ) Based on an Artificial Neural Network Approach". In: *2021 3rd International Conference on Research and Academic Community Services (ICRACOS)*. 2021, pp. 17–22. DOI: 10.1109/ICRACOS53680.2021.9702096.
- [16] Adrian Fernandez, Emilio Insfran, and Silvia Abrahão. "Usability evaluation methods for the web: A systematic mapping study". In: *Information and Software Technology* 53.8 (2011). Advances in functional size measurement and effort estimation - Extended best papers, pp. 789–817. ISSN: 0950-5849. DOI: <https://doi.org/10.1016/j.infsof.2011.02.007>. URL: <https://www.sciencedirect.com/science/article/pii/S0950584911000607>.
- [17] John D. Gould and Clayton Lewis. "Designing for Usability: Key Principles and What Designers Think". In: *Commun. ACM* 28.3 (Mar. 1985), pp. 300–311. ISSN: 0001-0782. DOI: 10.1145/3166.3170. URL: <https://doi.org/10.1145/3166.3170>.
- [18] Agnes Grudniewicz, Onil Bhattacharyya, K McKibbon, and Sharon E Straus. "Re-designing printed educational materials for primary care physicians: design improvements increase usability". In: *Implementation Science* 10.1 (2015), pp. 1–13.
- [19] B. L. Hanson. "Human Factors and Behavioral Science: A Brief History of Applied Behavioral Science at Bell Laboratories". In: *Bell System Technical Journal* 62.6 (1983), pp. 1571–1590. DOI: <https://doi.org/10.1002/j.1538-7305.1983.tb03499.x>. URL: <https://onlinelibrary.wiley.com/doi/abs/10.1002/j.1538-7305.1983.tb03499.x>.
- [20] Azham Hussain, Emmanuel O. C. Mkpojiogu, Nur Hafiza Jamaludin, and Somia T. L. Moh. "A usability evaluation of Lazada mobile application". In: *AIP Conference Proceedings* 1891.1 (2017), p. 020059. DOI: 10.1063/1.5005392. URL: <https://aip.scitation.org/doi/abs/10.1063/1.5005392>.
- [21] Jun H Kim, Daniel V Gunn, Eric Schuh, Bruce Phillips, Randy J Pagulayan, and Dennis Wixon. "Tracking real-time user experience (TRUE) a comprehensive instrumentation solution for complex systems". In: *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*. 2008, pp. 443–452.
- [22] Kari Laitinen. "Document classification for software quality systems". In: *ACM SIGSOFT Software Engineering Notes* 17.4 (1992), pp. 32–39.
- [23] Carine Lallemand, Guillaume Gronier, and Vincent Koenig. "User experience: A concept without consensus? Exploring practitioners' perspectives through an international survey". In: *Computers in Human Behavior* 43 (2015), pp. 35–48. ISSN: 0747-5632. DOI: <https://doi.org/10.1016/j.chb.2014.10.048>. URL: <https://www.sciencedirect.com/science/article/pii/S0747563214005718>.

- [24] Bettina Laugwitz, Theo Held, and Martin Schrepp. "Construction and Evaluation of a User Experience Questionnaire". In: *HCI and Usability for Education and Work*. Ed. by Andreas Holzinger. Berlin, Heidelberg: Springer Berlin Heidelberg, 2008, pp. 63–76. ISBN: 978-3-540-89350-9.
- [25] Bettina Laugwitz, Theo Held, and Martin Schrepp. "Construction and evaluation of a user experience questionnaire". In: *Symposium of the Austrian HCI and usability engineering group*. Springer. 2008, pp. 63–76.
- [26] Natalia Limantara, Fredy Jingga, and Stephanie Surja. "The Evaluation of Business Process Simulation Software from User Experience Perspective using the User Experience Questionnaire". In: *2019 International Conference on Information Management and Technology (ICIMTech)*. Vol. 1. 2019, pp. 261–265. DOI: 10.1109/ICIMTech.2019.8843820.
- [27] Gitte Lindgaard. "Aesthetics, Visual Appeal, Usability and User Satisfaction: What Do the User's Eyes Tell the User's Brain?." In: *Australian Journal of Emerging Technologies and Society* 5.1 (2007), pp. 1–14. ISSN: 14490706. URL: <https://login.e.blibliu.se/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,uid&db=a9h&AN=25121067&lang=sv&site=eds-live&scope=site>.
- [28] A. Mäkelä and J. Fulton Suri. "Supporting Users' Creativity: Design to Induce Pleasurable Experiences". In: *Proceedings of the International Conference on Affective Human Factors Design*. 2001, pp. 387–394.
- [29] Alan Manning and Nicole Amare. "Emotion-spectrum response to form and color: Implications for usability". In: *2009 IEEE International Professional Communication Conference*. IEEE. 2009, pp. 1–9.
- [30] TC Melewar, Kara Bassett, and Cláudia Simões. "The role of communication and visual identity in modern organisations". In: *Corporate Communications: An International Journal* (2006).
- [31] Jonathan Moizer, Jonathan Lean, Elena Dell'Aquila, Paul Walsh, Alphonsus (Alfie) Keary, Deirdre O'Byrne, Andrea Di Ferdinando, Orazio Miglino, Ralf Friedrich, Roberta Asperges, and Luigia Simona Sica. "An approach to evaluating the user experience of serious games". In: *Computers and Education* 136 (2019), pp. 141–151. ISSN: 0360-1315. DOI: <https://doi.org/10.1016/j.compedu.2019.04.006>. URL: <https://www.sciencedirect.com/science/article/pii/S0360131519300855>.
- [32] Jakob Nielsen and Rolf Molich. "Heuristic evaluation of user interfaces". In: *Proceedings of the SIGCHI conference on Human factors in computing systems*. 1990, pp. 249–256.
- [33] Heather L O'Brien and Elaine G Toms. "The development and evaluation of a survey to measure user engagement". In: *Journal of the American Society for Information Science and Technology* 61.1 (2010), pp. 50–69.
- [34] A.A. Istri Ita Paramitha, Gede Rasben Dantes, and Gede Indrawan. "The Evaluation of Web Based Academic Progress Information System Using Heuristic Evaluation and User Experience Questionnaire (UEQ)". In: *2018 Third International Conference on Informatics and Computing (ICIC)*. 2018, pp. 1–6. DOI: 10.1109/IAC.2018.8780430.
- [35] David Robins and Jason Holmes. "Aesthetics and credibility in web site design". In: *Information Processing and Management* 44.1 (2008). Evaluation of Interactive Information Retrieval Systems, pp. 386–399. ISSN: 0306-4573. DOI: <https://doi.org/10.1016/j.ipm.2007.02.003>. URL: <https://www.sciencedirect.com/science/article/pii/S0306457307000568>.
- [36] Virpi Roto, Marianna Obrist, and Kaisa Väänänen-Vainio-Mattila. "User experience evaluation methods in academic and industrial contexts". In: *Proceedings of the Workshop UXEM*. Vol. 9. Citeseer. 2009, pp. 1–5.

- [37] Martin Schrepp, Andreas Hinderks, and Jörg Thomaschewski. “Applying the User Experience Questionnaire (UEQ) in Different Evaluation Scenarios”. In: *Design, User Experience, and Usability. Theories, Methods, and Tools for Designing the User Experience*. Ed. by Aaron Marcus. Cham: Springer International Publishing, 2014, pp. 383–392. ISBN: 978-3-319-07668-3.
- [38] Martin Schrepp, Andreas Hinderks, and Jörg Thomaschewski. “Applying the user experience questionnaire (UEQ) in different evaluation scenarios”. In: *International Conference of Design, User Experience, and Usability*. Springer. 2014, pp. 383–392.
- [39] Mads Soegaard. *The History Of Usability: From Simplicity To Complexity*. <https://www.smashingmagazine.com/2012/05/the-history-of-usability-from-simplicity-to-complexity/>. Accessed 2022-05-05.
- [40] International Organization for Standardization. *ISO 9241-11:2018: Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts*. <https://www.iso.org/standard/63500.html>. Accessed 2022-04-19.
- [41] International Organization for Standardization. *ISO 9241-210:2019: Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems*. <https://www.iso.org/standard/77520.html>. Accessed 2022-04-20.
- [42] International Organization for Standardization. *ISO/IEC 25010:2011: Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — System and software quality models*. <https://www.iso.org/standard/35733.html>. Accessed 2022-04-19.
- [43] Australian Bureau of Statistics. *Statistical Language - Quantitative and Qualitative Data*. <https://www.abs.gov.au/websitedbs/D3310114.nsf/Home/Statistical+Language+-+quantitative+and+qualitative+data>. [Accessed 2022-05-06].
- [44] N Tractinsky, A.S Katz, and D Ikar. “What is beautiful is usable”. In: *Interacting with Computers* 13.2 (Dec. 2000), pp. 127–145. ISSN: 0953-5438. DOI: 10.1016/S0953-5438(00)00031-X. eprint: <https://academic.oup.com/iwc/article-pdf/13/2/127/2668972/iwc13-0127.pdf>. URL: [https://doi.org/10.1016/S0953-5438\(00\)00031-X](https://doi.org/10.1016/S0953-5438(00)00031-X).



Appendix A: UEQ word pairs

Left	Right	Scale	
annoying	enjoyable	Attractiveness	pink
not understandable	understandable	Perspicuity	green
creative	dull	Novelty	orange
easy to learn	difficult to learn	Perspicuity	green
valuable	inferior	Stimulation	red
boring	exciting	Stimulation	red
not interesting	interesting	Stimulation	red
unpredictable	predictable	Dependability	cyan
fast	slow	Efficiency	blue
inventive	conventional	Novelty	orange
obstructive	supportive	Dependability	cyan
good	bad	Attractiveness	pink
complicated	easy	Perspicuity	green
unlikable	pleasing	Attractiveness	pink
usual	leading edge	Novelty	orange
unpleasant	pleasant	Attractiveness	pink
secure	not secure	Dependability	cyan
motivating	demotivating	Stimulation	red
meets expectations	does not meet expectations	Dependability	cyan
inefficient	efficient	Efficiency	blue
clear	confusing	Perspicuity	green
impractical	practical	Efficiency	blue
organized	cluttered	Efficiency	blue
attractive	unattractive	Attractiveness	pink
friendly	unfriendly	Attractiveness	pink
conservative	innovative	Novelty	orange

Figure A.1: All the word pairs from the UEQ, with their respective categories.