CHALMERS
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Exploring Interusability Factors for Crossmedial, Complementary Services

A Compilation of Key Interusability Factors for Digital Platforms within the Module House Manufacturing Context

Master's thesis in Interaction Design and Technologies

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Abstract

Over the past three decades, services distributed over more than one computing platform, also called cross-platform services, have become more and more common. Today, users frequently perform tasks by using more than one platform (both software and hardware) in order to achieve their goals. Therefore, when considering the usability of cross-platform services, it is not enough to only consider the usability of each individual platform interface in isolation. Thus the concept of interusability was born, i.e. the usability across several components in a system. In this master thesis, the field of interusability and cross-platform interaction was explored with regards to the current composition of A-hus cross-platform service. A-hus is a house manufacturer company offering a service selling module houses (complete house models). Their digital platforms are of a crossmedial, complementary composition. At the start of this masters thesis, there was little theory or previous studies available concerning interusability of cross-platform services with crossmedial system delivery and a complementary component organization. By using A-hus as a case study, the goal was to identify and establish what factors that are relevant for the composition and context of A-hus' cross-platform service, and thus answer the research question: *What are key interusability factors for crossmedial, complementary cross-platform services within a module house manufacturing context?* To explore the field of interusability, and establish key interusability factors, the original design of A-hus was evaluated to outline the circumstances of current interusability. Based on the evaluation and current available theory, new design solutions were created to increase the interusability. These designs were then evaluated, by re-using the same evaluation as the original design underwent. This evaluation worked as a validating tool, where the resulting data pointed at the impact of the alterations and served as a basis when establishing key interusability factors within the module house manufacturing (MHM) context. This resulted in nine interusability factors that are believed to be important to understand and to consider when designing for this kind of cross-platform service. However, the factors are in need of validation and iteration.

Keywords: Interusability, Cross-Platform Interaction, Cross-Platform Services, Crossmedial Services, Complementary Composition, Exploratory, Case Study, Module House Models.

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Beatrice Andersson, Johanna Sindby, Gothenburg, May 2021

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Introduction

Over the past three decades, services distributed over more than one computing platform, also called *cross-platform services*, have become more and more common. Today, users frequently perform tasks by using more than one platform (both software and hardware) in order to achieve their goals (Majrashi, 2016). The users can be said to achieve their goals or tasks *horizontally* over several platforms, and therefore it becomes relevant to discuss and explore *horizontal usability*, also referred to as *cross-platform usability*, *inter-usability* (Majrashi & Hamilton, 2015), or *interusability* (Rowland, 2015, chapter 9). The concept refers to more than just the usability of each individual platform, it incorporates transitions between platforms, and the resuming of tasks after the transition (Wäljas et al., 2010). Traditional usability is typically concerned with different quality attributes that determines the ease-of-use of an artifact (Nielsen, 2012). In this context, traditional usability may be referred to as *vertical usability*, which describes usability based on users interacting with only one specific platform (Majrashi & Hamilton, 2015). The traditional usability field is vast and contains numerous design principles, guidelines, heuristics, and frameworks that can guide designers in creating usable interfaces. However, considering only vertical usability for a cross-platform service is not enough (Rowland, 2015, chapter 9).

A-hus is a module house manufacturer company and a part of Derome AB. They offer a service selling module houses (complete house models) where the customer chooses one of A-hus's many catalogue house models and then only has to manage additional options such as facade paint, exterior door, floor and kitchen doors, etc. Their digital platforms help the customers visualize and make all of these choices. Today they have three main digital platforms, their main website: A-hus.se, their web-based house customization tool: Husbyggaren, and their phone/tablet application: Husvisaren in which the user can interact with some of their house models in a 3D and AR view. All of the platforms are used by the customers or potential customers of A-hus. The potential customers mainly use them to determine what their house could or will look like, should they decide to hire A-hus as their house contractor. If the user has already hired and signed a contract with A-hus, and hence has become a customer, the platforms have a slightly different usage area. That usage area is mainly to use the house-building tool (Husbyggaren) to make choices regarding their house which is under construction.

1.1 The research problem

While A-hus reportedly likes their three platforms, they believe that the three separate platforms might be a source of confusion to the customer. According to A-hus, their customer journeys appear to be fragmented and incoherent based on reports and surveys made by the company. A-hus themselves have speculated about the possibility that the platforms might not be interpreted as intended, i.e. three components of their service in one holistic process, but rather as three separate processes with no apparent connection to the others. A-hus' three platforms are intended to work in concert, as they were created to complement each other in terms of functionality. However, the fact that the platforms are not being used as intended has led the researchers of this study to hypothesize that A-hus' issues might be connected to the *interusability* of their three platforms.

In this master thesis, the field of interusability (i.e. the usability *between* several platforms or devices) and interactions of cross-platform services will be explored with regards to the current composition of A-hus cross-platform service. A-hus will be used as a case study, with the goal to create a body of knowledge for interusability regarding complementary, crossmedial platforms, primarily within a module house manufacturing (MHM) context. This master thesis will strive to answer the following research question:

RQ:

> *What are key interusability factors for crossmedial, complementary cross-platform services within a module house manufacturing context?*

The aim of the project is to identify and establish what factors are relevant to consider for the specified cross-platform service within the context of module house manufacturing. Furthermore, the aim is to contribute to the current body of knowledge that constitutes the field of interusability and cross-platform interaction

1.1.1 Limitations

The first limitation of this thesis stems from the academic context of the project. As one of the primary stakeholders of this project is an academic institution, Chalmers University of Technology, there are certain conditions to take into consideration. The project must be implemented within the time frame given by the institution, and keep to specific research standards provided. The second limitation of the project is the ongoing Covid-19 pandemic, and the restrictions provided by the Swedish public health authority within the first half of 2021. As a precaution, it was determined at an early stage of the project that any usability testing would be performed remotely by using an online video conference tool. This in turn means that the project runs the risk of losing some ecological validity, mainly with regards to methods used during usability test sessions that involve observation of the tests subjects.

1.1.2 Delimitations

As the project is constricted by a set time frame, a delimitation of the project will be to explore particular instances of the interusability field. Due to the variation of different compositions a cross-platform service can appear in (see chapter 3, section 3.2 for more details), it will not be possible to explore the field of interusability at large in this thesis. By concentrating the project around the pre-existing composition of A-hus digital platforms (a crossmedial complementary composition), and thus making it a case study, it will be possible to explore interusability in depth for this particular composition. The web based platforms of A-hus are available as both desktop and mobile view, but the project will only focus on the desktop views of these platforms.

Related to the delimitation of the interusability field, the project is primarily aimed towards interusability within a house manufacturing context. As the project heavily relies on a case study based on a house-selling service, any key interusability factors resulting from the study will be presented as recommendations for the specified context. However, whether the result has the potential to be extrapolated to a larger context will be discussed.

A-hus has two primary types of customers: the potential customers and their current customers. The project will be delimited to only consider the experience of potential customers, in particular those who have never had any previous encounters with the three platforms. Furthermore, a delimitation of the project is that the existing service composition will not be changed. Also regarding the planned usability testing of the project, only participants that understand the Swedish language will be recruited, as A-hus platforms to date are only available in a Swedish version. The participants will also be recruited based on A-hus' recognized target groups (see chapter 6, section 6.1.3.5).

1.2 Stakeholders

The primary stakeholders for this master thesis are Chalmers University of Technology and the researchers of this study. Chalmers has an academic interest in the study, and provides faculty guidelines that will shape this master thesis. The secondary stakeholders are A-hus, and in extension Derome, which are the providers of the service which the platforms are built for. They are also the provider of the platforms themselves. They have a direct interest in a thorough evaluation and the potential findings, since it will possibly reveal issues connected to their service. As A-hus are about to remodel parts of their platforms, they are interested in the results of this study for potential alterations that will support their ambitions. The potential customers of A-hus and Derome are also stakeholders, since their goals are tied to the execution of the service. If the customer's goals are effectively met, then ultimately the goals of A-hus are also met.

2
Background

In this section, background information regarding A-hus and its associated platforms as well as the characteristics of the module house manufacturing context will be presented. The purpose behind the platforms will be presented, as well as available functions and information. Important and distinguishing characteristics of the house manufacturing context will also be described and presented, as they are expected to have an impact on the end results of this thesis.

2.1 The platforms of A-hus

A-hus' service consists of three separate platforms. According to Cooper et al. (2014), a platform can be described as the "combination of hardware and software that enables the product to function" (p. 205). Cooper et al. (2014) also characterizes the concept as used to describe a product with regards to important features, such as its physical structure and form, input methods, connectivity, and operating system. Different products consist of their own individual constellations of features, where the features affect the design, production and usage of the product. A platform should be created to fit the context, business constraints and objectives, as well as the technological capabilities of the owning company and its clients.

Returning to A-hus, their three platforms are distinguished from each other with regards to having different constellations of both software and hardware. The platforms serve different purposes and have corresponding features, postures, and run on different devices. However, even if the platforms are located separately, they are intended to work as complementary parts in a holistic process. The platforms are created to be used as tools in the process of building a house in association with A-hus. The technical details of the platforms will be outlined in the following sections (2.1.1 - 2.1.3). Reportedly, the platforms are not designed to be used in any specific order.

2.1.1 A-hus.se

A-hus.se is the main platform of the service and the first to be created by the company. It is an informational website originally designed to be used on desktop. Informational websites are essentially a place where the user can get access to information, and are distinguished from interactive web-delivered services, which is a much more recent invention (Cooper et al. 2014). The purpose of A.hus.se is to de-

liver relevant information regarding their service to current or potential customers. It mainly provides information about available house models to choose from, where and when it is possible to attend house showings, currently or future available lots, a guide of the house buying process with A-hus, contact information, etc.

The primary navigation structure is a classic top navigation bar, where users can click or hover over the links in the menu to reach different pages of the website that correspond to the user's current goal. The secondary navigation is typically a second menu bar which sticks to the top of the screen when scrolling down. There are also several transition points available which can redirect or inform the user about the other two platforms.

2.1.2 Husbyggaren

Husbyggaren is a web application, and the second asset to be launched by A-hus. Web applications are much more interactive than informational websites, and they are similar to desktop applications but are instead run inside a browser. Web applications are usually not as powerful as desktop applications, and thus need to be designed accordingly with regards to potentially limiting constraints (Cooper et al., 2014). The main purpose of Husbyggaren is to enable the user to customize the features of a chosen house model, both externally and internally. This is done inside the house configurator, which can be accessed through the main page of Husbyggaren. For instance, it is possible to change the structure and color of the facade, redesign the kitchen doors, change bathroom tiles, etc. Husbyggaren is a much more shallow website than A-hus.se, and does not contain all information available on A-hus.se. The information shared between the two platforms is mainly the house models and associated information to the house models. Husbyggaren is available by opening it through A-hus.se, but it is also possible to access it through an URL address in a browser, as the platform runs independently from A-hus.se. A-hus' intended use for Husbyggaren is to work as a complementing tool to A-hus.se, with which the user can realize the available house modifications before making any definite choices.

2.1.3 Husvisaren

Husvisaren is an application created for smartphones and tablets. Husvisaren is an augmented reality app, which essentially means that 3D content can be projected onto the real world through the screen of the device used. The purpose of Husvisaren is to project a 3D model of one of A-hus' available house models onto a flat surface in a 1:1 scale, suggestively onto a lot where the user might want to build a house. It is also possible to project a house on a smaller surface, which will cause the projected house to be smaller as well. Apart from being able to view the projected and (up)scaled house from the outside, it is also possible to walk into the projection and view the house from the inside. The projection can help the user visualize a house model they are interested in, and create a realistic feeling of what the finished house might look like. The app offers a limited selection of the house models available on A-hus.se. It is not possible to customize a projected house in any way. The app, like

Husbyggaren, displays a scarce amount of the information available on A-hus.se. It is not meant to display a large amount of information, it is rather an externalized function that works better for the intended context on a device that is more mobile than a desktop. It is presumed to be much more convenient to bring a smartphone or a tablet to a potential lot, than to bring a desktop.

2.2 The module house manufacturing context

It can be argued that module house manufacturing (MHM) is a unique industry. It resembles the retail industry in that the objective is to produce finished products which the end customer will ultimately buy. However, the end products of the regular instances of the retail industry are typically much smaller in size, much cheaper and much less permanent than the end products of the MHM industry. Buying a house is for many people the largest and most expensive purchase of their lives. Therefore, it can be argued that the customers of A-hus are a clientele with needs out of the ordinary. What applies to that industry is possibly not directly comparable to e.g. the regular instances of the retail industry, as buying a house is not that similar to buying a sweater or an expensive TV.

The process of buying a module house is lined with an extensive amount of decision making and other time consuming and important activities. In the early stages of the process, the customer must decide which house model they want to build, and live in, out of the available products. This decision is perhaps one of the most terminal, and it can therefore be assumed to be a heavy task for the customer. The process will also contain much decision making regarding internal and external characteristics and appearances. Naturally, the mentioned process activities and tasks will affect what assets should be designed by the company to facilitate the process, and ultimately how they are designed. An online store created by a clothing company will have to adapt their assets to fit that particular context, process and clientele as well, which ultimately will define what can be considered useful and necessary in terms of features, functions and information in that case. How much the MHM context will affect the usability and interusability of the assets, e.g platforms, used in the module house buying-process is not certain but it is worth taking into account.

3
Theory

In this section, relevant theories and theoretical concepts related to the field of interusability will be presented. The interusability concept itself will be thoroughly examined, explained and a working definition for this thesis will ultimately be formed. Interusability will also be connected to vertical (regular) usability, as the two concepts are intertwined and inseparable. Furthermore, different types of platform compositions will be described, as identifying the kind of platform composition at hand is fundamental for exploring the interusability concept. The most relevant findings of interusability up to date will thereafter be outlined, as they will be a backbone of this study and used in the process of establishing the sought key factors.

3.1 Interusability

The cross-platform domain in general is a large but fragmented and variegated research field. Brudy et al. (2019) states that the domain has experienced a rapid progression over the last 30 years, due to fundamental changes in the way people interact with technology. Because of this paradigm shift, where interactions now typically transcend through more than one device, the cross-platform research topics have increased drastically with scarce internal or logical order. According to Brudy et al. (2019), this has led to a disconnected terminology, but they also empathize that despite the immense variety of research topics and agendas, the field is united by the strive to create a united understanding that will deliver "experiences that transcend the individual device" (p. 13).

As described by Majrashi et al. (2020), the detached and uncoordinated terminology of the domain has led to many terms and definitions to refer to *interactive cross-platform systems*, such as "multiple user interfaces", (MUI), "multiple platform user interfaces" and "distributed user interfaces", (DUI). However, the term "*cross-platform service*" is described by Majrashi et al. (2020) as "a set of user interfaces for a single service on two or more computational platforms" (p. 2). The definition is used to specifically emphasize transitions being made from one platform to another in order to complete a task. *Cross-platform service* will henceforth be used throughout this thesis to describe the interactive cross-platform system relevant for the project.

As cross-platform services contain several interfaces, it becomes relevant to consider usability. However, when considering the usability of cross-platform services, it is

not enough to only consider the usability of each individual platform interface in isolation. The reason is that traditional, or vertical, usability theory is not equipped enough to cover usability that extends across several interfaces (Rowland, 2015, chapter 9). *Cross-platform usability*, or horizontal usability, has therefore emerged as a relatively new research theme. Due to the described field variegation, many terms and definitions have emerged that essentially refer to cross-platform usability. The concept of *inter-usability* was first coined and named by Denis and Karsenty (2005). They described inter-usability as "the ease with which users can reuse their knowledge and skills for a given functionality when switching to other devices" (p. 4). This definition appears to still stand to date to describe usability that transcends multiple platforms or devices, but the term has since then evolved into *interusability*. Rowland (2015, chapter 9) refers to the interusability concept as "the user experience of interconnected devices and cross-platform interactions" (p. 337), and argues for the importance of considering interusability when designing cross-platforms services and the interactions in between, sometimes referred to as *cross-platform interaction*, in order to create an overall coherent experience. Segerståhl (2011) defines the interusability concept as being primarily focused on "the consistency of presentation, transitions between devices and on how tasks are picked up after these transitions." (p. 28). For this thesis, the term interusability will be adopted and used to describe *the ease of which the user experiences the interactions with cross-platform services.*

3.1.1 Interusability in practice

Rowland (2015, chapter 9) states that the cross-platform usability is a very interesting topic in the practitioner community but has not received much attention in the academic world. This has created a lack of theory, but not of demand for implementation in practice. A consequence is that many cross-platform services are currently being designed and used without much or any research as support. As industry practice it is not uncommon for cross-platforms and devices to be designed one by one, where one is the key reference for the others following, such as the Facebook app looking similar to the Facebook website. These kinds of translations work best when the platforms are similar in terms of functionality (multichanneled) but when platforms have different functions and are created to work in concert, adapting subsequent platforms can rather impair the system (Rowland, 2015, chapter 9).

Regarding the current lack of academic interest in the cross-platforms domain, Brudy et al. (2019) listed the gap between studies and systems as one of the key challenges and research areas of cross device-interaction. They highlight the fact that although many technical contributions push forward the technical boundaries, and although some work has attempted to compare different systems, there is no frame of reference to compare with and evaluate from academia within the cross-platform field. Segerståhl (2011) writes that since technology constantly is evolving, "the way in which people use and adopt multiple devices and applications and relate to services need to be better understood to map areas in which interactions are challenged" (p. 95). She also stresses that further research on the topic should attempt to use different methodological approaches. The described shortage of academic interest

and engagement might complicate this exploratory project, but it might also imply that our work could be of great value in the process of expanding the field.

3.2 Service composition

A fundamental aspect of interusability is which composition constitutes the devices or platforms of a cross-platform service. Cross-platform services can take several shapes and forms. Depending on the ultimate purpose behind the service, different compositions will be suitable. However, the characteristics of interusability depends largely on the composition of the cross-platform service, as it differs between the composition variants. Therefore, research considering one type of composition might not be relevant for another type of composition. This makes it crucial to identify the composition of the cross-platform service at an early stage of exploring interusability for a specific service. In the following sections, different aspects of platform composition will be brought up and explained.

3.2.1 Component organization

Firstly, Denis and Karsenty (2005), Wäljas et al. (2010), Majrashi et al. (2015) and Rowland (2015, chapter 9) recognize three degrees of redundancy. The degree of *redundancy* explains the relationship between the service components in what role is distributed to what platform or device.

The highest degree is (1) *redundant* components, where the components can provide access to all data of the service and functions regardless of what device is being used. The components are supposed to work interchangeably with each other, meaning that the same task can be performed on either of the service components. Today, this is a common service composition as it has become desirable to reach e.g. the same applications from different devices.

For (2) *Complementary* components, the components share some of the data and features between themselves, but at least one component reaches data and functions that the others don't have access to. The components are partially redundant.

The lowest degree of redundancy for the components of a service is (3) *exclusive* components, where all data and functions are completely separated on all devices. The service consists of two or more dissimilar components that are needed to create the intended experience.

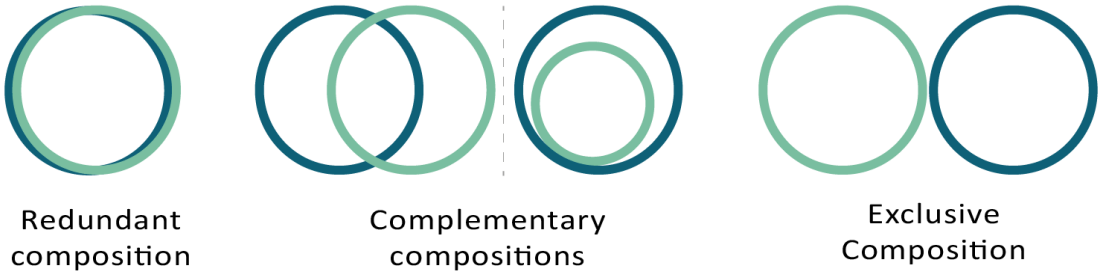


Figure 3.1: A visual representation of the degrees of redundancy of two platforms, inspired by Denis Karsenty (2005)

3.2.2 Synergistic specificity

The degree of device redundancy can be used to identify the *synergistic specificity* of the service, which is described by Wäljas et al. (2010) as "the degree to which a system achieves greater functionality by its components being specific to one another within a specific configuration" (p. 220). This means that high synergistic specificity within a service or system can support functionalities that are more than the sum of its parts, where parts refer to the separate components. According to Wäljas et al. (2010), detaching one or several components from such a system or using one in isolation might have a negative impact, or impair the system or service. They also state that both device redundancy and synergistic specificity are two important concepts that should be considered when evaluating a cross-platform system, since it may explain occurring conflicts when users interact with the system in unintended ways.

3.2.3 Service delivery

Wäljas et al. (2010) describes two types of services that are defined by what they deliver; *Multichanneled* systems can be reached from a range of devices and provide the users with the same features and content regardless of which device is being used. The aim of multichanneling typically responds to the user needing or wanting to access the service at any point. *Crossmedial* systems on the other hand typically have a service extended over several devices or applications to optimize communication and interaction resources for different contextual purposes. The combination of devices and applications constitutes a systematic construction around a specific activity. In other words, the activity is created through multiple task-supporting components that apply to different contexts (Segerståhl, 2009). The platforms of crossmedial systems each have specific features and qualities that should be used to reach the goals of the intended experience (Pasman, 2011).

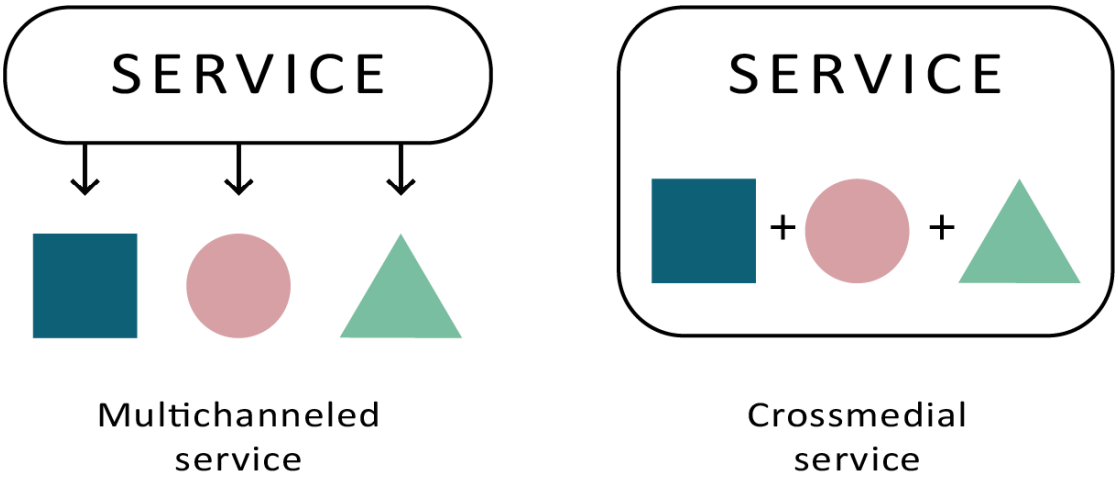


Figure 3.2: A visual representation of service delivery, inspired by Wäljas et al. (2010).

Multichanneled services are typically low in synergistic specificity since there is no need to run them on more than one platform. Crossmedial systems are typically high in synergistic specificity, as the components of the service needs to be used in combination for the user to experience the full service (Segerståhl, 2009)

3.3 Previously identified key aspects of inter-usability

In this section, previous research, conclusions and findings within the cross-platform and interusability field will be presented.

3.3.1 Knowledge continuity and task continuity

Based on theories drawn from cognitive science and an exploratory empirical study of functionalities across multiple devices, Denis and Karsenty (2005) establishes the concept of *service continuity*. When users engage in inter-device transitions, service continuity involves two dimensions; *knowledge continuity* and *task continuity*.

3.3.1.1 Knowledge continuity

Knowledge continuity is based on the user's memory of a previous interaction with one or more devices and the user's ability to retrieve and adapt this knowledge to the current device or platform. Device and platform will henceforth be merged into *components*, as the division is unnecessary for the sake of this report. Denis and Karsenty (2005) writes that the ideal presentation of a service, with regards to knowledge continuity, is to present all components in the same way with access to the same functions and data, i.e. redundant components. However, they also

acknowledge that this might not be realistic or desirable in all cases.

When knowledge continuity falls short, usability difficulties can occur, as it may prevent the user from transferring their understanding of a service from one component to another. To support knowledge continuity, all components of a service need to maintain a consistent visual appearance and terminology, i.e., the surface features of the service components. The user needs enough visual cues in order to determine that two objects are related. Visual appearance may refer to two aspects of the interfaces, *spatial organisation* of information and the *shape* of an interface. If there are differences in where the same information or feature can be located in different components of a service, the user's workload might increase and ultimately lead to the conclusion that it is not available. Furthermore, differences in *shape* between two components of a service might result in the user failing to associate an object with its function. However, some graphical inconsistencies between components might not necessarily be impairing, such as differences in size, colour or orientation. A consistent terminology is also important between components of a service. If objects are labelled differently between components, users might experience difficulties when determining if objects share the same function.

Knowledge continuity also depends on the composition of the service. The user will potentially encounter different challenges depending on the composition. An *exclusive* composition could confuse users by making them believe that they can access all functions on all devices if they are too similar. A *redundant* composition has the opposite challenge, in which they could potentially fail to signal the degree of redundancy if the interfaces are too different. A *complementary* composition may give rise to a mix of the challenges mentioned for exclusive and redundant devices.

3.3.1.2 Task continuity

The other dimension, task continuity, is based on the user's memory of the last interaction with a service, and the user believing that this memory is shared with the system, regardless of which component of the system is being used.

Task continuity is relevant when a user has to switch component in order to complete a task. For the user to be able to maintain task continuity, the system must recover and translate data across the service components within the right context of the activity. When the user's task is interrupted due to a required transition between components, resuming the task can be difficult because data and context must be remembered correctly. The service needs to translate the circumstances from the previous component to the new component in a way that matches the expectations of the user in order to create a seamless transition. Failing to do this might lead to the user having problems with retrieving a representation of the previous task when transitioning between devices. Loss of context is also a hazard when an interruptive transition is being made. The interruption can be short, which is ideal since it might facilitate the recovery of data from the previous context. If the interruption is long, memory loss relevant to the task can occur.

3.3.2 Design principles for Inter-usability

To aid users with knowledge and task continuity when making a transition between components of a service, Denis and Karsenty (2005) developed three main design principles on which inter-usability should be based; *consistency*, *transparency* and *adaptability*.

The notion of *consistency* regards perceptual, lexical, syntactic and semantic consistency between devices, as long as it doesn't interfere with technical or operational constraints.

- *Perceptual consistency* regards the information structure and appearance should be as similar as possible across the service components.
- *Lexical consistency* regards the labelling of objects, which should be similar across the service components.
- *Syntactical consistency* regards the operation of which a goal is accomplished. The same operation should be required in order to attain the same goal for different components of the service.
- *Semantic consistency* regards that the operational effects should be as similar as possible across the components of the service. This also includes synchronization between components, where actions performed on one component should be visible in the other components of the service.

Transparency depends on the user's representation of the system, and is thus a dynamic concept. Transparency regards aiding the user in constructing an accurate representation of the system. In practice, this means that the user needs to immediately be able to create an understanding of all available functions, how they work and how the system will react when using them. This means reusing knowledge and procedures between components in a system, although with caution to the component composition.

- For *redundant* compositions, transparency means that the system must help the user understand that the same data and functions are available, if the appearance of the components differs.
- For *exclusive* compositions, transparency means that the system must help the user understand the different characteristics unique to each component, i.e. the user must create the correct representation of the specifics.
- For *complementary* compositions, the solutions of both types of issues might be suitable, depending on the case.

The transparency of a system might create extra cognitive workload for the user, as it might be required to present extra information about the system properties. Therefore, it is important to take the context of use into account.

This connects with the concept of *adaptability*, where the system's transparency should be dynamic enough to be able to adapt to the user. A user's representation of a system evolves over time with experience (frequency of use), and the system should

adapt accordingly. Novice users will likely need more guidance than expert users, and thus the system should be able to help the different kinds of users on a suitable level. Adaptability might also mean that the system helps the user contextualize the situation brought on by previous actions.

3.3.3 Composition, continuity, consistency

Based on qualitative data collection from users interacting with multichanneled cross- platform services, and inspired by Denis and Karsenty (2005) amongst others, Wäljas et al. (2010) conceptualized a framework of cross-platform user experience (interusability) with three main designable characteristics; *composition*, *continuity* and *consistency*. According to Wäljas et al. (2010) the three main themes represent important characteristics that influence user experience for cross-platform services.

3.3.3.1 Composition

Composition regards how the users perceive the different system components, i.e. its functionalities and purpose. To help the user understand the distribution of roles within the system, a clear structure of roles is needed. The first aspect of composition is *component* role allocation, which refers to how the purpose of each system component is communicated and perceived by the user. It is for instance possible to distribute isolated functions to specific components for a specific purpose. The allocation of roles can be defined in two ways; *task-based allocation* and *situation based allocation*. Tasked-based allocation is when a certain platform is used for a certain task, and situation-based allocation is when a certain device is used for the same task but in different situations. Designers need to understand how users allocate roles between functionalities in this kind of way to be able to provide the right kind of functionality to the right platforms.

Since some tasks primarily might be performed on one platform, there might not be a need to implement it on all platforms. Therefore, a distribution of functionality and content based on the platform's respective strengths might be an advantageous solution. However, there is a risk that the distribution of system components does not match the user's expectations. Thus, there should be some functional modularity, that is, a degree of adaptability between the platforms to not limit the user. With a convenient component role allocation and distributed functionality, the experienced complexity of one device might decrease and simplicity increase.

3.3.3.2 Continuity

Continuity regards how the system supports *cross-platform transitions*, *task mitigation* and *synchronization*. A *cross-platform transition* is described as a transfer between platforms resulting from an interaction of the user. These points of interaction between devices and platforms (we will call them transition points) need to be made clear to the user in order for them to understand the transition. *Task mitigation* is important for users to be able to continue a task on another device. Here, Wäljas et al. (2010) note that consideration needs to be done to whether

the system delivery is *crossmedial* or *multichanneled*. In crossmedial systems there must be support for a logical chain for the task to be carried out. In multichanneled systems, the system must be able to pick up the task on one device where the user left off on another device. Here, *synchronization* of actions, data and content of the system components is key. When users transition from one platform to another during the execution of a task, they generally expect that the system will support the transition and that it will be reflected in the current platform.

3.3.3.3 Consistency

Consistency regards using similar look and feel, semantic terminology and navigation scheme on every platform to enhance a perceived system coherence. Semantic consistency is achieved by usage of the same terminology and symbols across all devices and platforms. Similar navigation schemes on all platforms will help the user to perceive them as logical. Consistency between devices will help the user to make connections and learn how to use them faster. The major goal when designing cross-platform services is to gain consistency in the overall system that supports a coherent user experience.

3.3.4 Recommendations for cross-platform services

In her PhD, Segerståhl (2011) identified composition as a "designable characteristic of cross-platform systems constituted by structure of roles, distribution of functionality and content and functional modularity" (p. 3). Her studies include the previously mentioned article by Wäljas et al. (2010), amongst others, although her PhD focuses on crossmedial (or transmedial) design rather than multichanneled systems. From the results of the studies Segerståhl identified and proposed five general design guidelines for effective composition. With these principles, Segerståhl wants designers to understand systems as a temporal phenomena and that the system components need to support the changes of human activity, fluidity, temporality, and situatedness.

Identify a structure of roles. By starting with identifying already existing or potential roles of the different components in a service system may help to reveal opportunities for the next design guideline; allocating functionality complementairly. These structures may be identified by analysing in which situations (physical, social and temporal) each device has opportunities or constraints, as well as analysing the subjective meanings that users may assign to the devices.

Allocate functionality complementarily. Instead of providing the same functionalities with different interfaces between components, focus on contextualizing the different use cases of each individual component. Provide functionality optimized for the specific component to complement for a bigger variety of use cases, instead of adding complexity to all components. By allocating functionalities complementary complexity might be reduced on the individual devices and issues on one platform might be reduced with support from another.

Employ components as layers. Alternatively, or in addition to being complementary in functionalities, different components could also serve varying degrees of support. One component might offer a basic set of functionalities, while others add on complementary with more and more advanced features. This layered architecture will benefit a wide variety of contexts and users, from beginners to intermediates to experts.

Cut-down unnecessary redundancy. By allocating functionalities across components users might more easily perceive the different strengths of each component, i.e. help users understand the system image. Furthermore, a functionality that does not suit the available input techniques of a device need not be crammed in.

Maintain functional modularity. Components in a system should not have a too high degree of synergistic specificity, this is to avoid that the components become useful only when used in combination and not alone. A device should be able to be used on its own, even though it works best in concert with all components of the system. Therefore, some core functions are recommended to be incorporated on all components. This is also important to be able to support the layered architecture as principle 3 mentions.

3.3.5 Measuring interusability

Denis and Karsety (2005), Wäljas et al. (2010) and many other researchers within the cross-platform field offer guidance when designing and heuristically evaluating interusability of cross-platforms. They do not, however, offer any guidance to subjectively or objectively measure the interusability in cross-platforms with users. Majrashi and Hamilton (2015) set out to change this by developing a user-based cross-platform usability measurement model (CPUM). They based their model on their definition of cross-platform usability, which in its turn was based on reviews of usability attributes such as those previously mentioned and by identifying characteristics of multiple interactive systems. The definition that guided them to develop the CPUM model states as follows:

> The extent to which services cross-platform can be used by specified users to achieve specified horizontal goals from different contexts of use with acceptable level of several measurable factors including efficiency, effectiveness, learnability, memorability, productivity, accessibility, understandability, satisfaction, universality, helpfulness, safety, and visibility. (p. 6)

The CPUM model has since been developed to incorporate horizontal tasks (tasks that transition users between devices), a combination of the data collecting techniques; observation, think-aloud and questionnaires and the utilisation of cross-platform usability metrics (Majrashi, 2016). A study by Majrashi et al. (2020) was conducted to evaluate the viability and performance of the CPUM model. This was done by applying the model in an evaluation of three different multichanneled cross-platform services across three devices. The results show that the model was

valuable and successful in finding and quantifying cross-platform usability. All three data collection techniques (think-aloud, observation and questionnaire) were valuable, although the think-aloud technique uncovered the most cross-platform usability issues. One of the most important strengths of this model was the combination of the three techniques since they allow both objective and subjective measurements for seamless transition. The CPUS also proved to generate data about the interusability of a cross-platform service, making this a suitable tool for studies regarding cross-platform user experience.

3.4 Conceptual models and mental models

In his book *The Design of Everyday Things*, Don Norman (2013) establishes the *conceptual model* of the system as one of the seven fundamental principles of interaction. A conceptual model is a simplified explanation of how something, e.g. a system, works, i.e. it doesn't have to match the technical reality of the system. The main requirement is that the conceptual model is useful. A system doesn't have one conceptual model, it differs depending on e.g. who the user is, the user's relationship to the system and the user's previous knowledge. Conceptual models can be described in the manual of a product to help the user understand it, but what is ultimately of interest for the designer is the *mental model* that the user is able to create of the product.

Mental models are conceptual models formed inside the mind of a user, and it corresponds to their understanding of how something works. This means that the mental model can differ and vary substantially between different users, depending on their experience with a system. Users can also construct multiple mental models for the same product, and they can potentially conflict with each other. How a user constructs a mental model can vary. Manuals are one source, but it is usually the interaction with the product that generates the model. The user gathers available information in order to create a mental model. This available information is referred to as system image by Norman (2013), and is usually based on aspects such as the perceived structure of the system, the look-and feel of the system, the previous knowledge of the user, instructions etc. The system image needs to provide the user with all information and clues they need to be able to construct a functioning mental model, and in extension, be able to understand and use the system correctly and as intended by the designer.

The notion of conceptual models has a strong and important connection to interusability. Each isolated component of a cross-platform service must provide the user with a rich and functional system image to enable accurate constructions of individual conceptual models, i.e. vertical usability. However, to only consider vertical usability of the isolated components is not enough for a cross-platform service (Rowland, 2015, chapter 9). The user must be able to construct a conceptual model of the system as a whole, i.e., the presented system image of a cross-platform service must take the composition of the service components into account. *Composition* is identified as a key dimension by several authors (Rowland, 2015, chapter 9; Denis &

Karsenty, 2005; Wäljas et. al 2010; Majrashi & Hamilton, 2015), and slightly different approaches to the concept is discussed above. Composition is tied to the distribution of functionalities across the components of the cross-platform service, which essentially regards what platform does what (Rowland, 2015, chapter 9). Therefore, it is crucial for the users to understand what platform does what in order to create a correct mental model which they can understand and use the platforms effectively.

According to Rowland (2015, chapter 9), forming a conceptual model of a cross-platform service is substantially more complex due to more interfaces involved, which means data distributed over a large area, and because there are more connections and transition points. Essentially, there are more places in the system where things potentially could go wrong. How to distribute data and functions across a cross-platform service is not an issue with one solution, it depends on what the users expect of the system as well as what context the components will be used. Ultimately, a good composition should make use of the strengths of each component.

3.5 Summary

Interusability can be defined as usability that transcends across the components of a cross-platform service. Generally, interusability is a fragmented research field without long-established design principles or guidelines of how to design to achieve "good" interusability. However, a few attempts have been made over the last 20 years to outline the most important characteristics and dimensions of interusability and how to design for them. As cross-platform services can take many forms and shapes, it is very difficult or impossible to develop a comprehensive set of guidelines of how to design for interusability. Instead, usability theory has to be broken down into the different configurations and compositions that cross-platform services can appear in and develop theories within the different instances of the cross-platform domain.

4
Methodology

In this chapter, relevant methods will be discussed as well as the design approach for this project. The methods described in this chapter corresponds to the stages of the design thinking process as described in section 4.1.1. Note that the methods do not strictly need to occur within the stage it is put in.

4.1 Design process

In this section, a design process and a method to be used for qualitative and exploratory purposes within the design process will be presented.

4.1.1 Design thinking

As this project seeks the answer to a wicked problem in an explorative study, the *Design Thinking* process (figure 4.1) was deemed useful as a point of origin. According to Friis Dam and Siang (2021), design thinking has the necessary tools to solve problems of a complex nature, with understanding human needs at its core. The five stages of Design thinking are *empathize, define, ideate, prototype* and *test*. The initial stage of the Design thinking process, *emphasize*, is where a vast array of information is gathered regarding the problem in question. The information is often gathered by conducting different kinds of user research, since a central aspect is the empathetic understanding of the issue at hand. The objective point of view is very important to maintain because the problem should not be coloured by the researchers own ideas and presumptions. The insights and understandings of the first stage are then used in the second stage, *define*. The accumulated insights and knowledge must be analysed and synthesised in order to define identified problems, key features and functions. During the *ideate* stage, everything gathered is used to generate ideas that will solve the defined problem(s). Typically, several ideation techniques are used to facilitate thinking ”outside the box”. The many ideas generated during the ideation stage are then picked to be included when *prototyping*. Ideas are evaluated and evolved many times over by rigorously *testing* them, which is counted as the fifth stage of the design thinking process.

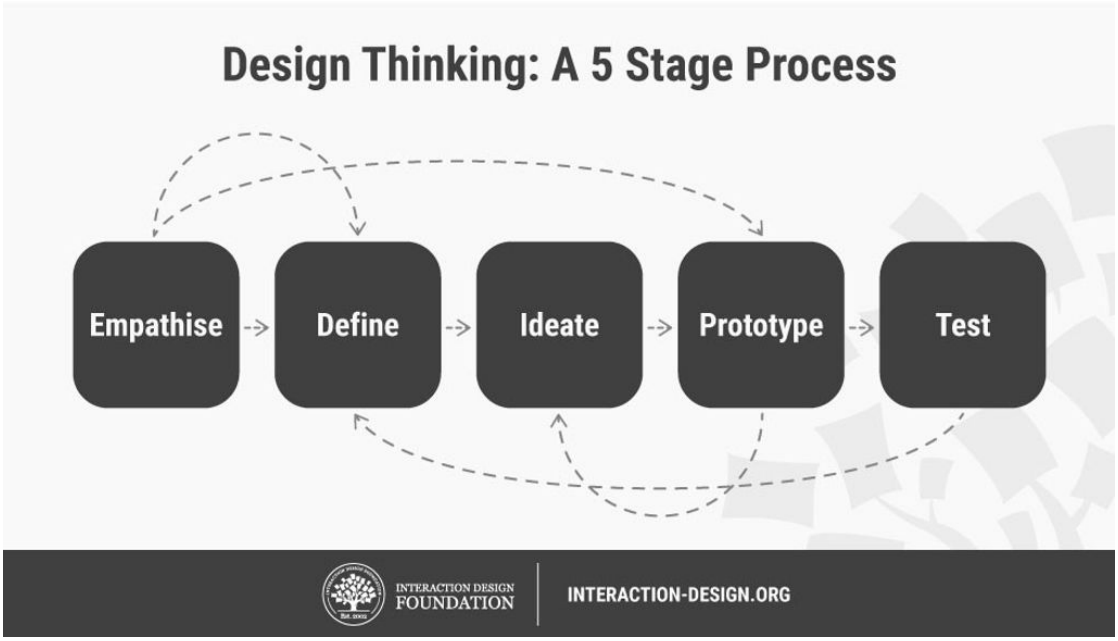


Figure 4.1: An Image Visualizing the 5 Stages of the Design Thinking Process (Friis Dam and Siang, 2021).

4.1.2 Case study

A case study is a traditional design method to be used for qualitative and exploratory purposes within the design process. It is a strategy for in-depth investigation of a single instance, or case, through several research methods and techniques (Martin & Hanington, 2012). Simultaneously, a case study will try to keep an overarching understanding of a complex problem so that the theoretical findings can be applied to similar environments (Wadsworth, 2011). Case studies are useful for comparisons, information-gathering, inspiration and study the effect of change etc. However, a case should and could not be used to support or reject a hypothesis, since a single case cannot verify the validity or reliability representativeness of different instances (e.g., the case or participants in the study). Rather, case studies are used to shed light upon theories (Martin & Hanington, 2012).

Using case studies is a common method in the cross-platform interaction field to investigate the interusability. In their study Wäljas et al. (2010) conducted in-depth field studies on three web-based services with cross-platform characteristics, facebook, Dopplr and Nokia Sports Tracker. The research methods they included were interviews and diaries for qualitative data and questionnaires for quantitative data. Segerståhl (2009) conducted a qualitative multiple case field study over a period of three months to investigate users using the crossmedial Polar fitness system. This was done using group interviews, diaries, questionnaires, and observations. When evaluating the cross-platform usability measurement (CPUM) model Majrashi et al. (2020) applied the model on three different cross-platform services as cases to study the effect. These were Real Estate (www.realestate.com.au), Trip Advisor (www.tripadvisor.com), and TED (www.ted.com). This model was evolved to be used on single use case studies at a time.

4.2 Methods for understanding

In this section we present methods suitable for the stages of empathise, evaluation and testing.

4.2.1 Literature review

Literature review is a traditional and explorative method used in both design processes and in research to collect and synthesize secondary data on a given topic. The method is used to extract relevant findings from already published sources and draw connections between references while still maintaining focus on the subject at hand. A literature review may be a freestanding paper, but could as well be a part of a larger research paper or project (Martin & Hanington, 2012). Conducting a literature review in the beginning could be useful for understanding the current state of art theories regarding the cross-platform and interusability field.

4.2.2 Usability testing

Usability testing is a traditional evaluative method used to gather both qualitative and quantitative data about the usability of a product (Martin & Hanington, 2012). The tests are designed around one or several goal-driven tasks to be conducted by the target user. The tasks should reflect the actual use of an interface and can be open or very specific depending on what research question is to be answered (Moran, 2019). Scenarios help the participant to contextualize the tasks and bring information necessary to conduct the task. The tasks should be objective to not influence the participant in how to solve the task. The usability tests are often accompanied with a think-aloud protocol. The aim of the method is to help teams to identify parts of the interface that confuses or frustrates the users so that these parts can be prioritized and fixed. Using this method could provide useful information about flaws in the interusability of the service, provided that the method is tweaked to fit the interusability context (Martin & Hanington, 2012).

4.2.3 Concurrent Think-aloud protocol (CTA)

Concurrent Think-aloud (CTA) protocol is a traditional evaluative usability method that has the participants verbalize what they are thinking, doing and feeling while completing a task (Martin & Hanington, 2012). This is compared to the Retrospective Think-aloud protocol technique where the participants complete their task in silence and afterwards comments on their process in completing the task, which leaves the participant a chance to complete the task with an uninterrupted flow, however with the risk of forgetting steps taken. The aim for the think-aloud method is to understand what the user finds pleasing, confusing or frustrating with an interface. To do this it is important that the session evaluates smaller parts of a product, rather than the usability of the entire product. According to Majrashi et al. (2020) recent findings show that CTA detects a high number of usability problems in usability tests, and a study of their own supports this claim regarding the interusability context.

4.2.4 Observation

Observation is a traditional qualitative exploratory method of systematically recording phenomena. The facilitators might have a guiding protocol or observe freely with an open mind (Martin & Hanington, 2012). In early stages of the design process observation may be useful for designers to understand user's context, tasks and goals. In later stages of the design process observation can be useful to evaluate how well a product supports the users tasks and goals. A shortcoming of observations is that the facilitators do not know what the participants are thinking. Therefore, if the participants are being observed in a controlled environment, the think-aloud technique is a useful tool to overcome this obstacle (Sharp et al., 2019).

4.2.5 Interview

Interview is an explorative, generative and evaluative method with which it is possible to collect self-reporting, first hand qualitative data from participants. Interviews may be unstructured, semi-structured or structured. The structure of the interview may be chosen depending on how much control the facilitators want to keep over the conversation. Unstructured interviews have the option of exploring a topic into a considerably more depth than structured interviews, although they might be more time consuming to conduct and more challenging to analyze than a structured interview that strictly follows premeditated questions (Martin & Hanington, 2012; Sharp et al., 2019).

4.2.6 Questionnaires

Questionnaires are a traditional exploratory and evaluative self-reporting method used to collect qualitative and quantitative data about people, for example their demographics, feelings, or attitudes. Although questionnaires are an appropriate tool to use in isolation, they are more commonly used together with other methods, for instance observations. Questionnaires can complement observations with self-reported

insights that may otherwise be lost (Martin & Hanington, 2012). Questionnaires can be very similar to structured interviews, but questionnaires are possible to electronically send to a larger number of people. This will enable fast collection of more data in comparison with how much an interviewer can collect during the same time. A weakness with this however is that if the respondent has any questions a facilitator might not be there to answer them (Sharp et al., 2019).

4.2.7 Cross-Platform Usability Measurement Model

The Cross-Platform Usability Measurement (CPUM) Model enables identification and qualification of cross-platform services usability (interusability) issues. The CPUM model is a systematic set of methods used to collect data. This model incorporates: horizontal tasks, questionnaires, CTA (concurrent think-aloud), observation, STS (seamless transition scale) and CPUS (cross-platform usability scale). The CPUM model method can help collect qualitative *formative* data that can be used to identify and fix interusability problems and their causes in cross-platform services. It can also help collect quantitative *summative* data to assess the improvements (or deterioration) of a new design (Majrashi et al., 2020).

The CPUM model addresses the five usability attributes: *efficiency, effectiveness, satisfaction, productivity* and *continuity*. The three first attributes (efficiency, effectiveness and satisfaction) are three traditional usability attributes and all these five are the only remaining attributes from Majrashi and Hamilton's definition mentioned in chapter 3. Theory, section 3.4. Efficiency is measured through user's execution time and action count when conducting the horizontal tasks. Effectiveness is measured through task completion rate and error count. Satisfaction is measured using the scores from the CPUS. The productivity attribute was added to address the user's productivity when attempting to reach a goal using several components and is measured through unproductive periods. Continuity was added since it is one of the most pertinent attributes within cross-platform usability and is measured through task resuming success, the time taken to resume a task, and the score from the STS. With the mix of methods within this model there will be a mix of observational (observation and the parameters in table 4.1) and subjective (CTA, STS and CPUS) data (Majrashi, 2017; Majrashi, et al. 2020). See table 4.1. This method is one of few tailored and evaluated methods for an interusability context and might therefore be a suitable option for the current project.

Table 4.1: UT1: Metric Means for all Participants per Transition and Total Mean for all Transitions by Majrashi et al. (2020)

Metric	Parameter	Settings
Efficiency	Execution time	The time spent executing a HT.
	Actions	The total number of steps required to complete a HT.
Effectiveness	Task completion	The successful completion of a HT.
	Errors	The total number of errors when progressing towards a HT goal.
Satisfaction	Satisfaction	The score produced by the CPUS.
Productivity	Unproductive period	The time spent seeking help or recovery from errors when progressing towards a HT goal.
Continuity	Task resuming success	The successful continuation of an interpreted task after switching devices.
	Resuming time	The The time a user needs to resume an interrupted task after transition.
	Transition	The score produced by the TS

4.2.8 Wizard of Oz

The Wizard of Oz technique is a traditional generative and evaluative method used to collect qualitative and quantitative data about users' behaviour. It is a technique where the facilitators (i.e. the wizard) simulate the intended responses of a system when a user interacts with a prototype. The users are thus led to believe that they are interacting with a fully working prototype. The goal with this method is to have the user interact with a lower fidelity prototype and report its experience while facilitators observe the interaction before a more advanced prototype is built. It is a good method to be used in an iterative design process that can guide the designers in the earlier formative stages as well as measure and conclude in the later summative stages of the design process (Martin & Hanington, 2012).

4.2.9 RITE

The RITE (Rapid Iterative Testing and Evaluation) method is a formative quasi-empirical evaluation method with the key feature of being "quick and dirty". Usability tests are conducted without following strict protocols, issues are identified, and changes are implemented immediately. No reports are written as the updated prototype will be the new guiding direction. RITE can be implemented as soon as

a low-fidelity prototype is in place and as many times as needed. As long as there is a change following the method, the tests can continue (Martin & Hanington, 2012; Hartson & Pyla, 2012).

4.3 Analysis methods

In this section, two methods for analysing qualitative data will be presented.

4.3.1 Affinity diagram

Affinity diagram is an adapted qualitative technique used to generate and extract meaningful clusters of insights from observations, interviews and other data generating methods. It is used to explore the data, identify themes, write them down individually - often on sticky notes - and look for an overall narrative. Hartson and Pyla (2012) call their notes "activity notes" and point out the importance of tagging the notes with a source ID to be able to track the notes and see patterns. Any common issues and problems of the interface will emerge and can be categorized into themes (Martin & Hanington, 2012; Hartson & Pyla, 2012).

4.3.2 Content analysis

Similarly to the affinity diagramming technique, content analysis is used to analyse qualitative data (written, spoken or visual material) and sort it into themes and patterns. However, the content analysis will summarize these themes by occurrence and supply them with words, phrases, images or concepts to represent the theme, depending on the data. An affinity diagram is a good starting point for this method (Martin & Hanington, 2012).

4.4 Ideation methods

In this section, methods suitable for the ideation stage will be described.

4.4.1 Stakeholder meeting

UX meetings is a way of sharing information and updates between team members or stakeholders. Compared to workshops, meetings cover many topics more shallowly during a shorter period of time. The meetings should be prepared and structured to be as efficient as possible (Kaplan, 2020). By conducting meetings with stakeholders, goals can be aligned and a design vision could be set before development begins (Farrell, 2017).

4.4.2 Workshops

UX workshops are an innovative participatory method used to generate qualitative findings to explore, generate or evaluate something during the design process (Martin

& Hanington, 2012). It is a way of reaching a solution, consensus or an actionable goal. Compared to meetings, the scope is often more limited but with a deeper focus during a longer period of time. Workshops are often more structured than meetings, typically demanding more active participation, where brainstorming of ideas and solutions and sometimes creating quick artifact creations are common activities (Kaplan, 2020). There can be many different scenarios where workshops come in handy. Kaplan (2020) lists five different kinds of workshops: discovery workshops, empathy workshops, design workshops, prioritization workshops and critique workshops.

4.4.3 Brainstorming

Brainstorming is a popular method which design teams use during the ideation stage to generate new ideas to solve prior defined problems. The method is best used in controlled although free-thinking environments with at least one facilitator to keep track of things. By using "How might we" questions, the goal is to generate a considerable number of ideas or concepts without judgement and with a quantity over quality mindset. Eventually the team will draw connections between all these to land in a conclusion (Interaction Design Foundation, n.d.; Martin & Hanington, 2012).

4.4.4 Sketching

In design, sketching is a rapid exploratory method used to generate and express ideas with more focus on concepts and less on detail. It is described as the visual representation of brainstorming and discussion. Designers use sketching as a way of embodying their cognition, as an extension of their cognition to boost their creativity, as a way of communicating with other team members and as a history of their thinking (Hartson & Pyla, 2012).

4.5 Prototyping methods

According to Sharp et al. (2019) Prototyping is a method for communicating ideas and opinions between designers, stakeholders and to users. It is a realisation of an idea that can be interacted and explored with as well as evaluated. A prototype can take many forms, all from a paper and pen storyboarding to a more sophisticated piece of software. They all have the common goal of being evaluated in a cheaper form before being turned into an actual product. Prototypes are generally talked about in low-fidelity prototypes and high-fidelity prototypes. A low-fidelity prototype is used in the beginning of a design process to communicate early ideas. They are often very cheap to create and do not particularly look like the final product nor provide any of its functionalities, i.e. sketches and wireframing. Their aim is to be easily criticized and changed and are not meant to be kept until the final design. High-fidelity prototypes are more similar to the final design and often provide its functionalities. It is common to use different kinds of software to create these prototypes.

4.5.1 Wireframes

Wireframing is a quick low-fidelity prototyping tool used to be able to explore high-level concepts, layout, behaviour and sometimes the look and feel of a product. Wireframes consist of lines and outlines of boxes and other shapes constructing a web page, screen content and navigation flow. They are supposed to be simple to promote feedback. A higher fidelity prototype might send the message that the prototype is not open for constructive criticism (Hartson & Pyla, 2012).

5
Planning

In this chapter, the planned process of the project will be described. The planned time schedule will also be presented.

5.1 Design thinking modification

The design process we are planning to use is a slightly modified version of the design thinking process described in chapter 4. Due to the evaluative and explorative nature of the project, the plan is to add an extra stage, "evaluation". We plan to move iteratively between the first five stages of the design thinking process. However, as the design results derived from the first five stages will be evaluated against the original design, we thought it appropriate to assign that evaluation activity to its own stage. Our planned design process is represented in figure 5.1 and the methods we are planning to use for each stage can be seen in table 5.1.

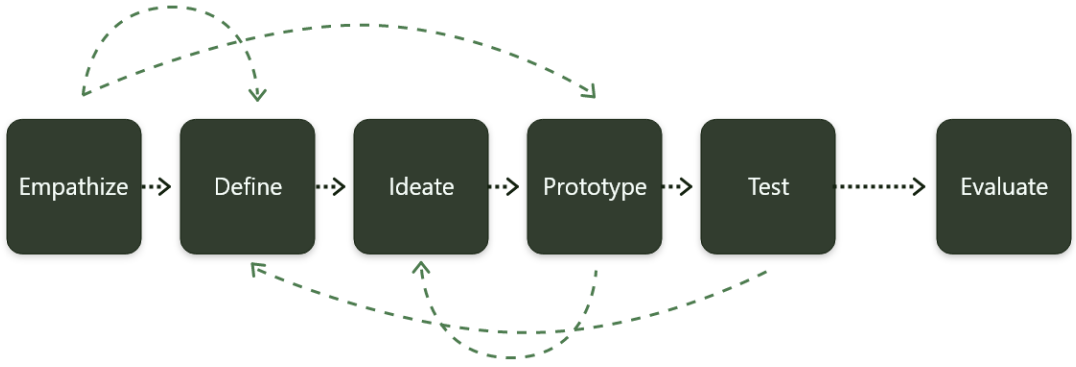


Figure 5.1: A model representing the design process inspired by Design Thinking (Friis Dam and Siam, 2021).

5.2 Time plan and chosen methods

Please observe that the time plan in table 5.1 is written with the week of the project outside the parentheses, and calendar week inside the parentheses. Also note that all described stage intervals are not strictly chronological, some of these stages will

overlap. And finally note that when we planned our time line we had not been given deadlines for the submission of the report for presentation, opposition week or when to submit the final report.

Table 5.1: A table showing the outlined time plan for our project, including design stages and chosen methods

Week	**Stage and process**
Week 1-5 (3-7)	Empathize • Study the relevant literature and write literature review. • Plan evaluations/surveys: what kind of data do we need and methods to use to acquire it. • Write and submit planning report week 4 (6). • Conduct stakeholder meetings. • Conduct CPUM (usability testing) – Questionnaire (dem.) – CTA – Observation (HT) – STS – CPUS – User interview (short after CPUM)
Week 5-7 (8-9)	Define • Transcribe interviews. • Analyze the gathered data with affinity diagram and content analysis. • Evaluate and summarize.
Week 7 (9)	Ideation • Reconciliations with stakeholder, feedback from A-hus. A chance for A-hus to look at our findings and give feedback on future designs. • Workshop with peers. • Brainstorming, sketching.
Week 8-11 (10-13)	Prototype and testing • Create wireframes and design solutions. • RITE, quick usability tests to evaluate and refine design choices.

Week 12-15 (14-17)	Evaluation • Conduct CPUM (usability testing) on wireframes – Questionnaire (dem.) – CTA – Observation (HT) – STS – CPUS – User interview (short after CPUM) • User interview (short after CPUM)Transcribe interviews. • Analyze the gathered data with affinity diagram and content analysis • Evaluate and summarize.
Week 16-19 (18-21)	Full time report writing and preparation for the presentation and opposition week.

5.3 Deviation from the planned design process

Some deviations from the planned design process and time plan occurred during the course of this project. The empathize stage took about two weeks longer than planned since both writing the planning report and creating the usability testing was more time consuming than expected. This shifted the entire time plan, resulting in less time in the prototyping stage and the evaluation stage. Furthermore, the final deadline and presentation week was put one week earlier than planned resulting in one less week of report writing.

Since the data analysis made with the affinity diagram gave us the material we needed to continue our project, the content analysis did not seem necessary to conduct due to it being a very similar method. Furthermore, since the platforms of A-hus were easy enough to replicate as interactive prototypes, we did not need to create wireframes, but could ideate directly onto the replicated platforms, resulting in hi-fi prototypes after some iteration.

6
Process

This chapter will describe the process of this project divided into the stages of the design thinking process. The stages do not correspond to the chronological order of the process but are described as such to be able to explain the uses and the outcomes of the chosen methods.

6.1 Empathise

This section will describe the steps taken to empathise the project at hand. This was done by conducting a literature review (section 6.1.1), analysing, and understanding A-hus's digital platforms according to the literature and in relation to interusability (section 6.1.2) and by preparing (section 6.1.3), and conducting a usability study of the platforms (section 6.1.4).

6.1.1 Literature Review

To gather relevant background knowledge, this project was initiated by studying the current state of the art within the cross-platform service and interusability field. This resulted in a literature review that allowed us to create a comprehensive understanding of the subject at hand. The major learnings of this literature review can be read in chapter 3, where the design principles, heuristics and metrics that were deemed relevant to the study are summarized.

6.1.2 Understanding A-hus's digital platforms

A steppingstone of this project was to analyse and outline A-hus's cross-platform service in order to understand the nature of the original interusability formed by the platforms, and also to be able to tailor the usability tests to fit the context. This includes previously identified key aspects of interusability and the transition points of the three platforms. A-hus' service is supported by their three platforms: A-hus.se (informational website), Husbyggaren (web application) and Husvisaren (smartphone/tablet application). The components of the service, i.e. the platforms, are organized as complementary components, where the platforms all share certain information, but also have information and functions that are exclusively held. What the platforms have in common is a selection of house models that A-hus offers to its customers. On A-hus.se it is possible to gather an extensive amount of information regarding the house model, on Husbyggaren it is possible to customize the house

model, and in Husvisaren it is possible to view the house model in an augmented reality view. Most of the information on each platform beyond this commonality is exclusive to each platform, with some exceptions.

For the sake of the creation of the usability tests, the natural connections between the platforms of the cross-platform service had to be outlined on each platform. These connections will in this thesis be referred to as "transition points". The platforms each contain a number of transition points important to the user's movements between the platforms. The transition points are primarily links which lead the user to another platform within the cross-platform service but may also be information about another platform. On A-hus.se, several transition points lead to Husbyggaren. They are primarily links with the label "Bygg Online". As Husvisaren is a phone/tablet application, the transition point from A-hus.se will be counted as the page which contains information about Husvisaren. From Husbyggaren, one transition point which leads to A-hus.se can be found on its main page. On the main page, information about Husvisaren is also located as well, which is counted as a transition point. From Husvisaren, A-hus.se can be reached through a link in the hamburger menu. Husbyggaren can be reached through two transition points, one is a link in the hamburger menu, and the other is a curtain that drops when clicked on within each house specific page.

Regarding the knowledge continuity between the three platforms, there is some knowledge continuity beyond the commonality of them all having information about the house models. For instance, they all have a similar graphic design e.g. the same color scheme and flat design, there is also some information about each platform on the respective platforms. However, regarding the task continuity, there is practically none. This is not surprising since the platform does not share any of the same functions that require data synchronization as a result of the user interacting with the platforms. The most prominent task continuation on the platforms are the transition points directing the user between the platforms, specifically those that direct the user directly between the same house model.

The synergistic specificity of the service is relative. When entering the process of building a house, using the platforms in consort might facilitate the rather difficult and complex process of deciding on what house they want, and its ultimate appearance. In this sense, the platforms form a united service which might achieve facilitating conditions for the user. Therefore, it can be said that the service is more than the sum of its parts, which points to high synergistic specificity. However, both A-hus.se and Husbyggaren are required to be used in the process, but the customer is never obliged to use Husvisaren. Therefore, it can also be argued that the service is low in synergistic specificity, as the process in practice only relies on two of the components.

The service delivery of A-hus is considered to be crossmedial, since their service extends through their three platforms. The different platforms have separate contextual purposes and functions, which supports the primary activity of the user.

The platforms are meant to work as a complement to each other in one common process and aid the user's end goal, which is to build a new home to live in. Again, it is in practice possible to build a house with A-hus by only using A-hus.se and Husbyggaren. Husvisaren is an optional, but arguably very valuable component which the service does not rely on. It depends on whether the service the customer wants is the full, intended service created by A-hus or not.

Another aspect worth taking into consideration is the order of which the platforms were created. As mentioned in the theory section 3.1.2, creating a system where one platform is treated as the "original" and the subsequent ones created to fit the first one, it can result in creating a fragmented experience. Reportedly, A-hus's three platforms have been designed separately, where A-hus.se preceded the other two. The second one to be launched was Husbyggaren and the last one was Husvisaren. According to A-hus, Husbyggaren and Husvisaren are additions to the initial platform, A-hus.se, and are designed to fit on top of it. This might be a contributing factor to the reported issues experienced with A-hus's service, the components of the service are not designed holistically in order to work in a flowing system.

6.1.3 Preparation of usability testing

The setup of the usability test of the platforms was partly inspired by the CPUM model. We chose to structure the usability test similarly to the CPUM model since we were concerned that a "regular" usability test setup would not cover the interusability of the platforms. However, since the CPUM model was created to fit multichannel systems and not crossmedial systems, slight adjustments were needed. In order to prepare the usability testing we held a stakeholder meeting (section 6.1.3.1), constructed tasks for the participants to conduct (section 6.1.3.2), prepared questionnaires (section 6.1.3.3) and an interview (section 6.1.3.4) and outlined what participants should be considered for the usability tests (section 6.1.3.5).

6.1.3.1 Stakeholder meetings

The stakeholder meetings were held with the aim to gather knowledge about A-hus's experienced issues, contextual knowledge of the industry and each platform, mapping of potential target groups, and discussions about potential tasks to be used in the usability testing sessions. The results of the stakeholder meetings are presented in section 2.1, section 6.1.3.2, and section 6.1.3.5. Furthermore, the stakeholders present at the meeting were able to input their expert knowledge of the MHM context into the creation of the tasks, which was taken into consideration when the tasks were developed and established.

6.1.3.2 Tasks

To be able to analyse the interusability of the platforms, the usability test was created which revolved around a set of six goal driven tasks that force the participant to transition between the platforms, without explicitly revealing that they should

change platform. To be able to analyse all possible orders of transitioning between the three platforms six horizontal tasks were created, see table 6.1.

Table 6.1: A Table Showing the Tasks and its Related Transitions

Platform	Transition	Task
A-hus.se	None	Hitta Villa Anneberg och leta upp "Husunika fördelar" under rubriken "Fakta" *Find Villa Anneberg and find "Unique house benefits" under the rubric "Facts"*
Husbyggaren	AB	Måla Villa Annebergs fasad röd *Paint the facade of Villa Anneberg red*
Husvisaren	BC	Titta på Villa Anneberg genom AR-funktionen "Se på skärmen" *Look at Villa Anneberg through the AR-function "See on screen"*
A-hus.se	CA	Hitta Villa Ekbacken och leta upp planlösningarna för "Tillval" *Find Villa Ekbacken and find the floor plan for "Additions"*
Husvisaren	AC	Titta på Villa Ekbacken genom AR-funktionen "Se på skärmen" *Look at Villa Ekbacken through the AR-function "See on screen"*
Husbyggaren	CB	Måla Villa Ekbackens vindskivor och foder svarta *Paint the windshield and lining black of Villa Ekbacken black*
A-hus.se	BA	Vilken adress kan man gå på visning för Villa Kobbskär? *What address is it possible to go on a tour for Villa Kobbskär?*

Note. A = A-hus.se, B = Husbyggaren and C = Husvisaren. I.e. Transition AB corresponds to a task beginning at A-hus.se and ending at Husbyggaren.

Since A-hus's three digital platforms form a crossmedial, complementary service, each of these tasks can only be concluded on one of the platforms. The tasks are thus arranged to be initiated on one platform which the participant cannot conclude the task on, see figure 6.2 for illustration. The participant must therefore transition

to another platform, and it will be up to the user to figure out which one, and how. Given the complementary nature of these platforms, there ought to be priming, nudges or cues that there are more platforms with other functionalities to be explored. If the participant is trying to find a function not available on the platform they are currently on, there should be cues enough for the user to understand this. Thus, how the participants complete these tasks will then be the foundation to the interusability analysis.

Instead of providing the user with a made-up scenario beforehand, the tasks are arranged with a red thread to rely on each other to build a context. Every task has the common denominator that they all concern house models to keep the goal of the platforms that they should inform A-hus's target customers about their products. This way the hope is to retain some level of ecological validity even though the tests are conducted in a controlled environment.

To balance training effects and participant fatigue amongst the tasks there are two orders in which the participants are conducting the tasks, see figure 6.2. Slight modification of the phrasing of the tasks related to transition None and CA was needed to keep a similar red thread between the two orders. The modification regarded which house they were tasked to interact with, see appendix D for exact phrasing. The starting platform is always A-hus.se though, since the statistics provided by A-hus show that that is the most visited platform by far and thus we conclude that very few find Husbyggaren or Husvisaren without having visited the website before. The first task is therefore an opportunity for the participant to become familiar with A-hus as a company on A-hus.se without having to transition to another platform. The following tasks start where the participant completed the previous task.

6.1.3.3 Questionnaires

This study includes three questionnaires. One questionnaire is a *pre-test* to collect demographics, this is so that we can make sure that the participant in fact is part of the target group we seek. We will also take into consideration the participants' level of expertise of interacting with several units simultaneously since Majrashi et al. (2020) found this to be a potential influencing circumstance. See appendix C. to find the questionnaire.

The second questionnaire is a *post-transitioning* questionnaire that is to be conducted after every task to measure the transition. It is greatly inspired by the seamless transition scale (STS) by Majrashi et al. (2020). Since the original STS was created to test the seamlessness of transitions in a multichanneled service delivery in redundant devices, a change of focus had to be done to test the transitions in a crossmedial service delivery in complementary components. Majrashi et al. (2020) motivates the questions in STS as based on the attribute of continuity as described by Denis and Karsenty (2004), see section 3.3.1 for more details. The angle of these questions however, is more on task continuity than knowledge continuity, which is in favour for a multichanneled service. The components of this study are

limited in task continuity and therefore we had to switch focus in the questionnaire to acknowledge knowledge continuity more. Thus, two initial questions and one last open ended question were added. Furthermore, all questions are translated to Swedish since our participant must be Swedish speaking due to A-hus's platforms are only available in Swedish. But for the sake of this report, we provide the questions in both languages. The questions are answered with a standard 1-5 likert scale.

The word "seamlessly" in the last question was switched to "easily" since complementary devices do not necessarily need to be seamless. In some cases, there needs to be or is an obvious change between components to not confuse the user. Such in the case of A-hus where the different platforms have different functions and purposes. If the transition would be so seamless that the user does not notice the change of platform, they might not realize that new functions are available and some functions are no longer available (Denis & Karsenty 2005; Wäljas et al., 2010). However, we still want to investigate how the user is experiencing the transition, and thus we ask how "easily" the transition was carried out. Because of this word change we can no longer call this scale for "Seamless transition scale", instead we call it "Transition scale (TS)".

1. Jag är nöjd med den tid det tog att förstå att jag behövde byta plattform för att kunna utföra uppgiften.
   I am satisfied with the amount of time it took to understand that I needed to change platform in order to complete the task.

2. Jag är nöjd med den tid det tog att förstå vilken plattform jag behövde förflytta mig till för att kunna slutföra uppgiften.
   I am satisfied with the amount of time it took to understand which platform I needed to change to in order to complete the task.

3. Jag är nöjd med den tiden det tog att återuppta uppgiften jag började på i den föregående plattformen.
   I am satisfied with the amount of time it took to resume the task I started from the (e.g.,mobile device).

4. Jag upplevde att jag behövde komma ihåg information från den föregående plattformen för att förstå hur jag skulle kunna fortsätta utföra uppgiften på den nuvarande plattformen.
   I found I needed to remember information from the user interface on the (e.g., mobile device) to be able to continue with the task using the user interface on the (e.g., tablet).

5. Jag upplevde att jag enkelt kunde fortsätta med min uppgift efter jag bytt från den föregående plattformen till den nuvarande plattformen.
   I felt I could easily continue with my task after switching from the user interface on the (e.g., mobile device) to the user interface on the (e.g., tablet).

6. Vad tycker du om bytet mellan plattformarna? Svara muntligt eller i text
   What is your opinion about the transition between the platforms? Answer orally or in text

The third questionnaire is the cross-platform usability scale (CPUS) by Majrashi et al. (2020). It is a post-test, to be performed after all individual tasks are completed, to assess the user satisfaction of the transitions. As with the STS, the CPUS also follows a standard practice of the likert scale, and it includes four negative statements and four positive statements. Having both negative and positive statements in a self-reporting assessment surveys is a good way to avoid problems with response bias, i.e., when participants only use the extreme points on the rating scale (Shaughnessy et al., 2012). The only changes made from the original CPUS is that we translated it to Swedish:

1. Jag kände mig produktiv när jag använde flera plattformar.
   I felt productive when using many platforms.

2. Det var enkelt att använda varje gränssnitt.
   It was easy to use each user interface.

3. Jag tyckte att varje gränssnitt på plattformarna var designat på ett sätt som jag förväntade mig.
   I found each system cross-platform designed in the way I expected it.

4. Jag tyckte att gränssnitten över plattformarna behövde mycket förbättring.
   I felt that user interfaces cross-platform needed much improvement.

5. Jag tyckte att de olika funktionerna över plattformarna var väl integrerade.
   I found the various functions cross-platform were well integrated.

6. Jag behövde lära mig att använda vardera gränssnitt separat.
   I needed to learn how to use each user interface separately.

7. Jag noterade inkonsekvenser mellan gränssnitten över de olika plattformarna.
   I noticed inconsistencies between user interfaces cross-platform.

8. Jag blev frustrerad av gränssnittens olika design.
   I was frustrated by the different designs of each user interface.

Since the data from both the STS and CPUS is only a numeric score the use of these scales will come in hand first when the score of the current platform design of A-hus is compared to the new design suggestion.

6.1.3.4 Interview

To not miss any important aspects of the participants' experience of the platforms and the test we constructed a concluding semi-structured interview to be held at the

end of the usability test as a conclusion. The aim of the interview was to catch the participants' understanding of the platforms, how they experienced the transitions between the platforms, if they felt like the platforms lacked something and any other comment they might have. The interview consisted of some guiding questions (appendix E), but the facilitator was free to depart from these if needed i.e., if the participant point of view was already clear if they seemed impatient or tired.

6.1.3.5 Selection of target user

From the stakeholder meeting we learned that A-hus had three main target groups. The target groups are as follows; "Familjebildarna" ("The Family Builders") (age 25-35), "Medvetna barnfamiljen" ("The Conscious Kids Family") (age 35-45) and "Familjeminskarna" ("The Family Downsizers"), (age 45 +). In order to collect data that would reflect the actual users, or the intended user, participants matching the three main target groups as closely as possible were recruited.

The opinion of how big a sample size for usability tests in interaction design should be differs amongst researchers. According to Sharp et al. (2019), the most common sample size for usability testing in interaction design is twelve. According to Majrashi et al. (2020) though, researchers have stated four to nine participants is "an adequate number to carry out an effective usability test" (p. 8). Due to the time consuming process of conducting usability tests, transcribing and analysing them, six participants will be recruited for this test, where the aim is two participants for every one of the three main target groups. The participants will have no previous experience of A-hus' digital platforms to avoid biases such as training effects when comparing the current and the new design.

6.1.3.6 Pilot testing

Four pilot tests were conducted with slight changes to the design of the usability tests after every pilot. The main reason for the pilot tests was to see if the constructed tasks fulfilled its purpose (make the participant move between the platforms), if the participants understood the instructions and the tasks and to try out how we as facilitators should behave. The pilots proved that the tasks fulfilled their purpose, even though some tasks were found to be very challenging for the pilots which appeared to elicit much frustration. To avoid this, standard hints were added that the facilitator could provide to the participants after 2 minutes if needed, see appendix M. To provide some clarity to the participants we changed the wordings in some of the tasks and instructions, i.e. made it extra clear that the participants always had access to the current task by asking us or having a glance at the form they were given. Finally, it was noticed that the facilitators should turn off their cameras to not distract the participant.

6.1.4 Usability test 1

The aim of this usability test 1 (UT1) was to create a *summative* and *formative* knowledge base to understand and identify potential issues related to interusability.

The findings of this usability test to use when ideating new design solutions.

Due to the ongoing Covid-19 pandemic the usability tests were held remotely with the online video conference tool Zoom, the online survey tool Google Forms and the online design and prototyping tool Figma. This combination of tools was chosen based on what we as facilitators had access to, had knowledge about and was the most suitable for the test. However, the online user research platform Maze.design was considered to start with. It is able to collect both the qualitative and quantitative data that we need. It can also integrate directly with Figma and other prototyping tools, run questionnaires as well as count clicks, measure time and rate successful tasks etc. The plan was then to recreate all of A-hus's digital platforms into Figma prototypes to be able to control what pages the participants visit. However, in the end this was decided against since it was considered too constraining for the participants. As mentioned, the aim of this usability test was not only to collect summative data, but also to collect formative data to be used as inspiration in the ideation stage. Therefore we wanted the participants to feel as free as possible. However, Husvisaren still needed to be recreated as a Figma prototype to be run on desktop since there was no solution to record the participants phone screen found.

6.1.4.1 Pilot testing

The participants were recruited to the tests with the premise that they needed a computer, no previous knowledge of A-hus's digital platforms, belonging to the "right" target group and that they sometimes in the future could see themselves possibly building a house.

The total number of participants recruited for this usability test was six. There were three women and three men, one from each of the three main target groups of A-hus. Three in the age group 25-35, one in the age group 36-45 and two in the age group 46 +. One in the age group 25-35 fit into the target group "Medvetna barnfamiljen" except for their age. One was a student and five were employed.

6.1.4.2 Procedure

The participant was informed that the test would take approximately 1 hour to complete and that the facilitators needed to record their screen view and sound. The participants were then invited to the tests with a link to a Zoom meeting, and were there given a link to a Google Forms in with all information needed to complete the test, see appendix B, including a consent form, see appendix A. The facilitators asked the participant to share their screen view in Zoom and asked for permission to start the recording of their view and informed the participant that they were welcome to turn off their camera if they did not wish to have their face recorded.

As explained in section 6.1.3.2, two orders were created (see figure 6.2) in which the participant was presented with the tasks, resulting in two different Google Forms. Three participants were assigned to each, one from every target group. The leading facilitator and the participant together went through the form of consent and

instructions to make sure that everything was understood before the participant answered the demographic questionnaire. Then the facilitators turned off their cameras and the supporting facilitator also turned off its mic before the participant started conducting the tasks. All tasks were conducted on A-hus "real" digital platforms except for the app Husvisaren. Since this test was run remotely the facilitators had no way of observing the participants if they used their own phone, therefore a prototype simulating the app had been created with Figma, see appendix K. This prototype was shared with the participants using a link and could be opened in any desktop web browser.

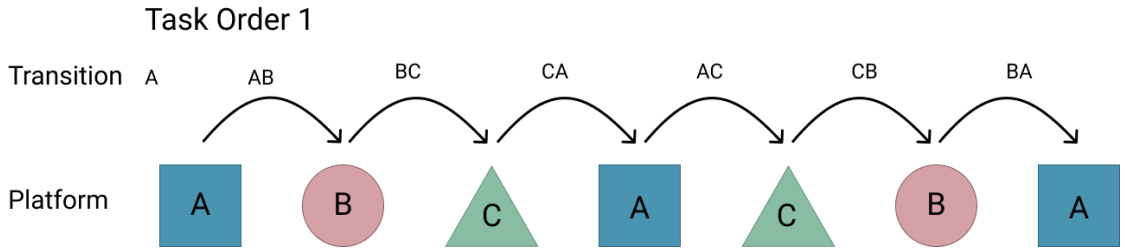


Figure 6.1: A Figure Showing Order 1 of the Tasks

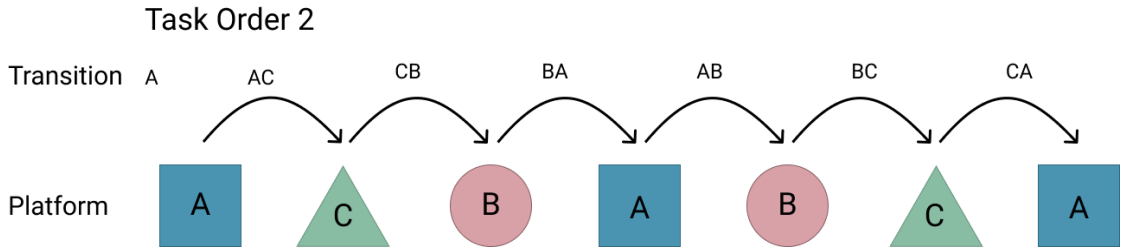


Figure 6.2: A Figure Showing Order 2 of the Tasks

Note. A = A-hus.se, B = Husbyggaren and C = Husvisaren. I.e. Transition AB corresponds to a task beginning at A-hus.se and ending at Husbyggaren.

After every task, the participants conducted the TS questionnaire, and when all tasks were completed, the participants conducted the CPUS questionnaire. The facilitators were always available during the questionnaires if the participants had any questions. During the tasks, the participants were encouraged to think aloud. The facilitators only spoke if addressed, to remind the participant to think aloud, and to provide hints after two minutes if the participant seemed to struggle. No strict observation protocol was filled by facilitators during the session since it was being recorded. After all tasks, TS's, and the CPUS had been completed, a concluding semi-structured interview was held with the participant, see appendix E and F for interview questions.

6.2 Define

This section describes the steps taken to define the data accumulated in the empathize stage, and the result from the usability test 1.

6.2.1 Processing of data

The first step taken to process the data was to transcribe the recorded sessions, see appendix G for the transcription template that was created and followed. Both speech and behaviour was transcribed. Every participant was given a code to anonymize them if any third party (i.e. supervisors and other stakeholders) wanted access to the transcriptions. The transcriptions were then analysed by timing execution time, unproductive time and by colour coding actions (clicks), errors (wrong clicks), hints required, statement by the participant and observations by the analyser.

The TS score and the CPUS score was also processed and analysed. During the tests it was noticed that a considerable number of participants interpreted statement four in the TS differently from each other and differently from task to task. This made the answers for statement four unreliable and was therefore removed from the total score of the TS. Furthermore, half of the questions of CPUS were framed negatively and half were framed positively, therefore all answers for the negatively framed questions were reversed to create a uniform score.

The extraction of this data was inspired by the definition of cross-platform usability metrics by Majrashi et. al. (2020) as described in section 4.2.7, table 4.1. However, to make the data fit this case, some alterations were needed. Table 6.2 shows how the data was extracted in this study. “Actions” was defined to be a click done by the user (Tullis & Albert, 2013) to make it easier to quantify. Since this study was designed to force the user to complete the task, therefore no fail option was available and the definition of the metric “task completion” was changed and the metric “hints required” as a numerical score was added. An “error” was defined to be all clicks that led the user further away from completing the task. “Seamless Transition” was changed to “transition” since the TS does not measure seamlessness as explained in section 6.1.3.3 Questionnaires. “Resuming time” was removed because of the crossmedial nature of the service, where tasks are typically continued rather than resumed. “Execution time” and “unproductive period” metrics remained the same.

Table 6.2: Definition of cross-platform usability metrics inspired by Majrashi et al. (2020)

Attribute	Metric	Settings
Efficiency	Execution time	The time spent executing a task.
	Actions	The total number of clicks required to complete a task.
Effectiveness	Hints required	The total number of hints required to complete a task.
	Task completion	The successful completion of a task without hints.
	Errors	The total number of errors when progressing towards a task.
Productivity	Unproductive period	The time spent seeking help or recovery from errors when progressing towards a task.
Satisfaction	CPUS	The score produced by the CPUS.
Continuity	Transition score	The score produced by the TS.

All noticeable observations and statements were put into a rainbow spreadsheet to be able to get a better overview of the commonalities between the participants and quantify all findings (see appendix H). All of these observations and statements were then transferred to (digital) sticky notes to be analysed using the affinity diagram method. The sticky notes were tagged with codes for each participant and transition. This was helpful in several ways. It was easier to see the frequencies of an observation and therefore more patterns could appear. And if any uncertainties appeared with the notes it was possible to track them back to its original source. The summative findings of the affinity diagramming technique can be read in section 6.2.3.

6.2.2 Quantitative findings of UT1

Table 6.3 shows the metric means for all participants per transition and total mean for all transitions. The same pattern follows all metrics: The tasks requiring the participant to transition to Husvisaren (AC and BC) yielded higher mean values than the tasks requiring the participant to transition from Husvisaren (CA and CB), except for the TS score, which may indicate that AC and BC were more difficult tasks to complete. The tasks which required the participants to transition between A-hus.se and Husbyggaren (both directions, i.e., AB and BA) yielded the lowest mean values in general, except for the TS scores which were the highest compared to the others. This may indicate that AB and BA were the “easiest”

tasks to complete out of the total.

Table 6.3: UT1: Metric Means for all Participants per Transition and Total Mean for all Transitions

Transition Metric	AB	BC	CA	AC	CB	BA
Execution time	01:02	05:04	02:05	05:39	02:23	01:00
Unproductive time	00:04	03:20	01:05	02:43	01:16	00:17
Actions	5,3	21,5	15,3	21	20,3	6
Errors	0,2	7,8	9,2	12,3	11,2	1,2
Hints required	0	1,7	0,2	2,2	0,3	0
Task completion	6/6	2/6	5/6	2/6	5/6	6/6
Transition Scale	4,4	2,1	3,1	2,5	3,2	3,6

Note. A = A-hus.se, B = Husbyggaren and C = Husvisaren. I.e. Transition AB corresponds to a task beginning at A-hus.se and ending at Husbyggaren. For all individual scores per participant, see appendix H.

The mean execution time for the tasks differs between 01:00 minutes to 05:39 minutes. There is a noticeable longer mean execution time for the tasks where the participant needed to transition to Husvisaren, both with the starting platform A-hus.se (AC) and Husbyggaren (BC). On average, the fastest transition in general occurred between A-hus.se and Husbyggaren, both ways (AB and BA). The rest of the transitions regarding Husvisaren (CA and CB) fall in between the others. Similar numbers can be seen regarding the actions required to complete a task. All tasks regarding Husvisaren (BC, CA, AC and CB) required many more actions by the participant than the tasks not including Husvisaren (AB and BA). This may indicate that there is a lower efficiency fort the tasks including Husvisaren.

For the tasks regarding Husvisaren (BC, CA, AC and CB) there is a higher number of errors than for the tasks between A-hus.se and Husbyggaren (AB and BA). No hints were required when the participants had to transition between A-hus.se and Husbyggaren and thus the task completion rate was 6/6 for those tasks (AB and BA). There is a slightly higher number of hints required and a lower task completion rate for the tasks with transitions to Husvisaren (AC and BC) than for the tasks with transitions from Husvisaren (CA and CB). All tasks regarding Husvisaren had the highest mean error count, required hints and a lower task completion rate. Therefore, we see a lower effectiveness for all tasks including Husvisaren than those tasks without Husvisaren. The pattern continues for the metric unproductive time, thus showing that the productivity was the highest for the tasks with transitions between

A-hus.se and Husbyggaren (AB and BA), lower for the tasks with transition from Husvisaren (CA and CB) and the lowest for the tasks with transition to Husvisaren (AC and BC).

Regarding the TS score, the participants reported a better score for the tasks with transitions between A-hus.se and Husbyggaren (AB and BA) than for the tasks regarding Husvisaren (BC, CA, AC and CB). The satisfactory score from the CPUS cannot tell us anything more than that the score is 2,1 on a scale from 1-5. This score will tell us more in comparison to the CPUS score for the new design evaluated in usability testing 2 in section 6.5.1.

6.2.3 Qualitative findings of UT1

Table 6.4 shows a synthesis of the observations and statements as a result from the affinity diagramming technique of the qualitative data from usability test 1 (UT1). The arrangement of this section is partly inspired by the usability report as presented by Martin and Hannington (2012), listing the most prominent observations and statements found by frequency. The frequency refers to the number of participants generating these observations and statements. This section of findings will mostly focus on potential problems that emerged during the test to serve as guidance for the continuation of this project. For the full set of observations and statements, see appendix H.

Table 6.4: Observations Made by the Facilitators and Statements Made by the Participants

No	**Problem description**	**Frequency**
	Navigation	
1.	User were observed to find the navigation system hard to use as a novice.	6
2.	User experienced issues with the navigation structure on A-hus.se.	6
3.	User stated that it is complex to transition between platforms.	5
4.	User stated that it was hard to find natural transitions between the platforms.	4
5.	User stated that it is impossible to transition from Husbyggaren to A-hus.se.	4
6.	User tried to click on the logo in the house configurator of Husbyggaren to return to A-hus.se (not possible).	4
7.	User got bothered by several open tabs as a result of navigation back and forth between A-hus.se and Husbyggaren.	4

8.	User clicked on the logo on Husbyggarens homepage expecting to reach A-hus.se (not possible).	3
9.	User expressed that the navigation system should be more obvious and visually clear.	3
10.	User wished for a more seamless transition to not perceive the change between platforms.	3
11.	User did not instinctively understand the responsiveness of the sub menu on A-hus.se.	3
12.	User did not notice the transition point to Husbyggaren in the hamburger menu.	3
13.	User stated that the navigation system is too deep.	2
14.	User seemed to find it hard to understand the top menu versus sub menu relationship at A-hus.se.	2
15.	User was observed to understand the sub menu as tabs.	2
16.	User got stuck in the house configurator of Husbyggaren.	2
	Information presentation	
17.	User is observed to feel frustrated when looking for information they do not found (Husvisaren).	6
18.	User did not find the information about Husvisaren at Husbyggaren.	6
19.	User seemingly had problems with identifying tabs in menus by their names.	4
20.	User fails to find information about Husvisaren even though the user has already found the information before.	3
21.	User stated that too much information is presented at the same time in A-hus.se on a house specific page.	3
22.	User stated that information presented felt illogically placed at A-hus.se.	2
23.	User stated that they would never find the information about Husvisaren without help from facilitators.	2
	Platform as bridge	
24.	User failed to find information about Husvisaren at Husbyggaren, instead used A-hus.se as bridging platform.	6
25.	User failed to find transition points on Husvisaren to Husbyggaren and instead used A-hus.se as bridging platform.	4
26.	User believed that house model had to be chosen first in A-hus.se before being able to enter Husbyggaren.	3

	Similar concept expectation	
27.	User expected to find the AR-function beside closely related content at A-hus.se, e.g. 3D Model, Digital Rundvandring, Digital Visning and Bilder (where it could not be found).	6
	Platform redundancy	
28.	User expressed a wish for more redundancy between the platforms.	5
29.	User wished for more data synchronization between platforms (e.g. be able to see customized houses in Husvisaren).	3
	Platform distinction	
30.	User understood A-hus.se and Husbyggaren as the same platform.	5
31.	User did not notice that A-hus.se had been left when transitioned to Husbyggaren.	3
	Expectation versus possible actions	
32.	User tried to edit (customize) a house model in Husvisaren.	4
33.	User looked for AR-functions at a house specific page of A-hus.se.	3
34.	User looked for AR-function at a house specific page of Husbyggaren.	3
	Confidence	
35.	User stated that they felt stupid at some point during the test.	3

Note. These are compiled sentences of similar observations and statements as a result from the affinity diagramming technique. For the full set of observations and statements, see appendix H.

Navigation

All participants were observed to find the overall navigation system hard to use as a novice. Some participants found it complex to navigate (transition) between the platforms, for example due to a too deep navigation structure. They also experienced issues with the navigation structure on the individual platforms. For example, when using the menus at A-hus.se, specifically on a house specific page, it has been identified that participants had a hard time understanding the relationship between the top main menu and the sub menu. Generally, participants had no problem using the top main menu, but on a house specific page it disappeared when scrolling down, which made participants forget about its existence. When it disappeared it changed

place with the sub menu. This responsiveness of the sub menu was not noticed by all participants hence leading to wrong expectation of the functions of the menus. Some thought that the sub menu (when attached to the top of the screen) was the top main menu, which led to some participants believing that the sub menu functioned in the same way as the top menu, with tabs.

Few participants had problems finding their way from A-hus.se to Husbyggaren. Most of the participants found their way there through the buttons (transition points) presented on the top main menu or the sub menu on a house specific page. Some also found information about Husbyggaren on the homepage of A-hus.se or on a house specific page. However, some stated that it was impossible to transition from Husbyggaren to A-hus.se. This is reflected in the slightly lower transition scale (TS) score for BA than for AB in table 6.3. But in fact, it was not impossible to transition from Husbyggaren to A-hus.se, but it was obviously challenging. The observations show that the participants tried different ways, mainly by clicking on the A-hus logo in Husbyggaren expecting to reach A-hus.se, which was not possible. Clicking the logo in one platform and expecting to reach another platform might seem unreasonable. But the homepage of Husbyggaren did have the characteristics of an ordinary web site, which might have made it harder for the participants to understand that it is its own platform. Whatever the reason, this resulted in some of the participants getting stuck in Husbyggaren and having to transition through open tabs in the browser. This was no problem per se, but some participants were bothered by the several open tabs as a result of navigation back and forth between A-hus.se and Husbyggaren.

Some participants wished for more seamless transitions to not perceive the changes between the platforms. This was also supported by some participants expressing that the navigation system should have been more obvious and visually clear, i.e. easier to use. This was for example reflected in the observation that some participants did not notice the transition point to Husbyggaren in the hamburger menu in Husvisaren. Thus, some titles, labels and pieces of information were hard for participants to see or understand.

Information presentation

From the observations and statements, a pattern emerged in regard to how different kinds of information was presented on the platforms and about the platforms. First and foremost, all participants had a starting point at A-hus.se, leading them to always be aware of its existence. However, some participants reported that how the information on A-hus.se was presented sometimes was confusing. For example, none of the participants found their way to Husvisaren or any information about Husvisaren at either A-hus.se or Husbyggaren without hints from the facilitators, leading to some frustration. Some participants also failed to find information about Husvisaren even though the participant had already found the information before, some altogether forgot that the information existed, and some just did not remember where they read it. A common denominator seemed to be that nowhere on A-hus.se or Husbyggaren were the participants reminded of Husvisaren except on

Husvisaren's own page, which is hidden deep within a hierarchical structure. This resulted in recollection issues for some of the participants and a lot of frustration. This is supported by several statements from the participants that they would never find the information about Husvisaren without help and that they wish to see information about Husvisaren at the homepage of A-hus.se to get reminded of it. Some wished to find Husvisaren through the top main menu. And almost all participants searched for and expected to find information regarding the functions of Husvisaren in the house specific pages close to similar content (3D Model, Digital Rundvandring, Digital Visning and Bilder).

Given the nature of the tasks and the design of the test a lot of the participants started by looking for the solution to and information about their task wherever their starting point was. Some of the participants tried to exhaust every corner of information and functions before giving up on the platform they were currently on. Since Husvisaren does not have that much information and very limited amounts of functions, some participants quickly realized that they were on the wrong platform. Although, the first time a participant was given a task to be completed on Husbyggaren and happened to start that task on Husvisaren, all of them thought that the tasks could be completed on Husvisaren (i.e. that they could customize a house in Husvisaren which was not possible). Whenever the participants started on either A-hus.se or Husbyggaren, many of them found themselves spending a lot of time trying to find information for the solution of the tasks due to the massive amount of information available. This was especially the case for A-hus.se. These observations are supported by the statements of the participants where they expressed that there was too much information on the house specific pages on A-hus.se, that there was too much information hidden in "Bostadsklok", and that the information presentation sometimes felt illogically placed, hinting to an informational overload.

Another identified issue that made it harder for the participants to find information is that they seemingly had problems with identifying tabs in menus by their labels. The facilitators observed an inconsistent and unintuitive labelling in menus and links, which gave the participants some lexical difficulties when trying to identify the corresponding content and leading to confusion. For instance, they tried to find information regarding the functions of Husvisaren in the house specific pages close to related content but did not find it there. In cases where the participants seemed extra confused, stated that they felt confused or seemingly clicked seemingly random menus and links, the facilitators drew a possible conclusion that the participant lacked a coherent mental model of the platforms. Their actions did not seem to mirror any expectations but were rather random actions used as a strategy that by chance might lead them on the right path, due to not being able to understand how to solve the task by active choices. This was especially the case for the tasks including Husvisaren (AC, CA, BC and CB), thus we see a high number of actions and errors for these transitions in table 6.3.

Platform as bridge

In some instances where the participants failed to find information about Husvisaren

at Husbyggaren, they used A-hus.se as a bridging platform. Similarly, in instances where the participant failed to find transition points on Husvisaren to Husbyggaren they used A-hus.se as a bridging platform instead. Whether this is due to the participant not being able to find the information or transition point or simply not having the patience to look for them, is not known. A common denominator though is that it was not easy enough for some of the participants to find the information or transition points to just "stumble upon " them, and instead chose to move to A-hus.se instead. Three of the participants that did this also had problems with differentiating between A-hus.se and Husbyggaren. One of the participants can be considered a bit of an outlier since they understood the A-hus.se and Husbyggaren as different platforms, however still thought that they had to choose the house model at A-hus.se. This was shown by the behaviour of actively rejecting the "Bygg online" tab in the top main menu and instead choosing to go to Bygg online via the sub menu on a house specific page on A-hus.se. This behaviour hints at issues of the participants' mental model of the differences between A-hus.se and Husbyggaren.

Platform redundancy and platform distinction
Some participants expressed a wish for more redundancy between the platforms, i.e., more data synchronization between platforms (e.g. be able to see customized houses in Husvisaren). These wishes were often expressed in the concluding interview when the participants had had a chance to understand the actual set up of the platforms. Before that realization, most often the same participants understood A-hus.se and Husbyggaren as the same platform. Some of them did not even notice that A-hus.se had been left when transitioned to Husbyggaren. This might sound like a good, seamless experience, but rather it leads to several different kinds of problems. For example, the problems of the participant not being able to understand how to leave Husbyggaren, as already mentioned. This was especially the case when the user had opened Husbyggaren through the sub menu on a house specific page in A-hus.se, which would lead the participant directly to the house configurator in Husbyggaren, with the chosen house model pre-selected. The lack of feedback of the change of platform made it impossible for the participants to understand where in the system they were and how to leave that place. Another problem related to this is that some participants expected information and functionalities to be redundant on the platforms and experienced frustration when not finding the expected information.

Aside from participants having a correct mental model or completely lacking a mental model (total confusion), in most cases they seemed to have an incorrect mental model. That is, they had constructed a mental model that made it a little bit harder for them to interact with the platforms. The facilitators have been able to identify three possible sources that might have contributed to the participants constructing an incorrect mental model: (1) inconsistent labelling in menus and links, (2) presenting partially the same information on different platforms under the same labels and (3) insufficient platform distinction within the design. An incorrect mental model does not necessarily need to be a problem if the participants are still able to use a product without friction. However, in this case it was observed that the participants who had an incorrect mental model had gained false hopes when pressing a link and

formed expectations of being able to find related features in the same place when it's not possible, as mentioned.

In summary, despite clear instructions and continuous reminders that this usability test was not constructed to test the participants, half of the participants still stated that they felt stupid at some point during the test due to not understanding how and where to complete a task.

6.2.4 Conclusion

From the UT1 several patterns of problems appeared which became some of our main focus for the continuation of this project: navigation, information presentation, platform as bridge, similar concept expectation, platform redundancy, platform distinction and expectation versus possible actions. These accumulated insights and knowledge from the literature review were then used to generate ideas that could solve the defined problems in the ideation stage. This section 6.2. Define described the main findings from UT1. Section 6.3 Ideation and 6.4 Development of new design solutions will go into further detail with the exact problems of the interfaces. By basing potential solutions on these problems and previous theory we hoped to move one step closer to determining key interusability factors.

6.3 Ideation

In the following sections, the stages of the ideation stage will be presented and outlined. This part of the process is where the foundations of the new design solutions were laid. As described in the previous section 6.2, we had by this point conducted a usability study of the platforms especially designed to outline the interusability between the platforms. The study and subsequent analysis revealed a number of problematic areas and potential issues presented in table 6.4. This data is the starting point of the subsequent stages.

Three main ideation sessions were conducted. The first one was a stakeholder meeting, presented in section 6.3.1, and the second one was a peer workshop, presented in section 6.3.2. The third was a brainstorming session conducted with only the authors of this thesis, and resulted in a summary of all aspects of the platforms that were judged to be important to take into consideration during the upcoming stage, see section 6.3.3. The findings from these ideation sessions were used in the simultaneous ideation and prototyping stage (section 6.4).

6.3.1 Stakeholder meeting

A stakeholder meeting was held together with two representatives from A-hus.se, one of which was our assigned advisor from A-hus. The aim of the stakeholder meeting was to brief the participating stakeholders from A-hus of the results we had gathered from UT1, to collect their thoughts and feedback of some of the major perceived issues, discuss potential origins of identified issues, and discuss potential

solutions to the issues as an unstructured ideation session. Since the representatives of A-hus can be viewed as experts of the MHM context, an important part of this stakeholder meeting was to put the findings in the light of an MHM context in order to create a greater understanding of important attributes associated with it.

From this meeting we brought with us the following points. The stakeholders as industry experts had no objections or contextual input to our findings. They did not present any contradictory arguments to what is considered useful in an MHM context in contrast to what we regarded as issues or potentially impairing the service. The stakeholders agreed that the structure of the top main menu on A-hus.se should be altered to facilitate the navigation of the users. Two potential solutions that were discussed was to make the navigation shallower, and to rename some of the links in the menu to better match the expectations of the users. We also presented the stakeholders with the issue that the users seemed to expect a higher degree of information redundancy between Husbyggaren and A-hus.se. This discussion landed in a solution where Husbyggaren is stripped from all information strictly not necessary for its intended functionality. By increasing the difference in appearance and available functions between Husbyggaren and A-hus.se, i.e. making them appear less redundant, the users might more easily form the correct expectations of the actual redundancy.

6.3.2 Peer workshop

A peer workshop was held as a part of the ideation process. The goal of the workshop was to ideate and brainstorm on a particular identified issue, namely the navigation layers between sub-menu and top-menu of A-hus.se, as this was an identified issue with no easy or apparent solution. The workshop was used as an opportunity to collect expert input, reflective thoughts and insights of the navigation of A-hus.se, but also the navigation between the platforms. Four peers participated in the workshop, none of which were familiar with the platforms beforehand. The workshop was held with the online video conferencing tool Zoom.

The workshop was initiated with an introduction of the platforms. All platforms were given a short introduction of purpose, and features of the platforms. The group was asked to download the app to their smartphone, as that platform would be a part of the workshop later. To make the participants more familiar with the platforms, and also to study experts' interactions of the platforms, ten tasks were invented which would be used in a "treasure hunt". The participants were asked to move from one platform to another, much like the set up of UT1, but much less structured. The participant who was the fastest to reach the correct platform and location of the platform, and thus completed the task, would get one point. In the end, the participant with the most points won the treasure hunt. The learnings from the treasure hunt activity were mainly that several participants reported confusion regarding not being able to tell the two platforms A-hus.se and Husbyggaren apart, which made it challenging for some of the participants to complete their given tasks. This information was valuable, as it resembled the issues identified during UT1 con-

nected to the navigation structure and to the distinctions of the platforms.

The second exercise of the workshop was a sketching exercise. The participants were briefed about the issues we had identified regarding the navigation structure of A-hus.se through usability testing. In particular, the issue they were to sketch a new solution to was the sub menu of the house specific pages located on A-hus.se. The participants were divided into two groups and asked to quickly sketch up suggestions of possible solutions of the sub menu in the online design tool Figma. The sketching exercise resulted in three alternative sub menus, presented in figure 6.3 and 6.4. A discussion regarding the current features of the overarching navigation system also resulted from the exercise.

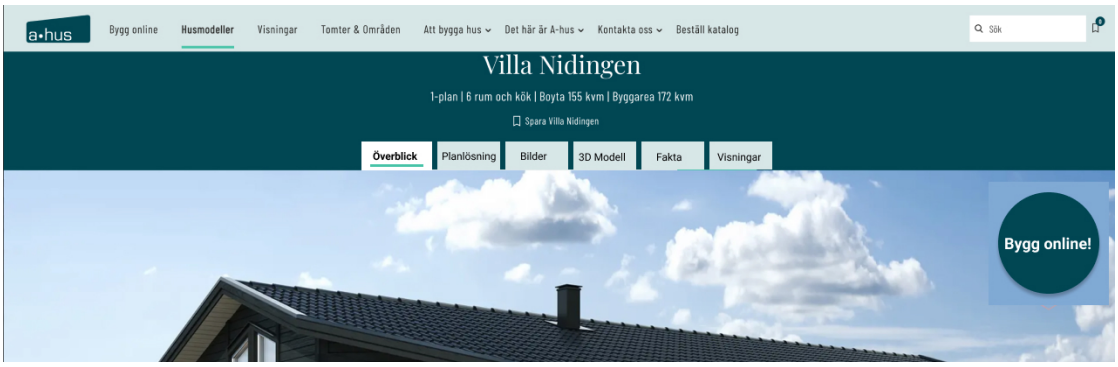


Figure 6.3: Sketching Exercise Result 1: Sub Menu as a Tab Menu

Figure 6.3 shows one of the resulting sketches of the sub menu as a tab menu with more colour indicating the current status of the page. The button functions have been removed from the menu. The contact form was redundant in the top main menu and further down below in the page and therefore no longer included. The Bygg online button was placed below the menu as a separate button.

Figure 6.4: Sketching Exercise Result 2: Expanded Sub Menu and Vertical Sub Menu

Figure 6.4 shows a sketch with two solutions to a new sub menu structure. One solution suggested was that the sub menu should be expanded from the main menu (here painted in blue) and be visible as long as the user interacts with the associated page (specific house page). Instead of only having a responsive sub menu, both the main menu and the expanded sub menu is responsive and sticks to the top of the screen and follows as the user scrolls. The other suggestion visible in figure 6.4 is that the sub menu can be arranged vertically and follow on the user's screen as they scroll the page up and down. The sub menu would still be dynamic and move the user up and down when clicking on a label, but the menu would better map to the dynamic motion if arranged this way.

The discussion that stemmed from the sketching exercise identified several different types of existing navigation systems in place with the original navigation structure of A-hus.se, which potentially could impair or complicate the system. The links in the original menus also held different functions, which added to the perceived inconsistencies and the confusion amongst the participants. For example, the sub menus main function was to navigate the user between different places up and down on the same page, but two links were buttons, one that opened a contact form overlay and one that opened Husbyggaren in a new tab. The exercise also elicited a discussion about whether or not the main menu at the top should be dynamic or static, which landed in that the menu should be static. Lastly, the participants also discussed if the sub menu should be dynamic or static. This discussion landed in that it should also be static, because it was discovered that the dynamic properties of the current sub menu differed a lot between the participants who used different operating systems on their computer. When using Safari on a Mac computer, the dynamic properties of the sub menu disappeared, which made the sub menu appear as a tab function rather than a dynamic movement that moved the user up and down the same page when interacting with the sub menu.

To summarize, the workshop further validated some of the findings we had found from the previous usability tests and led to interesting discussion, insights and ideation regarding the menu structure of A-hus.se. The resulting sketches and insight were used in the upcoming prototyping stage as inspiration for the development of the new design suggestions.

6.3.3 Brainstorming

The third method used in the ideation stage was a summarizing brainstorming session, where the aim was to make an initial judgement of what needed to be altered on each platform to increase the interusability of the cross-platform service at hand. The ideated suggestions of the brainstorming session, presented in appendix J, are grounded in the information and data we had gathered up to this point. The list served as a guide to what we believed should be redesigned, added or removed, and later evaluated during the next usability testing.

6.4 Development of new design solutions

In the following section, a simultaneous ideation-prototyping stage will be presented. This stage was devoted to developing new design solutions of the platforms, in an attempt to improve the interusability of A-hus's cross-platform service. The new design solutions are based on the original design of the platforms, but alterations have been made based on findings from UT1, the result of the ideation sessions, the design guidelines of the reviewed literature and literature regarding vertical usability. In cases where the literature provided us with no apparent solution, RITE tests were conducted to quickly evaluate several design solutions. The new design solutions will be presented, platform by platform, and the new design solutions will be explained and motivated. The prototypes were created in the online prototyping tool Figma, a link to three prototypes is provided in appendix L.

6.4.1 A-hus.se

The results from UT1 yielded several issues regarding the interusability of A-hus.se. First and foremost, all participants had problems finding information about Husvisaren (information presentation), thus we have added transition points on several different locations and extra information about the app. A lot of participants also had problems with sorting through the different kinds of information available on the website, so we aimed at reducing the amount of information and structuring it differently. Lastly, some participants also showed difficulties in navigating internally at A-hus.se, therefore we also aimed at reconstructing the navigation system.

Main menu
A link to Husvisaren was added to the top main menu since most of all participants in the study searched through the menu to find information about the app. It was placed in a drop down-list to the new title "Inspiration" since it was decided that it did not fit as its own title in the main menu, and fit with the contents on the page "Inspiration". Inspiration was previously placed in the drop down-list "Att bygga hus", but from the conclusion of UT1 we noticed that users had a hard time locating both "Inspiration" and that it was impossible to find the information about Husvisaren. This directly contradicts the interusability design principle "transparency" mentioned in section 3.3.2. The user needs aid to understand what components are available. The navigation structure was simply too deep to aid the user in such a way, and with this structure we have made an attempt to make it shallower. Furthermore, adding more transition points will promote continuity as described in section 3.3.3.2. Figure 6.5 shows the original design of the top main menu and figure 6.6 shows the new design suggestion.

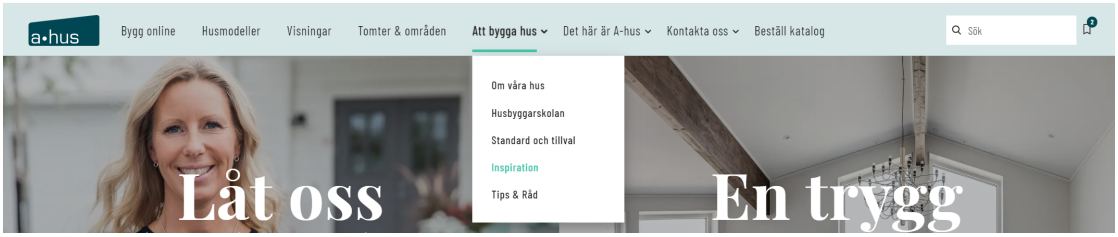


Figure 6.5: A-hus.se: Original Design of Top Main Menu

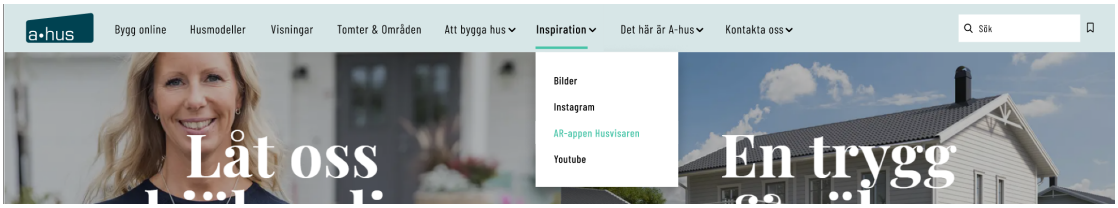


Figure 6.6: A-hus.se: New Design of Top Main Menu

Homepage

Information about Husvisaren was added to the homepage of A-hus since participants from UT1 reported that they wished to see just that. A-hus.se already had a grid applied on the homepage with links to pages they wanted to advertise, so we reconstructed those links. A direct link to Husbyggaren was also added to gather all platforms in one unit. A "new tab"-icon was added beside the link to Husbyggaren to signify that a new tab would be opened if the user clicked there. Furthermore, to single out the platforms those were the only links not accompanied with images as background. These changes follow the same interusability design principle transparency as with the changes in the main menu, as well as the composition principle mentioned in section 3.3.3.1, i.e. aiding the user to understand what components are available in the system and their functionalities and purpose. Figure 6.7 shows the new design suggestion.

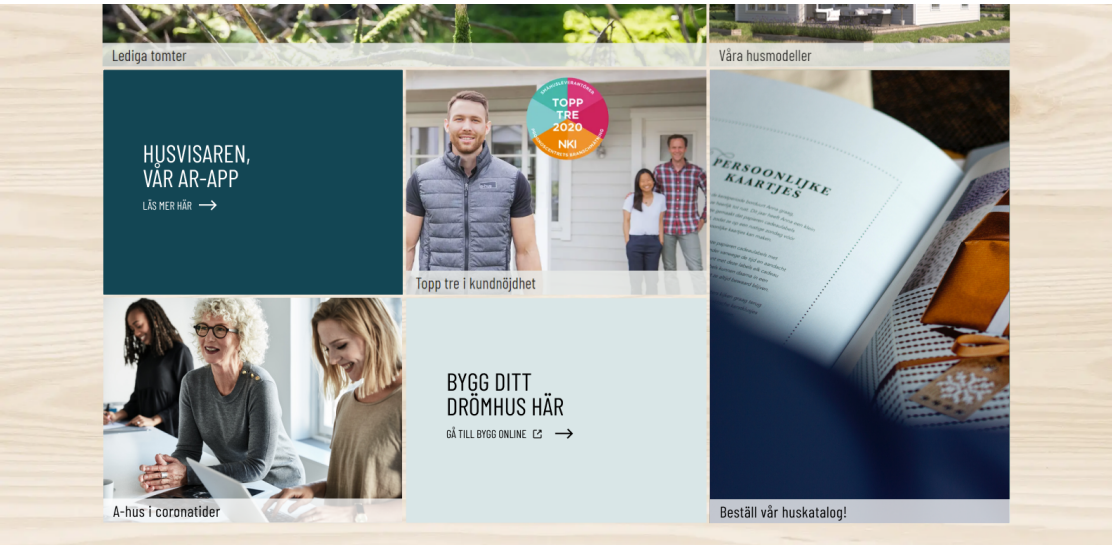


Figure 6.7: A-hus.se: New Design of Homepage Grid

Figure 6.8: A-hus.se: New Design of Close Up of "New Tab"-icon

Bygg online

UT1 showed that a lot of participants did not note the transition from A-hus.se to Husbyggaren when clicking on "Bygg online" in the main menu. As mentioned in section 6.2.2-6.2.3, this was a potential source of the many confusions and distinction problems between the two platforms. The transition was so seamless that some of the participants did not notice that they entered a new platform, which seemed to create issues with distinguishing the platforms, and thus with what the participant expected from the platforms. As an attempt to solve these issues a "bridging page" was added. As seen in figure 6.9. the new design suggests that users will get more background information about Husbyggaren on an individual page on A-hus.se. There the user will get a chance to learn about the functions of Husbyggaren and choose to enter it more actively. The user open Husbyggaren through the big green button "Starta Husbyggaren" accompanied with a "new tab"-icon to signify that a new tab would be opened if the user clicked there.

This informational page can also be supported by the concept of knowledge continuity as mentioned in section 3.3.1. Since knowledge continuity is based on the user's memory of a previous interaction with one or more devices and the user's ability to retrieve and adapt this knowledge to the current component, the issue of not noticing the transition can be argued to lack of knowledge. As well as supporting continuity through a more logical chain for the task to be carried out, as described

in section 3.3.3.2. Thus, hopefully this will leave the user in more control compared to being transferred to the platform without warning. This is also in line with the interusability design principle transparency mentioned in section 3.3.2 Even though an extra page has been added that potentially could add to the cognitive workload for the user, it was deemed necessary to add this information to aid the user to create an understanding of all available functions, how they work and how the system will react when using them.

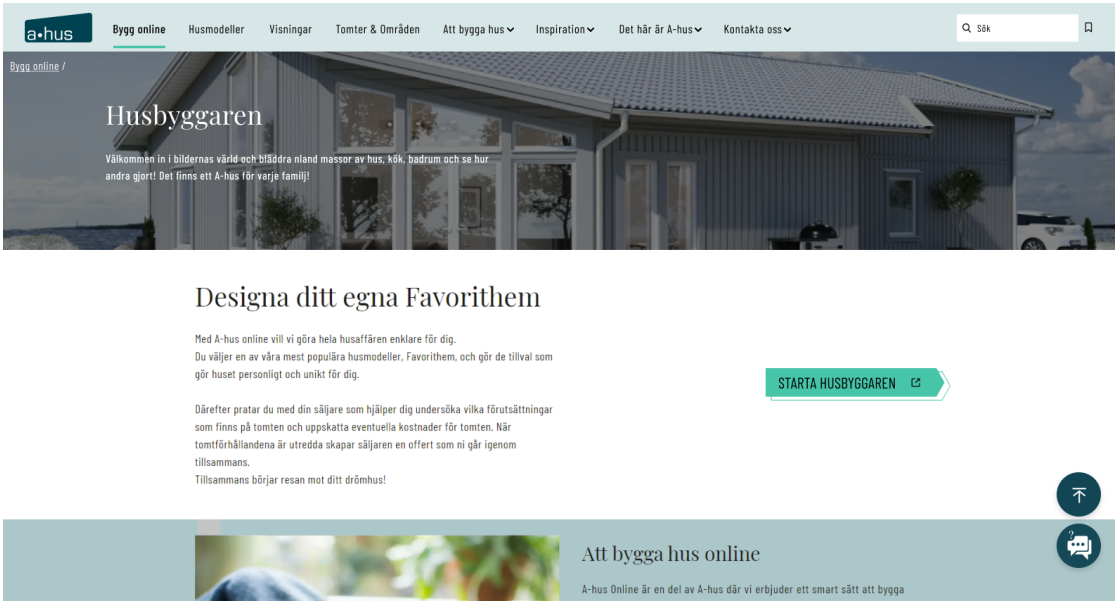


Figure 6.9: A-hus.se: New Design of Bygg Online Information Page on A-hus.se

Husmodeller

Some minor changes of the page "Husmodeller" that lists all the available house models was done. The relationship between the two buttons "Bygg online" and "Läs mer om huset" was askew. Participants have been observed to click on "Bygg online" by mistake. A possible explanation to this is that the button "Bygg online" is too jutting compared to the button "Läs mer om huset" and also placed in front of it (for left to right readers), drawing the attention of the user. Furthermore, that button does not indicate opening up a new platform in a new browser tab. To avoid this confusion, we considered removing the "Bygg Online" button altogether, since transitioning the user to Husbyggaren is not the main function of this page and thus this function might be unnecessary redundant (section 3.3.4). Although, it is nice having this transition point here to promote Husbyggaren through continuity and eliminate navigational excise for the expert user (Cooper et al., 2014). Furthermore, it is nice for expert users to have this shortcut. After several different new button setup options had been created (figure 6.10) these were run through a RITE testing with three external UX-students. They could choose their favourite button setup or leave comments.

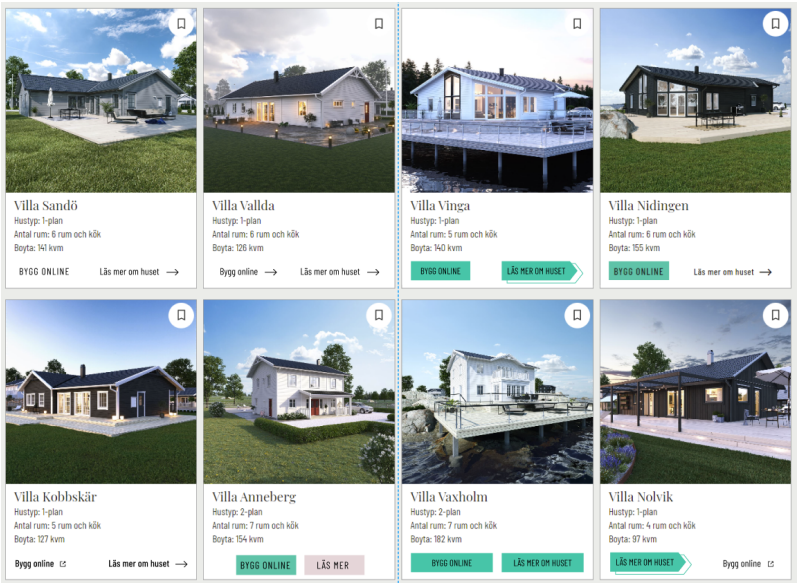


Figure 6.10: A-hus.e: New Design Suggestion of The Eight Button Setup Options Tested With RITE

The RITE session led to some further iteration and resulted in what could be seen in figure 6.12. The two buttons were created more similar to each other and switched places to give slightly more attention to the "Läs mer om huset"-button. We also added the "new tab"-icon to signal that clicking on "Bygg online" will result in a new tab opening.

The sorting filter has been moved to be placed among the other filtering options. Almost all participants expressed a wish to be able to sort in alphabetical order, which is possible. That led us to believe that no one saw the sorting-option.

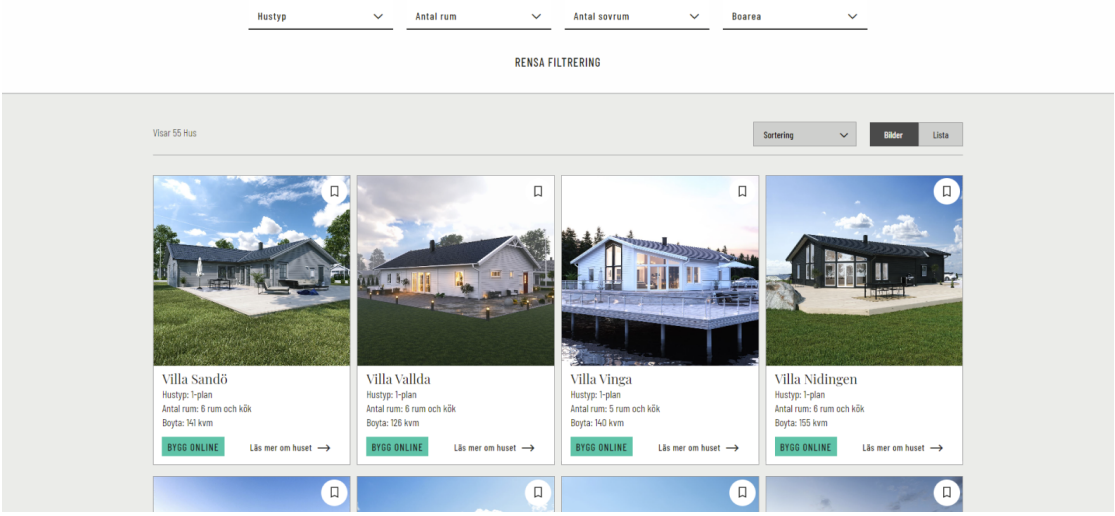


Figure 6.11: A-hus.se: Original Design of List of House Models

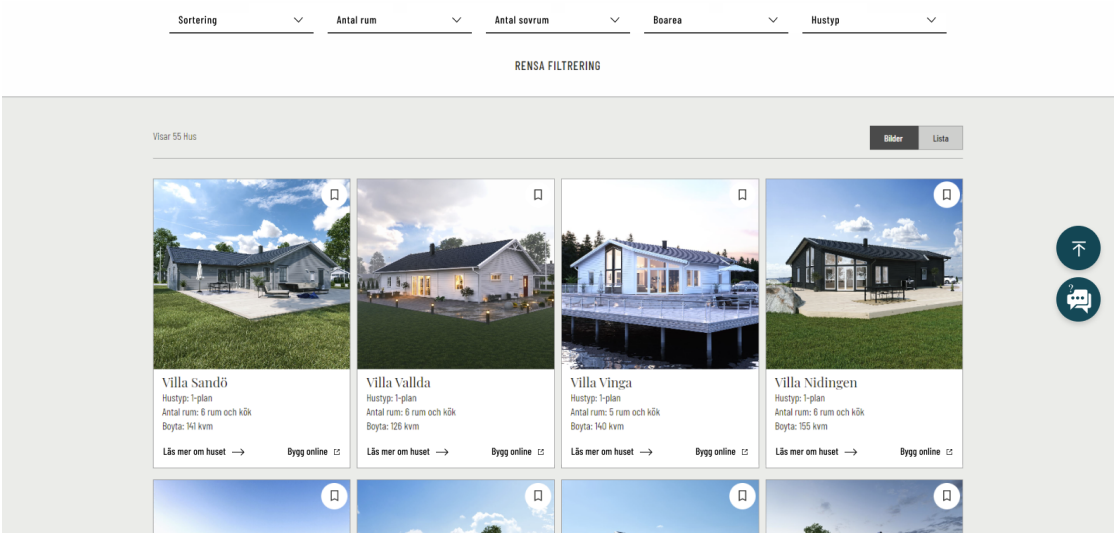


Figure 6.12: A-hus.se: New Design of List of House Models

Sub menu

UT1 showed that we needed to change the sub menu on the house specific page. Even though the participants could use the sub menu and found their way through it, some difficulties were noticed when the participants interacted with it which created unnecessary irritation. Some users had difficulties understanding the responsiveness of the sub menu, meaning that they did not notice when it changed place with the top menu when they scrolled down on the page. Some users mentioned that they forgot about the top menu when the sub menu was in its place. Others understood the sub menu as tabs that navigated them to different pages rather than navigating them to different places on the same page.

Figure 6.13: A-hus.se: Original Design of Sub Menu for House Specific Page Villa Anneberg

Our first decision of change was therefore to always keep the main menu visible, so that the user could always be reminded of where they are rather than having to recall their location themselves. For this purpose, we also added a breadcrumb trail. It will appear as soon as the user leaves the homepage, and can be found on

every page except for the homepage, see figure 6.13. A second decision of change was to change the feedback of the sub menu, to make it clearer where the user is navigated on the page. Instead of underlining and making the current title bold, which is a feedback that could be overlooked, we made a more drastic feedback of changing the background colour. We also did some "tidying". The sub menu had a mix of functions which had resulted in some unnecessary confusion for the user. Some links lead the user to different places on the page while other links functioned as buttons, one that opened up a contact form and another that transitioned the user to another platform. We changed all titles that functioned as buttons to have them function as the other titles instead. For instance, in the original sub menu the title "Bygg online" functioned as a button that without feedback opened the current house model in the configuration of Husbyggaren. To make this interaction more similar to the other titles of the sub menu we added information about Husvisaren on the house specific page and linked the button to that information. Although, it would still open the current house model in the configuration of Husbyggaren directly. These changes were partly inspired by the peer workshop. From these decisions we came with three ways of implementing a new sub menu, all including the changes mentioned above but located and functioned differently. To test them we conducted some RITE testing when we had created a number of different versions of the sub menu which resulted in further iteration of the sub menu. Three versions can be seen below.

One option was to keep the original dynamic tab sub menu, including the changes mentioned above. The reasoning behind this was that even though it is not a conventional way of navigating, it will not create unnecessary navigating between different views. However, one negative aspect of this one is that the menu might be perceived as universal to all house specific pages (Husmodeller) and not specific to the specific house model.

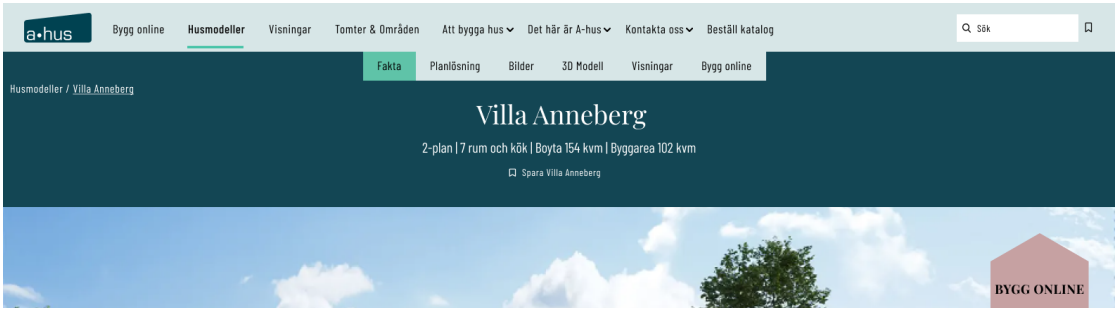


Figure 6.14: A-hus.se: New Design Suggestion 1: Dynamic Sub Menu

Another option was the opposite of the first option. A static tab sub menu with the information split in different views, the tabs, keeping all information separate and easily distinct. The reasoning behind this option was to keep the user from unnecessary scrolling and losing track of where they were located on the very long page. This option is also backed up by our user study where users have thought that the original sub menu functioned as tabs.

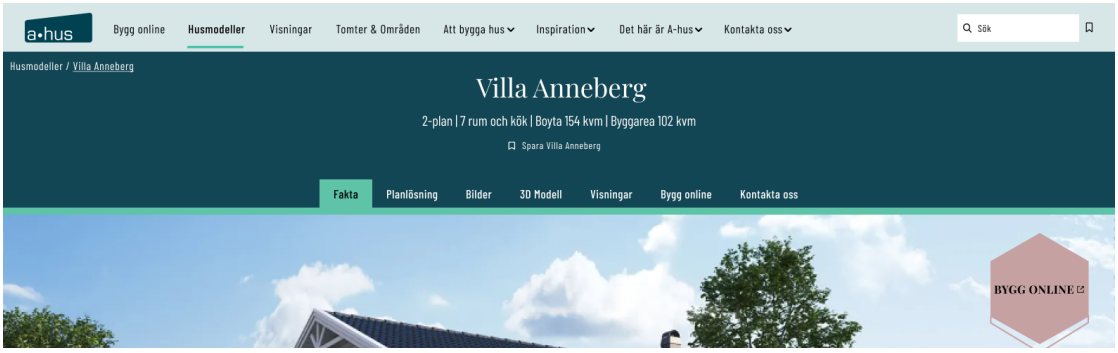


Figure 6.15: A-hus.se: New Design, Suggestion 2: Static Tab Sub Menu

A third option was a dynamic side pane sub menu. The reasoning behind this menu was that it made it easier to map the menu to the specific page and not to the whole website. And that the side menu mapped better when navigating on the page, since it is a long page that scrolls vertically, and so does the side pane menu. With this change we hoped to avoid the main menu versus the sub menu confusion. One negative aspect of this menu however was that it was very similar to the side pane menu located on Husbyggaren. This is negative since we want the user to perceive the two platforms as separate platforms, a perception that is not enhanced by having very similar menus.

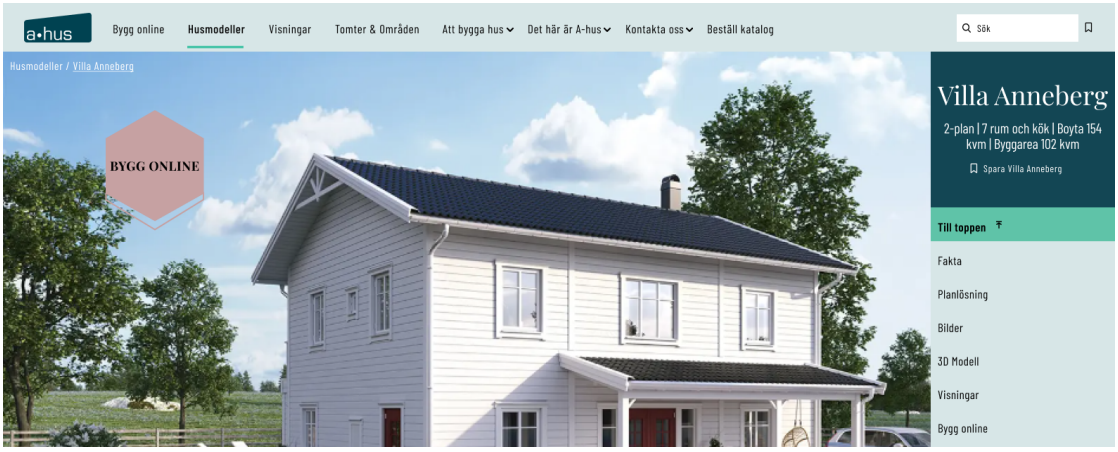


Figure 6.16: A-hus.se: New Design, Suggestion 3: Dynamic Side Pane Sub Menu

Since we found both positive and negative aspects with all types of menus when trying to decide between them, we turned to literature for guidance. Cooper et al. (2014) writes about several different techniques to eliminate navigational excise and reduce users' work effort. One of these techniques is to keep the number of places to navigate between, i.e. windows and views, to a minimum. This is in favour of the dynamic tab sub menu and the dynamic side pane sub menu, but it does not bode well for the static tab sub menu. They also write that keeping the number of panes to a minimum is preferable, which is not in favour of the side pane sub menu but all the others. However, Cooper et al. (2014) writes that although scrolling often

is a necessity it should be minimized if possible, which eliminates both the original dynamic tab sub menu and the sidebar menu and favours the static tab sub menu. To summarize, here we find a trade-of between keeping all things to a minimum; the number of places to navigate between, number of panes and the need for scrolling. In a dilemma such as this both Cooper et al. (2014) advice to follow the mental models of our users. Therefore, instead of having the user scroll through a long page and simultaneously having to keep track of and learn the dynamic sub menu, which has caused confusion, we decided to split the pages information in different tabs and go with the static tab sub menu in figure 6.15 Suggestion 2.

House specific page content
A lot of unrelated content was removed from the house specific page. All content not specifically related to the specific house has been removed. One exception is the contact form that has been kept, although altered to have the specific house already chosen as default. Furthermore, different pieces of information were grouped differently to match each other content wise and to fit the tabs in the sub menu, i.e. Visningar, Digital Visning and Digital Rundvandring beneath the tab "Visningar". Lastly information about Husvisaren has been added and was grouped together with the 3D model of the house under the tab "3D Modell", see figure 6.17.

All these changes are based on both the usability test and literature. It was quite obvious that a lot of our participants in the usability testing were bothered by the amount of information present on the page. When they looked for further information about the house they often got distracted by "fun facts" and "tips" not strictly related to the house, thinking that this content was specific to that house. We also wanted to limit the users' need for scrolling and therefore had to limit the amount of content on the page, i.e. eliminate excise (Cooper et al. 2014).

Lastly, since a lot of participants i UT1 looked for information about Husvisaren at a house specific page closely related to similar topics i.e. "3D Modell", that was an obvious edit since seemed to concur with the mental models of the users, as described in section 3.5. Once again, this change is also in line with the interusability design principle transparency mentioned in section 3.3.2 Even though an extra page has been added that potentially could add to the cognitive workload for the user, it was deemed necessary to add this information to aid the user to create an understanding of all available components in the system. This extra information can also be supported by the concept of knowledge continuity as mentioned in section 3.3.1, as well as continuity through a more logical chain for the task to be carried out and the addition of the transition point, as described in section 3.3.3.2.

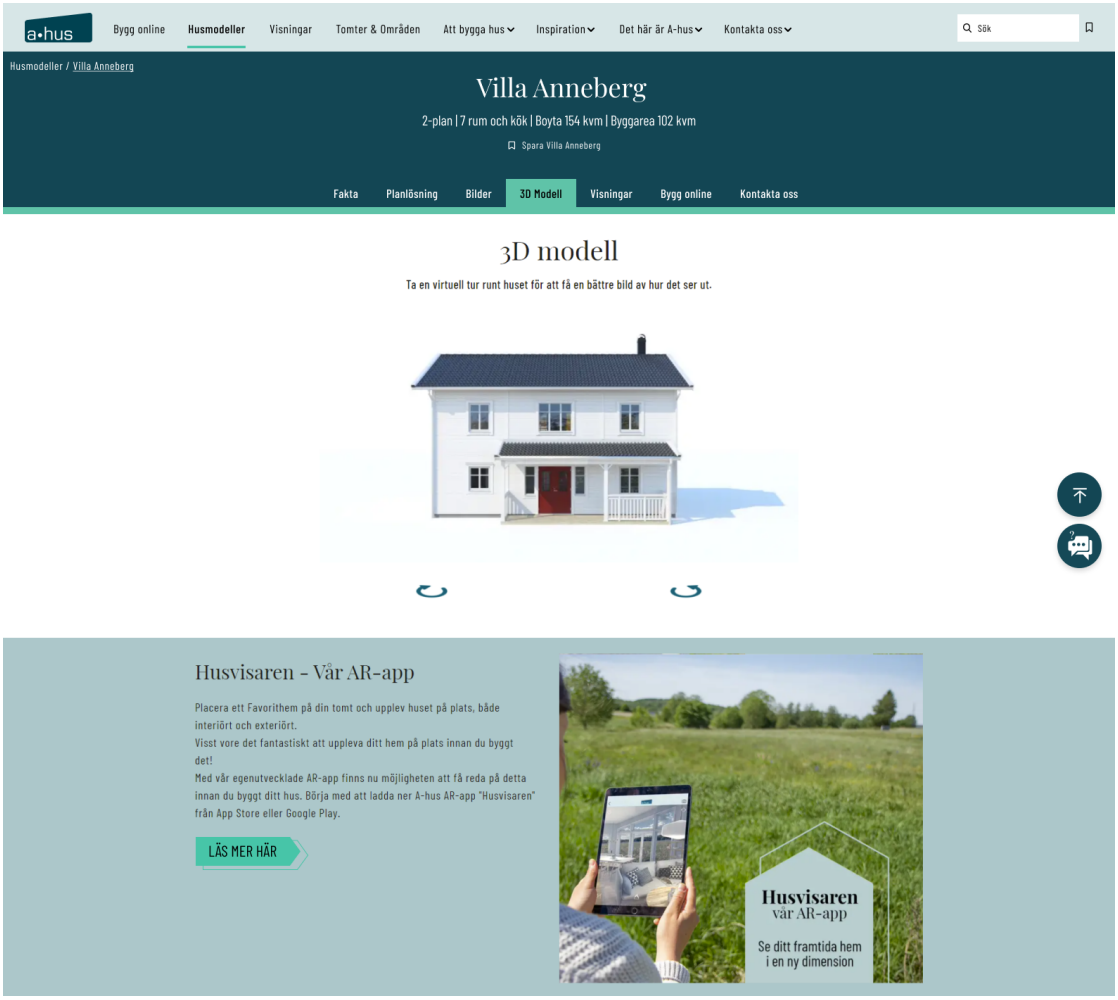


Figure 6.17: A-hus.se: New Design of Husvisaren in a House Specific Page

6.4.2 Husbyggaren

Several participants stated that they were not aware that Husbyggaren was a separate platform from A-hus.se after interacting with both platforms (platform distinction). This was one of the most prominent and troublesome issues found with Husbyggaren. It was mirrored in actions such as the participants opening Husbyggaren from A-hus.se, which was launched in a new tab, then changing their mind and trying to return to A-hus.se by clicking the back-button in the browser. This action was not possible, since they were on a new platform in a new tab which the participants were not aware of. Therefore, a central challenge of re-designing Husbyggaren was to distinguish the platform from A-hus.se. The aim of this decision was to prevent the user from creating a conceptual model of Husbyggaren as a part of A-hus.se. This was done by stripping the platform from everything that was deemed not useful to its core purpose, making it more shallow and look more different from A-hus.se. The design solution stems from the stakeholder meeting (section 6.3.1), and gains further support by the fourth principle of Segerståhl (2011); cut-down

unnecessary redundancy (section 3.3.4).

Outside the house configurator
In the original design of the platform, there were two main pages outside of the house configurator, the house configurator is the location where the house models are customized, see section 2.1.2 for more details. The homepage was linked to the house model page with a button that said “Börja bygg” (“Start building”), which led to a new page with the house models that was available to customize. To enter the house configurator, a button on a house model had to be clicked on.

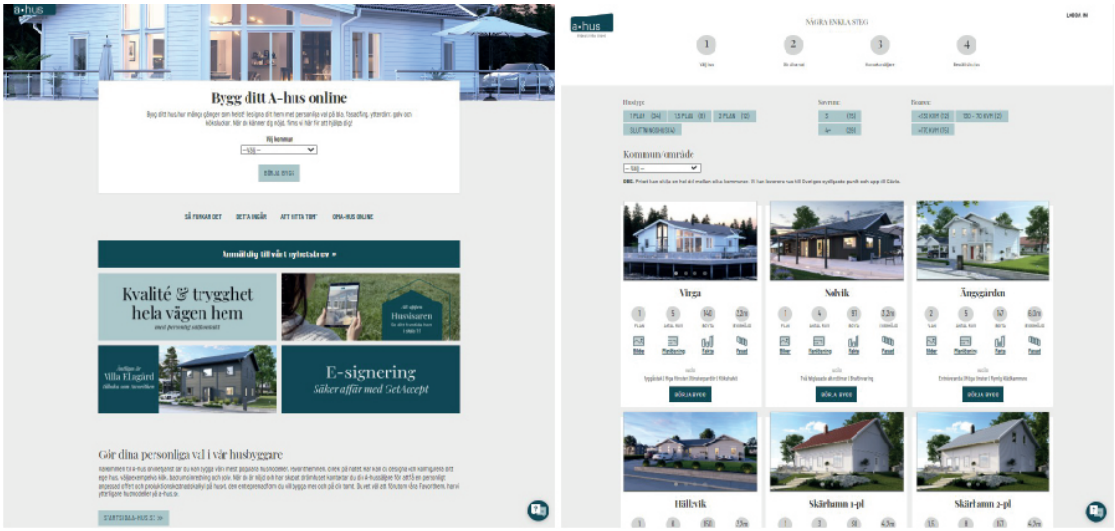


Figure 6.18: Husbyggaren: Original Design, Homepage to the Left and House Model List to the right

The homepage of Husbyggaren was filled with information that was in most cases shared with A-hus.se. The information was not specific to Husbyggaren, and not relevant to be able to understand or use the house configurator. No participant showed any interest in this information. Therefore, the main page of Husbyggaren and the page where the user chooses what house model they want to customize were merged together into one page. Thus, in the new design, Husbyggaren only has one page aside from the house configurator, see figure 6.19. This way, we got rid of much (for the purpose of Husbyggaren) irrelevant and unnecessary redundant content (excise) which could also be found on A-hus.se se.

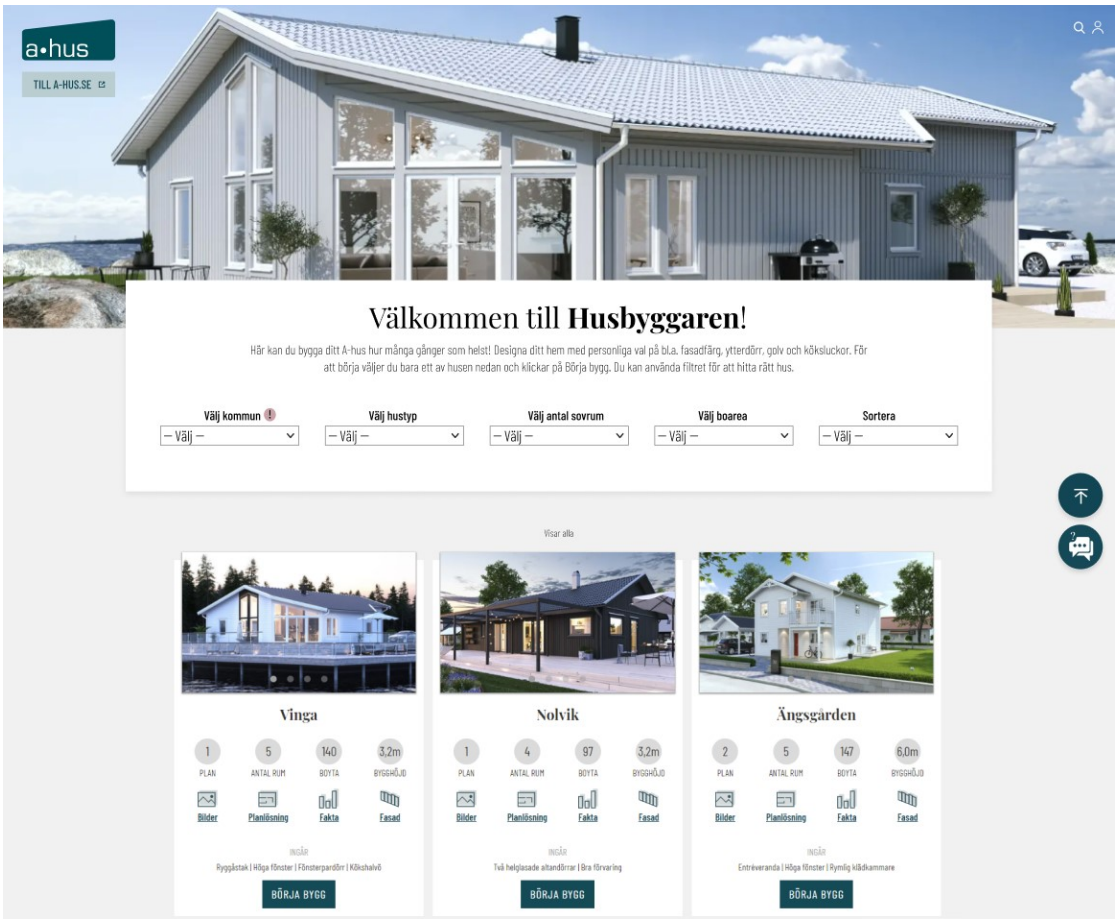


Figure 6.19: Husbyggaren: New Design of The Main Page of Husbyggaren

All filtering functions of the original design were placed in the same panel, and redesigned to look like the filtering functions found on A-hus.se, drawing on the consistency principle (section 3.3.3.3) between platforms. This also made the homepage look structured and thus enabling the user to quickly form an overview of possible interactions. As several participants tried to use the logo to return to their starting point at A-hus.se (which was not a possible action), a transition point was needed in the area. However, the same issue was observed inside the house configurator, but the users who used the logo in the house configurator used it to return to the main page of Husbyggaren. Therefore, in the new design, clicking the logo inside the configuration will transfer the user to the main page of Husbyggaren. But the homepage still needed a transition point to A-hus.se, which led to the decision to put a button just underneath the logo. So, if the user would try to use the logo on the homepage to go to A-hus.se and realize that the action was not possible, the solution to their problem would be found in the immediate vicinity of their pointer. The overall goal with the new homepage of Husbyggaren was to make it appear connected to A-hus.se, but at the same time distinguished enough to look like a separate platform. To achieve this, the platform was made shallow and designed to only contain the most relevant information. In essence, this was an attempt to help the user form the correct expectation of what kind of redundancy they could

expect from the platform. As the platforms are created to be complementary, it is important that the users understand what information the platform shares with the other platforms immediately, to avoid that the users form expectations that the information on A-hus.se is available on all other platforms. In other words, the transparency (section 3.3.2) of the platform was altered to help the user form a correct representation of the composition (section 3.3.3.1) of the cross-platform service.

Inside the house configurator

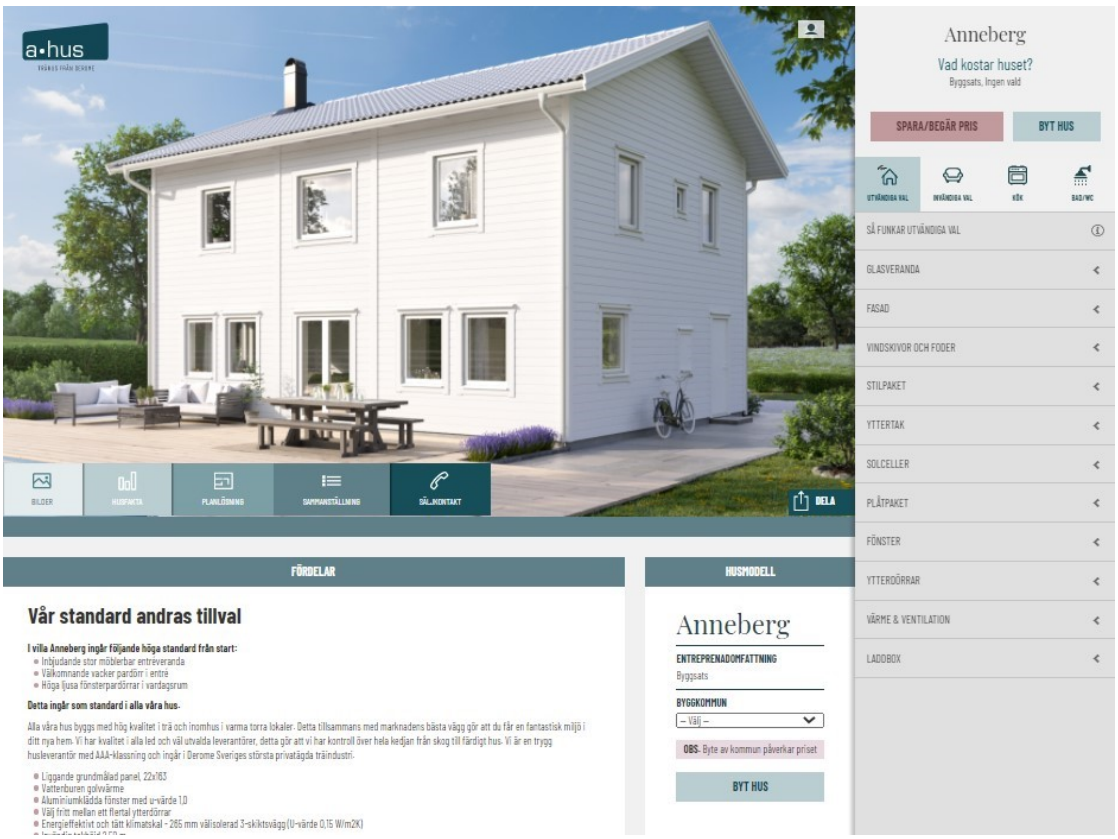


Figure 6.20: Husbyggaren: Original design of house house configurator

The issues discovered inside the house configurator for the original design were largely related to the participants trying to exit the house configurator. Several participants ended up feeling stuck and needed help to navigate to the main page of Husbyggaren, in other cases they used A-hus.se as a detour changed tab in their browser to an open tab of A-hus.se, and re-entered Husbyggaren to reach the main page. The logo inside the configuration was not clickable, although several participants expected that it was (see solution above). The users did not appear to have any issues with the toolbar on the right side, however, “Byt hus” (“Change house”) was missed by most participants. It was also the only transition point that let the user return to the main page of Husbyggaren. The information section under the picture of the house was interactable by using the tabs to change content. However, the tabs did not give any feedback of what tab was currently chosen, which made

the navigation unnecessarily complex. Several users did also look for the requested AR-function within the tabs, but it was not located there. The information about the app could only be found on the homepage of Husbyggaren.

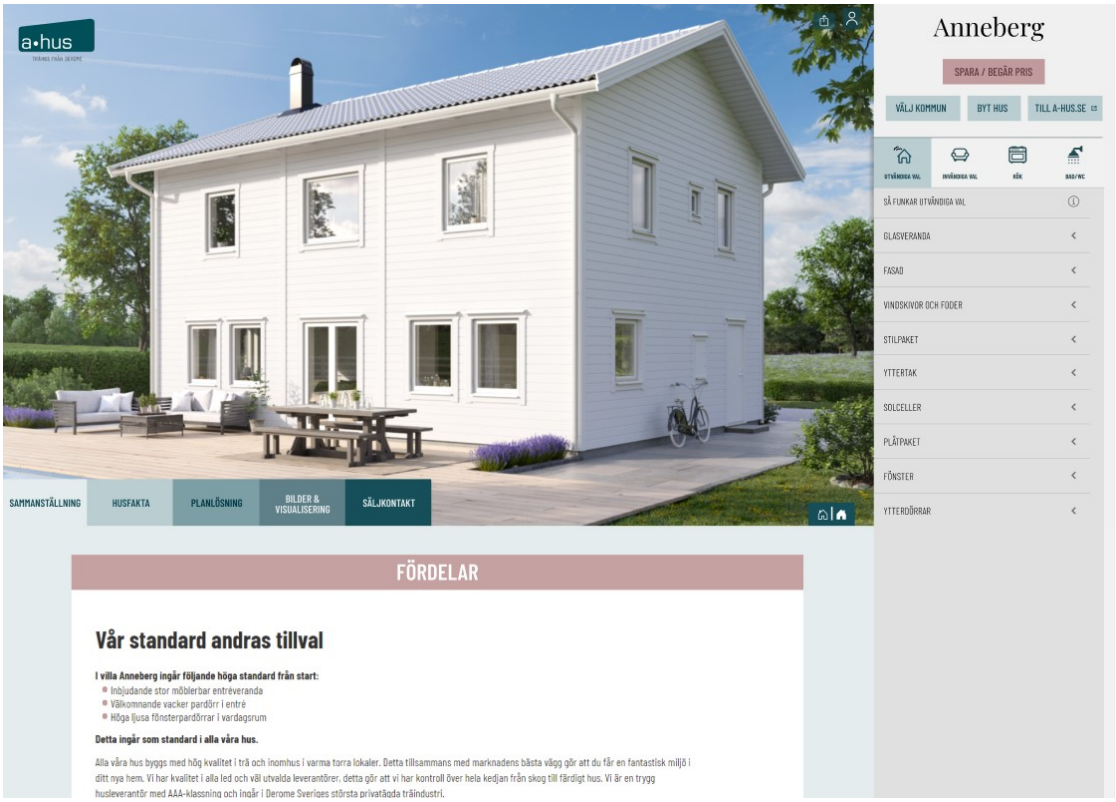


Figure 6.21: Husbyggaren: New design solution of house configurator of Husbyggaren

The overall appearance inside the house configurator has not been changed very much, as no major structural issues were discovered. In the top right corner the two buttons of the original design still remain, but they are accompanied by two more in the new design solution. As this area contained the only transition point from inside the house configurator in the original design (and unused by the participants), the idea was to highlight the area as a toolbar with similar transitional functions in the new solution, to make the top part of the panel appear as a space where transitions are possible. The red button “Spara/Begär pris” (“Save/Request price”) remains more salient than the other buttons in this design as well, as it is a feature important to the MHM context. From the panel it is possible to return to the main page by clicking on either the logo, or the “Byt hus” (“Change house”) button. To return to A-hus.se, the user can click on “Till A-hus.se” (“To A-hus.se”). Furthermore, the tab area has been changed to give more feedback of what tab is currently selected. In the new design, the background of the tab section matches the colour of the tab, which was not the case in the original design. This is thought to facilitate the navigation of the tabs, which is important since essential information can be found in the tabs.

An observed issue was that no participant was able to find the available information about Husvisaren on the homepage of Husbyggaren. Several participants found it by using A-hus.se as a bridge platform, and those who looked for the app on Husbyggaren looked inside the house configurator. Therefore, information about the app was, in the new design, placed under the tab “Bilder & Visualisering” (“Pictures & Visualisation”) in the house configurator to provide transparency (section 3.3.2). Conclusions were drawn that it might be a more suitable place to locate the information about the app there. As no current tab label matched the concept quite right, “Visualisering” (“Visualisation”) was added to “Bilder” (“Pictures”), as they can be seen as similar concepts, and “Visualisering” better describes the AR-app content. These concepts are also grouped together similarly in the new design of A-hus.se, which maintains some consistency. A decision was also made to make the information under the tabs appear in only one column, as the double-column design of the original design made the area seem unstructured and cluttered, creating visual excise.

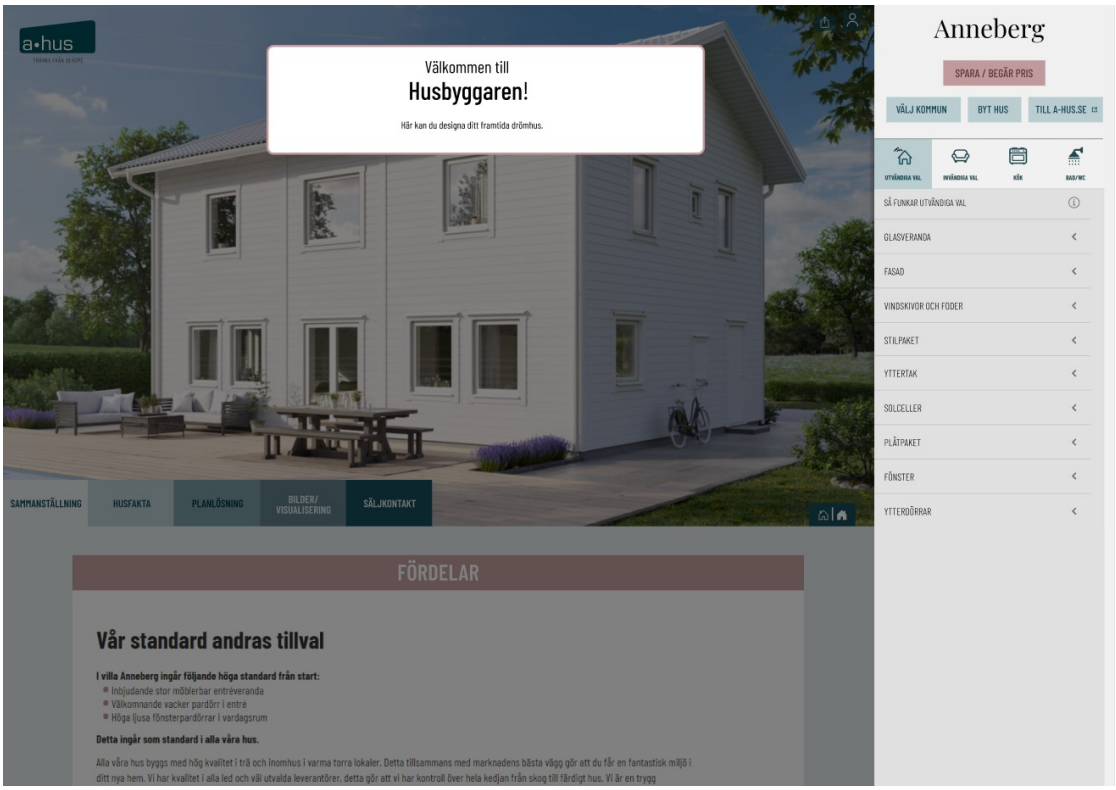


Figure 6.22: Husbyggaren: house configurator arrival overlay

An overlay was added, figure 6.22, to appear when the user opens up Husbyggaren through a transition point which leads directly into the house configurator, e.g. open Husbyggaren from a house specific page on A-hus.se. The overlay provides modeless feedback as it disappears after a few seconds, or if the user clicks anywhere. We wanted to create a clear signal that the user has opened up a new platform without creating too much excise and to promote knowledge continuity (section 3.3.1.1), and

help the user form a correct mental model. A second overlay was also added, figure 6.23, to appear when the user makes a decision to return to the homepage to change house. The reason for this is that unsaved changes might disappear when this action is made, which should be avoided. Another reason is to nudge a user to create an account where they can save customized houses.

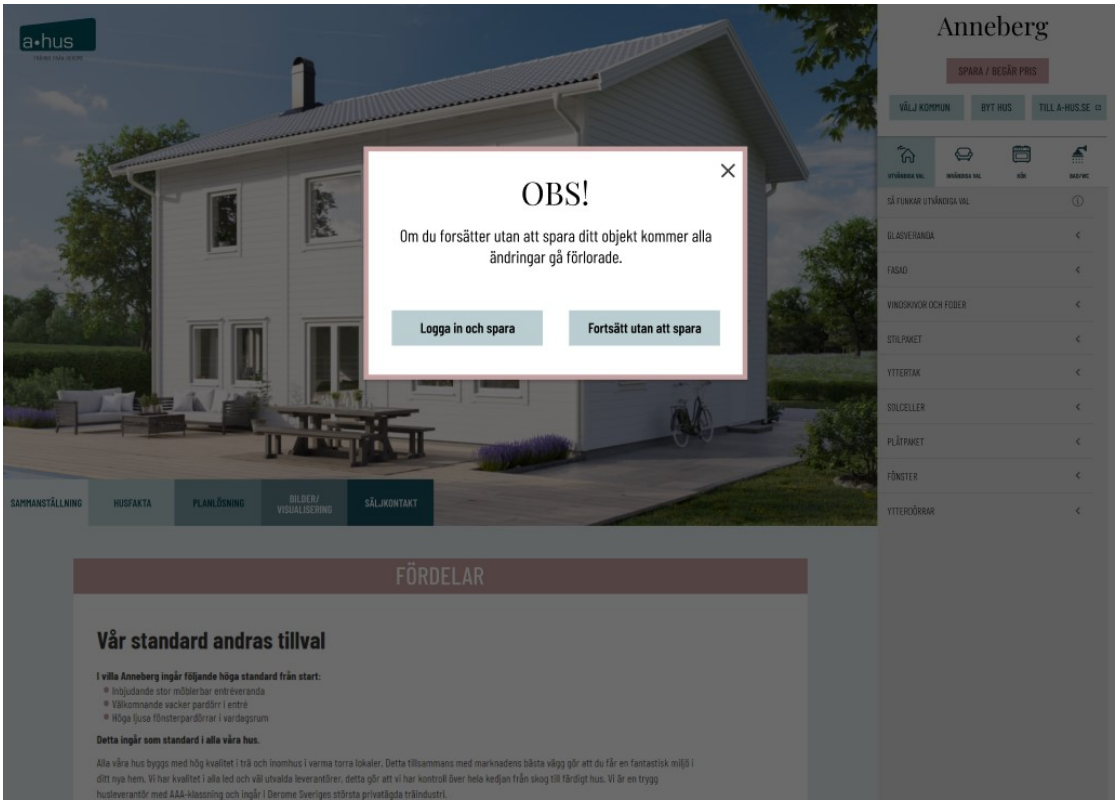


Figure 6.23: Husbyggaren: Leaving house configurator overlay

6.4.3 Husvisaren

From the findings of UT1 we noticed two main patterns regarding Husvisaren. One was that a lot of participants had trouble leaving the app (interusability navigation). This might be a test design confounding that the user forgot that they were interacting with a mobile application. But it might also be due to not finding the available transition points. Therefore, we aimed at changing and adding extra transition points in this prototype. The other main pattern we noticed was that some of the users did not seem to understand the limitations of the app and tried to execute functionalities and find information that was not available in the app (expectation vs possible action). Therefore, we aimed at providing clarity to what was possible to do in the app.

Welcome screen
Not many changes were done on the welcome screen of Husvisaren. The header, the footer and the hamburger menu were removed and the name of the app "Husvisaren" was made more salient. These changes were made to make a clear distinction that this is only a welcome screen and eliminating extra navigational excise (Cooper et al., 2014).

Figure 6.24: Husvisaren: Welcome Screen, Original Design to the Left & New Design to the Right

Hamburger menu
The navigation functions and the titles of the hamburger menu were remodelled quite a bit. The results of the UT1 showed that a lot of the participants had problems transitioning from Husvisaren to A-hus.se and that none transitioned from Husvisaren to Husbyggaren. Furthermore, out of seven links in the original hamburger menu, four of them would transfer the user directly to the web browser. The other three would open "overlays" instead of views. This led to a confusion for the participants about how they could use the hamburger menu. For instance, users would click on "Produktval", expecting that it would help them change their house model (the product of A-hus) or lead them to "planlösningar för tillval" (optional floor plans), which was not the case since an overlay of all products (appliances) used in the 3D model of the house was listed. To avoid these kinds of confusions "Husmodeller" was added in the menu to lead the user to the view with all house

models. Furthermore, all links in the menu were redirected from leading to overlays to lead to views instead. Lastly, we singled out two links that had to be the only ones that transferred the user to another platform, “Till A-hus.se” and “Till Husbyggaren”. The rest of the links could just as well have their own informational views in the app. The two transition points to A-hus.se and Husbyggaren were made into two more distinct buttons accompanied with a “new tab”-icon to hint that clicking on these will result in a new platform being opened, see figure 6.25.

Most of the changes made in the hamburger menu was based on the findings from UT1, but many of them could also be supported by vertical usability principles. This means removing the overlays and keeping the user on the same view would hopefully reduce confusing navigational excise and grouping the links in the hamburger menu differently to single out different functions (Cooper et al., 2014). Singling out the transition points also promotes interusability principles transparency (section 3.3.2) and continuity (section 3.3.3.2) by making it clear what more components are available. Hopefully, these transition points will become more noticeable and used to a greater extent, and remove the need for a bridging platform.

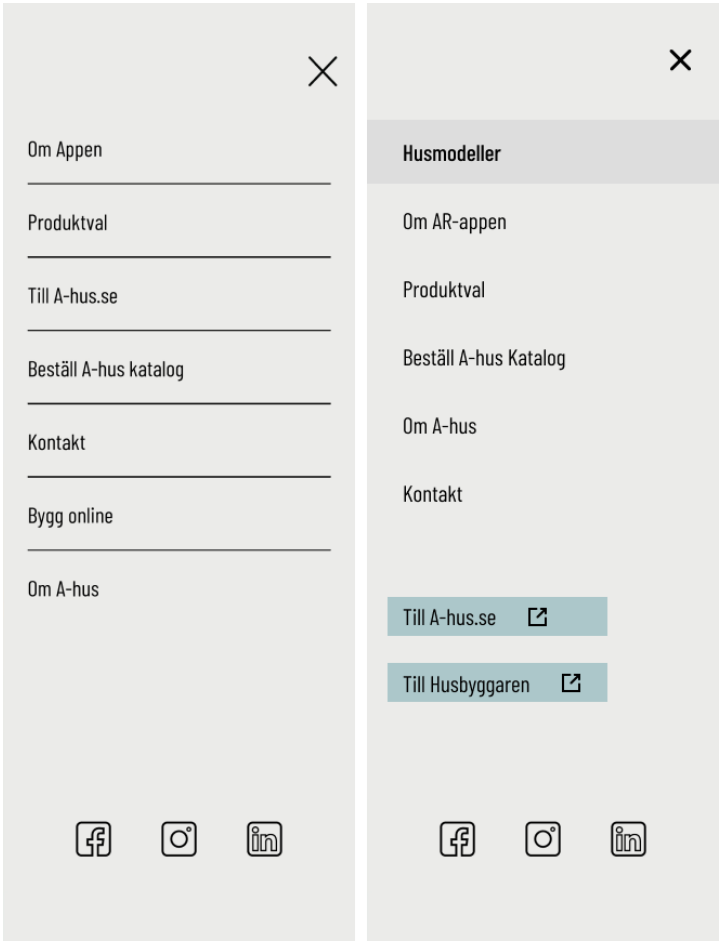


Figure 6.25: Husvisaren: Hamburger Menu, Original Design to the Left & New Design to the Right

Husmodeller

Apart from changing the layout of the filter-function and adding a sorting-function as vertical usability principles (Cooper et al., 2014) an active transition point accompanied with "new tab"-icon was added as a footer to promote continuity (section 3.3.3.2), see figure 6.26. The same kind of text was present in the original design, but did not function as a transition point, it was only an informational text. The new transition point as footer will appear on all views (except in the AR-view) to keep consistency as described in 3.3.3.3.

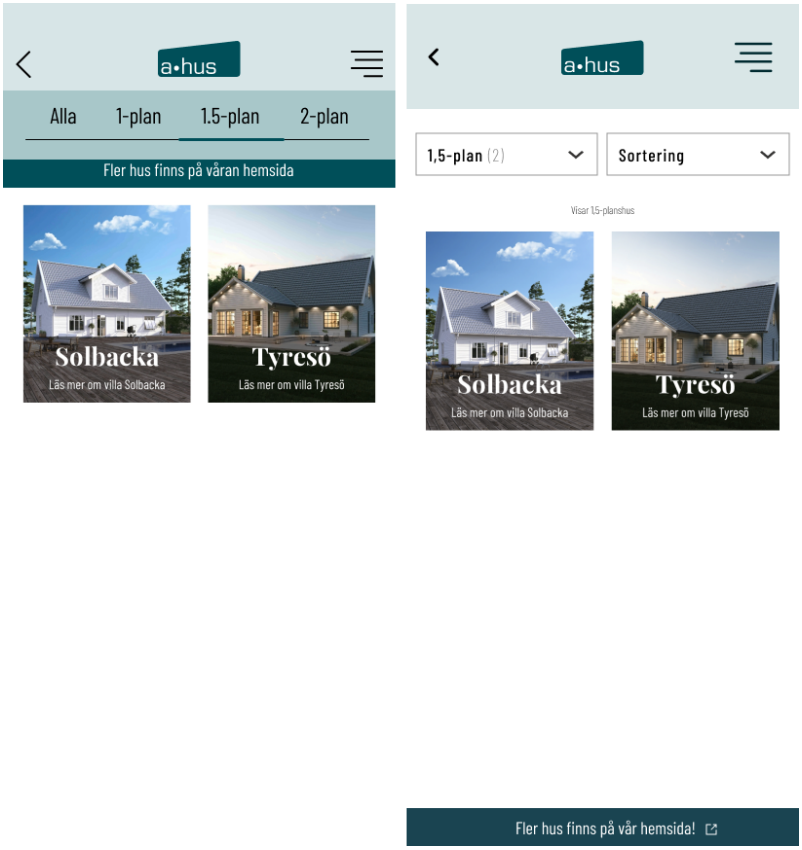


Figure 6.26: Husvisaren: House Model List View, Original Design to the Left & New Design to the Right

House specific view

The hidden curtain with a link leading the user to Husbyggaren has been removed, see figure 6.27. This decision was based on the fact that none of our participants in UT1 have noticed the curtain, making the function unnecessary. Furthermore, based on the designable characteristic to cut-down unnecessary redundancy in section 3.3.4 we tried to limit unnecessary functions to keep the platforms easy. Remaking the link, such as a transitions point button, could have been motivated by it functioning as a promotion for Husbyggaren through transparency. However, since the two platforms share no synchronized data, such as where the user can see their customized house in Husvisaren, we believe that promotion for Husbyggaren at this view is misleading as described in section 3.3.3.2 continuity. A transition point to A-hus.se

was added as a footer however, since more information about this house model can be found at the house specific page on the website. The transition point is the same kind as the one previously mentioned to keep perceptual consistency as mentioned in section 3.3.2, although it does lead to that specific house page at A-hus.se, rather than the homepage to promote continuity (section 3.3.3.2).

The tab within a tab menu was changed due to participants struggling with understanding that there are several different AR/3D options available with different functions. We believe that the tab system was designed to avoid scrolling and thus facilitate the understanding of the functions, but it might not serve its purpose very well. Instead, users might get a better overview of all functions with the new design solution. Furthermore, the outer tab navigation was not clear enough, because the tabs do not match the colour of the background, which makes it unclear what tab you currently have selected. Therefore we changed its colours to provide a bit more clarity and internal consistency (Cooper et al., 2014).

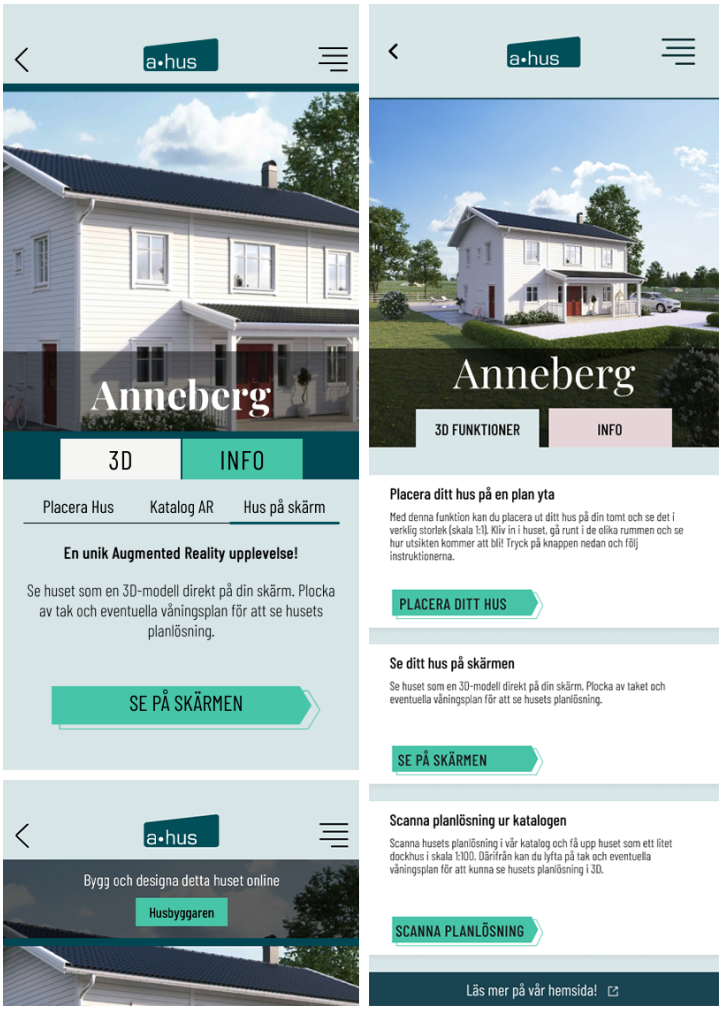


Figure 6.27: Husvisaren: House Specific View, Original Design to the Left New Design to the Right

Contact
When clicking on "Kontakt" ("Contact") in the hamburger menu in the original design the user was transferred to a A-hus.se page with six different kinds of contacting ways. Since the tasks in our UT1 did not include the contact-form we did not see any interactions with it. However, this kind of transition was deemed unnecessary since this is the kind of function that could as well be available in the app, since A-hus want their customers to have easy access to them. Therefore, instead of forcing a transfer, two of the six options provided in the original design (when being transferred to A-hus.se) are provided here. The two options are divided into tabs, to reduce scrolling, see figure 6.28.

Figure 6.28: Husvisaren: New Design of Contact view

6.5 Evaluate

In order to explore the field of interusability, and ultimately establish key interusability factors, the original design of the cross-platform service of A-hus was evaluated in UT1 to outline the circumstances of current interusability. Thereupon, all data extracted from UT1 was synthesized and interpreted, which lay the foundation of the succeeding ideation stage. The results from UT1 and the ideation, together with

the design guidelines of interusability established in literature, the original designs of the platforms were revised and redesigned according to the gathered material. This led to three interactable prototypes, one of each platform. The prototypes, which correspond to the original functionality of the current cross-platforms service, were then evaluated, by re-using the same usability test as original platforms underwent. The evaluation will work as a validating tool, where the resulting data potentially could point to the impact and importance of the alterations that were made in order to shape and improve the interusability of A-hus' cross-platform service. Furthermore, the evaluation will serve as a basis when establishing key interusability factors within the MHM context.

6.5.1 Usability test 2

The second usability test, henceforth referred to as UT2, was implemented by re-using the same test set up as UT1 (see section 6.1.3 and 6.1.4.2), with some minor alterations described in section 6.5.1.1. The same test set up was used to be able to compare the test results of the original design of the cross-platform service with the test results of the new, redesigned cross-platform service. The comparisons, the extracted data from UT2, and other material collected throughout the project will be considered when answering the research question of the project in the final parts of this report.

6.5.1.1 Preparation and changes from UT1

The set up for UT2 was essentially the same as UT1, however some minor changes were made before UT2 was initiated. Firstly, the tasks and the questionnaires were not altered in any way. For the concluding semi-structured interview of every test session, a set of questions were changed as a way to extract and adapt the interview to the elevated evaluative test-angle of UT2. What differed the most between UT1 and UT2 was the test environment. UT1 was held on the actual platforms of A-hus, while UT2 was completely based in Figma as interactive prototypes. This was a necessary arrangement, as it was not an option to implement the solutions on the real platforms for UT2. This also altered how the participant could open Husvisaren. Instead of being given a link by the facilitators, we had implemented an interactive hotspot at the "AppStore" and "Google Play" symbols leading the user directly to the Husvisaren frames as if they downloaded the app. These symbols were located wherever information about Husvisaren was placed. However, it had some implications regarding the possibilities of tab-navigation, which will be discussed further in chapter 8, Discussion. Another change from UT1 is that a smaller sample of participants was recruited, see section 6.5.3.1.

6.5.1.2 Pilot testing

One pilot test was conducted. The main objective of the pilot test was to check that the animations of the prototypes worked as intended, if any spaces or views of the platforms were missing, and if anything related to the structure of the test needed to be changed before initializing the actual tests. The pilot test revealed no

deficiencies with the animations of the prototypes, and no spaces or views seemed to be missing. However, the constrained navigation, that the participants in UT2 would not be able to use tabs to navigate between the platforms, was noted as a potential impact. To neutralize this difference as much as possible, it was decided that the test facilitator would inform the participant about a new tab opening every time the user performed an action that in reality would open up a new tab, for instance clicking on any link leading to Husbyggaren from A-hus.se.

6.5.1.3 Participants

The target groups still remained the same, due to the time consuming process of conducting, transcribing and analysing the usability tests, four participants were recruited, which is two less than in UT1. Like in UT1, the participants had no previous experience of A-hus's digital platforms in order to avoid biases such as training effects when comparing the current and the original design. The selection of participants was a convenience sample. Of the four participants, two were women and two were men. Two women and one man were in the age group 25-35, one man was in the age group 46+. One in the age group 25-35 fit into the target group "Medvetna Barnfamiljen" except for their age. One was a student, three were employed.

6.5.1.4 Tools and procedure

As with UT1, UT2 was held remotely due to the ongoing pandemic, using the online video conference tool Zoom, the online survey tool Google Forms and the online design and prototyping tool Figma. The prerequisites and procedure was the same as UT1 (see section 6.1.4.2.). The same tasks were used, and the same questions were asked in TS and CPUS. As mentioned in section 6.5.1.1, the only changes made was a few different questions in the concluding interview (see appendix F). Two participants were assigned each to Task Order 1 and Task Order 2 (see figure 6.2 and 6.2 for clarification).

6.5.1.5 Processing of data

The same measures were taken to process the data of UT2 as was taken with UT1 (section 6.2.1). The recorded test sessions were anonymized, transcribed and coded. The quantitative data was extracted and summarized (see section 7.1), and the qualitative data was put into a new rainbow spreadsheet (see appendix I). The quantitative and qualitative findings of UT2 will be summarized and presented in the following sections 7.1-7.2.

7
Results

In the following sections, the comparative results from UT1 and UT2 will be presented and analysed. The results presented in section 7.1 and 7.2, together with learnings and reviewed literature is the foundation of the key interusability factors presented in section 7.4.

7.1 Comparison of quantitative findings

Table 7.1 and table 7.2 are the compiled results of the quantitative data extracted from UT1 and UT2. Both usability testing sessions were based on the same test setup, where the participants performed the same tasks. All tasks were designed to contain a transition between two platforms. The data corresponding to each metric in the table was collected for all participants when performing all tasks. This generated one data set for the participants of UT1 and one data set for UT2. The tables show the mean value of each metric, calculated from all participants from UT1 and UT2 respectively. "Task completion" is an exception, the proportion represents how many out of all participants for each UT were able to complete the task. Table 7.3 shows the mean CPUS score for UT1 and UT2.

The three tables 7.1, 7.2, and 7.3 represent the results of the two usability tested versions of the same cross-platform service in numbers. The quantification of the usability tests is not made to be used in a statistical analysis. It is rather a data synthesis which can be used to analyse the impacts of alterations made to the original versions of the platforms. We will therefore be careful to draw any definitive conclusions based on the comparison. The quantitative comparisons will be used to potentially add a dimension to the conclusions regarding key interusability factors that the project will ultimately result in.

Table 7.1: UT1 and UT2 Comparison: Metric Means for all Participants per Transition AB, BC & CA

Transition	AB		BC		CA	
	UT1	UT2	UT1	UT2	UT1	UT2
Metric						
Execution time	01:02	02:04	05:04	02:20	02:05	01:24
Unproductive time	00:04	00:52	03:20	00:00	01:05	00:37
Actions	5,3	8,8	21,5	7,25	15,3	10,8
Errors	0,17	2,5	7,8	0,25	9,2	3,5
Hints required	0	0,25	1,7	0	0,17	0,25
Task completion	6/6	3/4	2/6	4/4	5/6	3/4
Transition Scale	4,4	4,4	2,1	4,6	3,1	4,4

Table 7.2: UT1 and UT2 Comparison: Metric Means for all Participants per Transition AC, CB & BA

Transition	AC		CB		BA	
	UT1	UT2	UT1	UT2	UT1	UT2
Metric						
Execution time	05:39	01:06	02:23	02:01	01:00	00:46
Unproductive time	02:43	00:00	01:16	01:05	00:17	00:00
Actions	21	7	20,3	18,3	6	5,3
Errors	12,3	0,5	11,2	8,8	1,2	0
Hints required	2,2	0	0,3	0,8	0	0
Task completion	2/6	4/4	5/6	2/4	6/6	4/4
Transition Scale	2,5	4,5	3,2	4,1	3,6	5

Note. A = A-hus.se, B = Husbyggaren and C = Husvisaren. I.e. Transition AB corresponds to a task beginning at A-hus.se and ending at Husbyggaren. For all individual scores per participant, see appendix H.

Table 7.3: Cross-Platform Usability Scale Score for UT1 & UT2

Metric	**UT1**	**UT2**
CPUS	2,1	3,9

There are a few interesting aspects to be found in the quantitative comparison. Generally, it seemed that all tasks took a shorter amount of time to execute in UT2, except for AB. The most notable difference can be found for task AC, where the mean execution times differed with 4 minutes and 33 seconds between UT1 and UT2. This may indicate that the execution of the task which began on A-hus.se and ended at Husvisaren took a considerably shorter amount of time when alterations had been made to the original design. The average number of actions required for each task generally also decreased in UT2. As these metrics correspond to the efficiency attribute, the average decrease may be an indication that the cross-platform service can be more efficiently used. Furthermore, the amount of unproductive time spent during the tasks also became considerably shorter in general, which in turn may indicate that the participants of UT2 spent less time seeking help or recovering from errors, i.e. they were able to be more productive.

The comparison of how effectively the participants were able to use the cross-platform service regards the combination of required hints needed, number of errors made and whether the participants were able to complete the tasks with or without hints. Generally, the average number of errors made decreased for each task in UT2 except for AB. However, no stable improvements of required hints or task completion can be seen in UT2. This means that it is not possible to draw any conclusions about the improved effectiveness of the new designs of the platforms. Furthermore, the TS score were generally higher for all tasks in UT2 compared to UT1, except for AB where the score remained the same for both tests. On average, the TS scores were between 4,1 and 5 for all tasks in UT2. The tasks in UT1 were rated between 2,1 and 4,4. These results may indicate that the participants generally experienced more continuity with the transitions in UT2. What is also noteworthy is the CPUS score. The average CPUS score of UT1 was 2,1, in contrast to the average CPUS score of UT2 which was 3,9. This could indicate that the overall satisfaction experienced with A-hus's cross-platform service was improved when the interusability alterations were made to the platforms.

Out of all tasks, the comparison between AC and BC revealed the largest decreases of all mean values, except for the TS score which increased for both tasks. Thus, it might be the safest assumption to make from all tasks that the interusability was improved for AC and BCs. Hence, the interusability alterations made to improve the transitions to Husvisaren from both A-hus.se and Husbyggaren might have had an effect. The comparisons for the CA, CB and BA tasks demonstrated small decreases in the majority of mean values from UT1 to UT2. The results may indicate that the

transition from Husbyggaren to A-hus.se were experienced as easier to execute. The results of CB were slightly lower in execution time, unproductive time and number of actions in UT2. However, the proportion of participants completing the task was lower in UT2, meaning that proportionally fewer participants were able to complete the task without help in UT2. The TS score was, however, higher for UT2 compared to UT1 for CB. The mean values of BA for both UT1 and UT2 are relatively low in execution time, unproductive time, actions, errors and hints required. This may indicate that the task is generally experienced as one of the less difficult ones for both UT1 and UT2. However, the results are slightly better for UT2, and the task is the only one to receive a perfect TS score of 5. AB was the only task to exhibit better mean values for UT1 than for UT2, except for the TS score which remained the same for both tests.

Overall, we believe to be observing a positive change in the experience of the cross-platform service between UT1 and UT2 based on the quantitative findings. The majority of the metrics showed signs of improvement in general. The execution time and unproductive time were lowered for all tasks except for AB. The number of required actions and errors also decreased on average for all tasks except for AB. However, for tasks AB, CA, and CB more hints were required in UT2, which resulted in a lower rate for task completion. The results of this quantitative comparison will not stand on its own in any conclusion. It will rather be used together with all gathered data collected during the project, and the qualitative findings presented in section 7.2 Qualitative findings to establish the key interusability factors within the given context, presented in section 7.4 Key interusability factors.

7.2 Comparison of qualitative findings

In this section the qualitative findings from the UT2 will be compared to the qualitative findings of the UT1. The comparison will be structured following the patterns of negative observations made by the facilitators and statements made by the participants in table 6.4.

7.2.1 Navigation

In UT1 we noted that participants perceived the navigation system at A-hus.se hard to use as a novice. This was not the case for UT2, which is reflected in the quantitative data in table 7.1 and 7.2. For UT1 half of the participants expressed that the navigation system should be more obvious and visually clear and wished for a more seamless transition to not perceive the change between platforms. We did not hear any such opinions during UT2 nor any expressed difficulties in navigating on A-hus.se. For example, during UT1 half of the participants experienced issues with the sub menu at the house specific page at A-hus.se, but no one experienced issues with the new sub menu during UT2. During both UT1 and UT2 there were generally no problems for the user with the internal navigation in Husvisaren, presumably because it is a very shallow application. Although, some problems were observed for two participants when they were trying to leave Husvisaren during UT2. Their

first instinct was to “go back” using the back button, resulting in them ending up on the welcome screen where no hamburger menu was available and them having to click on “Börja här” (“Start here”) again to reach the hamburger menu on the house model list view. Although both of these participants understood this quickly, it did create some unnecessary irritation. Optimally, this welcome screen should only have been shown when the user opened the app, and impossible to reach again.

Regarding the transitions between the platforms, a lot of participants stated that it was hard to find natural transitions between the platforms in UT1. For UT2 the participants experienced no issues with transition BA, BC, AC and all but one participant for AB and CA. During the CB transition (Husvisaren to Husbyggaren) one participant used the transition point in the hamburger menu as intended and found its way to Husbyggaren, compared to no one using it during UT1. Another participant in UT2 also used the transition point in the hamburger menu, but instinctively thought that they had ended up in the wrong place and turned back to Husvisaren (using the back function in the web browser). Despite some challenges still remaining with the interusability, one stated that it was generally easy to learn how to transition between the platforms. Furthermore, another participant in UT2 found the transition point “Bygg online”-button on the house model list page at A-hus.se seen in figure 6.12. The participant used it correctly and not by mistake as in UT1. This was a great validation since one apprehension was that it might not be perceived after we had made it less salient.

In UT1 we saw instances where the participants did not find any transition point in Husvisaren and chose to transition through open tabs in the web browser. This is generally not a problem, since in reality the user could put down their phone and switch to the computer. Although, it does hint to some interusability issues if the user is unable to find any transition points. This is quite hard to compare to UT2. As a result of the test being run in one Figma prototype, the participants were not able to transition through tabs at all, and thus were forced to find the transition points inside the platforms, which all of them did relatively easily. One participant in UT2 stated that they usually thought that it was stressful to navigate through tabs anyway. Although, three participants did mention in the concluding interview that it would feel "better" to navigate by tabs. Despite this obstacle and despite that all participants did feel stuck in the app at some point, both the transition points to A-hus.se in the hamburger menu and the footer was used without any problems, which is reflected in the quantitative data for transition CA. Although, one participant did mention that it could be easier to transition from the app. Another participant stated that it was easier to transition to the app than from the app and that out of the three platforms Husvisaren was the least clear to use.

In UT1 four participants stated that it was impossible to transition from Husbyggaren to A-hus.se, and two even got “stuck” in the house configurator in Husbyggaren. In UT2 no one experience issues with the transition BA (Husbyggaren to A-hus.se) and all quickly realized which platform they had to transition to complete the task. One participant transitioned by clicking on "Byt hus" (“Change house”)

in the house configurator, and then clicked on “Till A-hus.se” (“To A-hus.se”) on the homepage of Husbyggaren. Whilst the three others clicked on the A-hus logo in the house configurator then clicked on “Till A-hus.se” on the homepage. During UT1 several participants tried to click on the logo but that feature was not available in the original design, and none clicked on “Byt hus”. For the transition BC (Husbyggaren to Husvisaren) one participant in UT2 expected to reach A-hus.se by pressing the logo (ended up on Husbyggaren home page). This expectation was also observed in UT1, however for that design the logo was not clickable as mentioned.

7.2.2 Information presentation

In UT1 participants stated that too much information is presented at the same time in A-hus.se on a house specific page and that the presented information felt illogically placed. This resulted in a longer execution time since they were trying to navigate through and understand all information, much of which was excise. During UT2 we heard none of these statements and observed none of these behaviours. For instance, during UT1 none of the participants found information about Husvisaren and all of them felt frustration due to this. In UT2 no one of the participants had problems with finding information about the app in A-hus.se.

Another observation in UT1 was that participants seemingly had problems with identifying tabs in menus by their names. For UT2 we saw this as well, although under slightly different circumstances. One participant stated that “3D Modell” in the sub menu at A-hus.se sounded like a reasonable place to find a customization tool when they were looking for Husbyggaren (which is found in “Bygg online”). And despite adding the “Husmodeller” tab in the hamburger menu in Husvisaren, participants still clicked on “Produkval”, although this time only when they were looking for “planlösningar för tillval” (optional floor plans).

7.2.3 Platform as bridge

Using A-hus.se as a bridge for the transition between Husbyggaren and Husvisaren during UT1 seemed to be the most common strategy. This bridging strategy decreased in UT2, but some occurrences were still observed under, however under different circumstances. During UT1 this phenomenon was more of an adaptation due to lack of clear transition points, and during UT2 it was more of a strategy. Two participants from both orders in UT2 used A-hus.se as a bridge in BC (Husbyggaren to Husvisaren); these two did not seek out information about the AR function at Husbyggaren at all. The other two found the transition point for Husvisaren rather quickly in Husbyggaren by actively looking for information about the AR function in Husbyggaren and found it in the first place they looked (under “Bilder & Visualiseringar”). During the transition CB (Husvisaren to Husbyggaren) in UT2, three participants used A-hus.se as bridge, although two of these did it as an active choice since they quickly realized what platform to transition to. As mentioned, the third participant found the transition point to Husbyggaren from Husvisaren. Although they felt uncertain about the homepage and went back to A-hus.se to go to Hus-

byggaren through a house specific page. A possible explanation to this is that the user might have felt some confusion about the labelling “Till Husbyggaren” instead of “Bygg Online” which almost every other button to Husbyggaren is named. This is a lexical consistency fault of the design.

A-hus.se is the only platform that has been used as a bridge. When asked about why they used the website as a bridge, one participant from UT2 answered that when they felt slightly uncertain what to do, their instinct was to “reset” the task and go back to “the beginning”, i.e. looking for A-hus.se. This poses the question if information about Husbyggaren should have been available in Husvisaren to promote transparency and knowledge continuity as with the extra page about Husvisaren at A-hus.se.

7.2.4 Similar concept expectation

In UT1 participants expected to find the AR-function beside similar content at A-hus.se, e.g. 3D Modell, Digital Rundvandring, Digital Visning and Bilder (where it could not be found). Since information about Husvisaren (and thus the AR-function) was added beside the 3D model in the new design, several participants in UT2 did find the information and used it to their advantage.

7.2.5 Expectation versus possible actions

The expectation to be able to conduct an action in a platform where it was not possible decreased between the two tests, although present in both. In UT1, four participants tried to customize the house in Husvisaren compared to two people in UT2. This might be due to the participant not having enough time to understand all functions of Husvisaren since the task gave the participant very little time to build a full understanding of its functions. Both of the participants for UT2 had not heard about Husbyggaren before this interaction and might therefore have anticipated the given task would be possible to conduct on the current platform.

7.2.6 Platform redundancy and platform distinction

In UT1 we had participants expressing a wish for more redundancy between the platforms and for more data synchronization between platforms (e.g. be able to see customized houses in Husvisaren). No such expressions were noted for UT2. And even though we saw some instances where the participant expected more functionality and informational redundancy between the platforms, they all seemed to be able to construct a working mental model to a greater extent than the participants in UT1. We saw very few indications in UT2 that the participants understood A-hus.se and Husbyggaren as the same platform, which the majority of the participants in UT1 did. And in all cases for UT2 did the participant notice that A-hus.se had been left when transitioned to Husbyggaren, compared to only half of the participants in UT1. To conclude, the participants for UT2 might not have constructed a “correct” mental model according to the actual conceptual model of A-hus’s three platforms,

although they all created a mental model that worked for their purpose. This generally made their cross-platform interactions much easier which can be confirmed by the quantitative data to some extent, but also through the absence of frustration and expressed loss of confidence compared to the participants in UT1.

7.3 Creation of factors

A factor can be referred to as "one of the elements, circumstances, or influences which contribute to produce a result" ("factor", 2021). Thus, we interpret an interusability factor as a premise of the interusability within a cross-platform service. The creation of the key interusability factors is essentially based on findings from the reviewed literature, all data collection, and the findings comparisons. Important and reoccurring "factors" have been noted during the course of this project. The literature gave us a starting point, the data collections gave us inspiration and the design comparisons gave us a form of validation.

7.4 Key interusability factors

In this section, we will present the final answer to the research question; *What are key interusability factors for crossmedial, complementary cross-platform services within a module house manufacturing context?*. The interusability factors will describe what we think are important premises in this given context of interusability.

7.4.1 The Distinction factor

Distinct boundaries of each component in a crossmedial complementary cross-platform service makes it easier for users to understand the components separately and the service as a whole.

The notion of platform distinction is a recurring factor for crossmedial complementary cross-platform services. For the user to be able to understand and utilize the entire service it must provide transparency and knowledge continuity (Denis & Karsenty, 2005) regarding the composition (Wäljas et al., 2010) of the available components. Without this understanding, the user could potentially have a hard time understanding the distinctions of the available components, and thus have a hard time using them correctly.

The service must early on be transparent with the composition of all available components, what their functions are and how they work. In a crossmedial complementary cross-platform service in the MHM context, it is common to find a main informational website component, and a few other components. An informational website will leave more room for more deep rooted information about the other components in the system and their functionalities, for instance an informational page (section 6.4.1 and figure 6.9) or articles in a homepage grid (section 6.4.1 and figure 6.7). Nonetheless, information about all components must be available on all

components and this can be in the form of transition points in menus (section 6.4.1, figure 6.21 and 6.25) or close to similar content (sections 6.4.1, figure 6.17, 6.19 and 6.26) as discussed in *The Transition Factor*. Providing the user with information on all components will help with their understanding of what they can expect after having transitioned to another component through knowledge continuity (Denis & Karsenty, 2005). Having this knowledge of the components distinction will aid the user in understanding that they have transitioned to another component in the service, and thus they will understand what functions are available and how they can transition back.

Not having this platform distinction knowledge may result in the user not being able to distinguish between the components. This can cause the user to believe and treat two or more components as the same when they are not, i.e. they might not understand when they have transitioned between components and thus think that some functions should be available when they aren't (section 6.2.3). Furthermore, they might find difficulties in navigation as a result of not being familiar with all components of the cross-platform service (section 6.2.3).

Knowing when and where to present the user with information with other components is dependent on what component the information is supposed to present on. For instance, most crossmedial complementary cross-platform services have a certain degree of redundancy as described in *The Redundancy Factor*, therefore some information might be placed close to redundant or similar concepts or functions as described in *The Consistency Factor*. Furthermore, to be able to describe the components composition and distinction one must pay attention to the user's mental model as described in *The Mental Model Factor*.

7.4.2 The Redundancy Factor

The service mustn't create expectations of redundant functionality and information where there is none and vice versa.

A salient factor for crossmedial complementary cross-platform services is what degree of redundancy each component in the service has (Denis & Karsenty, 2005; Wäljas et al., 2010; Majrashi et al., 2015; Rowland, 2015, chapter 9). This generally regards redundancy for both data, functionality and information. Whatever the degree of redundancy is, it is of utter most importance to not create expectations of redundancy where there is none and vice versa. Too much redundant information in a crossmedial complementary cross-platform services composition might lead the user to believe that the system has a similar degree of redundancy as a multichanneled service (Denis & Karsenty, 2005), which would mislead the users (section 7.2.2 and 7.2.6). Too little redundancy might lead to a loss of context and give the users a hard time creating an understanding of the service composition (Denis & Karsenty, 2005). Therefore the "right" degree of redundant information and functionality is a trade-off between giving the user "just enough" information while still giving them as much as possible (figure 6.12).

The Redundancy Factor is not a straightforward matter, and what kinds of functionality and information to keep redundant depends on the component role allocation (Wäljas et al., 2010). By relying on the strength of each component in the system it is generally advantageous to cut-down unnecessary redundancy to enhance those strengths (Segerståhl, 2011; section 6.4.2 and figure 6.26). For instance, in this particular MHM context it might not be necessary to reproduce the massive amount of information located on an informational website component onto a web application component or on a tablet application. Reducing the amount of redundant information (figure 6.19) would aid *The Distinction Factor*, as well as create reasonable expectations of what kind of redundancy the user could expect from the component (section 7.2.4 and 7.2.5).

A clearly outlined redundancy of the service would also aid the user in creating a coherent mental model as described in The Mental Model Factor. Although, all users might not be able to create a "correct" mental model according to the conceptual model, and therefore some level of modularity or adaptability would also be advantageous. By keeping the context in mind, and by considering several kinds of users, functions and information ought to be allocated complementarily (Segerståhl, 2011; figure 2.12) to reduce the complexity of an individual component. This also goes hand in hand with trying to avoid a too high degree of synergistic specificity by maintaining functional modularity (Segerståhl, 2011) so that a component can be used on its own and is not dependent on the others to function.

7.4.3 The Conceptual Model Factor

The cross-platform service must provide a conceptual model to aid the creation of the user's mental models of the service composition.

As mentioned, both The *Distinction Factor* and *The Redundancy Factor* are important for creating a clear conceptual model of the crossmedial complementary cross-platform service. The information from these will generate a system image that can give the user clues about what the composition of the service is, what functionalities all components have and help the user construct their own mental model (Norman, 2013). Although, this also goes the other way around. For the system to be able to describe a conceptual model, the mental models of the users must be understood as well (section 6.2.3, 6.4.1, figure 6.15 and 6.17). When understanding the mental model of the users it will be easier to select what kind of information that must be included (figure 6.17 and section 7.2.2 and 7.2.6), to be able to clearly communicate the composition and distinction of the components.

The user must be exposed to the service structure quickly as described in *The Structure Factor*, e.g. by providing the right kind of information and clear transition points as described in *The Transition Factor*. *The Conceptual Model Factor* also acknowledges that users can inhibit several different mental models, thus a crossmedial complementary cross-platform service must support this, e.g. by presenting

alternative ways to transition as described in *The Bridge Factor*. One important aspect of *The Conceptual Model Factor* is that the system is not clear enough or easy to use until the users perceive it as such (section 7.2).

7.4.4 The Consistency Factor

Consistency should be maintained between and within the components of a cross-medial, complementary cross-platform service within a module house manufacturing context.

Overall consistency (Denis & Karsenty 2005; Wäljas et al., 2010) is crucial for any user interface, both for individual platforms and across platforms. Theory regarding consistency as a tool to promote interusability is primarily developed from a multichanneled system delivery (Denis & Karsenty 2005; Wäljas et al., 2010), which makes it uncertain if the same rules of consistency applies to this context of cross-medial system delivery. However, based on this project, it seems that the same consistency rules do apply to a crossmedial context. The look-and-feel of the platforms was already consistent in the original versions of the platforms, and no issues were discovered with an apparent connection to the style guide. Furthermore, labels should be consistent across the platform service for the same features, information, transition points, basically all instances where the same content can be accessed across the service. This is mainly to avoid that the user creates an inaccurate mental model of the platform redundancy (Denis & Karsenty, 2005; Wäljas et al., 2010; Majrashi et al., 2015; Rowland, 2015, chapter 9), as mentioned in *The Redundancy Factor*.

7.4.5 The Structure Factor

Clear structures between and within the components of a cross-platforms service within a module house manufacturing context will promote interusability.

Given the current prerequisites and context of interusability, the structure within the platforms appears to be of utter most importance. First and foremost, transparency (Denis & Karsenty, 2005) is an important structural aspect of the cross-platform service that applies to the structural relationship between the platforms. The importance of demonstrating the structural relationship between the platforms can be found in the result of adding easily accessible information about the other platforms on each platform (section 6.4.1 - 6.4.3 and 7.2). Regarding the MHM context (section 2.2 and 6.1.2) and the accompanied characteristics, such as the one platform being an informational webpage, the system needs an internal structure within each platform to aid and facilitate the use of each platform. This can be said to be particularly important regarding platforms laden with an extensive and heavy amount of information. This factor stems from the navigational changes made to the platforms and the results it yielded (section 7.2.1). When the navigation system within the informational webpage was changed, it seemed to severely facilitate the interaction and usage of the platform. Changes were made to dispose of the extensive amount of

scrolling through overwhelming and unstructured information (section 6.4.1). The new navigational system exposed the users to much less information units at a time, and users were observed to find important information e.g. transition points with much more ease, which facilitated the navigation between the platforms as well.

7.4.6 The Transition Factor

Well placed transition points facilitate interaction with cross-platform service components and support transparency. They should be consistent in appearance, phrasing and placed logically on each platform.

Transitions are essential aspects of cross-platform services, regardless of the service composition (Denis & Karsenty, 2005; Wäljas et al., 2010; Majrashi et al., 2015; Rowland, 2015, chapter 9). Well placed transition points, i.e. the locations within the platform from where the user can access another platform, or where they can collect information about another platform, has the potential to facilitate the interaction with the service, and thus promote the interusability of the service (section 6.4). The transition points are important tools to promote the transparency (Denis & Karsenty) of the service, as they signal the existence of the other components of the service. Furthermore, consistency (Denis & Karsenty, 2005; Wäljas et al., 2010) is an important part of the transition point within the platforms of the service, as mentioned in *The Consistency Factor*. Transition points that directly lead to the same platform and exhibit similar characteristics across the service tend to facilitate navigation by helping the user recognize the correct actions. Except for look-and-feel consistency of transition points, it is also important with lexical consistency (section 7.2.3). Keeping the labels of the transition points consistent might aid the user in creating a coherent understanding of the service, which is also in accordance with *The Consistency Factor*.

Furthermore, the transition points should have clear and logical locations within each platform. What ultimately is a clear and logical place to put transition points is not a straightforward matter and depends on context and service composition (Denis & Karsenty, 2005; Wäljas et al., 2010; Majrashi et al., 2015; Rowland, 2015, chapter 9). It will have to be established within each individual case. However, common and conventional platform features, such as hamburger menus for phone apps, might benefit from the same design alterations that proved useful in this context (section 6.4 and 7.2.1). For instance, when transition points inside the hamburger menu in Husvisaren were moved to the bottom of the hamburger menu and displayed as buttons (consistent with the other platforms) instead of internal navigation links (figure 6.25), they were used to a greater extent.

7.4.7 The Bridge Factor

Enabling a platform to be used as a "bridge" between other platforms might facilitate for a wider range of mental models.

The Bridge Factor addresses the "using platform as a bridge"-strategy. This means, instead of transitioning directly from platform 1 to 2, the user first transitions from 1 to 3 and then from 3 to 2 and thus using platform 3 as a bridge (section 6.2.2-6.2.3 and 7.2.3). This might seem like an unnecessary detour that the systems interface should help users to avoid, possibly by the designers having studied the users mental models thoroughly (section 6.4.2 and figure 6.25). And while that might be true, it is also true that there might exist as many mental models as there are users and thus it could be impossible to design for everyone. Although, in a crossmedial complementary cross-platform service in the MHM context, with one bigger informational component, it has been shown to be a common strategy for the users to want to "start over and begin from scratch" on this bigger component, and therefore using it as a bridge between the other components (section 7.2.3). Instead of trying to direct and change the behaviour of the users to "walk a golden path", the platforms should aim to facilitate even for some minor detours in their path. This factor is not as complicated as one might think. Ultimately, it means providing easy access to transition points to all components of the system on every component, as mentioned in *The Transition Factor* and *The Redundancy Factor*.

7.4.8 The Task Resuming Factor

Resuming a task after transitioning to another platform should be effortless.

In a crossmedial complimentary service in the MHM context there generally is very little task continuity (Denis & Karsenty, 2005; and 6.1.2), and thus it should generally not be a problem for the user to resume a task (or line of thought) when a transition between platforms has been made. Compared to a multichanneled redundant service, where there generally is a lot of shared functionalities and data synchronization between the components, there is practically none in this crossmedial complementary MHM context. Of course, functionalities like these can always be added. But in their absence, resuming a task generally should not be an effort for the user. And if it is, clear transition points and the "right" information about the other platforms could help, as mentioned in *The Redundancy Factor* and *The Transition Factor*. For instance, when a user accesses Husbyggaren through a house specific page, the user is transitioned directly into the house configurator with the house from the house specific page pre-select. This means that the user is able to resume the task at hand instantly when arriving at the platform.

7.4.9 The Vertical Usability Factor

Interusability is a concept inseparable from vertical usability. Interusability is dependent on that the platforms of the cross-platform service are usable in themselves.

This factor might be seen as common sense, but throughout this project, it has been made obvious that platforms which lack in usability will also lack in interusability. For the platforms of A-hus, several of the most prominent issues identified during the project can be attributed to vertical usability, and not directly to interusability. For instance, one of the most commented aspects during UT1 of A-hus.se was the sub menu of the house specific page (figure 6.13). The participants experienced several issues regarding the sub menu as described in section 6.4.1. However, the sub menu was not something we initially thought to change, as we failed to see how it could be connected to the interusability of the platforms. But further iterations revealed that the sub menu which is used to navigate one of the most important locations on A-hus.se (the house specific pages), could not be left unchanged. The mechanics of the sub menu was not directly connected to the actual transitions, but it left the users confused and with difficulties to grasp the content of the house specific pages, which can be argued are important in order to understand e.g. the transparency of the platforms. When the sub menu was redesigned to provide the user with a better overview, it resulted in no complaints and no observed issues with understanding the page (see appendix I). The participants were observed to have a better flow in the navigation through the house specific pages, seemed to grasp the navigation structure easier and in extension finding their way to transition points easier.

Furthermore, another usability aspect that was changed and yielded positive results was to group information that was perceived as related to each other (section 7.2.4). All in all, poor usability will ultimately result in poor interusability. If the components of a cross-platform service are hard or difficult to use vertically, then they will presumably also be hard to use horizontally.

8

Discussion

In this chapter, the results will be discussed in relation to the research question and previous work, and the potential to extrapolate our findings. Furthermore, the process and its potential weaknesses will be discussed. Lastly, ethical considerations taken into account during the project and possible future work to expand the interusability field will be discussed.

8.1 Result

Today the field of interusability is a small field of interest in comparison to usability. There is currently little theory and previous studies available concerning interusability, and even less concerning interusability of cross-platform services with crossmedial system delivery and a complementary component organization. We were not able to find any prior work that has been done to outline the characteristics of this particular instance of interusability, which is what initially sparked this thesis. What this thesis ultimately resulted in are nine factors that we believe are important to understand and to consider when designing for this kind of cross-platform service. However, the factors are in need of validation in further work, which will be discussed in section 8.4 Future work.

Most of the previous work have mainly investigated cross-platform services composed of several devices, whereas our case regarded a cross-platform service composed of one device in combination with two platforms, since Husvisaren run only on smartphone or tablet, while A-hus.se and Husbyggaren can be run on desktop, smartphone and tablet. Furthermore, most of the theory and literature that based this study regards multichanneled system delivery with a redundant component organization. This made the theory challenging to adapt to our case with a crossmedial system delivery with a complementary component organization. However, as several of those theoretical aspects appeared in the identified factors as important to consider in this context as well, e.g. consistency, knowledge continuity, transparency and component composition, it seems that conclusions can be drawn that the current body of knowledge concerning interusability is applicable in this case as well. Furthermore, the few available guidelines adapted to the same system delivery and component organization as this case study (section 3.3.4) were adapted to be used when designing a system from scratch, which we did not. Therefore, most of the theory we found functioned as guidance when trying to understand our case (section 6.1.2)

and creating the usability tests (section 6.1.3), and inspiration when creating new design solutions (section 6.4) and support when formulating the factors (section 7.4).

Some of these factors are highly based on this evaluative and exploratory single case study in the MHM context, which may be translucent in the lack of generalizability. For instance *The Structure Factor* and *The Bridge Factor*. Although, all of the factors stem from different kinds of theory, some factors are more based on theory with support from this study, and therefore more generalizable. For instance, some of our factors describe aspects not fully considered in our design suggestions, and some design suggestions have not been attributed to a certain factor. An example of this is that the question still remains if *The Distinction Factor* should be further applied to Husvisaren to make Husbyggaren more apparent on the app, or if it would confuse the user with potential functional redundancy that does not exist as *The Redundancy Factor* makes apparent. *The Consistency Factor* could also have been applied more, i.e. in making transition points and menu titles more consistent throughout the platforms. And since interusability have an obvious background in vertical usability, all "minor" changes in the design not strictly related to interusability could have been attributed to *The Vertical Usability Factor*. Therefore, the literature review, the design prototypes and the factors could go through several more iterations of refining.

8.2 Process

In this section, potential weaknesses of the process which can have had an impact on the results of the project will be acknowledged and discussed.

8.2.1 Instrument adaption

One of the challenges for this project was to find a way to evaluate the interusability for the cross-platform service of A-hus. To our knowledge, there does not exist any conventional procedure or specified methods to evaluate the particular instance of interusability that were relevant to our project. However, a specified set of methods have been put together by Majrashi et al. (2020), which are particularly suitable for multichanneled cross-platform services, see section 4.2.7. The Cross-Platform Usability Measurement (CPUM) Model. As the instruments of the CPUM model did not fit the constellation of our cross-platform service, we had to adapt it in order to be able to use it in the project. The CPUM model has been evaluated as a tool, but our adaptive alterations have not. As described in section 6.1.3 the STS questionnaire was altered quite a lot and changed into the TS questionnaire, and both it and the CPUS questionnaire were translated from English to Swedish. Not validating the questionnaires beforehand might lead to the risk of them not evaluating what they are meant to evaluate, and therefore the reliability of the questionnaires might be questionable. Fortunately, our test did not only rely on these two questionnaires, but also six other quantitative metrics and the qualitative data from the observations, the CTA and the interviews, which in turn should make the results more reliable. And from what we could see, all of the data concurred.

8.2.2 The tasks

The findings generated from the usability tests are largely based on the tasks that were created for the sake of this project. The aim of the tasks was, in UT1, to force the users to move naturally between the three platforms, in all possible directions, in order to investigate if the transitions and connections between the components of the cross-platforms service were somehow impaired. In UT2, the same tasks were used in order to evaluate how the alterations grounded in interusability theory that was made, had affected the cross-platform service. The challenge with the tasks lay in fabricating natural tasks that correspond to genuine user interaction sequences.

Generally, the tasks seemed to work as intended. They did in fact generate a lot of useful data which led us to identify several important issues with the original cross-platform service. However, the tasks we have identified as the most problematic for the participants to solve were the ones leading to Husvisaren. The core issue here is that the original version of A-hus.se and Husbyggaren showed very little evidence of an existing phone application. This meant that when we gave the participants a task which corresponded to the functionality of Husvisaren, they were in many cases unable to understand how to solve the task as it was too difficult. When the tasks were created, this was identified as a potential risk but as we wanted to keep the conditions of the task structure static for all platforms, it was decided as acceptable. However, the difficulties experienced by the users with these tasks yielded strong indications that those transitions worked poorly, but it yielded less inspiration to how to solve the issue. In retrospect, an alternative way of extracting information from the transitions might have been to make use of scenarios that framed the transitions in other ways. For instance, we could have built a clearer scenario for the user and framed the tasks around those, i.e. “Imagine if you had decided to build a house with A-hus, and wanted some way of visualizing it. Where would you have expected to find it?”.

8.2.3 Differences between UT1 and UT2

Some of the conditions between UT1 and UT2 had to be changed since the developed interusability prototype had to be built in Figma. The original versions of the platforms were tested in their natural state except for Husvisaren which was recreated in Figma. Since the interusability alterations made to the platforms were not implementable, all three platforms had to be created as interactive prototypes. This led to some constraints issues regarding the movements between the platforms. During UT1, the participants were observed to make much use of the tabs in their browser when navigating, much more than using natural transition points within the platforms. For example, many participants located inside the house configurator of Husbyggaren were observed to simply change to an open tab of A-hus.se when a transition was required. This does not necessarily have to be a bad thing. It worked because all platforms were located in the tabs of their browser. However, when we built the prototype of the new design of the cross-platform service, the users were not able to use the tabs as navigation tools, because the prototype could not be built to simulate tabs in a browser. This essentially means that the users were forced to

navigate between the platforms using only natural transition points.

The navigational differences between UT1 and UT2 raises the question of validity of the comparisons made between UT1 and UT2 regarding the navigation. Our aim was to create the prototypes to feel as real as possible, to be able to draw definitive conclusions about the alterations. However, the fundamental navigational differences as a result of UT2 being run on a prototyping tool caused us to rethink the weight of the conclusions we were able to draw. Although, it can be argued that if it is easy to navigate between the platforms using natural transition points, then the browser tabs might not be needed for the users to navigate with. Navigation in UT2 seemed to be much easier for the participants than the navigation of the participants in UT1, even though they had no access to browser tabs.

Another aspect which differed between the usability tests was the extent of the platforms. None of the platform prototypes built in Figma were created to fully correspond to its real life counterpart, i.e. include all pages, views and functions. The decision to restrict the platforms to only contain what we believed would be the most important content was mainly taken because of the limited time we had at hand. This was a trade-off, as we would save time but ran the risk of missing out on important data if we miscalculated which frames were needed. We based the selections of frames in the prototypes on what frames had been used in UT1. In UT2 we observed if users tried to access parts of the prototype which were unavailable, or tried to interact with things that were not interactable. No major occurrences were observed that led us to draw conclusions about the prototypes not including enough frames, or that the restriction ultimately had any negative or confounding effect on the comparison. For instance, some participants tried to use some filter options, or fold down a drop down list that had not been constructed in the prototype. In these cases, the participants were informed that this was a constraint in the prototype and not in the actual platforms and what would have happened if they could have used these options. But for most parts we had created too many frames. None of the participants needed to visit the page “Inspiration” to find Husvisaren in UT2, compared to UT1, where “Inspiration” was the only place to find Husvisaren. None of the participants visited the frames “Om appen”, “Om A-hus”, “Beställ katalog” or “Kontakt” in Husvisaren. And not all of the tabs were visited in Husbyggaren in UT2 compared to UT1. These behavioral changes can most probably be attributed to the changes of the design in which the user found the information they needed much faster and did not need to go looking for it in several different places. However, as we did not know this beforehand, we still created these frames.

A third aspect that differed between the usability tests was the different numbers of participants. Originally it was planned to keep an even number of six participants for both tests. But as we experienced time constraints it was decided that for UT2 only four participants would be recruited, to not risk collecting more data than could be processed within the time frame. As mentioned in section 6.1.3.5, four participants are to be considered the minimum number of participants to be able to conduct an effective usability test. However, our opinion is that this number

is quite low because the risk of missing usability issues is greater the lower the number of participants. The only reason we accepted this number was because we had already conducted UT1 with six participants and the fact that the four participants for UT2 actually showed the same pattern of behaviour (hinting that more participants would also do so). However, comparing an uneven number of participants between the two usability tests was not ideal either, since UT2 had not had as much chance as UT1 to reveal interusability issues. Furthermore, since there were such a low number of participants and different participants conducting the two tests they would still have been hard to compare given that the interusability issues found could be attributed to the individual participants rather than the design itself. When comparing two designs it is generally a good idea to conduct an A/B testing with the same participants under the same circumstances in a random order until statistically significant results have been achieved (Martin & Hanington, 2012). The different circumstances under which our usability tests were conducted in this exploratory study, i.e. on different software and with different participants and the few participants, left us unable to develop the factors based on any statistical significance. Instead, they are based on an exploration of the context.

8.2.4 Limitations of remote usability testing

As mentioned in the introduction, the ongoing Covid-19 pandemic caused the decision that all usability testing would be conducted remotely. This is a shortcoming of this project. Ultimately it resulted in us having to recreate Husvisaren as an interactive prototype in Figma so that we could observe and record the user interacting with it on desktop (section 6.1.4.2), instead of observing the participants interacting with Husvisaren on a phone/tablet as preferred. This may have led to loss of ecological validity for both UT1 and UT2, and may have affected our findings. Some participants of both usability tests stated that they sometimes forgot that Husvisaren was an app, and that they had treated it as a third desktop platform.

The issue here can be illustrated by an example. When participants in UT1 had transitioned once to Husvisaren and were later given a second task which had to be performed on Husvisaren again, some participants retraced their steps from their first transition to Husvisaren. This led them to an informational page about Husvisaren, but not to the actual platform. When they were asked why they retraced their steps, some answered that they did not know if they were allowed to switch to the tab with the Figma preview, as they were given a link the last time they were supposed to enter Husvisaren. They were allowed to switch to the open tab with the preview of Husvisaren at any time, but few did. If the usability tests were held in a physical environment as would have been preferred, then the participants would have been asked to download the actual app to their phone when finding the information about Husvisaren the first time. This way, the participants might form a more realistic mental model of the relationship between the components of the cross-platform service. However, in the concluding interviews the participants were asked if they at any time during the test forgot that Husvisaren was supposed to be an app, and if so, during which tasks. This was done to clarify the behaviour of

the participants regarding their understanding of the platform, and thus be able to overlook confounding behavior connected to Husvisaren being run on a desktop.

8.3 Ethical considerations

The ethical consideration of this project has primarily been to anonymize the data collected during UT1 and UT2. The participants were informed that the recording of their usability test session would be anonymized and that it would not be shared with any third party. All participants were informed that they could revoke their participation anytime during or after the test session. They were also informed that all data would be treated in accordance with GDPR. See appendix A for details. No participation was revoked, and therefore are all data collected from the ten participants used in this project. All recordings and data where an individual's identity can be recognized will be deleted after the completion of this project.

As no accessibility principles have been developed specifically for the interusability field, we have not been able to take such aspects into account. Furthermore, accessibility has not been a primary consideration for this project. However, accessibility might be a suitable area to focus further work within the field of interusability, which will be further discussed in 8.4 Future Work.

Regarding the accessibility of this project, it was early on decided to only include participants fitting the target customer groups of A-hus to be able to draw any conclusions regarding the context. This means that we did not recruit participants under the age of 25 or if they could not see themselves build a house in the future. Although, we did overlook the participants current economic situation, which is otherwise an important aspect of the customers of A-hus. Furthermore, we could not recruit participants that did not speak Swedish, due to the digital platforms not being available in another language. These delimitations limited the range of participant demographics to a rather homogeneous group, even though the age range was large. This is a potential confounding of the study that decreases the generalizability from any drawn conclusions, as the results are based on the data from a limited range of users.

8.4 Future work

The interusability field is, as described, a poorly researched field in general. As cross-platform services come in many different constellations and organizations, future work is needed to develop a full picture of the field, and of what characterizes interusability of the different instances. In particular, more work is needed to outline crossmedial service organizations, as most interusability theory focuses on multichanneled service organizations. We also suggest that design guidelines should be developed for services with the same service composition as this project, where the factors developed as a result of this project could potentially be taken into consideration. Future work of these device compositions should also take other contexts

into account and widen the rage of participant demographics.

Furthermore, the notion of synergistic specificity is something that has been somewhat overlooked in this project. This does not mean that it is an unimportant aspect in any way. Synergistic specificity has been used in this project to understand the constitution of A-hus' cross-platform service (see 6.1.2). As this project is based on a real cross-platforms service, the synergistic specificity was an existing condition of the case, and not something that we could alter given the delimitations of the project. However, the optimal synergistic specificity, i.e. what kind of component composition is the most useful in the MHM context is currently not known and could be investigated further.

The apparent lack of accessibility guidelines for the field of interusability suggests that future studies are needed to outline the need for specific accessibility guidelines, but also to establish the potential guidelines. As for now, interusability will have to rely on conventional accessibility guidelines, but whether this is enough or ultimately generates substandard cross-platform services is yet to be determined.

9
Conclusion

This project has primarily been focused on exploring interusability for cross-platform services within a module house manufacturing context. In response to the research question "What are key interusability factors for crossmedial, complementary cross-platform services within a module house manufacturing context?", nine factors have been developed as a result of this project.

The factors are based on a case study conducted on the cross-platform service provided by the module house manufacturing company A-hus. The cross-platform service of A-hus has a crossmedial service delivery and a complementary service composition, consisting of three platforms: one informational website, one web application and one smartphone/tablet application, which are all a central part of this explorative study. A-hus's cross-platform service was first evaluated by conducting a usability test on the original design version in order to discover and identify potential interusability issues. Based on the gathered knowledge about interusability from an initial literature review and the usability test, the platforms were then redesigned through an iterative design process, with the aim to to enhance the interusability of the cross-platforms service. Thereafter, the new state of interusability of the platforms were evaluated one again using the same usability test. The collected data from the usability tests performed on the original and the new version of A-hus's cross-platform service were analysed and compared, which yielded new knowledge and insights that were used in the creation of the factors. From the quantitative and qualitative data comparisons it was estimated that the overall interusability of the cross-platform service had been improved with the new design solutions of A-hus's cross-platform service. The execution time required to achieve the tasks of the usability tests had generally decreased, as well as the amount of unproductive time recorded, the number of action steps needed, and number of errors made. From the qualitative analysis, it appeared to be easier to navigate within and between the platforms, distinguish between the platforms and to create a coherent mental model of the cross-platform service.

The total of nine factors identified were summarized from interesting and important findings made during this project and its associated design activities. The factors represent what the project yielded as important and typical circumstances and premises within the given context and instance of interusability. The nine factors found states as follows:

1. The Distinction factor
   Distinct boundaries of each component in a cross-platform service makes it easier for users to understand the components separately and the service as a whole.

2. The Redundancy Factor
   The service mustn't create expectations of redundant functionality and information where there is none and vice versa.

3. The Conceptual Model Factor
   The cross-platform service must provide a conceptual model to aid the creation of the user's mental models of the service composition.

4. The Consistency Factor
   Consistency should be maintained between and within the components of a crossmedial complementary cross-platform service within a module house manufacturing context.

5. The Structure Factor
   Clear structures between and within the components of a cross-platforms service within a module house manufacturing context will promote interusability.

6. The Transition Factor
   Well placed transition points facilitate interaction with cross-platform service components and support transparency. They should be consistent in appearance, phrasing and placed logically on each platform.

7. The Bridge Factor
   Enabling a platform to be used as a "bridge" between other platforms might facilitate for a wider range of mental models.

8. The Task Resuming Factor
   Resuming a task after transitioning to another platform should be effortless.

9. The Vertical Usability Factor
   Interusability is a concept inseparable from vertical usability. Interusability is dependent on that the platforms of the cross-platform service are usable in themselves.

The factors are in this report kept specific to the house manufacturing context, but provided that a service within another kind of context have the same service composition, it is very likely that the factors are applicable to them as well due to the recurrence of general interusability theory within the factors. However, this speculation will have to be validated in order to draw any definite conclusions. Furthermore, the factors must also be validated in order to know for certain that they truly mirror the typical circumstances and premises of the given context and

service composition. The factors identified are a small but significant contribution to the current body of knowledge that constitutes the interusability field. The resulting factors of the project have the potential to be further extrapolated, developed, and used to determine a more comprehensive picture of interusability.

Bibliography

Brudy, F., Holz, C., Rädle, R., Wu, C-J., Houben, S., Nylandsted Klokmose, C., & Marquardt, N. (2019). Cross-Device Taxonomy: Survey, Opportunities and Challenges of Interactions Spanning Across Multiple Devices. *In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. Association for Computing Machinery, New York, NY, USA, Paper 562, 1–28. DOI: https://doi.org/10.1145/3290605.3300792

Cooper, A., Reimann, R., Cronin, D.,
Noessel, C. (2014). *About face : The essentials of interaction design*. John Wiley & Sons, Incorporated, Somerset.

Denis, C., & Karsenty, L. (2005). Inter-Usability of Multi-Device Systems - A Conceptual Framework. In: Seffah A & Javahery H (Eds.) *Multiple User Interfaces: Cross-Platform Applications and Context-Aware Interfaces*. Wiley & Sons. DOI: 10.1002/0470091703.ch17

Factor. (2021, May 14). In *Wikipedia*. https://en.wiktionary.org/wiki/factor

Farrell, S. (2017). How to Collaborate with Stakeholders in UX Research. *Nielsen Norman Group*. https://www.nngroup.com/articles/collaborating-stakeholders/

Friis Dam, R., Siang, T. (2021-01). *5 Stages in the Design Thinking Process*. Interaction Design Foundation. https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process

Hartson, R., & Pyla, P. S. (2012). *The UX Book - Process and Guidelines for Ensuring* a Quality User Experience. Elsevier.

Interaction Design Foundation. (n.d.). *Brainstorming*. https://www.interaction-design.org/literature/topics/brainstorming

Kaplan, K. (2020, February 16). UX Workshops vs. Meetings: What's the Difference?. *Nielsen Norman Group*. https://www.nngroup.com/articles/workshops-vs-meetings/

Majrashi, K. (2016). *Cross-platform user experience*. [PhD thesis, RMIT University].

Majrashi, K., & Hamilton, M. (2015). A Cross-Platform Usability Measurement Model. *Lecture Notes on Software Engineering*, 3(2). DOI: 10.7763/LNSE.2015.V3.179

Majrashi, K., Hamilton, M., Uitdenbogerd, A. L., & Al-Megren, S. (2020) Cross-Platform Usability Model Evaluation. *Multimodal Technologies and Interaction*, 4(4), 80. DOI: 10.3390/mti4040080

Martin, B. & Hanington, B. (2012). *Universal Methods of Design - 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions*. Rockport Publishers.

Moran, K. (December 1st, 2019) Usability testing 101. *Nielsen Norman Group*. https://www.nngroup.com/articles/usability-testing-101/

Nielsen, J. (January 3rd, 2012). Usability 101: Introduction to Usability. *Nielsen Norman Group*. https://www.nngroup.com/articles/usability-101-introduction-to-usability/

Norman, D. (2013). *The Design of Everyday Things - Revised and Expanded Edition*. Basic Books.

Pasman, G. (2011). Lost in transition: Issues in designing crossmedia applications and services. *Proceedings of the 29th ACM International Conference on Design of Communication*, 175–179. https://doi.org/10.1145/2038476.2038511

Rowland, C. (2015) *Designing Connected Products: UX for the Consumer Internet of Things*. (1 ed.). O'Reilly Media.

Segerståhl, K. (2009). Crossmedia Systems Constructed around Human Activities: A Field Study and Implications for Design. In T. Gross (Eds.), *IFIP International Federation for Information Processing*, (pp. 354-367).

Segerståhl, K. (2011). *Cross-platform functionality in practice:exploring the influence of system composition on user experiences of personal exercise monitoring*. [PhD thesis, University of Oulu].

Sharp, H., Rogers, Y., & Preece, J. (2019). *Interaction design: beyond human-computer interaction*. (5th ed.). John Wiley & Sons, Inc.

Shaughnessy, J., Zechmeister, E., & Zechmeister, J. S. (2012). *Research methods in psychology* (9th ed.). McGraw-Hill.

Tullis, T., & Albert, B. (2013). *Measuring the user experience : Collecting, analyzing, and presenting usability metrics* (2nd ed.). Elsevier Inc.

Wadsworth, Y. (2011) *Do IT Yourself Social Research - The bestselling practical guide to doing social projects*. (3rd ed.). LEFT COAST PRESS, INC.

Wäljas, M., Segerståhl, K., Väänänen-Vainio-Mattila, K.,
Oinas-Kukkonen, H. (2010). Cross-platform service user experience: A Field Study and an Initial Framework. *Proceedings of the 12th International Conference on Human Computer Interaction with Mobile Devices & Services: Mobile HCI* 2010 (2010), p. 219. issn: 9781605588353. http://search.ebscohost.com/login.aspx?

A

Consent form

Denna undersökning är en del av ett masteruppsatsprojekt av studenter från Chalmers Tekniska Högskola i samarbete med A-hus. Syftet med undersökningen är att analysera upplevelsen av A-hus 3 digitala plattformar.

I denna undersökning kommer vi att be dig använda plattformarna på olika sätt. Undersökningen är till för att testa plattformarna och inte dig. Det finns inga rätt eller fel svar och ingen åsikt är förolämpande. Din medverkan kan komma att bidra till utvecklingen av plattformarna.

Med ditt godkännande kommer din skärm och ditt ljud att spelas in. Inspelningarna kommer endast att användas till att analysera A-hus plattformar. All data som samlas in kommer behandlas i enlighet med GDPR (General Data Protection Regulation). Det innebär att inspelningarna kommer att anonymiseras när den behandlas, raderas efter att undersökningens rapport är färdigställd och kommer inte att delas med någon tredje part.

Deltagandet är helt frivilligt och du kan när som helst avbryta ditt deltagande och dra tillbaka ditt samtycke utan att uppge anledning. Detta gäller både under tiden undersökningen pågår och efter den är genomförd.

Personuppgiftsansvariga är Beatrice Andersson (beaande@student.chalmers.se) och Johanna Sindby (johhellg@student.chalmers.se). Vill du dra tillbaka din medverkan eller har några frågor är du välkommen att kontakta oss när du vill.

Om du inte har några frågor kan du kryssa i rutan.

[ ] Jag godkänner villkoren för undersökningen nämnda ovan

B

Instructions

Du kommer att få utföra 7 uppgifter på A-hus digitala plattformar. Uppgifterna kommer att vara både lätta och svåra och ta olika lång tid att utföra. Om du upplever att det är för svårt får du hjälp av oss. Mellan och efter uppgifterna kommer du också att få besvara några frågor om din upplevelse av uppgifterna och plattformarna. Undersökningen avslutas med en kort intervju.

Du har alltid tillgång till att läsa uppgifterna, men du kan också be oss upprepa dem. När du utför uppgifterna på A-hus plattformar är du fri att röra dig hur du vill mellan dem, du är aldrig begränsad till att röra dig på endast en plattform.

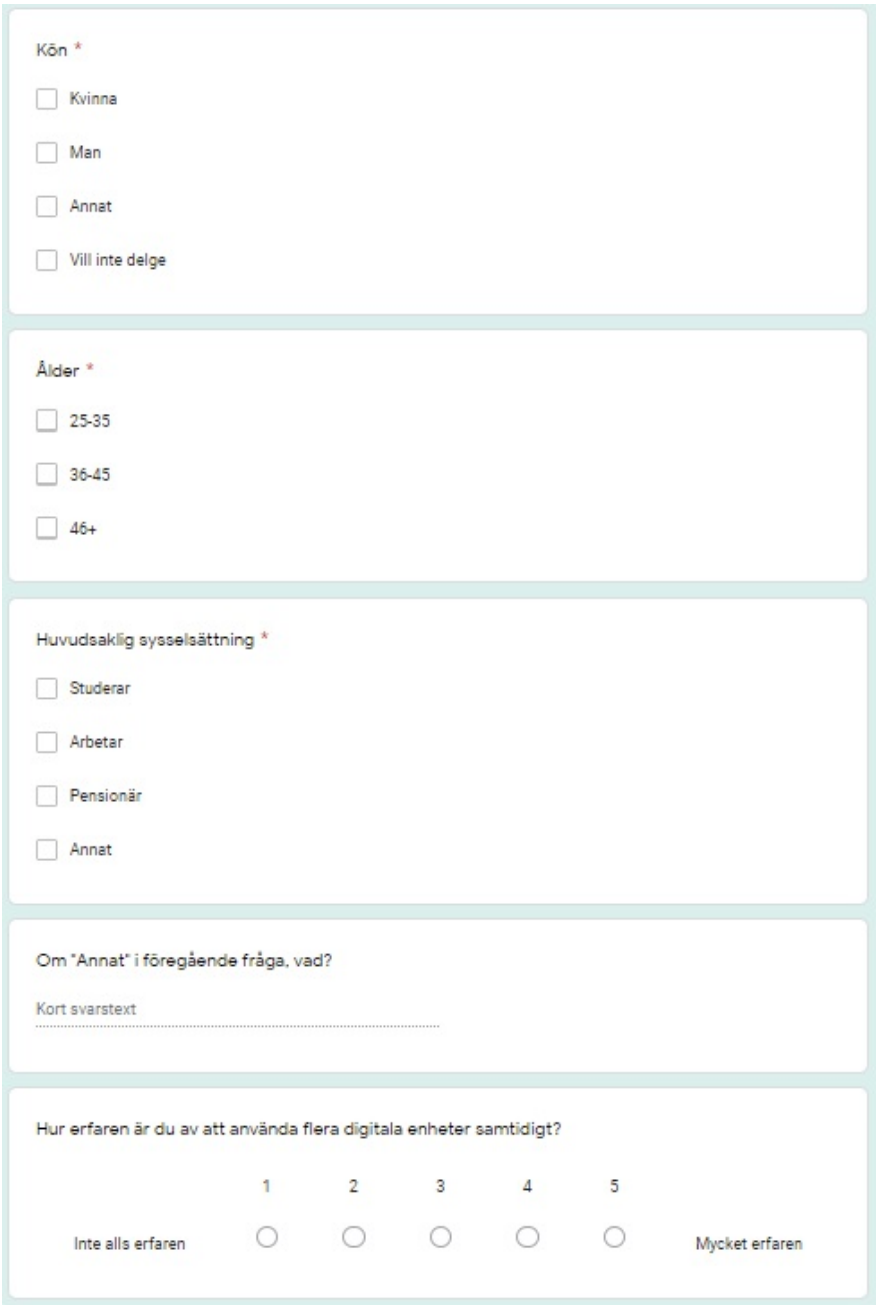
Vi vill att du hela tiden pratar högt och berättar för oss vad du gör, vad du tänker och hur du resonerar under tiden du utför uppgifterna. Beskriv kontinuerligt dina tankegångar samtidigt som du interagerar med plattformarna.

Kom ihåg: det är plattformarna vi testar, inte dig.

Har du några frågor?

C

Demographic questionnaire



D

Tasks UT2

Table D.1: A Table Showing the Tasks and its related transitions for order 2

Platform	Transition	Task
A-hus.se	None	Hitta Villa Ekbacken och leta upp "Husunika fördelar" under rubriken Fakta *Find Villa Ekbacken and find "Unique house benefits" under the rubric "Facts"*
Husvisaren	AC	Titta på Villa Ekbacken genom AR-funktionen "Se på skärmen" *Look at Villa Ekbacken through the AR-function "See on screen"*
Husbyggaren	CB	Måla Villa Ekbackens vindskivor och foder svarta *Paint the windshield and lining black of Villa Ekbacken black*
A-hus.se	BA	Vilken adress kan man gå på visning för Villa Kobbskär? *What address is it possible to go on a tour for Villa Kobbskär?*
Husbyggaren	AB	Måla Villa Annebergs fasad röd *Paint the facade of Villa Anneberg red*
Husvisaren	BC	Titta på Villa Anneberg genom AR-funktionen "Se på skärmen" *Look at Villa Anneberg through the AR-function "See on screen"*
A-hus.se	CA	Hitta Villa Ekbacken och leta upp planlösningarna för "Tillval" *Find Villa Ekbacken and find the floor plan for "Additions"*

Note. A = A-hus.se, B = Husbyggaren and C = Husvisaren. I.e. Transition AB corresponds to a task beginning at A-hus.se and ending at Husbyggaren.

E

Questions of semi-structured interview, UT1

När förstod du att det fanns tre olika plattformar?

Vad tyckte du om att röra dig mellan plattformarna A-hus.se, Husbyggaren (bygg online) och Husvisaren (appen)? Var något enkelt? Svårt?

Vad tyckte du om att röra dig från A-hus.se till de andra plattformarna?

Vad tyckte du om att röra dig från Husbyggarens (bygg online) till de andra plattformarna?

Vad tyckte du om att röra dig från Husvisarens (appen) till de andra plattformarna)?

Tycker du att alla plattformar kändes nödvändiga? Varför? Varför inte?

När du använde plattformarna, tyckte du någonting saknades?

Hade du föredragit att alla plattformarna var som en enhet eller att de är tydligt distinkta från varandra?

Har du några andra tankar eller frågor?

F

Questions of semi-structured interview, UT2

Mental modell av plattformarna

- A-hus har tre olika plattformar som du nu har rört dig på under testets gång. Vad har du för syn på dessa?
- Förstår du vilka det är?
- Tycker du det är tydligt att det finns tre plattformar?
- Förstod du att Husvisaren ska finnas som en app som går att ladda ner på din telefon?
- Tycker du dom skiljer sig åt på ett bra sätt?
- Tycker du det borde skilja sig åt?
- Tycker du de borde skilja sig åt mer?

Interusability/övergångarna mellan plattformarna

- Hur tyckte du det var att röra mellan de tre olika plattformarna?
- Tyckte du att något hade kunnat vara bättre i övergångarna mellan plattformarna?
- Vilka plattformar du var det svårast att förflytta sig mellan?
- Vad tyckte du om att det fanns en liten förflyttningssymbol?
- Kände du dig låst någonstans, eller som att du hade begränsad rörlighet?

Övrigt

- Kände du dig förvirrad vid något eller några tillfällen? Varför?
- Vad tyckte du var bra med A-hus.se?
- Vad tyckte du var bra med Husbyggaren?
- Vad tyckte du var bra med Husvisaren?

G

Transcript template

Link to Transcript template

H

Rainbow spreadsheet, UT1

Link to Rainbow spreadsheet, UT1

I

Rainbow spreadsheet, UT2

Link to Rainbow spreadsheet, UT2

J

Brainstorming, List

Link to Barinstorming list

K

Figma prototype link to original design of Husvisaren, used in UT1

Link to Figma prototype link to original design of Husvisaren

L

Figma prototype link of new design solutions used in UT2

Link to Figma prototype link of new design solution

M

Standard hits for usability tests

Hintar kan ges 2 minuter in efter varje fråga:

- Upprepa uppgiften.
- Du är aldrig begränsad till att röra dig på en enda plattform.
- Du fri att röra dig hur du vill mellan plattformarna.
- Betona olika saker i uppgiften.
- SIST: Kan hinta till information om navigation.