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InspiredDesign: A Brainstorming Support Tool for Sustainable Interaction Design

Master Thesis

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ZUSAMMENFASSUNG

Die Auswirkungen der Forschung im Bereich Sustainable Human-Computer Interaction (SHCI) sind limitiert, weil die wissenschaftlichen Theorien kaum in der Design-Praxis angewendet werden. Um dieses Problem, bekannt als Theorie-Praxis-Lücke, anzugehen, wurde im Rahmen dieser Arbeit eine Anwendung für Tablets namens InspiredDesign entwickelt. Das Ziel von InspiredDesign ist es, seine Benutzer beim Brainstorming zu unterstützen und das Wissen, welches im Bereich SHCI erarbeitet wurde, in die Praxis zu übertragen. Um das Potenzial und ihre Auswirkung auf den Brainstorming Prozess zu prüfen, wurde eine qualitative Evaluation mit 13 Designers durchgeführt. Die Resultate zeigten, dass InspiredDesign einen wertvolleren Ansatz zur Übertragung von komplexen Design-Theorien in die Praxis darstellen kann. Die Studienteilnehmer integrierten die Anwendung in ihren natürlichen Brainstorming Prozess und erweiterten ihre Design-Ideen mit den Vorschlägen von InspiredDesign. Neben den positiven Auswirkungen von InspiredDesign auf den Brainstorming Prozess wurden aber auch Limitationen der Anwendung aufgedeckt und Vorschläge für weitere Verbesserungen aufgezeigt. Bei der weiteren Diskussion wurden Schlussfolgerungen gezogen und mögliche Ideen für zukünftige Anwendungen vorgestellt, um die Theorie-Praxis-Lücke zu minimieren.

ABSTRACT

The impact of Sustainable Human-Computer Interaction (SHCI) research on design practice is limited by the prevalent issue of successfully applying theoretical frameworks to practice, often referred to as the theory-practice gap. To address this gap, a tablet application called InspiredDesign was developed in this thesis, serving as a brainstorming companion that incorporates SHCI knowledge into design practice. To assess the potential of the tool and the impact on the brainstorming process, a qualitative evaluation with 13 designers was conducted. The results show that the tool is a valuable approach of communicating complex design theories to design practice. The study participants integrated InspiredDesign into their usual brainstorming process and enriched their design ideas by design propositions from the tool. In addition to the positive effect on the brainstorming process, limitations of the application as well as suggestions for improvement were identified. The results are discussed to draw conclusions for future design interventions to bridge the theory-practice gap.

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1 INTRODUCTION

In recent years, research in Sustainable Human-Computer Interaction (SHCI) has grown and gained importance. A wide research field arose that deals with different problems and in which various frameworks and guidelines have been developed to address issues of environmental sustainability. Sustainable interaction design (SID) is one of the areas of SHCI (Blevins, 2007). This area has a strong focus on how products are designed and on the designer, seen as person in charge for the resulting product design. One main goal of SID is to design more sustainable products in terms of reducing resource wastage and pollution (DiSalvo et al., 2010).

The usage of electronic devices increases steadily and at the same time the life cycle of those devices becomes shorter (Ala-Kurikka, 2015; Widmer et al., 2005). Electronic devices are outdated after a short period of time and usually disposed prematurely. A term that often appears in this context is obsolescence, which describes the state of an electronic device that is no longer used but still functional. As a result, the amount of e-waste grows continually, including negative environmental consequences (Benko, 2015; Lewis, 2013). One framework in the field of SID, the Attachment Framework (Gegenbauer & Huang, 2012a; Odom et al., 2009), provides an approach to prevent the problem of obsolescence. It is based on the idea that products should be designed in a way that people build up a strong relationship with their devices. Hence, they will use them longer, and the longer usage of devices yields a positive contribution to minimize the resource wastage as well as the amount of e-waste. Although the Attachment Framework is theoretically well-founded, it has not been implemented successfully into practice yet (Remy et al., 2015). This gap between theory and practice is a common problem of many design guidelines and frameworks developed by SHCI researchers, which limits the impact of SHCI research (Stolterman, 2008).

This thesis aims to contribute to the understanding of how to close the theory-practice gap. The goal of this work is to build and evaluate a design tool that applies the Attachment Framework to design practices. Therefore, a tablet application, which should act as a brainstorming companion, was developed with the aim to inspire designers to include attachment criteria into their product designs. Thus, the resulting product designs should exhibit characteristics that are able to enforce the relationship between the users and their devices. To evaluate the tool, 12 designers were asked to integrate it into their ideation process and provide feedback about their experience using the application. The resulting sketches and ideas as well as the interview transcripts were analyzed in order to answer the following three research questions:

1. What is the influence of the application on the design ideas created in the brainstorming?
2. What is the influence of the application on the design process, according to the designers?
3. Is the application able to fulfil its purpose as Sustainable Interaction Design brainstorming companion?

The results of the study show that the transformation of a theoretical framework, as the Attachment Framework, into concrete design suggestions is a successful way to communicate theory to design practice. The study participants liked the basic idea of the application and they integrated the tool into their usual design process. Moreover, the design ideas, developed by the participants, featured various attachment properties that were proposed by the application. However to be accepted in practice, the tool needs to be further extended to support more practical applications.

The thesis is structured in the following way. First, the background is introduced and related work is presented. Then, the development of the tablet application InspiredDesign is illustrated. Afterwards, the study setting and results are described. Finally, the results are discussed and an outlook for further research is provided.

2 THEORETICAL BACKGROUND

First, this chapter defines the Attachment Framework, which depicts the main basis for the creation of the application's content. Furthermore, the current state of research on the prevailing theory-practice gap in SHCI is presented, which provides essential findings that were used to inform the development of the application.

Inspired by the study conducted by Remy et al. (2015), we decided that the idea generation phase is the most fitting stage within the design process to integrate a new tool, because in this stage designers tend to be more open for new sources of inspiration. A widely used and well-known creative method during ideation is brainstorming (Isaksen & Gaulin, 2005). Since the fundamental brainstorming rules pander the implementation of new tools, it emerged as a suitable method to integrate the application. Due to the fact that the tool should complement and not change the usual way people brainstorm, the idea came up to build the application as a companion, which should serve as a further source of design ideas. For this reason, the brainstorming rules that are commonly applied in practice and research, which is related to the topic of how designers get inspired, were studied in more in detail. The results are introduced in this chapter.

Finally, related works, as for example existing tools for ideation, are described.

2.1 Attachment Framework

The Attachment Framework describes the fact that people use some objects for a longer period of time, because they built up a relationship or strong attachment to them. In the context of SHCI, the framework can be seen as a valuable approach to tackle the increasing obsolescence of electronic devices. If new devices were constructed in a way that their users developed a strong attachment with them, they would use and keep the devices longer.

There is a considerable amount of papers linking product design to disposal of objects. For example, Blevis (2007) investigated the connection between innovation and disposal as well as the promotion of renewal and reuse. He indicated that the design of the product and the product service provided, as for example updates, have a substantial effect on the life span of a product. Therefore, Blevis (2007) claimed that designers have to consider the potential influence of their design decisions on sustainability. Odom et al. (2009), Gegenbauer and Huang (2012a), Gegenbauer and Huang (2012b) conducted several interviews in households to evaluate which properties an object needs to possess to evoke a strong relationship. In summary they introduced the following seven categories of attachment:

1. Histories

“The extent to which the materials of an object preserve personal histories or other memories, either by explicitly showing physical signs of use or implicitly by virtue of its persistence over time” (Odom et al., 2009)

2. Augmentation

“The extent to which an object has been reused, renewed, modified, altered or otherwise made to be a part of something augmented beyond its original intended use and as such has become a symbol of the resourcefulness and/or creative expression of its owner” (Odom et al., 2009)

3. Engagement

“The extent to which an object invites and promotes physical engagement with its owner during use” (Odom et al., 2009)

4. Perceived durability

“The extent to which an object’s owner regards an object as long lasting either in terms of function or in terms of longevity or both” (Odom et al., 2009)

5. Earned functionality

“The extent to which an object continues to be used because of the time and effort spent becoming familiar with it.” (Gegenbauer & Huang, 2012a)

6. Perceived worth

“The extent to which an object is perceived as having a high objective worth, thus making it irrational to dispose of.” (Gegenbauer & Huang, 2012a)

7. Sufficiency

“The extent to which an object continues to be used or kept because it is capable of serving its intended purpose.” (Gegenbauer & Huang, 2012a)

Moreover, they provided concrete design implications based on the Attachment Framework, which should be applied by product designers to develop more sustainable products.

Another study, which is strongly related to this topic, was conducted by Huang and Truong (2008). They examined the reasons for discarding, replacing or acquiring mobile phones. Remarkably, they exposed that the purchase of a new device was mainly driven by a price reduction due to the subscriptions of the users. Therefore, they claimed that services should support and not hinder longevity. In this thesis, the goal is to extract the design implications that are named in these papers and incorporate them into a tablet application in a way designers are able to use them in their ideation process.

2.2 Theory-Practice Gap

Stolterman (2008) accentuated the differences between design practice and design research and stated that the theories developed in research are often not successfully applicable to practice. One important point that he focused on was how design practice and design research deal with complexity. In design research one common goal is to reduce complexity and to focus on small tasks in order to measure individual variables. Hence, researchers introduced methods to reduce complexity in design, too. However, in design practice, complexity can be seen as “required condition for innovation and creative design to happen” (Stolterman, 2008). Therefore, complexity seems to be a stimulus for design success. As a result, he claimed that researchers should familiarize

themselves more with design practice and they should ensure that their tools, techniques and methods can be integrated into the design process. Furthermore, Stolterman (2008) gave more concrete design implications for tools, frameworks and methods that are supposed to be used in design practice, as for example that tools need to be precise and simple.

Remy et al. (2015) went further and attempted to apply a framework, the Attachment Framework, into practice. They asked 14 designers to create design sketches of tablet computers, which encourage the relationship between the device and its owner. Seven designers received further, detailed, information about the Attachment Framework. Afterwards, the sketches were evaluated by design experts and Attachment Framework experts. The results expressed that the framework had no effect on the attachment criterion of the designs. However, the designs of the group with further information about the framework showed a positive effect with respect to novelty and creativity. Based on this results Remy et al. (2015) introduced four challenges and hinted how to deal with these challenges when applying SHCI theory to design practice, namely, addressing the right target audience, finding the appropriate stage in the design process, transferring and transforming SHCI design knowledge, and evaluating applications of SHCI research. Especially, the challenge of transferring and transforming SHCI design knowledge is a well-known problem, which is also identified by Grosse-Hering et al. (2013), who analyzed how the Slow Design principles, another framework related to product attachment, can be applied in design practice. They conducted a study, where designers were asked to use the Slow Design principles to design a fruit juicer. At the beginning, the designers were not able to transfer and use the principles for their design process. They required concrete design examples in order to fully understand the principles. Grosse-Hering et al. (2013) claimed that designers are not researchers and thus, the theory needs to be presented in a more understandable, applicable way. Sutcliffe (2000) even suggested that the complexity of the theory should be hidden from the designers.

The presented papers (Grosse-Hering et al., 2013; Remy et al., 2015; Stolterman, 2008) as well as other papers mentioning the theory-practice gap (Roedl & Stolterman, 2013; Rogers, 2004) show that it is still an issue to put theory successfully into design practice. This thesis aims to combine and build up on these results and tries to create a tool that integrates the Attachment Framework, as an example of a theoretical framework, into the design process. In contrast to Remy et al. (2015) and Grosse-Hering et al. (2013), the theoretical framework was only taken as a basis for generating concrete design suggestions which were presented to the designer. Thus, a new way of communicating the framework was explored and the theoretical background was completely hidden from the designers.

2.3 Brainstorming in Practice

Since one aim of this thesis is to develop an application that should serve as a brainstorming companion, it is important to first understand and later consider the fundamental aspects of brainstorming for developing the application. Brainstorming, in a group or for oneself, is a common and frequently used creative technique for

ideation, which can help people to come up with completely new trains of thoughts (Gause & Weinberg, 1989; Gerber, 2009; Gonçalves et al., 2011). Osborn (1963) claimed four essential rules, which are still used in design practice, for a successful brainstorming session. First, there should be a focus on quantity. Since brainstorming is a creative technique the main goal is to produce as many ideas as possible during a session. Second, criticism should be avoided. Regardless how silly an idea is, it can lead to another useful one and more important, most of the greatest ideas seemed foolish in the beginning (Gause & Weinberg, 1989). Third, unusual ideas should be welcomed, because they often bring new inspiration and they can likely be a basis for an innovation. Fourth, ideas should be seen as a source for new ideas. They should be taken, combined and mutated to generate further ideas.

Due to these rules, designers are generally expected to be open for new inspirations or tools during this phase. Hence, there are many papers about tools or technics which have the aim to make brainstorming more effective (i.e. Gerber, 2009 or Shih et al., 2009). However, there are also some well-known problems when applying brainstorming in practice. Although, brainstorming is an established tool for ideation and usually associated with creativity and creative problem solving, there often emerge limitations in practice, as for example the free-riding problem. Isaksen and Gaulin (2005) named three common problems: Applying judgment inappropriately, giving up on the group, and interacting within a limiting process structure. In their research, they showed the potential of a trained facilitator and the usage of tools to overcome these problems. Additionally, they indicated that people should combine several ideation techniques in order to exploit the advantages of all of them and that group as well as individual idea generation should be reinforced.

Based on the insights of the research related to the theory-practice gap, one aim of this thesis is that the application can be fully integrated into the existing brainstorming process and that it must not disturb the ideation phase. Thus, one requirement was that the application must not violate Osborn's rules and that it should consider the problems, which can appear when using brainstorming in practice.

2.4 Inspiration of Designers

Since the tool should be used for brainstorming and should inspire designers to come up with criteria, which support the attachment properties of their end product, it was essential to analyze potential sources of inspiration of designers. In their research, Gonçalves et al. (2011) discussed different ways of how designers get inspiration. They stated that although visual stimuli can have negative effects, the use of images emerges as a preferred source for inspiration for designer. Especially in a time constraint setting, as it often prevails in practice, images can be used as a fast way for receiving new insights. Additionally, they accentuated the potential of text, which has the advantage to be easily accessible for ideation. Their research is supported by several other researchers. For example, Jonson (2005) evaluated different tools that could be used for ideation, as words, sketching, computers and models. For this reason, he conducted a study with several designers from various domains, as for example

fashion or product designers. Among other things, the results of the study expressed the importance of words. The verbalization was proven to be an essential tool for getting started and was the tool most used for the experience of sudden insights. Goldschmidt and Sever (2011) examined the potential of text, too. They executed an experiment to measure the influence of texts on originality and practicality. They showed that texts have a significant positive influence on originality, regardless of whether the texts are related to the subject of the task or not. Furthermore, they noted the usefulness of visual stimuli as a good source of inspiration. However, they also mentioned a disadvantage of images in contrast to texts, that images are not always available. Another topic, which they briefly discussed, was the difference between experienced workers and novices. Experienced workers often access their collected knowledge from past works to gain inspiration. Novices do not have this resource. Due to this fact, novices and experts may need to be treated differently. Goldschmidt and Smolkov (2006) discovered another important fact while evaluating the impact of visual stimuli on design. They conducted a study with two different design tasks to elaborate how various kinds of visual stimuli affect the design criteria creativity, originality and practicability. The results revealed that the stimuli had mixed effects on the parameters depending on the design task. Thus, they concluded that design problems are not all of the same kind and as a consequence, visual stimuli can have positive or negative impacts on design problem solving. Therefore, it is important to carefully analyze the design task first, in order to evaluate the best fitting stimuli.

Another important study, which deals with the inspiration of designers and how tools probably could enhance it in practice, was performed by Dorta et al. (2008). They assessed a system called Hybrid Ideation Space that was developed to expand analog tools with digital capabilities. In their research, they stated common problems of existing tools as well as important aspects, which should be considered when developing a tool with the aim to support the ideation phase. For example, they claimed the development of simple tools, without large menus. Otherwise, the idea generation process could be interrupted by too much interaction with the system. Moreover, designers are not computer specialists. They should be able to concentrate on their main task, ideation, without being distracted by the interaction with a system. Therefore, the systems should be designed very user friendly and simple to use.

Based on these results three requirements for the design of the tablet application arose: First, text should be used as a main source for inspiration. Second images should be utilized to make the application more appealing and as an additional source for inspiration. Third, the application needs to be simple to use without possessing large menus.

2.5 Related Work

Searching for existing tools, which assist creativity and the idea generation process, leads to several innovation and idea management systems or platforms. They support discovering current ideas and sharing new ideas within a community, a group or a company. Some examples are described in Table 2.1. The main focus of these systems lies on sharing and using ideas for concrete projects to solve actual problems. Furthermore, they assist to select and refine ideas by providing several features, as ranking of ideas, assistance of collaboration work and project tracking.

Name	Main Purpose	Main Target Audience	Target Platform/ Device	URL
Barineet	Sharing of ideas with companies (i.e. Nespresso) to improve the everyday used products. Brands receive valuable feedback about their products.	Private persons, brands	Available on several platforms, devices	braineet.com
OpenIDEO	Community members can interact with each other on the open innovation platform to tackle the toughest global issue.	Private persons	Desktop Computer, optimized for mobile usage	openideo.com
IdeaScale	Cloud-based innovation software platform, where the community members can share, review and rate ideas for implementation.	Private persons	Available on several platforms, devices	ideascale.com
Vetter	Employee suggestion box to gather, to edit and to reward ideas from employees.	Organizations	Desktop Computer, optimized for mobile usage	getvetter.com
IdeasMine	Collaborative Idea Management System to collect progress ideas from the employees.	Organizations	Desktop Computer, optimized for mobile usage	ideasmine.net
Codigital	Enable groups to generate, prioritize and refine ideas.	Organizations, interest groups	Desktop Computer, optimized for mobile usage	codigital.com
Crowdicity	Idea management software to gather the thoughts of employees.	Organizations	Desktop Computer, optimized for mobile usage	crowdicity.com

Table 2.1: Existing Idea Management Tools

Another type of tools, which support creative thinking, are systems developed to serve the representation of mind maps. Accordingly, they can be used to organize ideas and to store them for later use. Most of them are online

tools and the maps can be accessed and edited from everywhere. In Table 2.2 some tools, which can be used for drawing mind maps, are presented.

Name	Main Purpose	Main Target Audience	Target Platform/ Device	URL
Exobrain	A web-based mind mapping tool for visualizing, organizing and generating ideas.	Private persons	Desktop Computer	exobrain.co
bubbl.us	To easily create colorful mind maps to print or share with others.	Private persons, organizations	Available on several platforms, devices	bubbl.us
Mindjet	Mind Map Software that supports the visualization of ideas.	Private persons, organizations	Available on several platforms, devices	mindjet.com
MindMeister	Online-Mindmapping tool that supports collaboration and other features.	Private persons, organizations	Available on several platforms, devices	mindmeister.com
XMind	An open source project for creating mind maps.	Private persons, organizations	Desktop Computer	xmind.net
Coggle	Shared workspace to create and work on mind maps together.	Private persons, organizations	Desktop Computer	coggle.it

Table 2.2: Existing Tools for Visualization

Moreover, there is a huge amount of mobile applications, which are developed to encourage creative thinking and to draw visual diagrams to organize information. The tools for mobile devices provide similar functionalities as the tools for desktop computer and are mainly built with comparable incentives. Several examples of mobile applications are summarized in Table 2.3.

In summary, most of the tools presented are built for the representation of complex thoughts or the exchange of ideas between different users. The main purpose of the tablet application, which has been developed in context of this thesis, was to inspire designers to come up with product criteria, which increase the relationship between a user and his device. In contrast to the existing tools for ideation, the application serves as a brainstorming

companion, presents concrete design suggestions derived from the Attachment Framework and provides no possibilities for creating illustrations as maps. Therefore, this application differs a lot from related, existing tools.

Name	Main Purpose	Main Target Audience	Target Platform/ Device	URL
Brainsparker	Application to brainstorm and to share ideas.	Private persons	iOS	brainsparker.com
Fleck	Application to share inspiring photos to topics and to vote on submissions.	Private persons	iOS	getfleck.com
Idea Generator	Tool that use the random input creativity technique for inspiring people.	Private persons	Android	https://play.google.com/store/apps/details?id=com.designtop.generator
iThoughts	Applications that support the creation of mind maps.	Private persons, organizations	iOS	http://toketaware.com/
SimpleMind		Private persons	iOS and Android	simpleapps.eu/simplemind
SchematicMind Free mind map		Private persons	Android	qdvsoftworks.wordpress.com/schematicmind

Table 2.3: Sample of existing Mobile Applications for Ideation

3 BRAINSTORMING TOOL - INSPIREDDSIGN

The development of the tool was performed as an iterative process, which started with the initial itemization of the requirements and the selection of the technical frameworks for the implementation. The resulting specification revealed that the tool consists of only a few basic functionalities and provides nearly none interaction possibilities for the users. For this reason and to receive rapid feedback from design practitioners, it was determined to create a fully functional prototype for the study evaluation. However, in advance, the first functional version of the tool was enhanced based on the assessment of a HCI expert to ensure a good usability of the application. The adapted version, a fully functional prototype, was then presented to designers for a further evaluation and development. Afterwards, based on the comments of the participants the application was adjusted again (see Section 5.3.1).

3.1 Specification

Inspired by past works described in Chapter 2.2, we decided to design a mobile application for tablets that should be platform independent and support the user during brainstorming. A tablet was chosen to be a suitable device because it was expected that a tablet can be easily used along with paper and pencil and that it could, for example, work as a replacement for a book or a magazine. Thus, the application could be integrated into the normal design process.

The basic idea was that the resulting application should contain an amount of design ideas derived from the Attachment Framework. Each of these ideas should be transferred into a practical design proposition and be displayed in the form of a brainstorming flash card. Then, these cards should be randomly shown to the users. Influenced by their daily business, designers have a focus on aesthetic qualities and tend to react sensitive to the visual appearance of devices and applications. For this reason we planned to design a plain, simple and modern user interface. Therefore, existing web pages and mobile applications were visited and tried out to gain inspiration for the user interface. Thus, for instance, the idea came up to have a slide show of images in the background on the start screen to make the view more engaging (see Figure 3.3). An additional intention was to provide only features, which were mandatory to support a successful brainstorming session (see Chapter 2.3). For this reason, we came up with the following list of requirements:

- Displaying of design ideas in form of brainstorming flash cards
- Randomization of the flash cards
- Possibility for the user to browse through the cards
- Slide show that automatically switches the flash cards
- Possibility for the user to start and stop the slide show
- Possibility for the user to change the time interval for the slide show

The initial plan was to not only use the tool for the study but also to distribute the tool over different channels, as for example Google Play Store¹, to assemble feedback from practice at a later point in time. Consequently, the application needed two modes, one for the study and one for a normal brainstorming session. Moreover, the application should support multiple languages, English and German. Thus, more specifications revealed:

- Two modes, one for normal brainstorming and one for the study, user can choose the mode
- Displaying of study information and possibility for the user to register for the study
- Logging of user behavior during brainstorming in the study mode
- Recording of the brainstorming session in the study mode
- Possibility for the user to start and stop the recording
- Automatically upload of recordings and log files to the server
- Internationalization, the content needs to be provided in English and German
- Possibility for the user to switch the language

3.2 Technical Implementation

Due to the fact that the application should be platform independent, we decided to utilize the open-source mobile development framework Apache Cordova² for the implementation. Apache Cordova has the advantage that it is free and it allows to create mobile applications for various platforms using common web technologies, as CSS, HTML and JavaScript. Therefore, we could avoid developing separate applications in several platform specific development languages. In order to trigger the distinct functionalities of the various devices, as for example the storage or the camera, the framework provides individual plugins for each platform, which can be added to the project. In addition, there is a large community using this framework. Hence, one can consult a wide knowledge base when a problem arises.

To enhance the controlling of the system and the structure, a second open-source framework, AngularJS³, was used. The web framework AngularJS enables the utilization of a client side model-view-controller software architecture for single-page applications. As a result, the routing between single views was facilitated and variables could be defined and used on various views. Moreover, the AngularJS module angular-translate enabled the utilization of the two languages German and English for the application.

To support the combination of the two frameworks, Apache Cordova and AngularJS, in practice ngCordova⁴, an AngularJS wrapper for Apache Cordova plugins, was included into the application. In addition, other JavaScript libraries were used to complement the functionalities of the application. To simplify the styling Bootstrap⁵, a common known front-end framework, was used.

¹ play.google.com/store

² cordova.apache.org

³ angularjs.org

⁴ ngcordova.com

⁵ getbootstrap.com

3.3 Brainstorming Flash Cards

After the requirements and the technical frameworks were concretized, the first prototype was implemented. During this process another question about how the brainstorming flash cards should look like arose. Ideas for the flash card content are based on suggestions given by Odom et al. (2009), Gegenbauer and Huang (2012a), Blevis (2007), Huang and Truong (2008) and Grosse-Hering et al. (2013). Many design propositions were also derived from the design sketches collected in the study performed by Remy et al. (2015). To structure the huge amount of ideas a mind map with the following general terms was formed:

- Material
- Customization and personalization
- Device as an everywhere companion
- Reusability and augmentation

Thus, we were able to concretize the suggestions and to form prompts. Moreover, it helped to sort out redundant terms and to detect potential gaps. To avoid that the prompts were too monotonous, they were written in different forms as for example as questions, as examples or as requests. Some instances of prompts are:

- *Is it possible to use wood for the outer shell? Wood is a renewable resource that represents quality and stability.*
- *To make a device unique it could use a software that learns from the user.*
- *If the device had a modular structure, the individual parts could be reused for new applications.*
- *Why not develop a do-it-yourself kit for the device?*

Moreover, we add two prompts, which were more general and based on the broader topic sustainability:

- *Ensure that the device is fully recyclable.*
- *Can you use recycled material to build the device?*

In addition to the statements, we also gathered images to illustrate them. The images were a mix of sketches, drawn by participants from the past study by Remy et al. (2015), photos, retrieved from Pixabay⁶, and graphics. As a result, we were able to accumulate 28 prompts and corresponding images. To answer the question, how the arrangement of the prompts and the pictures should be defined, literature, described in Chapter 2.4 about how designers get inspired was consulted. Based on the research, we decided to put the illustrations in the background and to prioritize the prompt, because especially text was proved to be inspiring and to possess low potential for being misleading. Thus, the image in the background could be regarded as complement and further explanation of the prompt. Examples of resulting brainstorming flash cards are displayed in Figure 3.1 and Figure 3.2. A list of all prompts can be found in the Appendix A.

⁶ pixabay.com

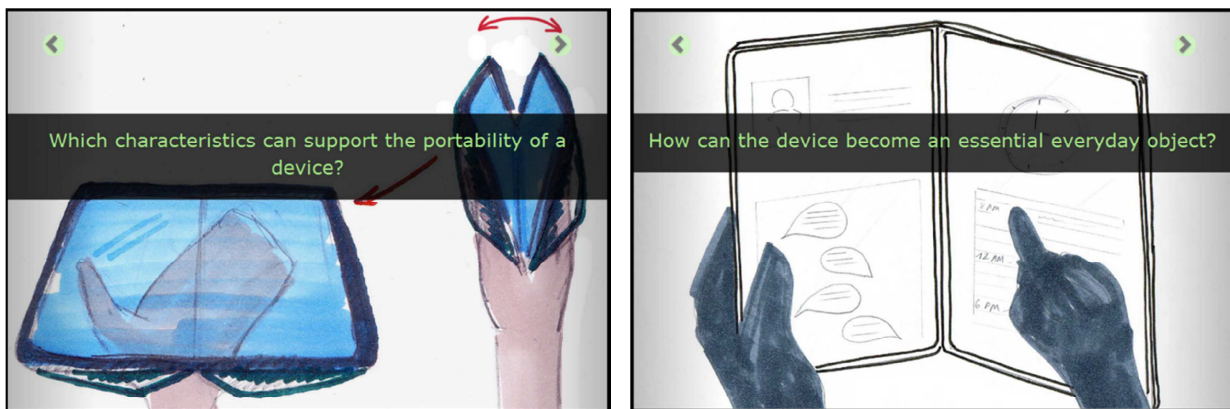


Figure 3.1: Examples of brainstorming flash cards illustrated with sketches developed in the study conducted by Remy et al. (2015)

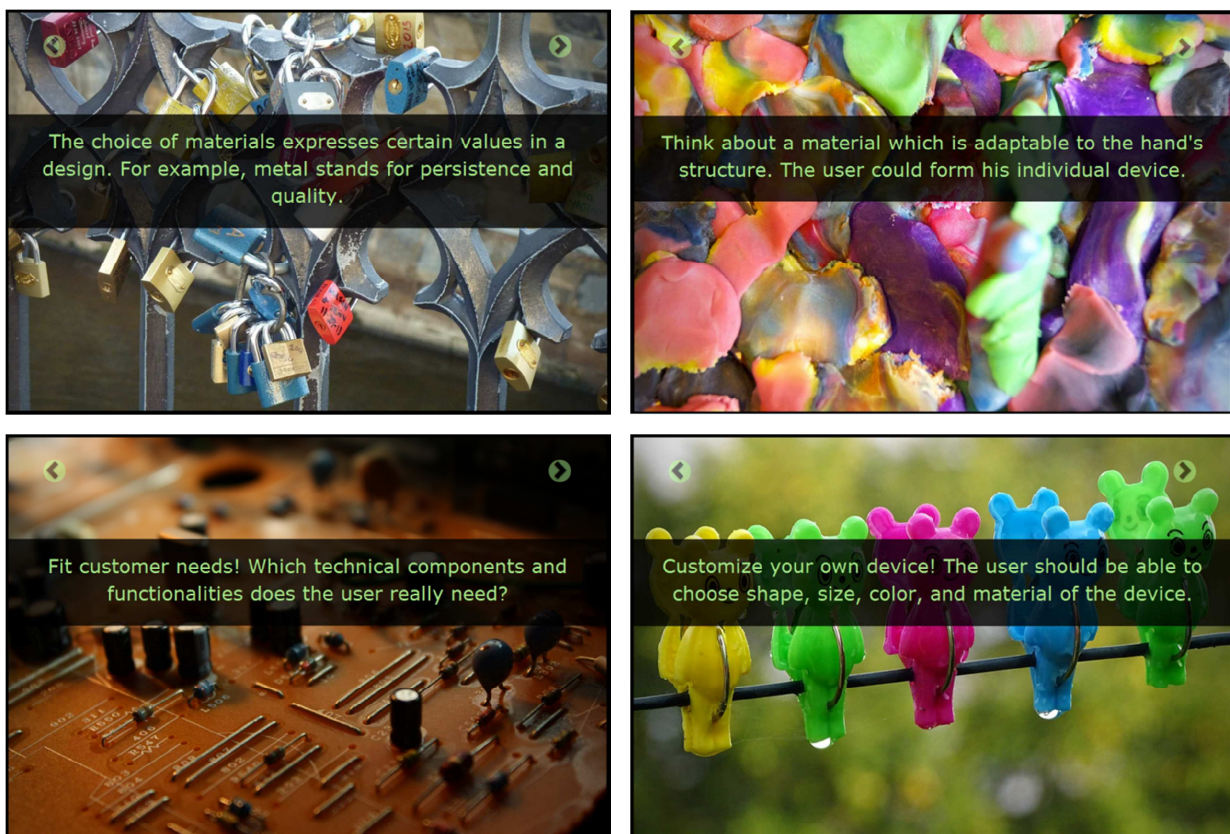


Figure 3.2: Examples of brainstorming flash cards illustrated with photos retrieved from Pixabay

3.4 Assessment by HCI expert

To get a first feedback about the tool and its usability an expert in HCI was asked to test the tool. Therefore, a think aloud approach was chosen and the expert performed several predefined use cases and described verbally what she is thinking about when interacting with the tool. The results of the think aloud approach showed that the tool was able to fulfill its basic purpose, to assist the user to slide through brainstorming flash cards to gain inspiration. Furthermore, the expert inspected the tool and gave several suggestions to enhance the usability and the appearance. As a result, she proposed a feedback possibility for the normal brainstorming mode. Thus, we added two additional requirements to the specification of the tool:

- Possibility to give written feedback to the whole application
- Possibility to give written feedback to single cards during normal brainstorming

The expert also recommended several smaller changes of the textual descriptions, an adaption of a brainstorming flash card and the enlargement of the time intervals for the automatic slide show of the brainstorming flash cards. Moreover, she facilitated to redesign the start screen to a more structured version. Initially, the two start buttons, one for the normal mode and one for the study, were among themselves. The expert advised to more separate the modes by arranging them side by side. The resulting start screen is displayed in Figure 3.3. In addition, she gave some remarks that concerned the study, as for example that study participants may want to hear their recordings.

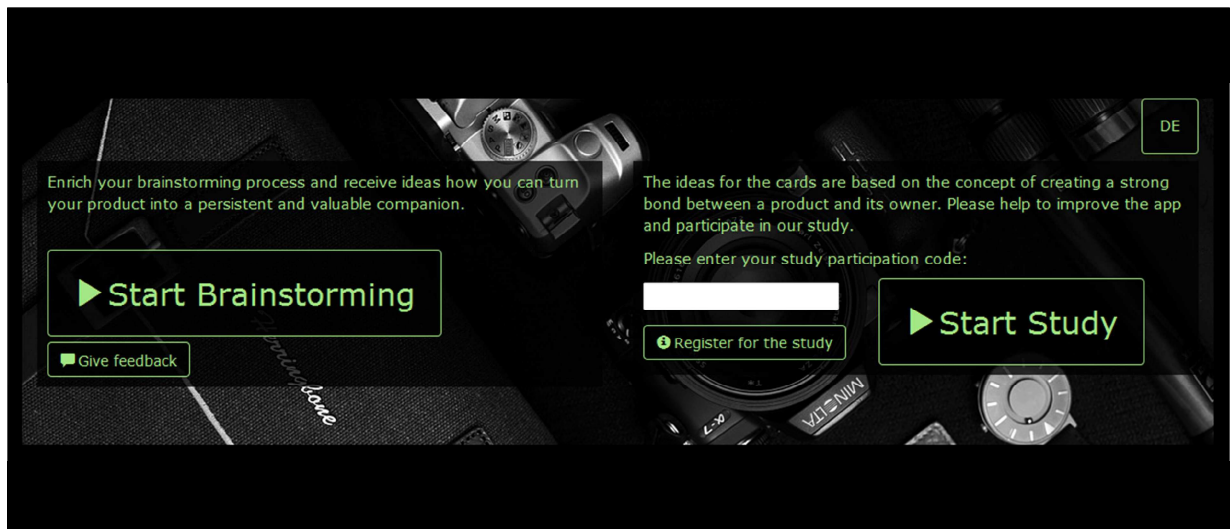


Figure 3.3: Start Screen

4 EVALUATION OF INSPIREDDSIGN

Once the tablet application had reached a certain level of maturity, an evaluation of the brainstorming tool was possible to assess the potential of the tool as a brainstorming companion and to iterate on the application's design. Initially, it was planned to conduct two evaluations, one in a local, more controlled study environment with a fictive task and a remote study, in a real-world application. However, due to time restrictions and the huge amount of feedback that was accumulated in the local study, we decided to postpone the remote study and first closely analyze the results from the local study. Section 4 describes the research questions, the study structure, the participants and the evaluation methods for assessing the data gathered during the study.

4.1 Research Questions

The research questions form a basis for the study structure, the interview questions and the study evaluation. They are derived from the main goal of the thesis, to create a tool that applies the Attachment Framework successfully into practice. We came up with three research questions, which are supposed to assess different aspects of the application.

The first question deals with the transformation of the theoretical framework into concrete design suggestions and how the designers incorporate them into their product ideas. Obviously, the primary aim of the tool is to effectively communicate the design properties derived from the literature about the Attachment Framework (see Chapter 3.3). Thus, it is essential to examine the influence of the application on the design ideas created during the brainstorming session, for example, by comparing the accumulation of attachment criteria from the brainwriting with the collection from the brainstorming session.

Another research question focuses on the influence of the application on the design process. Since the research about the theory-practice gap, introduced in Chapter 2.2, demands that new tools must not disturb the prevalent design process to be successful in practice, it is necessary to sense how the tool matches into the ideation phase. Unfortunately, design processes are largely individual to designers, customers, products or the general context. Hence, they are difficult to generalize and to be fully reproduced in a lab environment. Therefore, the answer to this question depends on the perception of the designers, how they feel about the application influencing their design process.

The last research question investigates the general usability of the tool and the user's acceptance. Since the user's acceptance is always a critical factor when introducing a new software system, it is important to detect potential problems and concerns. In this context the target users are the designers. Thus, we need to evaluate how they interact with the system and how they think about using the system for brainstorming in practice.

To sum up, the following three research questions were developed for the evaluation of the tool:

1. What is the influence of the application on the design ideas created in the brainstorming?

2. What is the influence of the application on the design process, according to the designers?
3. Is the application able to fulfil its purpose as Sustainable Interaction Design brainstorming companion?

4.2 Study Structure

The lab study was scheduled as follow: The designers were welcomed and received a consent form, which contains the basic conditions of the study, as for example the duration and the reward. Then, the main task was introduced. The designers were also instructed that the study serves as a part of a larger research project, which examines how to increase people's attachment to their possessions in order to promote a longer usage of their belongings, such as electronic devices, as a way of supporting environmental sustainability.

The main task of the designers was to accumulate design ideas for a basic design task, with a focus on how such an object, with a strong bond between the device and his owner, could look like. The designers could choose if they wanted to use an effective, current design task as a basis for their ideation process or a fictive design task, which we provided. The fictive design task was the development of a health and fitness monitoring tool or device. We selected this design task because it fits to the content of the application and it is an upcoming new topic, which is not completely explored and established yet. Moreover, to construct a health and fitness monitoring tool provides lot of space for creative solutions.

Figure 4.1 displays a graphical illustration of the main task, which the designers received as an additional instruction.

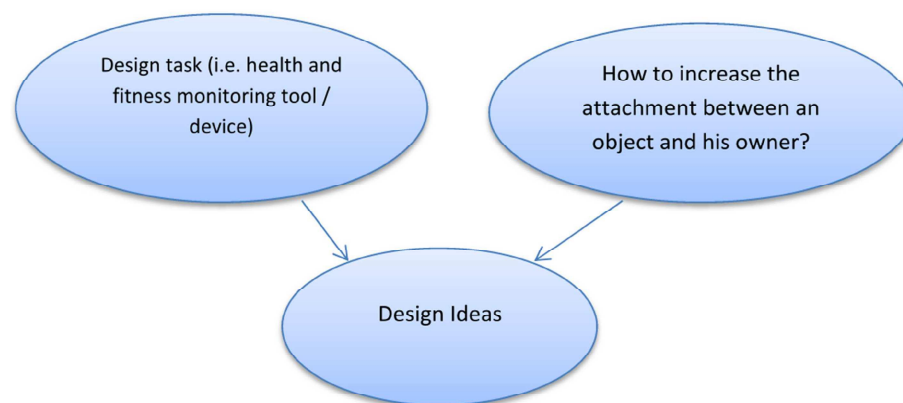


Figure 4.1: Main task to collect design ideas for a design task with a focus on attachment

Before the participants started their ideation phase, they were asked to briefly describe their normal brainstorming technic and the tools, as for instance flash cards, paper, colored pencils or a whiteboard, they usually need for brainstorming. By preparing everything in advance, we ensured that the process was not interrupted in any way later. Additionally, it was essential that all utilities were available to guarantee that the designers were able to perform the brainstorming session as they were used to in everyday life. Since the tablet application should be

capable of being integrated into every considerable form of brainstorming practice, it was not necessary to force a predefined procedure during brainstorming. It was more important to encourage the designers not to adapt their usual process and that they should proceed as they would normally do when confronted with a similar task in practice.

Subsequently, the designers started their idea generation process with a 10 minute brainwriting session, which they performed by themselves, without the assistance of any tools. In case a designer was not familiar with the creative technique brainwriting, a short explanation was given. Afterwards, a 15 minutes brainstorming session with the developed tool followed. The initial brainwriting session should help the designers to first reflect about the topic on their own. Thus, they had the possibility to first retrieve their own knowledge about attachment and sustainability. Hence, they were able to mark which ideas are evoked by the tool during the brainstorming stage.

In the end, an interview that endured about 20 minutes was performed. The interview was held in a semi-structured way and was assisted by a protocol with several guidance questions. Sometimes additional interview questions arose based on certain observations during the brainstorming session. The duration of the whole study, including all explanations, was estimated to be one hour.

The English version of the study schedule used, the consent form, the design task description (including the brainwriting explanation) and the interview protocol is listed in the Appendix C, D, E and F.

4.3 Participants

Since the goal of this thesis is the implementation of a theoretical framework into practice, it was necessary to evaluate the tool with experienced designers. Product designers and industrial designers were set as the main target audience for this evaluation because the tablet application was primarily built to support the design process of concrete products. However, the recruiting text in the application form was written more open, to not exclude other kinds of designers who have practical experience in product development. Therefore, we searched for designers who possess experience in product or industrial design.

For the study 13 participants were recruited over different channels. We used advertisements on the online platforms ronorp.net, www.marktplatz.uzh.ch and blackboard.zhdk.ch. In addition, the product design students from the Zurich University of the Arts were directly contacted by a mass mail and flyers. Especially ronorp.net emerged to be a fruitful platform to recruit designers with many years of working experiences. The whole recruiting process lasted around one month and the response rate was not high, but acceptable and the responses were equally distributed over the recruiting time. Due to the fact that brainstorming sessions are often done in groups, we also recruited groups of two people for the study. However, we did not form teams of people who made a single registration, because this could lead to undesirable side effects, which are out of scope of this thesis. Therefore, we decided that the team members need to know each other and register together. To incentivize people to sign up as teams, a monetary bonus of 10 CHF per team member was offered. Therefore, 80 CHF was

paid per team and a single user received 30 CHF for his or her participation at the study. All recruitment texts were provided in German and English. The English version is listed in the Appendix B.

In total we conducted the study with 13 designers, four teams of two and five single participants. Seven of the participants were male and six were female. A brief overview about all participants is displayed in Table 4.1. Throughout this thesis, the participants are referred by their participant code, DP1 to DP5 for single users and DT1-1 to DT4-2 for group participants, where the first number denotes the team number and the second number after the dash distinguishes between the two participants of that group.

Since we advertised and held the study in Zurich, most of the participants conducted the study in German (10 participants). The remaining three studies were conducted in English.

Code	Gender	Language	Occupation	Area of specialization	Experiences work exp. = work experiences
DP1	Female	German	Graphics Designer	Graphics Design	work exp. > 4 years
DP2	Male	English	Student	Interaction Design	Projects during his studies
DP3	Male	German	Product Designer	Industrial and Product Design, 3D Corporate Design, Branding	work exp. > 4 years
DP4	Female	English	Student	Visual Communication	Part-time besides her studies and projects during her studies
DP5	Male	English	Student	Product Design	Various projects besides and during his studies
DT1-1	Male	German	Student	Industrial Design	Projects during his studies
DT1-2	Male	German	Student	Industrial Design	Projects during his studies
DT2-1	Female	German	Product Designer	Product Design	work exp. > 1 years
DT2-2	Female	German	Product Designer	Product Design	work exp. > 1 years
DT3-1	Female	German	Student	Product Design	Projects during her studies
DT3-2	Female	German	Student	Style and Design	Projects during her studies
DT4-1	Male	German	Product Designer	Industrial and Product Design	work exp. > 6 years
DT4-2	Male	German	Product Designer	Industrial and Product Design	work exp. > 7 years

Table 4.1: Participant Overview

The recruited designers showed a variety in practice experience: Seven of the participants study product design or a related field, as for example style and design or visual communication. Five designers were practitioners in product or industrial design and the last one was practitioner in graphics design. Thus, the range of professional experiences in product design varies a lot. While the students mostly performed projects during their studies or work part-time, the practitioners feature between one and seven years of practice.

In contrast, the designers exhibited similar knowledge about the term sustainability. Although none of them felt to have a clear grasp of the general definition of sustainability, most of them stated that the term is omnipresent and that designers need to care about sustainability, for example by choosing sustainable materials.

“It is hard to define the word sustainability [...] When working in groups everyone has his own opinion how to be green and sustainable.” (DP2)

“I think it is not possible to define sustainability anymore. Everyone use it as he likes. I think it becomes some sort of a trend word, similar to Bio.” (DT1-1)

“As a designer you have to produce something sustainable, because it is a trend. [...] In case you create something that fulfills the requirements, but it is not sustainable, than it is worthless in our industry.” (DT3-1)

4.4 Data Analysis

For each participant we gathered the output from the brainwriting and brainstorming sessions, as for example sketches and written design ideas. In addition, we took notes during the brainstorming sessions and the interviews. On top of that, the brainstorming sessions and the interviews were recorded. For the analysis of all data several evaluation techniques were used, these are described in this chapter.

4.4.1 Brainstorming and Interview Recordings

In total around 45 minutes of audio material was collected for each of the single participants and the teams from the brainstorming sessions and the subsequent interviews. In order to make these recordings evaluable, they were transcribed and additionally, the German transcripts were translated into English. Thus, a huge amount of material emerged that was used as the basic data for an affinity analysis.

The affinity analysis is a valuable technique to detect clusters or groups of similar or related items. Thus, it is possible to show a larger picture and to reflect general viewpoints (Holtzblatt et al., 2005). In our case the method was used to analyze the recorded statements of the participants. For that reason, all record transcriptions were split into direct quotes, according to certain topics or questions. Thus, more than 400 statements were produced. To make them uniquely identifiable, each quote got a code consisting of the participant identifier and a sequential number. Next, they were printed and cut into notes. Subsequently, a bottom-up affinity diagram was created. Therefore, we examined the stack of notes for identifying clusters or patterns of similar quotes, which preferably originate from different participants. Then, each of the resulting groups received a title, which can be seen as the common theme of the group. Afterwards, these themes were grouped again into more general topics. Figure 4.2 displays an image of the resulting diagram.



Figure 4.2: Affinity Diagram

In addition to the affinity analysis, the unified theory of acceptance and use of technology (UTAUT) was used to gain a feeling about the potential of the tool in practice. The UTAUT, which was originally formulated by Venkatesh et al. (2003), bases on prominent models from user acceptance literature and was proven to be a useful tool to predict the likelihood of success when implementing a of new technology. The UTAUT consists of four key construct (performance expectancy, effort expectancy, social influence and facilitating conditions) and four factors (gender, age, experience, voluntariness of use), which moderate the impact of the four key constructs. The interaction of these constructs and factors and the resulting effect on the user acceptance and the usage behavior are illustrated in Figure 4.3.

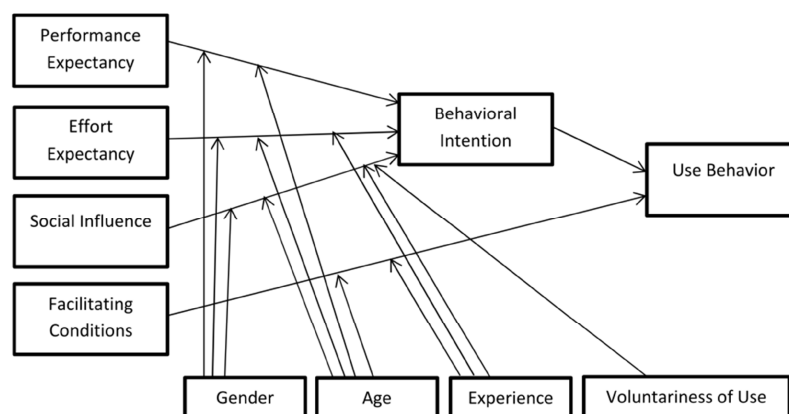


Figure 4.3: UTAUT – Research Model redrawn according to Venkatesh et al. (2003)

Although the UTAUT would be a valuable method to evaluate a user's intention to use the brainstorming tool, it was never planned to fully utilize the theory as an evaluation method, because it needs a large number of participants to apply the UTAUT properly. Moreover, the interview questions derived from the UTAUT are mostly closed questions, which require a structured interview. In contrast, we initially set the focus on a qualitative analysis with a small number of participants and a semi-structured interview. Therefore, the UTAUT was only used as an inspiration for several interview questions in order to get an impression about the acceptance of tool by the designers. The following questions from the interview protocol are based on or are strongly influenced by the UTAUT:

1. Could you envision the application to be included in your typical idea generation process? If yes, how would this influence your ideation process?
(If no, adapt next question)
2. How much effort and time do you think would it need to include the application in your brainstorming process?
(In which part of the process would you include the application? Would it replace another tool?)
3. Do you think the application could influence the effectiveness of your ideation process? (How?)
4. Would some kind of guidance or instructions be helpful when using the application (for the first time)?
5. What do you like/don't like about the application?
6. Did you have any difficulties using the application?
7. Do you have any suggestions for improvements for the overall interaction with the application?

4.4.2 Design Ideas

For the assessment of the design ideas, it was necessary to carefully analyze the whole output from the brainwriting and the brainstorming session. This includes all physical results, as for example illustration or written words and also concerns the spoken words, because some participants not only wrote down or draw certain ideas, but also described them in detail verbally. Therefore, the relevant transcripts were taken into account, too.

To expose the potential influence of the tool on the output, the design ideas and sketches were evaluated from different perspectives. First, for each participant the results from the brainwriting and the brainstorming method were closely compared to distinguish the ideas of which the participants thought about before they used the tablet application from the new ones. Second, the outputs were examined based on the Attachment Framework to predict the influence of the design ideas on the relationship between a user and her or his device. Third, usability and feasibility criteria were resolved to gain a hint for the potential of the design ideas in practice.

4.4.3 Observations

As a complement to the recordings and the physical results of the study, we also took notes during the brainwriting and especially, during the brainstorming session. The observation of people interacting with a software tool can be extremely informative. One is able to see when people hesitate and which function they use or even more interesting not use. Hence, one can draw conclusions from the handling of the users with a system.

In addition, we sometimes derived interview questions from certain observations to gain a better understanding of the user behavior. Thus, users reflected their interaction with the system and came up with detailed descriptions of their thoughts. As a result, we were able to gather valuable feedback about the usability of the brainstorming tool during the interviews, which was recorded for the further assessment.

5 RESULTS

A large amount of material in various forms was gathered during the study that could be used to evaluate the tool. Therefore, we applied the evaluation methods described in Chapter 4.4. This chapter presents the results from the affinity analysis, the feedback to the usability and the acceptance of the tool and the results derived from the design ideas.

5.1 General Themes emerging from the Affinity Analysis

Based on a bottom up analysis, we were able to detect similarities between participant statements and to form groups of common opinions. In a second step, these groups were arranged into nine common and more general themes. Finally, three more general topics emerged from these themes, which can be seen as broad requirements for tools, which are supposed to support the ideation process of designers. However, for the evaluation of InspiredDesign, especially the less general themes as well as the groups of common opinions were important, because they are more specific. The following subchapters discuss the results from the affinity analysis in detail.

5.1.1 A Tool needs to be simple, appealing and interactive

Several statements collected during the study showed that most designers have a focus on the visual appearance and that they emphasize the importance of an appealing user interface. Therefore, a software tool that is not assessed as attractive by designers will not be used and has little potential to be implemented in practice. Moreover, the participants noticed that a well-designed user interface, which is clear and simple, can encourage them to use the tool. In addition, designers call for interaction. They like it when the tool motivates them to perform tasks or when the tool reacts to certain inputs. Subsequently, the three resulting themes extracted from the affinity analysis, which are related to this general topic, are introduced by several example quotes from the study participants.

5.1.1.1 Attractive User Interface

In summary, the analysis demonstrates that designers evaluate the general appearance as one of the most important aspects of the tool. While using the tool, they regularly gave concrete design suggestions how to get a clearer and more appealing user interface structure. Moreover, they remembered that a color scheme is very important and that bright colors should be used as little as possible and only if they are really needed. They were even willing to minimize the usability to reach a more attractive user interface:

"In case I'm looking for exit, I only need about 2 seconds more if it's not red. That doesn't matter." (DP4)

Furthermore, it revealed that designers react extremely sensitive when something looks similar to a power point presentation and that the participants do not like to use such an application. Therefore it is important that the application does not awake any thoughts related to a power point presentation.

In addition to the general layout and the color scheme of the user interface, some designers also mentioned their concerns about the pictures. Since the application consists of a mix of diverse forms of pictures, as sketches and photos, it does not provide a stable picture language. This fact bothered the designers. They compared the inconsistency of the pictures to a book which was written using various fonts. As a result they claimed for uniform pictures.

Besides, several participants criticized individual images. Due to the fact that these quotes were specific and related to certain images, it was not possible to generalize them:

"I don't really like this slide. I thought it (picture) was too abstract." (DP4)

5.1.1.2 Simplicity

One requirement of the application was that it should be simple and easy to use. This requirement was confirmed by several designers and fortunately many designers appreciated that the application was simple to use, as for example:

"Everything is clear. It is obvious and I understand how it works at first sight. In this sense, it is perfect." (DP4)

"I really like that it is so simple. It is very intuitive." (DT2-1)

In addition, the participants gave various propositions how to make the tool even simpler, for instance by reducing or hiding functionalities that were not necessarily needed. Thus, the instructions could be reduced or even be omitted. This is important because when designers use the tool for the first time during ideation, they might not be willing to break their idea generation process flow to read instructions:

"When you start you don't read instructions like this. I'm not at the beginning of my process so I might be stuck and I want to start using it and I'm not gonna read the instructions." (DP5)

Furthermore, it is fundamental that the content of the brainstorming flash card is clear to the users. Accordingly, the prompts should be as simple as possible and all words should be understandable. Otherwise, it can happen that the designers do not fully understand the prompts or misinterpret them. It also needs to be ensured that the slides are not overloaded with information:

"The sentences talk about a companion and the image shows something that could be convolved. I think these are two different things. Therefore, it would be good to have two slides. Otherwise there is too much information on one slide." (DT2-1)

5.1.1.3 Interactivity

Due to the fact that it was aimed to build a simple tool with only basic functionalities, InspiredDesign offers no input possibilities. From the user's perspective it can be utilized as a picture book with suggestions of design properties. Thereby, the tool should not disturb the ideation phase by requiring too much effort from the designers. Nonetheless, many study participants claimed for more interactivity and variances. For example, they made the proposal that the brainstorming flash card content could be expressed with more variety by using keywords, sentences, images, videos and design tasks:

"I would say the idea of swiping cards is cool. I would try different types of cards. So you might have an image card, you might have text question cards, you might have a video, you might have a take 5 min break and drink a coffee card." (DP5).

In addition, several designers remarked the potential of the application as a reference tool. They described InspiredDesign as a collection of actual, well-known concepts and ideas and hence, they wished that the application could be extensible with their own experiences to keep it up to date. Moreover, a search function for keywords could be provided. As a result, the application could be used to replace their collection of books and other sources for inspiration, which they normally consider to gain hints for sustainable design.

5.1.2 The Tool as a critical, supportive and efficient companion

The affinity analysis revealed that the tool can work as a valuable brainstorming companion that complements design ideas and inspires designers to come up with totally new thoughts. In this subchapter, the themes connected to this topic are discussed in detail.

5.1.2.1 Tool as a Complement

The brainstorming tool was able to inspire the participants in various ways. For instance, several designers reported that the tool reminds them of aspects they might have forgotten to think about or that they came up with a totally new perspective, as the following quotes illustrate:

"I think it (the application) supports, because you often don't think about something or you think about it too late or you have something completely different in your mind. I think these aspects are essential and it is important to think about them in the beginning but often you forget about them. As a designer you may be focused on our idea [...] and you forget the basic things. Thus, you need to go back and to review your ideas afterwards. In this sense it is good to think about the important, essential things before you start to design the details of your idea." (DP1)

"It (the application) gives you fix topics that you can discuss. [...] It helps to check that you didn't forget anything." (DT3-2)

"Imaging I'm using it in a real situation. I think it will influence me, because it has a lot of inputs, like what's about the shape, what's about the material, what's about the function. Although, I list those categories before the brainstorming session, it gained me some ideas like, well, regarding to the material, what is about nature material. Then I can continue my brainstorming. Well, nature material, there is wood." (DP2)

The designers also declared that the application asked the right questions to give them new thoughts. Moreover, they felt reinforced by the application:

"For some cards we already had similar ideas but it (the application) helped us to reformulate the ideas that we already had." (DT3-2)

Hence, the ideas were also confirmed by the application and thus, they gained importance for the further idea generation process. Concluding, the participants expressed that the tool can be valuable to support and complement their ideation.

5.1.2.2 Tool as Critical Design Companion

During ideation many unfeasible ideas can emerge and it is sometimes difficult to stay on track. The designers appreciated that the tool helped them to stay focused and to put their design in context:

“You stay focused on the task, the question. Otherwise, while brainstorming, it often happens that you go once around the world before you get to a point.” (DT1-1)

In addition, they mentioned that the tool challenged their thinking by forcing them to consider various aspects of the design. Moreover, it animated them to think about new design properties and it supported them to exclude others:

“Also unneeded questions are not bad, because this way you are able to exclude something. Thus, I think the application is not restrictive but supporting, because you are able to come up with different aspects.” (DP3)

5.1.2.3 Impact on Ideation

Multiple designers discovered how the application affected their brainstorming process and that they came up with lots of ideas based on the brainstorming flash cards. They determined that their thinking was influenced by the pictures as well as by the texts as the following quote shows:

“Yes, they (brainstorming flash cards) influenced me. For example, I think, the text influenced me a lot, because there is an example here, it says, what's about the material and then the next question is, how about nature material, and then I wrote 'nature material' down here. [...] There is another background picture that looks like clay, so I wrote down 'clay'. I found that is an interesting material, it is recyclable and it can be customized. Customize is the keyword I get from the flash card” (DP2)

They also mentioned the potential the application could have when you stuck and you need a new source of inspiration or when you have to deal with a totally new topic:

“I think it is good [...] it could be helpful when you are confronted with a topic for which you have difficulties to come up with ideas.” (DT2-2)

5.1.3 The Tool should be adaptable

Interacting with the application, the participants came up with a lot of features they would like to have, as for example categories or an overview of all brainstorming flash cards. Additionally, they expressed their fear about being constrained by tools and that the tools need to be tailored to their specific design task. Subsequently, three themes from the affinity analysis, which are related to this topic, are presented.

5.1.3.1 Support for specific Design Task

One common response was that the tool was developed especially to serve the fictional design task that was provided for the study. As a result, the designers requested a more adaptable tool, which supports multiple design specializations and which could be used for different design task:

I could really imagine to use it, but I only have a few task that looks like this (i.e. Designing a cell phone) If one category were for media design, one category would be for product design and one would be for interaction design and one would be for just thinking about a process. Like in total general. "(DP4)

Moreover, they claimed that the tool should offer an overview of some general broad topics and then, the users can decide where they want to have more specific information or design ideas:

"iTunes once used diversified libraries. [...] Thus, you can crawl through all the top categories and when you stop somewhere it opens." (DT4-2)

5.1.3.2 Constraints by Tools

The affinity analysis exposed one very interesting theme, the fear of designer to be constrained by tools. Several designers declared their mistrust about the general usage of tools during ideation, because they had concerns that the tool interrupts their idea generation process flow and limits their thinking. Two example quotes that exemplary show this are from DT4-1 and from DT2-1:

"Brainstorming can be a very important aspect of the process, especially, when you have to work in a group. I think the methodology is very important. Based on my experiences, a technical tool hinders and it limits the freedom." (DT4-1)

"I prefer to work on paper, because thus, the whole process is more fluent." (DT2-1)

Moreover, the participants explained that designers can profit from their practical experience and do not need external assistance. One designer (DT1-1) even expressed that the usage of a smart tool for assistance can be seen as a way of cheating.

Usually, only the internet was named as a common tool that is utilized as a source of inspiration. Designers often consult the internet as a library or database for ideas and concrete images or to do research about certain topics.

With respect to InspiredDesign, some participants stated that they felt to be interrupted in their train of thought by the application and that they were persuaded to think about aspects, which were too specific for their current stage in their design process:

"From here (a slide about a particular material), it (the application) was too specific. [...] I think this is a very important topic but maybe for a later point in time. There could be like two stages. The first would be the rough brainstorming and then, there would be a finer one. [...] Because there we stopped, in this moment, we didn't know what our product is, if it is a device or only software." (DT2-2)

Others reported that they felt constrained by the pictures. As a result, they had concerns about being influenced too much by the pictures of the application:

"It would be interesting if it (picture) supports oneself to come up with an idea or if it influenced oneself." (DT2-2)

Additionally, the affinity analysis demonstrated that the designers normally use tools later in their design process, that they wished to have more time to try out the application and that the tool needs to be accessible on different devices, as for example on a desktop computer.

5.1.3.3 Structure in Design Process

Several designers declared that they miss an overview or structure. Since the brainstorming flash cards were displayed randomly and without any order, the participants stated that they would like to have more possibilities in order to categorize or link them:

“I think for me it is important when you brainstorm, that you can have an overview. Thus, you are able to combine ideas. That's the strength of brainstorming.” (DT4-1)

They also explained that the application sometimes jumps too much between completely different topics and thus, their idea generation process was interrupted by the tool. Moreover, they emphasized that for many designers linking of ideas belongs to the brainstorming method and therefore, it should be supported by the tool. In addition, one participant mentioned that you can easily get lost without having an overview and that it is difficult to retrieve certain brainstorming flash cards:

“An overview of all (cards) would be cool. Otherwise you get easily lost. It would be helpful, if you could order the questions to topics and then choose questions from different topics.” (DT3-2)

5.2 Design Ideas

Due to time restrictions during the study, the participants principally described their design ideas verbally. Especially, the teams mainly discussed their ideas during the brainstorming session, without taking any notes. In addition, most designers only listed design properties or briefly described a raw design idea. As a result, nearly none of them fully produced a sketch or a description of a concrete product idea. Thereby increases the difficulty to perform an accurate evaluation. Since the assessment of design ideas itself is often quite subjective and the material collected during the study is less concrete than elaborated design ideas usually are, the material provides a high scope for interpretation. Accordingly, it is not possible to derive certain design and attachment criteria from the data in order to compare and analyze the designs. Although it is unfeasible to apply any known evaluation method, some characteristics could be identified, which arose during the development of the design ideas and in the delivered material. These are described in the following.

5.2.1 Similarity in Design Ideas

The resulting material from the brainwriting reveals that several designers came up with similar design ideas and design properties in the beginning. One reason for this could be that most designers started their ideation by focusing on creating a permanent companion. Interestingly, the participants set a high value on how the emotional relationship between a user and her or his device can be intensified, because, they listed many properties that can enforce the personal history of users with their devices. Although, they sometimes considered potential devices,

which support portability, physical criteria, as for example the material or a modular design, were often not taken into account. Figure 5.1 shows three design sketches from different participants, which were drawn during the brainwriting session. All of them thought about devices, as for example a watch or a water bottle, which people often carry with them. Especially, the idea to build a device in form of a watch was named by many participants, because they linked the watch to a permanent companion and clocks are a frequently used form for fitness devices. During brainstorming, the participants usually developed the initial design ideas further to more individual and creative solutions. However, most of them considered design ideas as watches, water bottles or chips, which could be integrated into for example clothes. Additionally, a common feature was that the device should be able to record personal data in digital form. Thus, the user can access the data by the usage of a mobile application or an online tool.

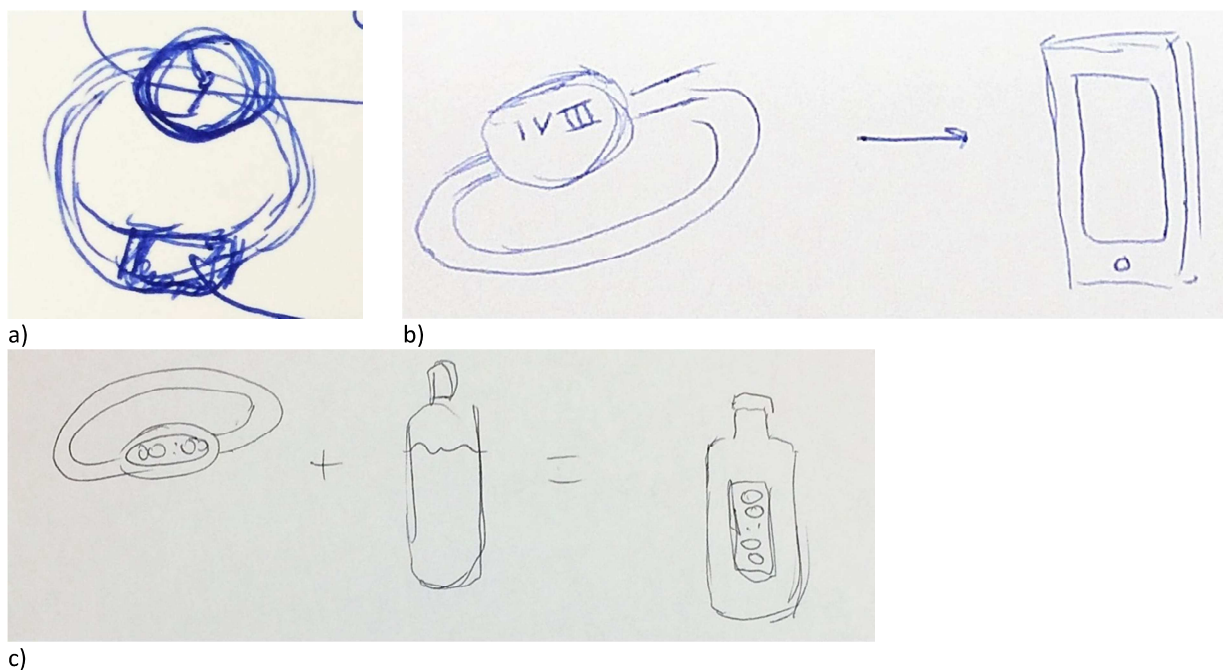


Figure 5.1: The sketches a), b) and c) were drawn during the brainwriting session by DP1, DT3-2 and DT3-1

5.2.2 Collection of Common Knowledge

Since the design properties, illustrated by InspiredDesign, build up on common well-known theories, it was frequently observed during the study that participants either already thought about certain criteria while brainwriting or that they complemented their list of properties when they brainstormed. Therefore the tool, seen as a collection of common knowledge, influenced the ideation in two ways.

First, most designers used the application as personal checklist to add properties to their already existing collection of criteria from the brainwriting. Moreover, they were able to reformulate and to concretize certain design ideas based on the examples of the brainstorming tool. In Figure 5.2 an extract from the notes produced by designer DP2 is displayed. It shows that DP2 already thought about material during brainwriting (black words) and that he wrote down several keywords concerning this topic, as not harmful, recyclable and light. During brainstorming the application assisted to continue this list by proposing the usage of natural material. This input was picked up by DP2 (blue words) and was further developed. Another example was given by DP5. A sketch from his final design idea, to create a shoe, is presented in Figure 5.3. During brainwriting he completely overlooked the topic material, but afterwards, InspiredDesign showed several brainstorming flash cards, which promoted the usage of potential material. Concluding, he expanded his initial design ideas by several material properties, as for example that part of the shoe could be made out of natural material and thus, this part could be recyclable.

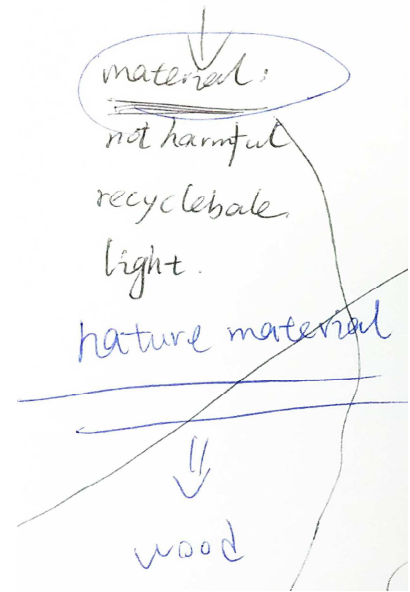


Figure 5.2: Extract from the Notes from DP2

Second, the designers felt to be confirmed in their thoughts through the repetition of design properties by the tool. Several times it was possible to notice that participant already came up with similar ideas during brainwriting. As a result, they felt reinforced by the application and these ideas gained importance. Thus, design ideas that foster the attachment were supported. However, this sometimes led to the disregard of other properties and since the tool is not a complete list of properties and design ideas, it could be that these properties were important too. Moreover, one designer (DP3) stuck on his experiences and excluded most of the new, not-repetitive inputs.

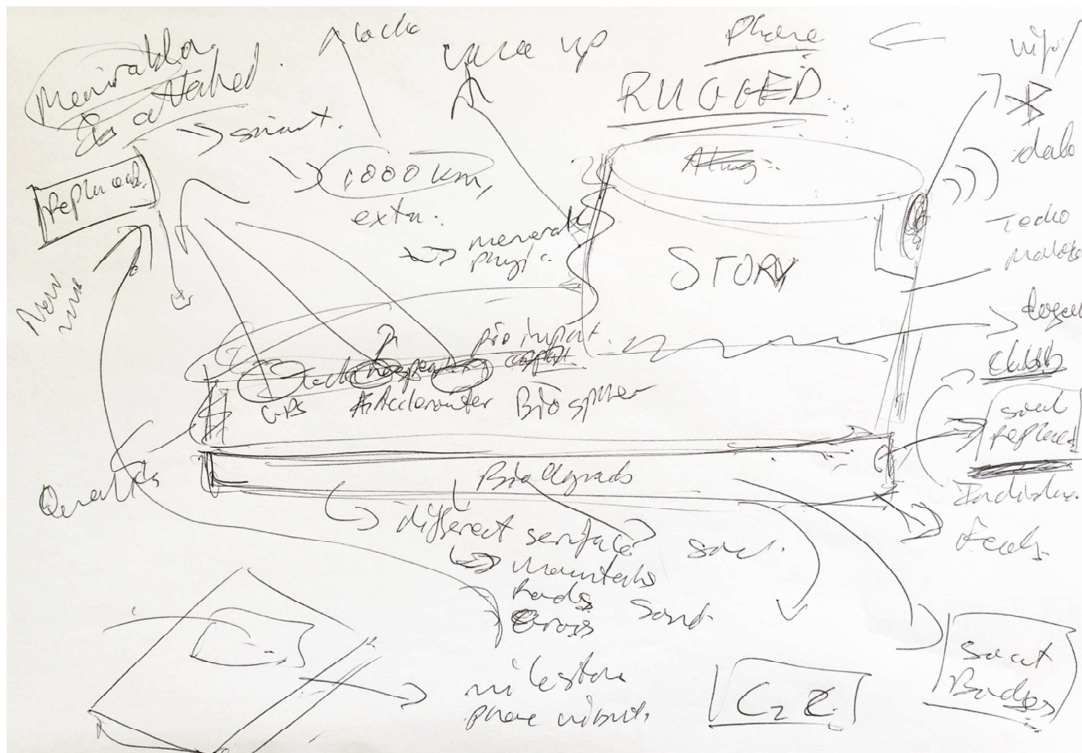


Figure 5.3: Design Sketch from DP5

5.2.3 New Perspectives

Based on several examples the application demonstrates its potential to inspire the participants by breaking their train of thought and giving them new perspectives.

In Figure 5.4 an extract from the notes produced by DP4 is shown. DP4 already collected a lot of ideas during brainwriting, for example that the actual quality and durability should be high for the device to ensure longevity. She also thought about the potential of repairing the device. However, when she used the application for brainstorming, she was inspired by the demand that repair cost should be lower than the price of a new device and she was fascinated from the design idea of a do-it-yourself device. As a result she picked up the different perspectives and combined them to the idea displayed in Figure 5.4. Another example was provided by design team DT2. After they finished their individual brainwriting sessions, they discussed the idea of a perfect companion. However, they completely neglected the materialization during their discussion. Due to this fact the tool interrupted their train of thought by enforcing them to think about potential materials. As a consequence, they started to concretize their idea and put it in context. Finally, largely inspired by the brainstorming card about tactile feedback, they came up with the idea of intelligent sport pants.

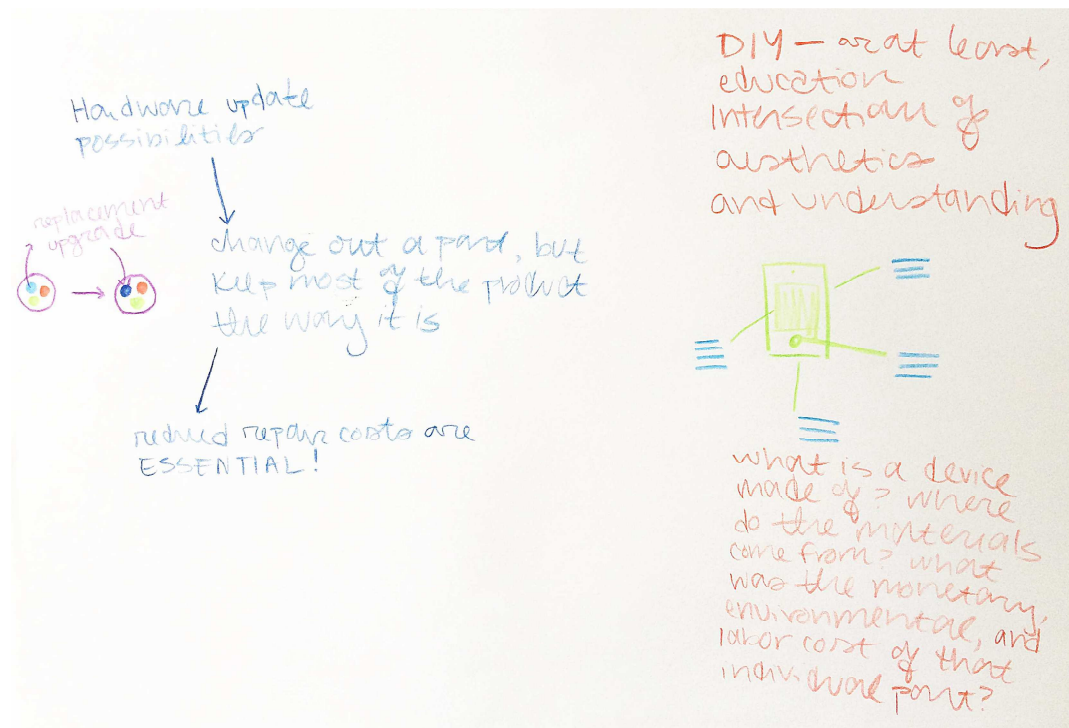


Figure 5.4: Design Sketch from DP4

5.3 Acceptance and Usability of the Tool

During the study much feedback about the user interface, the brainstorming flash cards and the operational capability of the tool in practice was gained. Furthermore, the experienced designers often discussed the status of sustainability in everyday business. In this chapter these results are presented.

5.3.1 Adaption of the User Interface

In the beginning the user interface was largely criticized by all participants. For example, the color scheme was regarded as too dark and too colorful, the proportions could be better synchronized and the images should not be hidden by the prompts. Therefore, we decided to adapt the user interface after a few interviews. As a basis for the new layout and the color scheme, propositions that were given by the designers were taken into account. The new layout is mainly a combination of the two layout recommendations, which are displayed in Figure 5.5. They were given by DP3 and DP4 in order to improve the acceptance of the tool by designers. In addition DP4 gave the required impulse to completely change the color scheme. The resulting new user interface in contrast to the old interface is illustrated in Figure 5.6 and Figure 5.7. The comparison between the old and the new version revealed that the prompts receive less weight and the pictures gained importance by being placed in the center. Moreover, the appearance of the whole application is more clear and friendly by using a white- instead of a black-colored

background. Additionally the tool is less colorful, because only green and black is used. Furthermore, the proportions were revised to ensure that all of them have the same size.

Although, the resulting second version of the user interface can be still improved, it received a largely positive feedback by the following participants.



Figure 5.5: Layout recommendations by DP3 (left) and by DP4 (right)

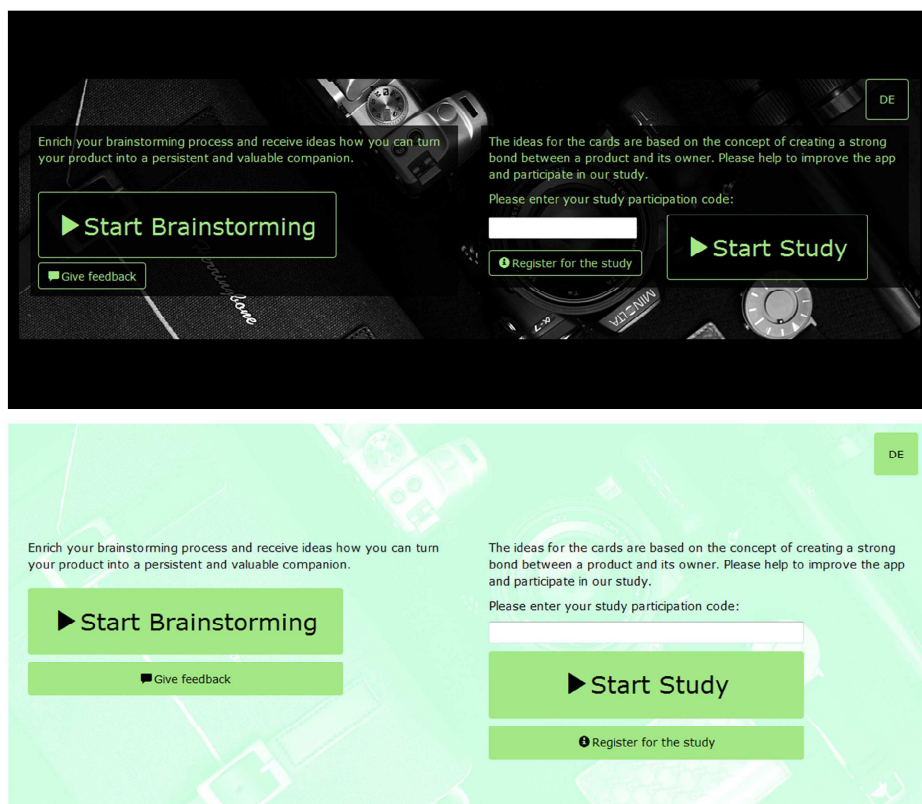


Figure 5.6: Start Screen from the old (top) and the new version (bottom) of the application

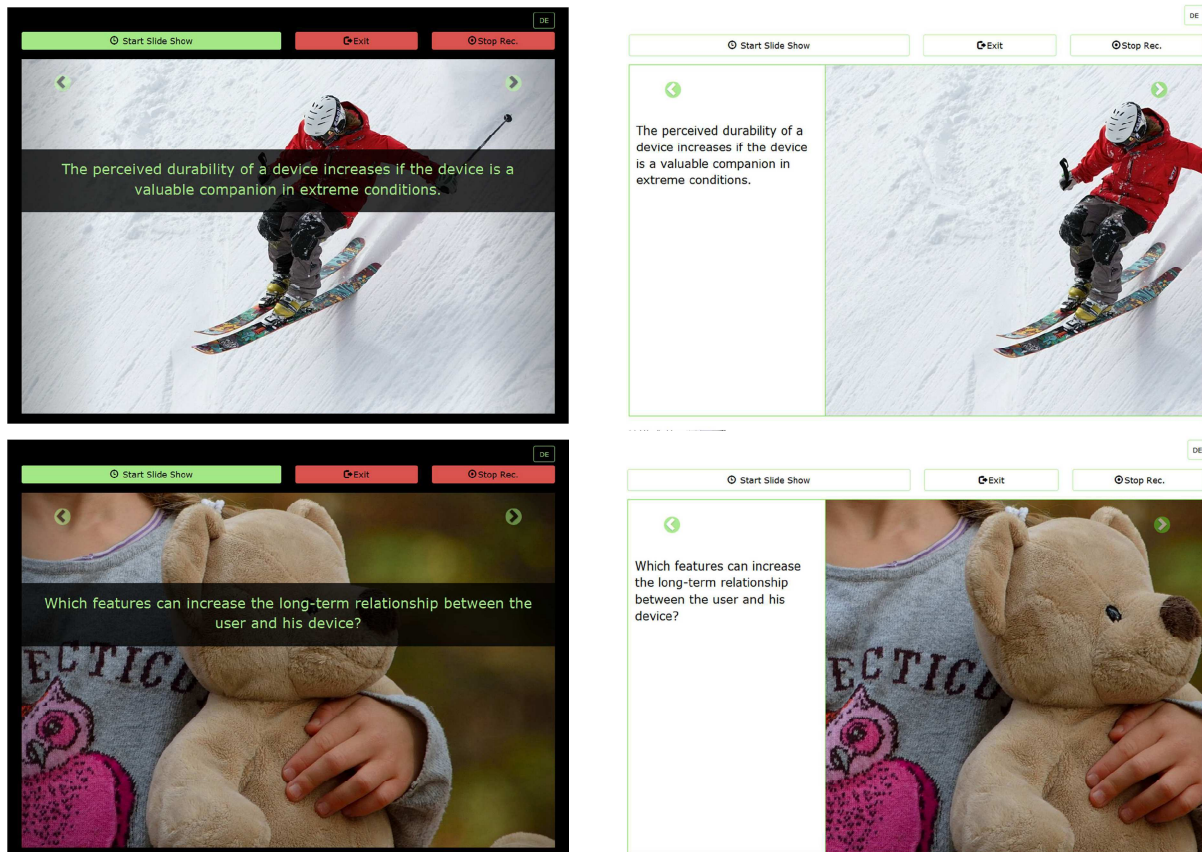


Figure 5.7: Two example brainstorming flash cards from the old (left) and from the new version (right) of the application

5.3.2 Feedback to UTAUT Questions

To get an impression about the potential acceptance of the brainstorming tool in practice some questions based on UTAUT were asked during the interview (see 4.4.1). In summary, we received positive feedback about the usability of the application. Only one participant (DP1) had difficulties to use the application properly. By mistake, she activated the slide show and was not able to stop it anymore. Moreover, several participants stated that they especially like the simplicity of the application. Additionally, the application was assessed to be self-explanatory. However, in the beginning, none of the participants detected the swipe functionality without being verbally instructed. As a conclusion an instruction page, with a few sentences about the functionalities and the tool, was included into the application and the participants were asked to read them before they start to brainstorm. However, the participants noted that to read instructions can disturb their process flow. In general, the participants reported that they would reduce the buttons even more, by hiding or removing the unnecessary ones. In addition to the usability and the simplicity, the designers emphasized that they like the basic idea of the tool to have an assistance coming up with sustainable aspects. For example, they mentioned the following three ways how the tool

helps them. First, the tool is useful when working in groups, because it proposes topics that can be discussed. Second, it assists when you have problems to come up with an idea. Third, it inspires by persuading the user to think about a topic from another perspective.

By asking the right questions the tool has also the potential to positively influence the effectiveness. Although we generally received a lot of positive feedback and the participants like the general concept with the brainstorming flash cards, nearly none of them could imagine including the application in his or her typical idea generation process. The main reason for this was that the application needs to have more functions, as for example to provide categories, an overview or the possibility to map or link brainstorming flash cards. In addition, they claimed for more brainstorming flash cards, which should support various design tasks and that the application should provide a possibility to add cards.

5.3.3 Feedback to specific Brainstorming Flash Cards

The brainstorming flash cards showed various effects on the users. Several of them introduce topics that were largely discussed by the designers. Others were taken as design inputs and thus, they largely influenced the design output. Then, there are cards which were ignored by the users or which were stated to be confusing. Subsequently, some topics provoked by the flash cards are presented.

5.3.3.1 Adaptable Material

One example of a flash card that showed high potential to positively influence the design ideas of the participants was the card about material, which is adaptable to the hand structure. A few designers stated that they really like the idea and especially the image, which looks appealing and reminded them of clay or another material, which they could use for their design idea. Therefore, the success of this card mainly based on the picture, which is able to evoke the interest of the users for formable material.

5.3.3.2 Feedback and Learning

Other flash card topics that were often picked up by the user were the usage of a soft cover in order to support tactile feedback and that the devices should be capable of learning. The designers were interested in these cards because the idea was either new to them or they had thought about something similar before but were not able to concretize it. Often, they saw it as a way to enforce an emotional relationship between the user and his or her device.

5.3.3.3 Patina

One flash card that provoked contradicting opinions is the card about the usage of material which supports the development of patina. Two users (DP1 and DP5) stated that they did not understand the word patina and one designer (DP1) described the image to be repulsive. In contrast several other designers came up with this property by themselves during the brainwriting session or took the suggestion as an input for their design idea, because they described patina as an important factor to enhance the attachment.

5.3.3.4 Reducing Repair Costs

Although the designers expressed that they really like the idea that repairing a device should be cheaper than buying a new one, they remarked their concerns that the implementation of this requirement could be an unsolvable challenge. Potential problems could be that users prefer to buy a new device instead of repairing an old one or that the production of the product is performed under fully optimized conditions in a country with low salaries. Nevertheless, the participants stated that reducing the repair costs is important to support durability and most of them further discussed this topic and linked it to related ones, which were introduced by other flash cards, as for example modularity or do-it-yourself. Thus, they came up with different solution how to tackle this challenge.

5.3.3.5 Influence of Customization

The influence of customization on the relationship to an object was the designer's favorite topic to be discussed. Although, some of them assessed customization as an important aspect to improve the individuality of a device, others stated that they think customization is overestimated. They doubted that people are able to know what they want in the long run. In addition, they referred to products, such as an iPhone, which have successfully proven to evoke relationships between the users and their devices even though they are based on a classic design and are not customizable at all. Moreover, they remarked that providing customizable products can increase the price.

5.3.4 Sustainability in Practice

All designers participating in the study were highly interested in the topic sustainability and they declared that sustainability is an often used and important term during their studies and work. However, especially experienced designers exposed the problem of implementing sustainability criteria in practice. They mentioned various reasons for this problem. One reason is that clients of designers often do not care about sustainability and thus, they limit the possibilities of designers. More concrete, not all companies are interested in products with a long life span. Another reason occurs because of the contradiction between fashion and longevity. Usually, products are designed based on current trends. Therefore, they are outdated as soon as a new trend occurs, which often happens after a short period of time. Consequently, designers ask for arguments and support to market sustainability properties to their customers. Therefore, they are open for all design suggestions which have the potential to make their products more sustainable and which also satisfy the needs of their customers.

6 DISCUSSION

The study setting and the evaluation build up on the three research questions, introduced in Chapter 0. In this section those research questions are discussed on the basis of the results described in Chapter 5 and the knowledge gained from past works introduced in Chapter 2. Resulting challenges and potential design implication are illustrated.

6.1 Influence of the Application on the Design Ideas

Due to the fact that the design ideas collected in the study are less elaborate than expected and that therefore a lot of space is left to interpretation, it is not possible to apply any evaluation method to properly analyze the design ideas (Dorta et al., 2008). Hence, it is not realistic to extract design properties or attachment criteria for an assessment (Remy et al., 2015). As a consequence, the comparison of the ideas that were collected during brainwriting to the ideas that were developed during brainstorming is only feasible on a low level, by comparing the listed and described properties and ideas. However, the results, described in Chapter 5, show that the design ideas are affected by the tool. The prompts and images, which are displayed by the tool, assisted the designers to complement, concretize and expand their list of design properties. Thus, the final design ideas possess many criteria that can enhance the relationship of a user to her or his device. Moreover, the tool was able to provoke completely new ideas and the users started to consider recommended materials and device characteristics (see for example Sections 5.1.2 and 5.2.3). It is difficult to assess if the pictures or the texts had more influence on the design ideas of the participants. However, most designers stated that they were either positively influenced by the text or the picture of a brainstorming flash card. This leads to the conclusion that a brainstorming flash card should not provide an inspiring picture and a challenging prompt at the same time. In addition, a designer criticized one flash card, which was overloaded with information (see Section 5.1.1.2). Therefore, a brainstorming flash card either needs a valuable text or an image to be effective. In case both is provided at the same time, it has to be ensured that the picture only emphasizes the statement of the text and does not evoke another discussion topic.

Even though it is not possible to elaborate all criteria for developing inspiring flash cards, we are able to collect several characteristics that show potential to act as beneficial stimuli, as for example challenging questions, impressive pictures and the proposal of certain materials. This finding supports the thesis that texts and images are important sources of inspiration (Goldschmidt & Sever, 2011; Goldschmidt & Smolkov, 2006; Gonçalves et al., 2011). However, one important observation often made and that should be considered is that a brainstorming flash card can be very valuable for one person and totally useless for another. Moreover, it happened several times that different participants showed contradictory reactions to the same flash card. Additionally, some participants' quotes lead to the assumption that novices are more open for new design ideas whereas practitioners with long work experiences tend to stick to their knowledge base and mainly used the tool to exclude ideas (see Section 5.1.2.2). Thus, it is difficult to formulate a general rule for designing inspiring brainstorming flash cards.

Summing up, the results demonstrate that the tool is able to communicate properties derived from the Attachment Framework and the complexity of the framework is successfully hidden from the designers, as proposed by several researchers (Grosse-Hering et al., 2013; Stolterman, 2008). However, the actual impact on the attachment criterion is neither measurable nor predictable. Moreover, some designers questioned certain design properties, which were suggested by the tool, as for example customization (see Section 5.3.3.5), of being useful to enhance the relationship between users and their devices in practice. Therefore, it is still an open question how much the influence of the tool would be on the attachment criterion of an elaborated, real product.

6.2 Influence of the Application on Design Process

The application influenced the design process of the participants in two ways, either it interrupted the process or it complemented it. The main reason for interrupting the process was that the participants were discussing a topic while the brainstorming tool introduced another theme. As a result, they stopped their discussion, even though they did not come to a conclusion, in order to deal with the new topic (see Section 5.1.3.2). After switching to the next brainstorming flash card, it happened that the participants were forced to change their topic again. Accordingly, the main subject of the discussion jumped around between various topics. Although it was never intended to disturb the design flow in any way, several designers remarked that being interrupted can also have a positive impact on the results and the design process, because sometimes designers are too focused on a small aspect and may stray from the main subject. In such a case it is helpful when they are stopped and brought back to the topic (see Section 5.1.2.2). Therefore, it can be useful when designers are forced to think about criteria as material, even though they usually would not discuss this topic at that time.

In contrast, some participants were able to fully integrate the tool in their design process without feeling interrupted. For them, the application asked the right questions to achieve a continual development of their design ideas (see Section 5.1.2.1). This and research conducted by Cross (2004) and Goldschmidt and Sever (2011) demonstrate that design processes or the way designers approach a design task are divergent, depending on their experiences or their usual way of thinking. Thus, the challenge is to build a tool that supports all idea generation processes. To make InspiredDesign more adaptable for different process structures, the brainstorming flash cards should be categorized. Thereby, the users can choose if they want to select a category or if they want the brainstorming flash cards be displayed randomly. Nevertheless, from time to time, a random flash card should be displayed, to motivate the user to consider other topics, too. Furthermore, some participants mentioned that to inspect an overview and to link and to cluster ideas are essential tasks of their normal brainstorm process and as a conclusion, these tasks should be served by the application. They especially missed an overview of all brainstorming flash cards when they tried to retrieve a specific card.

In addition, we also tried to analyze if the tool has a different effect on the process of teams in contrast to the process of single study participants. However, based on the evaluation, it is not possible to discover any noteworthy contrasting impact on the process of single participants and teams. Teams combined and discussed the

ideas generated by the two users and the suggestions from the tool. The single participants only combined their own ideas with the inputs from the application. Nonetheless, it could be that in a group with more participants the focus of the discussion remains on the design ideas of the group members and the inputs of the tool would be totally neglected.

6.3 Application as Sustainable Interaction Design Brainstorming Companion

After the user interface of the tool was adapted based on the design suggestions of the participants, the external appearance was positively evaluated by the majority (see Section 5.3.1). Additionally, the designers complimented the good usability of the tool. Furthermore, they appreciated the basic idea of the tool and they evaluated most of the brainstorming flash cards as nice, inspiring, relevant or useful. There are only a few things that concerned the general user interface and the flash cards which should be enhanced. Moreover, the introduction of the instructions is not fully solved and was criticized by some participants (see Sections 5.1.1.2 and 5.3.2).

In addition to the positive feedback that was received for the external appearance, the designs ideas, which were elaborated by the designers during the study and which are described in Chapter 5.2, show the potential of the tool to fulfill its purpose to act as a valuable brainstorming companion and its positive impact on the ideation and the design outputs.

These results state that the tool should possess high potential for being applied in practice, but almost all of the participants expressed that they cannot image to use the tool for ideation (see Section 5.3.2). The main reason for this is that the designers want more features and interactivity. Based on the fact that we initially planned to not overload the application and to build a tool that only provides the basic functionalities, it was never intended to serve more interaction. However, due to the feedback collected and presented in Chapter 5, the tool should be expanded and should at least offer a categorization of the brainstorming flash cards, an overview of the flash cards and the possibility to link and cluster flash cards to better support the normal brainstorming process (see Chapter 6.2). In addition it should be possible to increase the amount of brainstorming flash cards and the tool should be available online. Thus, the most important demands of the study participants would be fulfilled and the probability that the tool will be implemented in practice grows. Although, most of these requirements can be implemented without a fundamental change in design and software architecture, it may be worth to consider another, alternative approach. In order to provide online access to the tool, it is perhaps more effective to develop an online platform with a responsive design instead of reworking the mobile application. Thus, the tool can be used on all mobile platforms and on all kind of devices. One desired feature that should be further discussed is the possibility to add new brainstorming flash cards, because thus, the user is able to change the content of the application and the aim of the tool. One possible solution could be that the users could select which cards should be displayed to them, their own, the theoretically based ones or both. Another solution could be to provide an online assessment of new brainstorming cards. Thereby, several designers could evaluate the cards. However none of the two

propositions can ensure that the theoretical focus of the tool is kept. In addition, different kinds of brainstorming flash cards, as for example cards with only an image, a keyword or a task (see Section 5.1.1.3), could be offered as well as more advanced descriptions to explain certain cards with difficult contents (see Section 5.3.3.3).

Another aspect that should be discussed is the general purpose, to act as a brainstorming companion, of the tool. Several participants mentioned that they would like to utilize the application as a reference work. In addition, a tool that supports designers to market sustainable criteria to their customers could be beneficial to promote the practical implementation of sustainable design suggestions (see Section 5.3.4). Perhaps, there are other potential application possibilities of the tool that should be evaluated, as they could offer additional benefits.

7 CONCLUSION AND OUTLOOK

This thesis aimed to tackle the theory-practice gap, introduced in Chapter 2.2, by investigating an alternative way to communicate complex theoretical frameworks to design practice. For this reason we transformed design implications, extracted from the Attachment Framework and related research (see Chapter 2.1), into concrete design propositions and developed a tablet application to illustrate them. Afterwards, the tablet application, which was named InspiredDesign and has the purpose to serve as a brainstorming companion, was evaluated in a lab study by 13 designers. The results of this study, discussed in Chapter 6, demonstrate that InspiredDesign was able to motivate the study participants to examine the suggested design criteria. They accepted the tool as an additional and valuable source of inspiration. As a result, the design ideas, created by the designers during the study, exhibit lots of properties introduced by InspiredDesign. Furthermore, InspiredDesign showed a potential to be fully integrable into common design processes while the designers were not faced with the complexity of the underlying theoretical framework. Although, the tool was successfully applied by the designers in the study, most of them reported that they will not use the application in practice. They exposed several limitations and possibilities how the tool could be improved. First, they listed multiple features the tool should provide in order to better support the brainstorming process and thus, being more beneficial in practice. Some concrete requirements, which were already presented in Chapter 6, are listed in the following:

- The application should provide categories to serve different design tasks and fields
- The application should provide broad and general as well as concrete and specific design suggestions
- The application should provide a possibility to link and cluster design suggestions
- The application should provide a possibility to add new brainstorming flash cards
- The application should be available on all devices and platforms
- The brainstorming flash cards should be less monotonous

Second, some participants doubted the practicability or the impact on the relationship of several brainstorming flash cards. For example, they questioned all flash cards, which proposed the utilization of external properties for customization and individualization, of being effective to foster the relationship between users and their devices. Third, since the tool can function as a collection of common knowledge, the participants recommended alternative usages of the tool. For example, designers could use it as a reference work or as assistance to market sustainable product properties to their clients.

Overall it can be stated that in order to increase the potential of InspiredDesign to be successfully introduced in practice, the tool needs to be extended and enhanced. Moreover, to fulfill the requests of the participants it may be worth to reassess the target device, a tablet, and to think about developing an online tool that can be accessed on any device and platform. In addition, a remote study in a real-world application could be useful to further concretize the specification of the new tool. However, first, the brainstorming flash cards should be reviewed. For that reason, brainstorming flash cards, which are questioned by designers, need to be verified and the

representation of the flash cards should be adapted to provide more variety. Moreover the amount of flash cards should be increased and possible ways how users could add brainstorming flash cards should be considered.

Another issue that appeared during the assessment of the study results was the lack of a proper evaluation method to measure the real impact of the tool on the attachment criterion. Even though the design ideas, produced by the study participants, show lots of properties that could affect the relationship between users and their devise, it is an open question if these properties would persist throughout the entire product development process and would have an influence on the resulting elaborated products.

Finally, it can be concluded that InspiredDesign is a valuable approach of introducing a theoretical framework from SHCI into design practice, but to entirely bridge the theory-practice gap further design interventions need to be done.

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APPENDIX A: PROMPTS FROM INSPIREDDSIGN

Is it possible to use wood for the outer shell? Wood is a renewable resource that represents quality and stability.

A natural material, such as leather, can give your device an exclusive and valuable style.

The choice of materials expresses certain values in a design. For example, metal stands for persistence and quality.

Why not creating a device by using expensive metal to transform a simple object in a status symbol?

Is it possible to involve users to create individual devices? For example, give them the possibility to include personal objects, such as a favorite piece of jewelry, into the outer shell of their device.

A really nice patina can enhance the relationship between a user and his device.

Think about a material which is adaptable to the hand's structure. The user could form his individual device.

Ensure that the device is fully recyclable.

Can you use recycled material to build the device?

What about tactile feedback through the use of a soft cover?

Is it possible to reduce the repairing costs below the price of a new device?

A user should be able to not only select the color but also the material.

Customize your own device! The user should be able to choose shape, size, color, and material of the device.

Fit customer needs! Which technical components and functionalities does the user really need?

The device should be modular and easily upgradable. It guarantees that the hardware will always be up-to-date.

Why not develop a do-it-yourself kit for the device?

Which features can increase the long-term relationship between the user and his device?

To make a device unique it could use a software that learns from the user.

How can the device become an essential everyday object?

Which characteristics can support the portability of a device?

What makes a great constant companion?

Is it possible to create an association with an object that stands for durability?

Think about smart accessories which make your device persistent and environmentally friendly.

The perceived durability of a device increases if the device is a valuable companion in extreme conditions.

If the device had a modular structure, the individual parts could be reused for new applications.

Can your device be reused in a different context?

Think about different end-of-life scenarios. Are there alternatives to waste disposal?

Are there ways to enlarge the lifecycle, for example by providing update possibilities?

APPENDIX B: RECRUITMENT TEXTS

Online ad for job platforms:

Subject: Wanted: Looking for designers for sustainable interaction design study

Do you have experience in product design/industrial design? Are you interested in sustainable design?

The Group of People and Computing Lab at the University of Zurich is currently recruiting product designers for a sustainable design study. The study lasts for about one hour and takes place at the Department of Informatics in Zurich. During this study, we will ask you to integrate an app in your product design process and to brainstorm for a potential product. The brainstorming session will be recorded and, favorably, takes place in a group of two people. If you are interested in participating in our study please fill out the form on zpac.ch/designstudy so we can contact you. Your information will be kept confidential and will only be accessible to the researchers involved in this project. Further, they will only be used to contact you in case we decide to invite you to the study. Your participation is voluntary and you can leave the study at any point in time. As a gift for your study participation each of the participants will receive an Amazon voucher worth 30 CHF (or the equivalent in another currency, based on your preference). In case you register and complete the study in a group of two people, each of you will get a bonus of 10 CHF. If you have any further questions, please feel free to contact me at jessica.hediger@uzh.ch.

Jessica Hediger

People and Computing Lab, University of Zurich

<http://www.ifi.uzh.ch/zpac.html>

Text for flyers:

Do you have experience in **Product Design** or **Industrial Design**?

Are you interested in **Sustainable Interaction Design**?

The Group of People and Computing Lab at the University of Zurich is currently recruiting designers for a **sustainable design study**. The study takes about **1 hour** and is paid with **30 CHF**. Preferably the study is done by a group of two people. In case you register in a group, each of you will get **10 CHF Bonus**.

More information about the study as well as the registration form can be found here: zpac.ch/designstudy

Jessica Hediger
jessica.hediger@uzh.ch



APPENDIX C: STUDY SCHEDULE

1. Preparation: Fill out **consent forms** (2 papers), fill out **incentive receipt**.
2. Welcome of the participant.
3. Ask small talk question to get a better atmosphere (i.e. where did you read about the study?).
4. Inform the participant again about the study (duration, tasks, incentive,...) and give her/him the **consent form** to sign.
5. Ask the designer about a design task. In case the designer has no ongoing design task she/he can use the brainstorming tool for, give her/him the **study design task**. Read out study task.
6. Ask the designer about her/his brainstorming technic. What does he need? Cards, paper, colored pencils or a whiteboard? (Prepare everything)
7. Explain brainwriting and purpose of brainwriting, using **brainwriting explanation**.
8. Ensure everything is clear.
9. Participant starts "brainwriting" for 10 minutes about the topic on flash cards.
10. Participant starts Brainstorming with app for 15 minutes. (started App with a pre-set participation code) → Repeat that the app should be seen/ act as a companion.
11. End of design task and start of **interview** for 20 minutes (voice recorder).
12. End of study, payment of the participant.
13. Sign of the **incentive receipt**.

APPENDIX D: CONSENT FORM FOR STUDY

Informed Consent for ZPAC Study about Sustainable Interaction Design

Dear Participant:

We invite you to participate in our study about Sustainable Interaction Design, which purpose is to gain a deeper understanding about the ideation process of product designer and to test an app, which is built to support brainstorming.

What will we ask you to do?

If you agree to participate in this study, you will be asked to generate ideas for a specific design task and to write them down. Further, you will be asked to conduct a brainstorming session, with the support of an app, for the same design task. Concluding, we interview you to your everyday ideation process as well as to the usability of the app.

What type of personal information will be collected?

The brainstorming session will be recorded by the app and a voice recorder. The interview will be recorded (audio), too. The records will be used for the research and may be partially or fully transcribed. All your data will be anonymized in any stage of further processing it as well as in any written publication or presentation based on this research. If we choose to use some of your comments, they will be attributed to a participant number or a pseudonym.

Are there risks or benefits when participating?

There is no cost to participate in this study and there are no particular risks associated with the study beyond those associated with normal everyday activity.

As a compensation for your participation you will receive an Amazon gift certificate worth 30 CHF (and an additional bonus of 10 CHF when you participate in a team).

What happens to the interview data?

Participation in the study is voluntary and confidential. You are free to withdraw your participation at any point during the study, without needing to provide any reasons. Any information you contribute up to the point at which you choose to withdraw will be retained and used in the study, unless you request otherwise. Your data (audio files and/or interview transcripts as well as the ideas) will be saved on password-protected devices or in locked university filing cabinets or rooms of the University of Zurich. They will be stored for five years, after which they will be permanently deleted.

Uses of the interview data

The results of this study will potentially appear in both internal and external presentations and publications, as well as academic journals and conference proceedings.

Consent

If the interview is conducted via phone or Skype, we will ask you to give your oral consent during the audio recording.

With your signature on this form you confirm the following statements:

- An investigator explained the study and the listed conditions to me. I had the opportunity to ask questions. I understood the answers and accept them.
- I am at least 18 years old.
- I had enough time to make the decision to participate and I agree to the participation.

In no way does this waive your legal rights or release the investigators or involved institutions from their legal or professional responsibilities. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or new information at any time during your participation.

Participant's name (please print)

Location, date

Participant's signature

Researcher's name (please print)

Location, date

Researcher's signature

If you have further questions regarding our research and/or your participation in this study, please contact:

Jessica Hediger
jessica.hediger@uzh.ch

Dipl.-Inf. Christian Remy
remy@ifi.uzh.ch

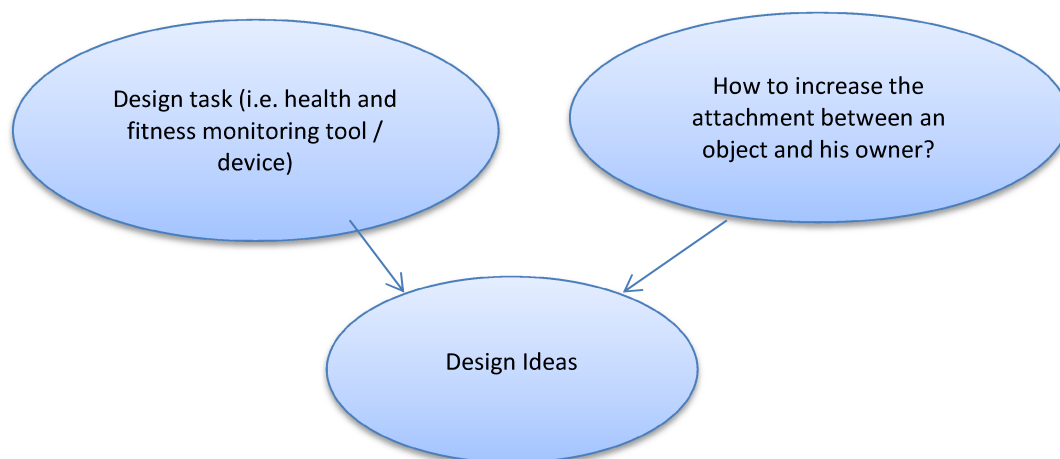
University of Zurich
People and Computing Lab
Binzmühlestr. 14
CH-8050 Zürich

APPENDIX E: TASK DESCRIPTION

Design Task

As part of a larger research project, we are considering how to increase people's attachment to their personal possessions as a way of promoting environmental sustainability. By fostering a strong bond between owners and objects such as electronic devices, our aim is to promote longer use and ownership of such devices than is currently the case.

In the following, we ask you to search for ideas how such an object, with a strong bond between the device and his owner, could look like. As a basis you can take a current design task. Otherwise, you can take a health and fitness monitoring tool / device as a basis for your design idea.



Brainwriting

Brainwriting is a creative technique which is similar to brainstorming. During brainwriting the designer should write all his thoughts to a specific topic on flash cards. It is important, that the designer produces and combines ideas without limitations / restrictions.

APPENDIX F: INTERVIEW PROTOCOL

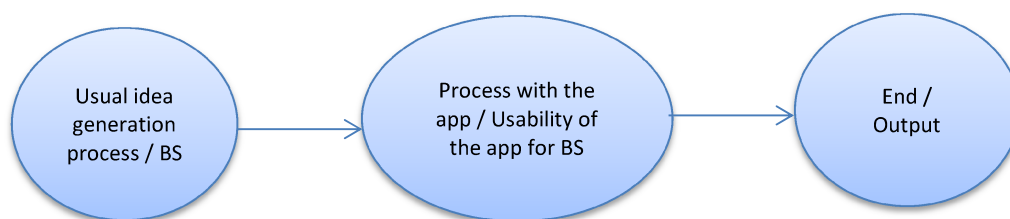
Duration:

20 min

Main focus:

1. Influence of app on process
2. Usability of the app

Structure of the interview:



Ask for usual approach to find ideas (process without app):

(Questions to get information about the normal idea generation process of the participant)

1. Can you imagine your last idea generation task during work? Please describe it.
2. Is this a frequent task?
3. What is your usual approach when you are confronted with an idea generation task?

(Questions to get specific information about the normal brainstorming process of the participant, if BS was mentioned)

4. You told me, that you use brainstorming for your idea generation process, could you please describe your usual brainstorming approach?
5. *(As an addition to question 4, if not already mentioned by the participant)* How many persons usually participate at your brainstorming session? Do you use any (technical) tools?

(Sustainable design or design of devices for longer lasting use.)

6. Do you have already experiences with Sustainable Design? If yes, please describe them.

Ask how the participant solves the task (process with app and perceived usability):

(Questions to get participant personal process experiences)

7. Did you feel in any way that the app restricted or supported your idea generation process?
(Could you show how you are influenced by the app at the example of one of your ideas)
8. Do you think the app influenced your idea generation process?
9. Did you feel that the flash cards influenced your brainstorming output? (How?)
10. *(May show app with flash cards)* Which flash cards stand out the most? Why? Positively or negatively?
11. Do you have any further comments to the brainstorming flash cards?

(Questions to get participant personal handling experiences / based on UTAUT)

12. Could you envision the application to be included in your typical idea generation process? If yes, how would this influence your ideation process?
(If no, adapt next question)
13. How much effort and time do you think would it need to include the application in your brainstorming process?
(In which part of the process would you include the application? Would it replace another tool?)
14. Do you think the application could influence the effectiveness of your ideation process? (How?)
15. Would some kind of guidance or instructions be helpful when using the application (for the first time)?
16. What do you like/don't like about the application?
17. Did you have any difficulties using the application?
18. Do you have any suggestions for improvements for the overall interaction with the application?

Concluding questions:

(The participant may want to say something positive or critical about the app, the task or the study environment)

19. How content are you with the output of the whole task and the brainstorming session?
20. What did you perceived as difficult about the task and why?
21. Do you have any other comments regarding the app?

APPENDIX G: CONTENT OF THE CD

The CD-ROM contains the following content:

- Zufsg.txt: The abstract of the thesis in the German version.
- Abstract.txt: The abstract of the thesis in the English version.
- Masterarbeit.pdf: The entire thesis.
- Results.zip: All results collected in the study in digital form.
- StudyTexts.zip: All documents produced for the study (ads, interview protocol, etc.).
- bsApp.zip: Apache Cordova project for InspiredDesign.
- ImagesDescriptionMapping.xlsx: Brainstorming flash cards content.