Universität Konstanz

Department of Computer and Information Science

Master Thesis for the degree

Master of Science (M.Sc.) in Information Engineering

Ideaflow - Supporting the Collaborative Idea-Finding Process for Design Teams On-The-Go

by

Stephanie Höhn

(Matr.-Nr. 01/734883)

1st Referee: Prof. Dr. Harald Reiterer

2nd Referee: Jun. –Prof. Dr. Tobias Schreck

Konstanz, March 20th, 2013.

Erklärung

Ich versichere, dass ich die anliegende Master Thesis mit dem Thema:

„Ideaflow- Unterstützung des mobilen kollaborativen Ideenfindungsprozesses in Designteams“.

„Ideaflow - Supporting the Collaborative Idea-Finding Process for Design Teams On-The-Go”.

selbständig verfasst und keine anderen Hilfsmittel als die angegebenen benutzt habe. Die Stellen, die anderen Werken dem Wortlaut oder dem Sinn nach entnommen sind, habe ich in jedem einzelnen Falle durch Angaben der Quelle, auch der benutzten Sekundärliteratur, als Entlehnung kenntlich gemacht.

Konstanz, den 20.03.2013

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I. KURZFASSUNG

Designer produzieren in den ersten Phasen eines Designprojekts eine Vielzahl unterschiedlicher Ideen. Die Zusammenführung verschiedener individueller Perspektiven auf ein Designproblem führt zu vielfältigen Lösungen und letztendlich zu kreativeren Artefakten. Deshalb werden diese Ideen bevorzugt in Teamarbeit generiert und evaluiert. Die drei Grundvoraussetzungen für effektive Designarbeit sind demzufolge Zusammenarbeit, Kommunikation und Bewusstsein gegenüber der Arbeit von Kollegen.

Diese Voraussetzungen sind ungenügend erfüllt wenn Designer unterwegs sind. Die größte Schwierigkeit besteht in den unzureichenden Möglichkeiten Ideen adäquat festzuhalten und zu kommunizieren. Inspiriert durch Einflüsse aus der Umgebung, wie Gerüche, Farben und Formenentstehen allerdings, gerade wenn sie sich nicht in ihrem gewöhnlichen Arbeitsumfeld befinden, spontane Ideen. Diesen Bedürfnissen gerecht zu werden ist eine Herausforderung für die Entwicklung von Software, welche das Ziel verfolgt, die kollaborative Ideengenerierung von Designteams zu unterstützen.

Basierend auf diesen Erkenntnissen, wurden im Rahmen dieser Arbeit Anforderungen zusammengetragenen und der Prototyp „Ideaflow“ entwickelt, der die kollaborative Ideengenerierung digital unterstützen soll. Dieses System bietet Methoden zur strukturierten Aufzeichnung, Archivierung und zum Austausch von mobil erstellten Ideen für verteilte Designteams, und für die gemeinsame Sichtung der Ideen mit einer zentralen Desktop Applikation.

Um die Vor- und Nachteile dieser Methoden für die Designarbeit zu untersuchen wurde eine Fallstudie mit Gestaltern der Kreativbranche durchgeführt. Dabei werden die Resultate kreativer Designarbeit, mit Unterstützung von Ideaflow unter bestimmten Bedingungen, untersucht. Die Ergebnisse dieser Studie geben Aufschluss über die folgenden Fragen:

1. Kann die Zusammenarbeit und Ideenfindung von kreativen Design-Teams unterwegs, durch System Meldungen über neu veröffentlichte Ideen, effektiv unterstützt werden?
2. Fördert das Ideaflow Ideenarchiv das Bewusstsein über die Arbeit von Kollegen?
3. Werden durch das Bewusstsein über die Arbeit der Teammitglieder, ausgelöst durch Archiv und System Meldungen, mehr aufeinander aufbauende Ideen produziert?

Abschließend kann man sagen, dass durch die Funktionalitäten von Ideaflow die mobile und kollaborative Ideenfindung von kreativen Teams digital unterstützt werden konnte. Weitere

Verbesserungen wurden erkannt, die Designern unterwegs eine Arbeitsweise ermöglichen können, die derer im Büro gleichkommt und diese optimiert. Es wurde festgestellt, dass Systeme die Design-Teams in den frühen Phasen des Design-Prozesses unterstützen sollen, spontane Ideenerfassung, Kommunikation von Ideen mit Kollegen, und das Bewusstsein für die Arbeit der Teamkollegen, ermöglichen müssen.

II. ABSTRACT

In the early stages of a design project, designers produce a variety of different ideas. Combining various individual perspectives on a design problem leads to various solutions and ultimately to more creative products. Therefore, these ideas are generated and evaluated preferentially in a collaborative manner. The three basic requirements for effective design work are thus collaboration, communication, and awareness of the work of colleagues.

The desired requirements for effective design work, however, are not met adequately if designers are on the go. The main difficulty lies in the unsatisfactory methods available to designers for recording ideas and communicating them, leading to lost opportunities to record spontaneous ideas generated as a result of inspiration by stimuli from the outside environment, such as smells, colors and shapes. This challenging task of developing software that aims to support collaborative idea generation by design teams by providing designers with the ability to record and share ideas on the go is the focus of this study.

Having determined the requirements of such a software the prototype "Idea Flow" was developed with the aim of digitally supporting the collaborative design workflow. This system provides methods for structured recording, archiving, and exchange of ideas created on mobile devices for distributed design teams, and for the collective review of the ideas on a central desktop application. In order to evaluate the efficacy of the system for, and its benefit to, the design work, a case study was conducted with the participation of designers from the creative sector. The study sheds light on the following questions:

1. Can collaboration and idea generation of creative design teams on the go be effectively supported by system notifications on new shared ideas?
2. Does the Ideaflows idea archive encourage more awareness on the work of colleagues?

3. Are more related ideas produced through the awareness of the work of team members precipitated by the archive and the system notifications?

In conclusion, with the provided functionality of Ideaflow we could support the mobile and collaborative idea generation process of creative teams digitally. Further improvements are identified which support designers on the go in a way that is parallel to the effective workflow in design offices. We found that systems should enable spontaneous idea capturing, communication of ideas to colleagues, and awareness of the work of collaborators.

1 INTRODUCTION

Designers follow a creative process in their aim to solve a given problem and generate creative artefacts (Warr et al. 2005). The first step of this creative process includes general research in order to identify the scope of the problem and generate initial ideas (Shalley et al. 2004). Frequently used sources of research for inspiration are public sources like the internet or magazines, but another important source of inspiration is the work of credible colleagues. Following the evaluation phase, designers select the most promising ideas for further modification and development, and preferably this evaluation phase involves the communication of ideas with colleagues for feedback (Sharmin et al. 2009, Oehlberg et al. 2011). Thus designers prefer to work in teams (Bellotti et.al. 1996, Vyas et.al. 2007).

While these early stages in the design process are easily conducted in the office environment, they are difficult when designers are on the go. These difficulties are detrimental to the idea generation process, as designers often get inspired when they are out of office (Bardram 1998). Thus in order to enable designers to capture creative ideas on the go, necessary tools must be developed in order to prevent the loss of ideas and to allow for real-time communication.

Related to the difficulty of capturing and communicating ideas on the go is the absence of a good tool for the structured and organized archiving of data, leading to the loss of ideas or older projects that could inform future ideas and projects (Höhn, 2011, Sharmin et al., 2009). This need is doubly crucial during early design phases, as a large number of novel ideas are produced (Sharmin et al. 2009), but these phases are still not well supported by digital tools (Geyer & Reiterer, 2011).

After having evaluated the success with which current tools on the market fulfil the work requirements of designers on the go in the early design phase, we conclude that none answers all of the crucial requirements and therefore set out to develop our own solution, Ideaflow (Höhn 2011, 2012). We then proceeded to evaluate Ideaflow by conducting a case study that simulates collaborative work of designers on the go. In addition to the quantitative data collected on the system, we conducted final interviews in the form of focus groups to supplement the quantitative data with participants' introspection.

In the chapter “Background”, the general working behaviour of creative designers is analyzed and discussed. The next chapter contains an analysis of commercial as well as research tools designed to support creative or collaborative processes. The discussion in the first two chapters informed the

development of the requirements for the system Ideaflow. In the chapter "Development Ideaflow", the requirements and the main concepts of the systems are presented. The following chapter "Main part Case Study" describes the case study, in which different groups of designers participated, that aimed to explore the effect of Ideaflow in its different modes on the creative collaborative idea generation process. The thesis concludes with a discussion of the results from the case study and their implications for future tools and further development of Ideaflow.

2 BACKGROUND

In order to develop an application that supports the creative work process, one first has to understand the characteristics of this project. Thus, the general creative problem solving process is analyzed and a brief summary of the work methods used in this process of creative designers is given. In the next chapter it is shown that there is a general preference of designers to work in teams. Furthermore, the study analyzes the benefits of collaboration and awareness about the work of colleagues in (distributed) design teams. The next section explains the work of designers and how it relates to the aspects of working on-the-go. This chapter will close with a discussion of the problems that affect the efficiency of the creative process, especially during the collaborative idea generation process.

2.1 WORK METHODS OF DESIGNERS IN THE CREATIVE SECTOR

Designers are adept at identifying design problems and offering solutions to those issues. In research this approach is called the creative process. Warr et al. (2005) describe this as an individual, internal process by which ideas are developed. In their study they analyze different accounts of the creative process (see Figure 1) and propose a process that is split into three iterative steps: Problem Preparation, Idea Generation and Idea Evaluation (see Figure 2).

<table>
<tr><th>Models</th><th colspan="2">Analysis of Problem</th><th colspan="2">Generating Ideas</th><th>Evaluating Ideas</th><th>Donating</th></tr>
<tr><td>Wallas [48]</td><td colspan="2">Preparation</td><td>Incubation</td><td>Illumination</td><td>Verification</td><td>X</td></tr>
<tr><td rowspan="2">Osborn [36]</td><td colspan="4">Idea Generation</td><td rowspan="2">Idea Evaluation</td><td rowspan="2">X</td></tr>
<tr><td colspan="2">Fact-finding</td><td colspan="2">Idea-finding</td></tr>
<tr><td>Amabile [2]</td><td>Problem or task presentation</td><td>Preparation</td><td colspan="2">Response generation</td><td>Response Validation</td><td>X</td></tr>
<tr><td rowspan="2">Shneiderman [44]</td><td colspan="2">Collect</td><td colspan="3">Create</td><td>Donate</td></tr>
<tr><td colspan="6">Relate</td></tr>
</table>

FIGURE 1 - COMPARISON OF CREATIVE PROCESS MODELS ACCORDING TO WARR ET AL. (2005:4)

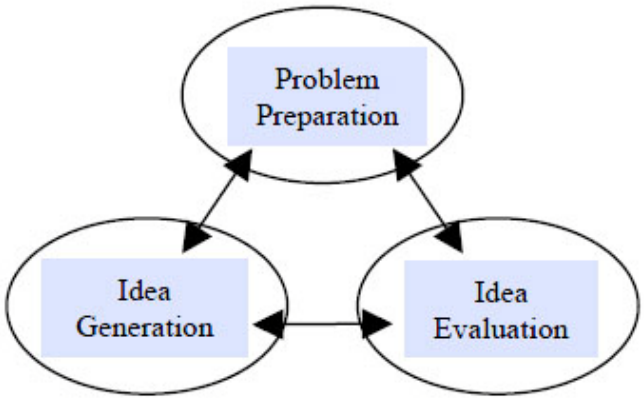


FIGURE 2 - GENERIC CREATIVE PROCESS MODEL OF WARR ET AL. 2005

Warr defines creativity as

> *"... [T]he generation of ideas, which are a combination of two or more matrices of thought, which are considered unusual or new to the mind in which the ideas arose and are appropriate to the characteristics of a desired solution defined during the problem definition and preparation stage of the creative process."* (Warr et al. 2005 p. 5)

In the work of Shalley et al. (2004) the creative process of developing ideas is divided into four steps.

(1) Identifying a problem or opportunity,

(2) Gathering information or resources,

(3) Generating ideas, and

(4) Evaluating, modifying, and communicating ideas.

Steps (2) to (4) are performed iteratively during the early design process. At the beginning customers brief the designers by introducing them to the problem. In order to analyze a design problem effectively, designers tend to use the help of colleagues. And as an aid in the idea generation stage during this early design phase, they normally start with a research. The first part of the research involves the individual information gathering (Höhn 2011). Preferred information sources are the internet and archives that include older projects, either their own or their colleagues' (Höhn 2011, Sharmin et al. 2009). Idea or project archives are major sources of inspiration. By reflecting on old projects, mistakes made in previous work can be avoided. And the re-use of aspects of previous work as well as the evaluation of old ideas may generate new solutions.

(Bellotti et al. 1996, Pedgeley 2007). Professional magazines or books are also used as source of inspiration (Mougento et al. 2008). The second part of the research mostly includes brainstorming ideas, which is done either individually or collaboratively in design teams (Paulus et al. 2001).

In their research designers don't want to limit themselves to one initial idea. Rather, they collect miscellaneous ideas, which may ultimately lead to several prototypes. Generating multiple ideas helps designers to understand the design problem and to create different solutions. On average, around 50 to 100 ideas are generated during the design research (Sharmin et al. 2009).

Another strategy for gathering information on a particular problem is to identify its source. Evaluations and observations from the users is a useful source of data for product development. In the early phases of design, users' observations help designers to analyze the users' perspective (Sharp et al. 2007) and to empathize with those potential users or customers (Vyas et al. 2009). Observations made by the target group can be elucidated and collected in the natural environment (in the field) of the users or in lab conditions where the users are observed while performing predefined tasks. In these tasks, users are asked to perform specific tasks with objects that are relevant for the context of the design problem. The information collected through the observation can serve to define or supplement product requirements.

Step (3) describes the conscious idea generation part. This part in the process involves a high level of brainstorming and sketching (Lee 2006). Both processes are done individually or in teams. During these tasks, designers usually externalize (Vyas et al. 2009) their ideas. In the early design phases they do this mainly by taking notes or drawings on paper (Höhn 2011). This kind of externalization is perceived as a natural method of communicating ideas to colleagues as well as simulating communications with others by committing their thoughts into writing of other types of communication (visual, audio, etc.). For example, sketching is an important strategy for designers, as it is a useful method for generating, developing, and recording spontaneous ideas. Schön (1983) describes this phenomenon as "Reflection in Action", whereby practitioners are aware of their creative endeavours and constantly reflect on their ideas as they go along. For example, while sketching or making notes, they reflect on the problem they need to solve and by fleshing out the components of this problem as well as their initial ideas of how to solve them, they generate new ideas or develop existing ideas for solving the problem. (Schön 1983)

According to Thomas et al. (2002), "People know much more than they know they know". The task of sketching helps them to explore their knowledge of the problem space. In addition, simple

sketches communicate ideas to others and provide space for interpretation. Van der Lugt (2005) discusses three types of sketches.

The "thinking sketch" is mainly used in the early design phases. This form of sketching is highly abstract and describes just the rough form of an object and therefore may lead to multiple re-interpretations. These re-interpretations can occur during the sketching process itself by the processing designer or as a result of viewing older sketches done by the designer viewing them or by fellow designers.

The "talking sketch" is a form of sketching that happens during team meetings. These quickly drawn sketches provide a shared visual context, which leads to a more efficient design process and therefore facilitates group discussion (Van der Lugt 2005). Like the individual "thinking sketch", this collaborative form of sketching also allows for re-interpretation and therefore may lead to novel ideas.

The "storing sketch" is useful in the recycling of older ideas. Sketches stimulate the imagination and are more easily stored mentally than words do. In contrast with ideas described by words, sketches or pictures produce also easier access to previous knowledge. These sketches are normally more detailed and mostly generated in later design phases. Storing sketches can be revisited in later phases of the project and used for inspiration in new projects.

Step (4) of Shalley (2004) normally requires feedback from colleagues. Designers always try to get feedback on their ideas (Bellotti et al. 1996, Oehlberg et al. 2011). They also share produced artefacts with managers or clients (Oehlberg et al. 2011). There are two reasons for this need to share ideas and products and seek out feedback. An initial constructive evaluation in a candid way can support creativity and motivation (Shalley et al. 2004). It forms confidence which in turn facilitates better ideas. The other advantage of an initial positive evaluation is that the more design specialists rate an idea positive, the more likely it is that it will become a success (Höhn 2012).

In the next chapter the need for collaborative work within the design process is discussed in more detail.

2.2 Aspects of the collaborative idea generation

It has been observed that design is a highly social process (Bellotti et al. 1996, Vyas et al. 2007), as it often involves communication of ideas, brainstorming and discussion, as well as collaboration on various aspects of a project in order to develop an idea and improve upon it (Bardram 1998). This work can take place at different times and in different places.

Designers use the chance to explain their early design ideas to colleagues in order to get feedback whenever possible (Prante et al. 2002, Sharmin et al. 2009). Designers also want to stay up to date on the work of their colleagues (Bellotti et al. 1996, Schneiderman, 2000, Caroll et al. 2002, Prante et al. 2002, Bravo et al., 2007). The presentation and discussion of their ideas helps them to get a better understanding of the design problem.

Awareness of their colleagues' work and communication about ideas is crucial when designers are "on the go", otherwise team efficiency suffers (Bellotti et al.1996). Designers prefer to have face-to-face conversations rather than non-personal communication, for example via email or phone (Guang et al. 2012). One type of valuable information regarding colleagues' opinions, which is only possibly via face-to-face interaction, is nonverbal cues (e.g. facial expressions and body language), a form of unspoken critique and feedback. Therefore, collaboration in design teams works well when team members can communicate in person (Sharmin et al. 2009).

Designers often work in teams to create ideas for products for customers (Vyas et al. 2009, Höhn 2011). There are several reasons why collaboration is crucial for successful design processes. Paulus and Yang (2000) found that individuals working alone produce fewer unique ideas than when in groups work involving brainstorming sessions. The authors attribute these findings to social attention and development time. Warr et al. (2005) test this hypothesis with the following case study. They compared the creative outcomes of a "Nominal Group" and a "Real Group". In the Nominal Group two individuals worked independently on a creative problem-solving task. In the Real Group, two individuals were working together to solve a creative problem. The results of their case study show that real groups produce more creative ideas because of the ability of the individuals in those groups to interact with each other. Warr et al. use the term "matrices of thought" to describe individuals' awareness of concepts or ideas and how they this interacts with significant features of the environment, thereby leading to "Distributed Cognition" [1] within a Group.

[…] we may consider the creative process as combining matrices of thought in our mind and our environment. (Warr et al. 2005:2)

By externalizing their matrices of thought, individuals increased the available resources useful for forming new combinations of ideas and approaches (see Figure 3).

[1] http://www.psychologie.uni-freiburg.de/Members/rummel/wisspsychwiki/wissenspsychologie/index.html/wissenspsychologie/DistributedCognition/ Latest Access: 20.02.13

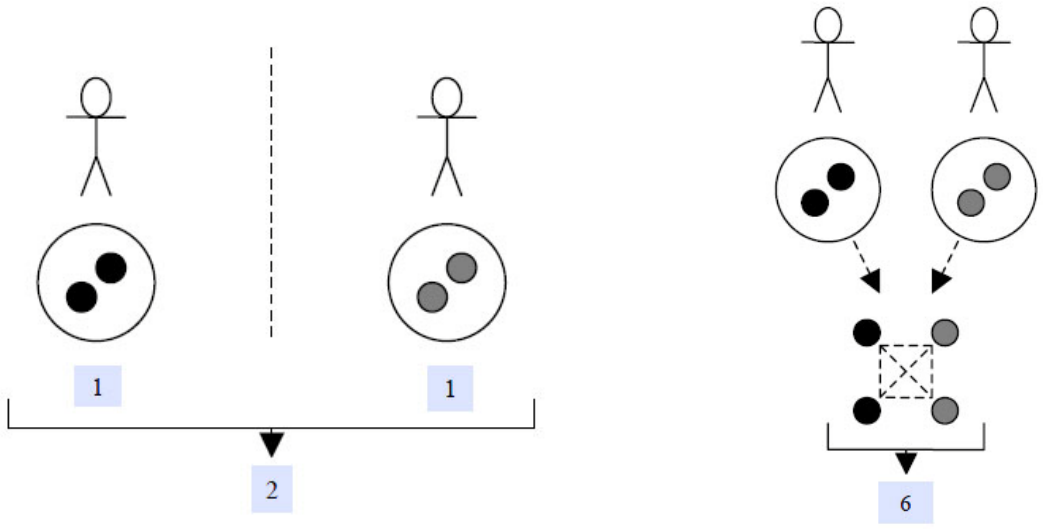


FIGURE 3 - CREATIVE IDEAS PRODUCED BY NOMINAL GROUP (LEFT) AND REAL GROUP (RIGHT) (WARR ET AL. 2005)

According to Van der Lugt (2005), creative meetings are held with the goal to solve a design problem using the group's combined knowledge. A particularly valuable part of this Distributed Cognition is the multifaceted knowledge and viewpoint of the potential user. Through the collective knowledge a better overall understanding of the problem is achieved, and this allows for gaining new perspectives, new ideas, and new creative artefacts (Arias et al. 2000, Hey et al. 2007, Oehlberg et al. 2012). Arias et al. (2000) argue that through the combination of ideas, cross products are created and subsequently to more creative artefacts. Bailey et al. (2010) mention that the opportunity to comment on the ideas of others improves creative results and produces higher motivation. Sharmin et al. (2009) explain that viewing others' ideas stimulates one's own creativity.

In order to communicate their ideas to colleagues within creative group meetings, designers tend to use sketches (Guang et al. 2012) along with screenshots and photos (Buxton et al. 2011, Oehlberg et al. 2012). The different forms of sketches used for externalization for individual use as well as for presenting ideas to fellow designers were presented in the previous section 2.1 “Work methods of designers in the creative sector”. The main tools used for externalizing, archiving, and sharing ideas are paper notebooks and whiteboards (Lee 2006, Oehlberg & Agogio 2010). These tools provide easy collection and sharing within group meetings.

“[...] a well-integrated idea generation process has a strong network of links.”(Van der Lugt 2001:57)

Van der Lugt (2001) argues that the quality of communicationcan be measured by how often new ideas inspired by preceding ideas in a specific group are developed. In addition, the approach of Linkography supplies the means to determine the value of an idea. Van der Lugt (2001) adopts this approach to measure the effectiveness of creative group meetings. In his approach the investigator has to see assess for each idea artefacts whether it has relations to previous ideas. If ideas can be clearly associated by shared characteristics e.g. a common theme, they can be thought to be linked. One main goal of Ideaflow is to support the creativity of individual designers by allowing them to re-interpret older project ideas or colleagues' ideas when they are on the go. One hypothesis evaluated in this study is that the availability of information facilitates multiple, new, and interlinked ideas. Van der Lugt`s (2001) process of Linkography was applied in order to evaluate the hypothesis. The exact implementation of the procedure related to current work is presented in section 5.5.1 "Measurement of the effectiveness of the collaborative work".

2.3 DESIGNERS ON THE GO

Designers are often on the go. As part of their job, they are out to meet customers and colleagues and attend conferences, and so they are often away from their office. While they are under way they often get inspired by outside stimuli, such as objects, forms or other people (Bravo et al. 2007, Prante et al. 2002, Höhn 2011). The stimuli designers are exposed to may give them insight suddenly and randomly, without any comprehensible connection with their current activity (Hewett 2005, Bardram 1998). Hewett (2005) argues that insights are gained in those instances when designers are not immersed in their design problem. In addition, communication with others preceding and following the cognitive process associated with gaining an insight seems to be relevant. In contrast, it is unlikely that an innovative idea occurs without any contact of collaborators (Hewett 2005). Thus it is important that designers have the possibility to capture these ideas when they are out of their office. Furthermore, capturing the idea should happen immediately after an insight is gained lest the creative ideas get lost. Thus the object that evoked the idea could only be temporary retainable for example the special color or form of a passing car.

In addition to the importance of designers' capturing their ideas, it is also important that they have the chance to communicate their ideas. In offices designers have the possibility to directly present new ideas to their colleagues once they have been arisen they get immediately feedback to them which is very useful for further development. If designers have the possibility to immediately react to ideas presented by colleagues when they are on the way this office situation is well emulated (Mougenot et al. 2008). In the late nineties Greenberg et al. investigated the possibility to collect notes to topics by the usage of private PDAs. They came to the conclusion that the technical

capabilities of mobile devices could be successfully utilized to support users' workflow that involves gathering and sharing data with others (Greenberg et al. 1999). Today designers sometimes use smartphones or tablets to capture and share ideas (Höhn 2011). In addition, designer use telephone and e-mail as means of communication with their colleagues when they don´t have the chance to do this face to face (Bellotti et al. 1996, Sharmin et al. 2009).

The third important aspect related to useful resources for designers on the go is the ability to access locally stored data. If designers have an idea when they are on the go, they often want to connect the new idea to older ones. Suppose that a special form or color inspires a designer. He might then want to immediately compare this with his previous work. Such a case, then, necessitates designers' ability to have mobile access to stored data (Höhn 2011).

2.4 PROBLEMS

The last chapters explain the importance of proper communication and collaboration during the design process. While there are many advantages to collaborative work in supporting the creative problem-solving task, there are also socially conditioned disadvantages caused by interpersonal situations in teamwork. For example, participants may be reluctant to publish ideas spontaneously without prior feedback of trusted colleagues. They may also be anxious about negative feedback from others. (Bailey et al. 2010)

Warr et al. (2005) enumerate the main social influences on creativity:

- Production Blocking,
- Free Riding, and
- Evaluation Apprehension.

Production Blocking is described as a problem that occurs when members of a group are simultaneously prohibited from expressing their ideas. In a brainstorming meeting, one member may not have the possibility to communicate his ideas before other do. As the conversation proceeds, he may feel his idea is no longer relevant or not as attractive as he originally thought, and thus will not voice his opinion. Warr et al. (2005) argue that if members are prevented from expressing their ideas as they occur, they can get discouraged from producing further ideas.

Free Riding, also known as “social loafing”, is a situation whereby some collaborative team members stop producing ideas because they feel as if others are producing enough ideas to get the project or discussion going.

Evaluation Apprehension occurs when members don't communicate their ideas because they fear of criticism from others.

These social hindrances on creativity mainly occur during face-to-face sessions. Warr et al. (2005) assumes that the introduction of anonymity of the participants increases the motivation of the members, decreases "free-riding" and prevents "evaluation Apprehension". One of the goals of this current study is to evaluate this hypothesis. Thus, we considered these aspects in the development of Ideaflow. The outcomes are discussed in the concluding chapter.

Successful collaborative design work is always based on proper communication between collaborators, be it when they are at work at their design offices or when they are on the go and communicate with collaborators remote. As described in the previous section, feedback is difficult to get or give when on the go. Designers may at their wits' end with a problem when they don't have the chance to collaborate with their colleagues in a similar to face to face interaction. Moreover, they would have to carry a lot of devices with them in order to provide feedback as they would in an office situation. And even then they might still be challenged by slow or missing internet connection and often uncoordinated asynchronous communication. Today there are several commercially available tools that could help reduce these problems (see section 3.1 "Commercial Tools"). However, these tools are not developed with the goal of meeting the specific needs of designers on the go. Also, while designers still mainly use telephone and e-mail to communicate with their colleagues (Bellotti et al. 1996, Sharmin et al. 2009), these forms of communication are not as effective as a direct face-to-face conversation. By communicating an idea verbally via telephone designers can discuss and get immediately feedback on an idea but the important visual exchange of information is not possible. In contrast, if the communication is done via e-mail, visual information is easily shared, but spontaneous feedback or discussions are difficult.

Another problem designers on the way have is the capturing of spontaneous insights, which often occur when they are out of office. If Designers don´t have the possibility to capture ideas the moment they occur, these ideas often get lost. To avoid this, some designers started to occasionally use smartphone's, tablets or mobile Netbooks (Höhn 2011).

One known fact is that designers like to categorize and annotate their ideas. Simply structured and presented data support the process of the collaborative idea generation (Prante et al. 2002). Additionally, by documenting the design process and the outcomes and decisions resulting from it, designers can reflect upon them, and this reflection can serve as a source of inspiration for the reuse and development of ideas (Hewett 2005, Thomas et al. 2002). Despite the availability of the

resources mentioned above, designers have no standard and wide-spread methods for saving and organizing their ideas. Thus, the artefacts on designers' physical and virtual desktops are often stored in an unorganized fashion (Sharmin et al. 2009, Höhn, 2011). These issues are still not solved in a satisfactory way even with the use of current digital tools (Geyer & Reiterer 2011). Early phases of creative design work are still insufficiently explored. Especially in the collaborative idea generation are tasks of design teams insufficiently supported for on-the-go designers (Maugenot et al. 2008). Therefore, modern research focuses on those phases that are still mainly needed to be taken care of by the designers themselves (Bellotti et al. 1996, Guretzky 2005).

In the next chapter we present the tools that were developed with the function of supporting different aspects of creative collaborative work.

2.5 SUMMARY

In this chapter we presented the working methods of creative designers and explained the creative process in which designers engaged in order to come up with the first useful ideas. This process consists of the following steps: “Identifying the Problem”, “Gathering Information”, “Generating Ideas”, and “Evaluating, Modifying and Communicating Ideas”, all of which continuously repeated. We discussed how designers work and behave in these different steps and argued for the importance of sketches, a common form of idea externalization. We showed that the creative design process is a social process based on proper communication and collaboration. We also showed the importance of feedback on ideas given by trusted colleagues. “Distributed Cognition” leads to a better understanding of the general problem space and to more creative ideas and as a result, designers often collaborate. We also enumerated the negative “Social Factors” that stem from social interactions that emerge from collaboration on design work. We established in addition other problems that complicate the process. As for idea generation, we assumed that creative insights often come about when designers are on the go, and these ideas have to be captured immediately, otherwise they are likely get lost. However, the ability to instantaneously capture an idea is more difficult to do on the go than in the office. The ability to review older ideas is likewise difficult to do when on the go. And lastly, communication with colleagues is also difficult on the go, due to connection losses and asynchronous communication. These factors pose a great hindrance on the design process. Some of these problems would be solved if designers had access to a mobile system that enables structured and organized idea saving. Alas, such a resource that solves all the issues discussed in his chapter is yet to be developed.

In the next chapter, we examine systems that were developed or have functions that could support different aspects of creative collaborative work.

3 Related Work

Designers are still in need of contemporary, mobile and advanced tools that supporting their creative work processes (Höhn 2011, Oehlberg et al. 2011). The early conceptual design phases are especially lacking in that regard. Oehlberg et al. (2011) interviewed 17 practicing designers and 17 design students on the type of systems they use to manage their work tasks. They were asked the following:

- Which tools they used for conceptual design and user research,
- How these tools affected their collaborative work behavior, and
- How in general they managed and shared information when they switched between individual and collaborative work in research on user needs and conceptual design.

The researchers gathered 53 tools that were used on all participants. They differentiated between Tangible Tools, Digital Hardware, Software, and Web services (Oehlberg et al. 2011:10). The table lists different types of Software and sets them in relation with the number and kinds of designers that use them. The tools clustered in four classes.

Tangible Tools: These vary from lightweight and mobile small-scale tools like Post-It Notes to large scale ones like whiteboards. Practicing designers used the latter type of tools the most during all design phases of collaborative work.

Digital Hardware Tools: These ranged from mobile smartphones to digital capture devices like photo cameras or video recorders. The most widely used hardware tool was the video recorder, which was used by practicing designers only.

Software Tools for Prototyping or Word Processing: These tools included, for examples, software like Microsoft Office Word, Excel and PowerPoint, which are also the most frequently used tools among all available tools.

Web Services: These services ranged from online surveys to online note taking tools like Evernote [4] or Wikis. The most used online medium was at first Email followed by online Applications like Google Docs and Web Conferencing tools like Skype.

Oehlberg et al concluded from their findings that practicing designers use a bigger variety of tools than student designers. Generally speaking, their findings corroborate results of previous (Höhn 2011) and present work (see section 5.3 "Pre Test Results – section over Designers"). These findings show that designers very rarely use software tools for their early design phases, and if they do they mostly use common office software, which are not tailored to their needs. As a result, they still mostly use physical tools like Post-Its and paper.

In order to understand why designers don't use commercially available tools, we analyze several sophisticated tools in the following section. We then investigate other tools that were developed for research purposes and whose main goal was to support the early design phases.

3.1 Commercial Tools

In this chapter we explain how commercial tools can support designers, focusing on those features that have this specific function.

The commercially-available tools we discuss here use features that emulate social interaction; that is, the exchange of information with a set of chosen people. Such features that enable social interaction could also support collaboration in the creative design context. Most applications make use of existing social networks or use simple e-mail functionality for sharing data, for example Adobe Photoshop touch [1], Evernote [4] or Paper[9]. There are also various online portals that allow sharing data related projects on specific topics. This function is especially useful for individual designers who don't normally collaborate with colleagues or work alone and therefore don't have potential collaborators.

Another main requirement of today's commercial tools seems to be interactivity and speed. Easy uploading of files is an addition imperative. These functionalities are not easy to adapt to mobile hardware and software due to the volatility of internet connection. Some tools include solutions for this problem. MockFlow [6], for example, provides an online/offline feature that enables capturing data everywhere without the constant need for internet connection. Instead, data changes are store locally and automatically, thereby avoiding the continual dependency on internet connection.

In the section 2.1 "Work methods of designers in the creative sector" we discuss the importance of the internet as a source of information and inspiration for designers in their pursue of new ideas or the development thereof. WayBackMachine [13], for example, is a large online web archive that designers can use as search machine for old archived websites.

There are also tools available for supporting the coordination parts of the collaborative design process. These project management tools are mainly developed for sharing and discussing documents related to projects like the application Sharepoint [10]. Basecamp [2], for example, provides useful to-do lists.

Skitch [12], which is a part of the Evernote [4] systems, provides some features for supporting the design process. Users can, for example, create notes or lists and capture photos or collect other multi-media files. The system also provides a sketch function, a drawback of its parent system Evernote (Höhn, 2012). Skitch, however, does not provide system notifications, i.e. alerts that are send to the user when new data have been shared by collaborators.

The mobile application WhatsApp [14] has functionality which supports data capturing and feedback on the go. It enables rich multimedia data capturing and sharing with others. The generation of groups for sharing data is also possible. All group members get a system notification if new data is shared. WhatsApp seems to be especially designed for textual conversations because the media capturing functionality is hidden behind a button and not visible in the main interface. Another drawback if it would be used of design teams is that it does not provide sketching functionality.

An example for sketching on the go is the application Paper [9]. This application provides drawing functionality for Apple tablets and the possibility of organizing the produced sketches in virtual books. Created artefacts can be shared via social networks.

Services like Dropbox [3] provide virtual space for stored data accessible from different devices via the internet. iTeleport [5], for example, is an app which provides desktop access with mobile devices. This app provides access to all locally stored data and applications. The designer can add or modify data everywhere and any time. Mura.ly [7] is an online application that enables designers to manage their artefacts on a table like interface. Designer can upload artefacts and place them on the virtual table.

All the aforementioned tools provide features that can be useful for designers in their daily working routines. However, no applications fulfill all of the requirements (see section 4.1 “Requirements”) required by creative designers.

3.2 Research Tools

So far a great amount of research was done to support the creative problem solving process. Tools were developed with the goal to support specific aspects of the design work or to get deeper insight

into the design process itself. In this section, some relevant previous research projects are briefly introduced in order to set the stage for the discussion of current work.

3.2.1 RESEARCH IN THEORY OF THE DESIGN PROCESS

In the literature review of Oehlberg & Agogino (2010), the authors explain that traditional design journals are used by designers to store, document, share, and provide mobile access of design information. They summarize three main motivations of today's researches to provide new ways to digitally enhance the possibilities for designers with physical paper design journals. They claim that the research deals with the

- Support of archiving and information management,
- Sharing and collaboration, and
- Engaging with multimedia.

Based on their research they raise new questions on the topic of generating personal information artefacts in collaborative design tasks. Answering questions on these topics would show how the social implications of the creative process impact the usage of individual design tools. Information on that topic would be useful to develop more sophisticated tools in the future. These could identify the precise needs of designers in handling both private and shared information.

Paulus & Yang (2000) do not discuss the usage of design tools like in Oehlberg & Agogino's study, but rather focused on the influence on social impacts on the creative process without the use of any communicative tools. As part of their study, they encouraged different groups to collect ideas, either individually or together as a design team. Their main finding was that individuals produce fewer unique ideas than groups in a Brainwriting[2] session. The authors relate these results to social attention and time allotted for development, two factors that lead to the production of more ideas in collaborative group sessions. The authors argue that the performance of idea generation could be improved if the negative social factors associated with face-to-face meetings would be eliminated. They assume that this can be achieved with methods like electronic Brainwriting.

3.2.2 SUPPORTING THE PROCESS OF COMMUNICATION AND PRODUCTION OF EARLY DESIGN IDEAS

Guang et al. (2012) focus their work on the support of asynchronous communication between collaborators early production stages of design ideas. They implement "SketchComm", which

[2] http://kreativitätstechniken.info/brainwriting/ Last Access: 07.03.2013

provides features like sketching and which supports the inclusion of rich contextual information like photo, video, audio and text annotations. All data in this application was combinable with a multimodal function, a feature, that, they hypothesize, would simulate real live face-to-face communication.

The system provided two interaction modes. In the first one, the "Creation Mode", designers could generate creative content, for example a sketch drawn with a pen or finger. Additionally different colors and brushes could be selected and the resulting sketches could be annotated with text. This mode also allowed users to capture real live objects with photos and to create audio and video recordings. In the second interaction mode, the "Review Mode", the audience could review the produced ideas in order to understand the design idea.

The multimodal communication provided linking between different data types, for example between sketches and audio. Linking was implemented in order to support the review of ideas and was supposed to simulate real face-to-face situations where someone may explain his thoughts both verbally and by drawing sketches. In addition, the inclusion of files from a local folder was possible via Bluetooth. Browsing the internet was a common task for designers. Therefore a web browser was also included in the system. SketchComm was implemented for windows 7 touch and pen capable tablet PCs.

Guang et al. (2012) recorded the thought process of designers by automatically recording a timeline of the interaction process. The system provided "step marks", which can be set by the designer to maintain a chronological order in order to better understand the audience and its responses. All of the created files were stored in a project folder, which could be shared with the audience.

SketchComm did not support feedback on the created materials; rather, only the review mode was available to the audience. The researchers mention that the task of providing feedback to ideas a potential topic for future exploration, having in mind such a feature as useful for design teams.

Unlike SketchComm, the system Dazzle (Oehlberg et al. 2012) focuses on face-to-face meetings. Dazzle is designed to support creative design teams with a shared display system. Oehlberg et al. (2012) wanted to support user research[3] and the workflow of brainstorming sessions, both activities beginning part of early design activity. Before they developed the system, the researchers

[3] http://www.usability-in-germany.de/definition/user-research /Last Access: 23.02.13

conducted a formative study in which they observed design teams at work. Through this observation they developed five design guidelines for understanding design teams:

- Supporting heterogeneous clients and media,
- Enabling individuals to selectively present design information to the team,
- Supporting shared meta-analysis of information,
- Recording shared decisions alongside individual contributions, and
- Offering an accessible, visible team archive.

Dazzle allows the sharing of files with other collaborators on one display. The system records the process of presenting artefacts' to others in an "Activity Log", which can be later tagged and searched. Capturing the state of the current whiteboard is also possible. Like SketchComm, Dazzle does not support collaborative editing or commenting on produced material, which was a drawback mentioned by the designers.

In contrast with Guang et al. (2012), Wigdor et al. (2009) support the collaborative work with a table instead of a display system. WeSpace is a collaborative workspace consisting of a multi-touch table, which allows simultaneous operations by more than one user at a time. Like Ideaflow, one of Wigdor et al.'s main goals was to support the collaborative scientific work with a visual computing space in a way that does not interrupt the users' day-to-day practices.

Wigdor et al. identified the need to give the users control over whether they share their own data with others or not. In their requirements they also considered the need of functionality, similar to a digital whiteboard where work can be collaboratively generated and stored.

All of the systems discussed above focus on digital support provided only to collaborative design work. In those systems, physically generated artefacts can only be integrated into the systems via digital captures like screenshots or photos, for example capturing images of the current Whiteboard in Dazzle (Oehlberg et al., 2012). With the system "iDeas" Lee (2006) wanted to support the creative Design work with the transition of cognitive artefacts into social digital artefacts. Cognitive artefacts are physical tools like paper-based notebooks and whiteboards.

iDeas supports the digital capturing of handwritten notes using the Anoto digital pen system[4]. By using digital pens, drawings, and handwriting with special physical pens on paper are captured as

[4] http://www.anoto.com/lng/en/pageTag/page:products/mode/view/documentId/998/

digital data in real time. Data capturing on the go is possible with snapshots via cameras or notes saved as text files. Both methods of data capturing can be stored with iDeas and directly imported via an online service. The primary access point of the system is a desktop browser on which the visualized data can be manipulated and searched through in order to solve design issues. The tool also captures metadata such as time and location, which supports easy sharing, searching and annotating. Lee also uses tags for categorizing stored artefacts. This tool supports the main tasks of the early design phases; tasks which Ideaflow also addresses. The system is design with focus on the digital support of office collaboration and hardly on the mobile support.

3.2.3 SUPPORTING DATA GATHERING ON THE GO

Greenberg et al. (1999) developed a "SharedNotes" system, in which users can write notes with their personal PDAs. When they meet with colleagues they can move the notes on a shared public display. Their main goal was to gather information about how people handle personal and public artefacts and how people shift from individual to group work. The system also supports distributed synchronous meetings where remote collaborators can connect to the session from their workstations.

Butterfly Net (Yeh et al. 2006) is a system which does not focus on the sharing of information on the go but rather on the gathering of data. It supports the daily work of collecting data in the field for biologists. Yeh et al. (2006) discovered that biologists collect an enormous amount of quantitative and qualitative data when they are out doing fieldwork. Butterfly Net allows researchers in the field to collect digital data such as photographs and notes and then to organize and link the collected data within the system. It also provides an efficient search options in the data repository. Yeh et al. also designed a solution for further manipulation of the data on local PCs. The collected data can be visualized and edited via a browser interface.

3.3 DIGITAL SUPPORT FOR SEARCHING, DOCUMENTING AND ANALYZING THE DESIGN PROCESS

Geyer & Reiterer (2011) conducted an experimental case study with the commercial tool Evernote [5]. Evernote allows capturing and archiving artefacts like notes, lists, sketches, images, as well as audio and video files, which could subsequently be shared via a cloud service. The system is based on a desktop application but extendable to mobile devices. Geyer & Reiterer used the software to document collaborative design processes. Their investigation led them to the conclusion that Evernote provided the basic features for documenting design process; however, improvements would be necessary to enable informal information management, visualization, as well as

communication and collaboration. The reasons for not using Evernote in this case study are documented in previous work of Höhn 2011.

A tool especially developed for the documentation of the design process is the system named PRT (Project Reflection Tool) developed by Dalsgaard et al. (2012), who focused on supporting research on the design process. They developed the web based PRT, which documents the design process in terms of events, sub-events and notes. As with "Ideaflow", which is the focus of this work, they used time as the organizing principle and recorded timestamps for all events. The system also provides access to a shared repository of the produced data for all participants. The participants have the opportunity to upload images, video footage and documents to an event. In addition, they can produce node items, which are also equipped with a timestamp, a text field and media files. The PRT System provides a view, in which events, sub-events, and the produced nodes are arranged along a timeline. The timeline was designed with the goal of providing the users with an overview of the project, its development, and its current state. A similar view named "TimeSort" has been designed as an Ideaflow Visualization (see section 4.3.1 "Visualization Concepts").

One drawback of PRT is the fact that the system is not designed for fast feedback and mobility. In their study, Dalsgaard et al. identified the need for direct and faster upload of media like text, images and video. They found that it is awkward to first transfer data captured by a mobile device to a local computer and then to upload it to a browser. They claimed that media should be automatically uploaded from smartphones to a project's media archive, and postponed exploring this feature to future work. Although PRT was made with the purpose of studying the design process and not the auxiliary aspects thereof, we argue that PRT could also be used to support the design process. Enabling the review of past and current projects is beneficial to users of such systems, as looking at older projects or material of others can be stimulating and inspiring.

The next system presented here is especially developed for research on the topic of memory recall by exploring archives. Hunter et al. (2011) developed the system "MemTable" to provide easy capturing and compact archiving of meetings for memory recall. The interactive tabletop system also supports meetings which are hold co-located and enables searching through the meeting archive. Captures may be composed of keyboard input, images, paper-based notes, audio recordings, and drawings on screen. Content can also be linked and available on and off the table.

The following systems are not concentrated on the support of organized archiving but on the organization of special workflow processes.

Similarly to Lee's (2006) system, iDeas (see section 3.2.2 “Supporting the process of communication and production of early design ideas”), Hinkley et al. (2007) also combine physical idea generation tools like digital pens with digital features. With the system InkSeine (Hinkley et al. 2007), they use this combination to support the task of organizing the design workflow. InkSeine is a Tablet PC application, which enables active note taking. This application is also optimized for browsing the internet as well as searching and manipulating documents stored on the Tablet PC. Active note taking means interleaved searching, linking, collecting and inking content within a pen-and-ink interface. The user can write notes with the digital pen and then initiate a search based on the note, and then drag documents from the search results and drop them into the note. The InkSeine interface also enables users to open a document, cut out parts of it, and copy them onto the note within saved in the system. The system does not, however, support active capturing of multimedia files like photos or videos.

The other system what focuses on organizing workflows is “Freed”. Mendels et al. (2011) designed this system to support design students by allowing them to organize their digital collection of documents related to their design projects. The software enables user to define relations between collections by creating a tree structure. The system can also be used as a presentation tool for discussions on the project. In addition, the software facilitates the use of images, videos, and text as well the ability to organize them as nodes in the hierarchical tree. The system thus equips users with the ability to view their digital content from various perspectives and in various structures.

3.4 SUMMARY

In this chapter, we reviewed many types of commercial software as well as research tools and their efficacy in supporting the creative problem solving process, many of which have been specifically developed for this specific process. In the chapter „Background“ we identified the need to support collaboration and idea generation for distributed design teams. Our main goal, then, is to provide features that emulate working conditions of the office .However, we found no software that was capable of optimally supporting the needs of designers on the go. In light of our findings detailed in this chapter, we decided to develop the tool Ideaflow, which specifically supports the needs of designers on the go. The next chapter summarizes the requirements of the tool, and following a description of the concept of the system „Ideaflow“ will be presented.

4 DEVELOPMENT OF IDEAFLOW

The following aspects of the implementation of Ideaflow are based on previous work by Höhn (2012).

The studies reviewed in "Background" show that there is still a need to support creative design teams in their early design phases. After exploring the existing tools, which are assumed to fill this gap, it was recognized that these tools do not adequately support the collaborative aspects of work in design teams. One reason for this could be that the work of this special design task is not well explored and therefore one of the main aspects of actual research in the field of creative design.

In the work of Warr et al. (2005) two interesting assumptions are made:

> [1] *[…]The ability for real groups to interact with each other in order to externalize matrices of thought increases the resources available to the group, giving them the opportunity to form new combinations of their matrices of thought and so produce creative ideas. […]*
>
> [2] *[…] providing groups with a comparison standard increase their performance and providing explicit feedback about individual performance also increases performance of group members. It is unclear what is the best way to provide such explicit feedback, and so increase individual and group performance by reducing free riding, while not causing a negative effect on creativity by increasing evaluation apprehension.[…]*

In current work we want to answer the question of whether collaboration and idea generation on the go of creative design teams can be supported in order to match the normal office conditions. The hypothesis is that collaboration similar to the one taking place in the office can be emulated in on-the-go situations by implementing system notifications on smartphones, triggered by new saved ideas, and by providing an idea. Furthermore, cross products can be generated and developed by increasing designers' awareness to the work of their colleagues.

4.1 REQUIREMENTS

With the goal of designing a tool, which can meet all of these specific features, and which is based on the tool originated in Höhn's (2011, 2012), the following requirements were developed.

4.1.1 MANY INPUT DEVICES IN ONE

Designers get inspired also when they are on the go, and those ideas that are generated spontaneously and away from the office must be captured the minute they are generated, lest they are lost. Ideaflow therefore comes to resolve this issue by providing all the modalities necessary for adequately recording an idea generation.

The main things designers do when they get inspired is take a picture of their inspiration or write their idea down (Oehlberg et al. 2012). Sometimes they make a sketch for externalizing their ideas. For this reason Ideaflow should at the very least provide support for taking pictures, making notes and for sketching ideas.

4.1.2 THE TIME FACTOR

In the mobile idea generation, time plays an important role. Some things that inspire a designer can be brief and fleeting. For example, the form of a passing vehicle or a natural event of short duration could give birth to an idea. Therefore, the idea capturing features should be easily and quickly accessed.

4.1.3 SUPPORTING AWARENESS

The creative idea generation process is a highly social process. Designers find it important that they stay current with their colleagues' work and ideas. They get inspired by the work of others and like to discuss their ideas with other teammates (Bellotti et al. 1996, Caroll et al. 2002, Bravo et al. 2007, Schneiderman 2000). In order to support the social and collaborative aspects of idea generation, Ideaflow must have features that enable users to receive real-time feeds on their collaborators' ideas and in general support real-time collaboration. In virtual teams, everyone should have the opportunity to access the shared pool of information and participate by commenting or further developing on the artefacts, regardless of their current location.

4.1.4 COMPACT AND STRUCTURED IDEA ORGANIZATION

Simple structure and presentation of ideas promotes the flow of information and insight in the collaborative generation of ideas (Prante et al. 2002). Thus, Ideaflow will support a streamlined idea organization concept.

4.1.5 TRACING THE IDEA GENERATION PROCESS

In order to investigate the idea generation process, it may be of interest to explore how an idea is developed. Such an investigation can shed light on important questions, such as which ideas trigger specific reactions and why they do so. The designer may find it helpful to reflect on past projects and

possibly incorporate tried-and-true and successful ideas or be inspired by aspects of them (Bellotti et al. 1996).

4.1.6 Elimination of inhibitory Social Factors

Sometimes when groups collaborate on a project, some team members do less than their colleagues because they think others will do the work. This aspect is called "free riding". Explicit feedback on anonymous ideas maybe lead the generators of these ideas to follow through on their projects and not rely on their collaborators to develop or complete the newly generated concepts, thereby reducing free riding. Anonymity also aids in the feedback process and is beneficial both for those receiving feedback and those giving it. On the receiving side, anonymity would help alleviate "Evaluation Apprehension" (Warr et al. 2005). Evaluation apprehension is the anxiety associated with discussing one's ideas due to fear of negative feedback from supervisors and collaborators. If ideas were submitted anonymously, those submitting their ideas would not fear of being exposed if their ideas are being critiqued. Those providing feedback would likewise be evaluating ideas more freely, unencumbered by the fear of discouraging their colleagues when providing critique. For that reason Ideaflow should support real-time feedback and anonymity.

4.2 Implementation Concepts

In order to measure how the collaborative way of working in the early design phases can be supported on the go the system, Ideaflow was developed based on the following four main aspects: communication, awareness, organization and reflection.

The goal of this chapter is to summarize the relevant aspects of the implementation of the tool, which can support a mobile collaborative working designer. Therefore, the fundamental techniques and concepts of the implementation of Ideaflow are explained. Technical details of the implementation are documented in the technical report of Höhn 2012.

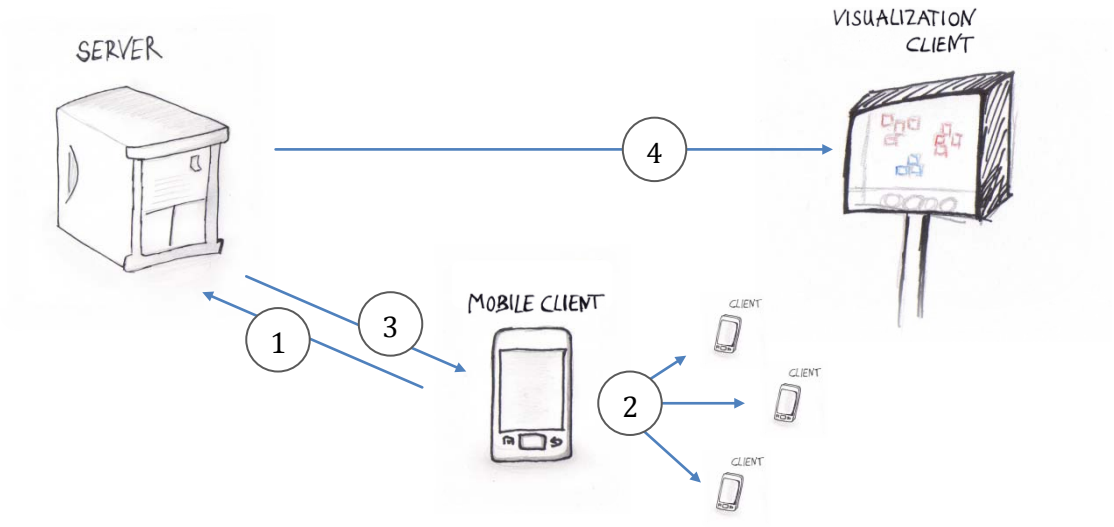


FIGURE 4 - SCHEME OF THE CLIENT SERVER ARCHITECTURE OF IDEAFLOW

Figure 4 shows a scheme of the client server application. The Ideaflow system is composed of three parts. The first component, the client application, is designed for data gathering, viewing, and communication on the go. The second component, the server database, is designed to save this data and the third component, the data visualization client, visualizes all collected data on a touch-capable display. The mobile client application exchanges data with the server on request. The designer has the possibility of gathering multimedia data (see section 4.2.4 "Gathering the data") and save it on the server (step 1). Whenever an idea is saved all mobile clients get a notification through the system (step 2). The converse flow of information is possible too: the designer can request data from the server (step 3) and view it in the Ideaflow archive (see section 4.2.5 "Approaches to stimulating collaborative work on the go"). When the data visualization application starts it requests all multimedia data from the server (step 4) and displays the multimedia data as objects on the screen. It provides four ways of data arrangement in support of the review process of ideas in the context of creative group meetings and in other situation (see section 4.3.1 "Visualization Concepts").

4.2.1 BASE STRUCTURE

Pocketbee (Gerken et al. 2010), a multimodal Diary application developed at the University of Konstanz for quick and easy data gathering on the go, was used as base frame for Ideaflow. Gerken et al. developed the system to support long time field evaluation based on the "diary method"[5]. The main benefit of Pocketbee is the ability of the participants to gather specific context-related data with smartphones without the presence of an investigator.

[5] http://srmo.sagepub.com/view/keywords-in-qualitative-methods/n16.xml/ Latest Access 14.02.13

The developers of Pocketbee decided to design the system on the Android Platform on the smartphones GalaxyS. This decision was made based on the larger market share and availability of Google's android platform. As part of the work of Höhn (2012), the current market was analysed[6]. This situation is still true to the second half of 2011. It was assumed that the marketshare of android Platform with the smartphones GalaxyS will continuously increase over time and therefore the platform and hardware was not changed for the development of Ideaflow. Actual research has proved this assumption to be true (see Figure 5/-6).

Worldwide Smartphone Sales to End Users by Operating System in 4Q12 (Thousands of Units)

Operating System	4Q12 Units	4Q12 Market Share (%)	4Q11 Units	4Q11 Market Share (%)
Android	144,720.3	69.7	77,054.2	51.3
iOS	43,457.4	20.9	35,456.0	23.6
Research In Motion	7,333.0	3.5	13,184.5	8.8
Microsoft	6,185.5	3.0	2,759.0	1.8
Bada	2,684.0	1.3	3,111.3	2.1
Symbian	2,569.1	1.2	17,458.4	11.6
Others	713.1	0.3	1,166.5	0.8
Total	**207,662.4**	**100.0**	**150,189.9**	**100.0**

FIGURE 5 - WORLDWIDE SMARTPHONE SALES TO END USERS BY OPERATING SYSTEM IN 4Q12. [7]

Company	2012 Units	2012 Market Share (%)	2011 Units	2011 Market Share (%)
Samsung	384,631.2	22.0	315,052.2	17.7
Nokia	333,938.0	19.1	422,478.3	23.8
Apple	130,133.2	7.5	89,263.2	5.0
ZTE	67,344.4	3.9	56,881.8	3.2
LG Electronics	58,015.9	3.3	86,370.9	4.9
Huawei Technologies	47,288.3	2.7	40,663.4	2.3
TCL Communication	37,176.6	2.1	34,037.5	1.9
Research In Motion	34,210.3	2.0	51,541.9	2.9
Motorola	33,916.3	1.9	40,269.1	2.3
HTC	32,121.8	1.8	43,266.9	2.4
Others	587399.6	33.6	595886.9	33.6
Total	**1,746,175.6**	**100.0**	**1,775,712.0**	**100.0**

FIGURE 6 - WORLDWIDE MOBILE PHONE SALES TO END USERS BY VENDOR IN 2012 (THOUSANDS OF UNITS). [8]

They also compared the different technical possibilities of the two most used SDKs Android and iPhone. They found that the technical possibilities of the Android SDK fit their product requirements better, as in the case with Ideaflow.

Another important goal of Pocketbee was to provide rich data gathering techniques. In order to map the context and the situation in which a user was creating an entry in the field study, it was necessary to gather rich multimedia data like textual notes, photos, videos and sound recordings. Gerken et al. decided to add a simple sketching function to give the users the chance to capture their thoughts visually. As we illustrated in chapter "Background", designers use many techniques and modalities to externalize and communicate their ideas, and Pocketbee addressed these exact needs

[6] http://www.gartner.com/newsroom/id/1924314 And http://www.gartner.com/newsroom/id/2237315/ Latest Access 14.02.13

[7] From http://www.gartner.com/newsroom/id/2335616/Latest Access 09.03.2013

[8] From http://www.gartner.com/newsroom/id/2335616/Latest Access 09.03.2013

designers' have by providing the aforementioned tool. Given these strengths of Pocketbee to answer designers' need, we adopted this architecture into the development of Ideaflow.

4.2.2 SETTINGS IN THE APPLICATION CORE

The preference[9] screen is reachable via the Android menu. There the user has to make the necessary settings in order to ensure that the application runs properly. After the first launch of the application the user has to set a password to ensure that his account is private and secure. This password is then stored on the database. Whenever the preference menu is launched verification via password is required.

Subsequently, the user has to set the server connection's information on the preference menu to allow for future data upload and download. Another necessary setting is the client identification via user name and identification code. To provide compact and organized data structures Ideaflow implements the concept of project folders. Creating a new project is done from the preference menu. When the user creates a new idea Node (see section 3.2.2 "Supporting the process of communication and production of early design ideas"), he can choose a project from a list and thus the Node and the project are linked. This linking feature makes available data review and evaluation opportunities later in the process of project development.

4.2.3 QUICK LAUNCH HOME SCREEN APPLICATION

The App Widget[10] is the main access point of Ideaflow to captured data. App Widgets are miniature application views which are accessible through the main Screen.

The main advantage of using App Widgets is that the miniature views can receive periodic updates and that their placement on the Home Screen provides quick access to the application functions.

Ideaflow's App Widget provides the key functionalities, such as data gathering, data viewing, and communication. It features two main parts represented by a Start button and an Archive button (see Figure 7 Left)

Touching the start button takes the user to the main functions available for capturing data and creating an idea Node. The archive button takes the user to a chronologically ordered List of all Projects and all stored data. In the archive the user has the possibility to add new data to the

[9] http://developer.android.com/reference/android/preference/package-summary.html /Latest Access 19.02.13
[10] http://developer.android.com/reference/android/appwidget/package-summary.html /Latest Access 19.02.13

existing depository of ideas and link those new ideas to old ones (see section 5.5.1 “Measurement of the effectiveness of the collaborative work”).

4.2.4 GATHERING THE DATA

Touching the start button lead the user to the start interface, which includes the media options commonly used for idea externalization (see Figure 7 Right).

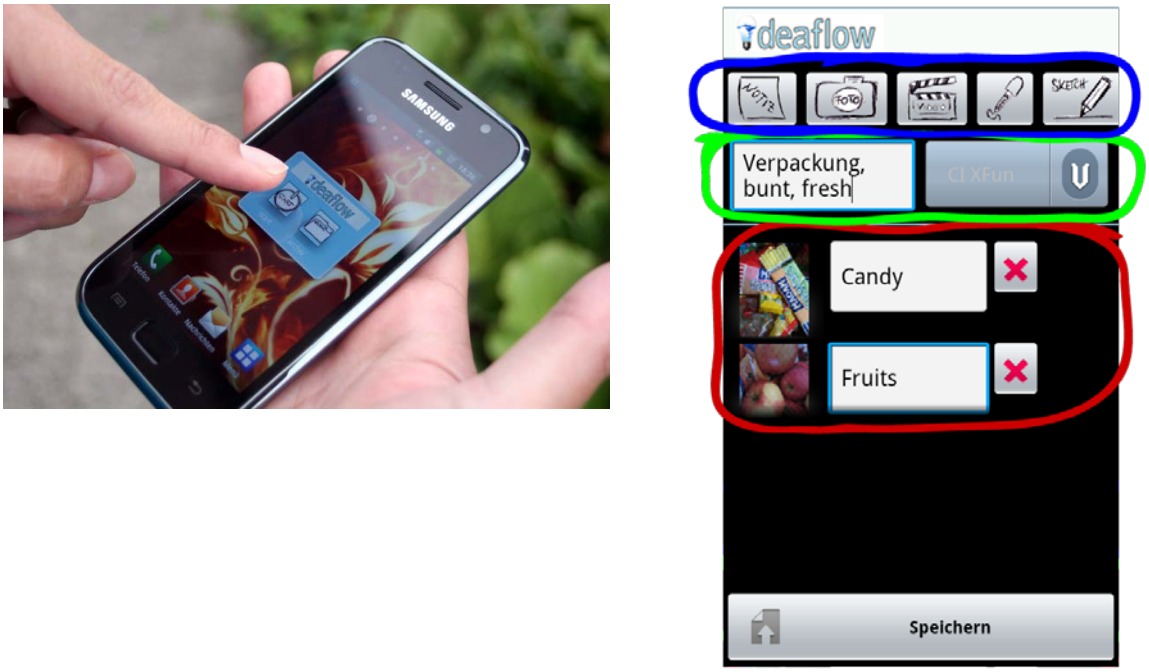


FIGURE 7 - LEFT: APP WIDGET IDEAFLOW. RIGHT: START INTERFACE IDEAFLOW

The part circled with blue includes Media Buttons for capturing rich media data. By pressing one of these buttons the user has the possibility of writing a short textual note, take a photo, capture a short video, record sound, or sketch a quick picture. Because of the universal tendency to look first at the top of the screen, the arrangement of the interface’s functionalities is in descending order by importance. By taking into account “The Time Factor” [4.1.2], the media buttons are placed at the very top of the screen in order to be perceived quickly by the user. When the user captures an idea – for example, a photo of fruits (see Figure 5 Right. Red circled area) – a new Node Element is added to the interface. This concept of creating an idea with several continuing elements is further described in the next chapter. The next logical step after adding a new data point is to assign link it

to, or associating it with, existing data or concepts. In order to fulfil the requirement “Compact and structured idea organization" [4.1.4], methods of organizing the recorded data for later use are provided. The green outlined area of the interface shows a Text View (Left) where the user can add keywords to the Idea Node. Right next to the Text View, a list containing all projects previously created on the preference menu (see section 4.2.2 “Settings in the application core”) is provided to enable the user to assign the Node to a specific project.

4.2.5 APPROACHES TO STIMULATING COLLABORATIVE WORK ON THE GO

The archive and notification concepts were developed to meet the requirements “Supporting Awareness” [4.1.3], “Compact and structured idea organization” [4.1.4] and “Tracing the idea generation process” [4.1.5]. Both concepts are designed to offer designers on the go the possibility to communicate their ideas, and option otherwise only possible when done face to face.

Another goal we set in developing Ideaflow was to fulfil the requirement “Elimination of inhibitory Social Factors” [4.1.6]. This was achieved by enabling anonymity, the possibility to create ideas spontaneously and by facilitating users' awareness of ideas of other collaborators. Warr (2005 p. 8.) already described aspects of this approaches:

[…] providing groups with a comparison standard increases their performance and providing explicit feedback about individual performance also increases performance of group members. It is unclear what is the best way to provide such explicit feedback, and so increase individual and group performance by reducing free riding, while not causing a negative effect on creativity by increasing evaluation apprehension.

The idea of posting newly generated ideas anonymously is designed to prevent Evaluation Apprehension inasmuch as anonymity disassociates the idea from the person who generated it. And so, negative evaluation will be directed solely at the idea. Another welcome consequence of anonymity and the idea-person dissociation is that negative evaluations would be directed at the ideas and not be marred by personal differences between the idea generator and the colleague who provides the feedback. Production Blocking can be obviated by virtue of the collaboaration not being done face to face. Designers are free to think of their own ideas without being other people's "stealing their thunder". Moreover, the system's notification allows for the suspension of new idea notification till after the designer has completed capturing an idea. That said, Ideaflow is designed to provide subsequent notifications, thereby increasing users' awareness of the work of other collaborators. Providing awareness of the ongoing process is a feature that is assumed to reduce “Free Riding”.

As we described in the previous chapters, one factor that spurs designers on to generate new ideas is being exposed to ideas of others. Being aware of the work of others, and crucially their colleagues, is a fundamental part of successful design work. In this section, the two relevant concepts that enable this aspect for on-the-go situation are presented. These approaches are fundamental to later research on supporting awareness and rich cooperative work of creative designers.

Archive Concept

The Archive provides the user with the possibility of being up to date of the current processes occurring within a design team. It offers a list of all previously collected ideas from all collaborators within a project in the form of varied multimedia information.

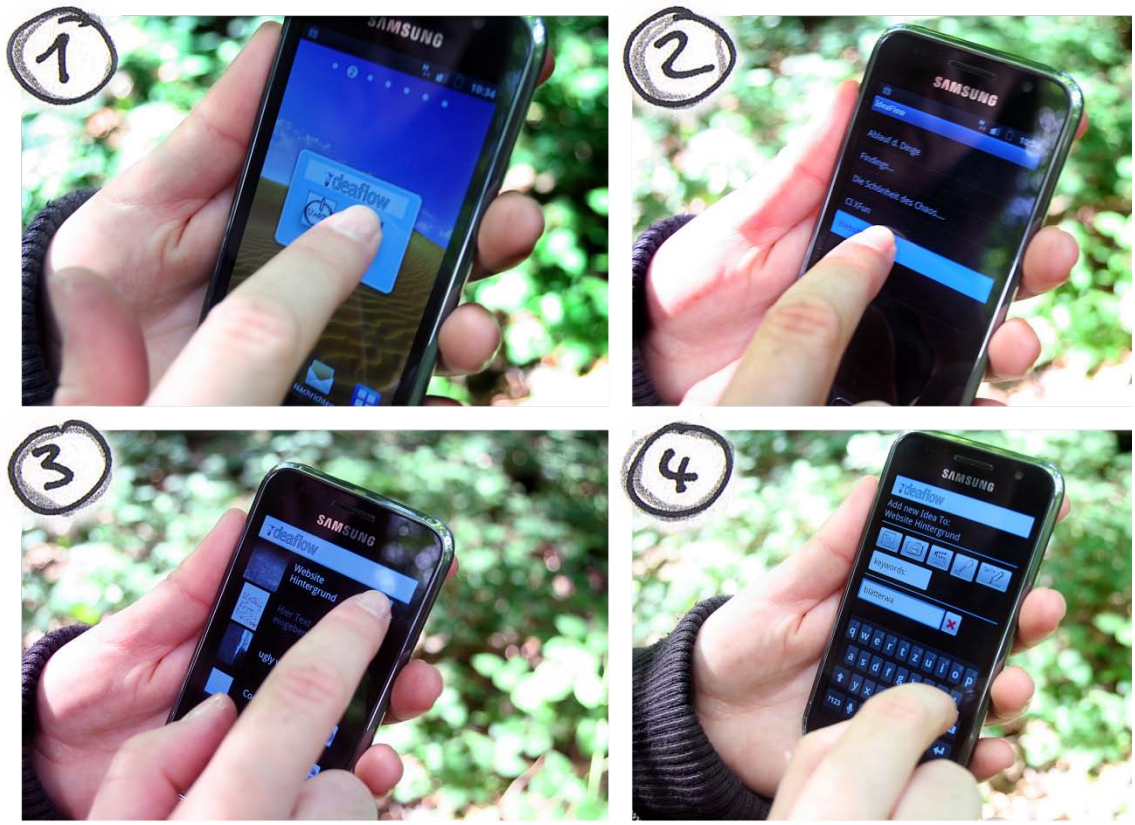


FIGURE 8 - STEPS FOR ADDING A NEW NODE ELEMENT TO AN OLDER ONE FROM THE ARCHIVE

Touching the Archive Button on the Ideaflow App Widget takes the user to a List View[11]. On this List all previously created Projects are arranged vertically (see Figure 8, 1-2). After touching one List Item the next view shows all Node Elements (idea items) already assigned to this Project (see Figure

[11] http://developer.android.com/guide/topics/ui/layout/listview.html/ Latest Access 19.02.13

8, 3). The last saved idea element appears at the top and all other idea items are arranged in a descending order by Id.

The user now has the possibility of scrolling through all created ideas within this project. If he gets inspired by an idea and wants to comment on it, modify it, or create a new idea related to it, he can click on the edit button right next to each Node Element (see Figure 8, 3). The user then passes to a new interface (see Figure 8, 4) where he has the same data gathering possibilities as in the starting interface for creating a new Idea Node (see section 4.2.4 “Gathering the data”) where he can add his new idea (see also section 4.2.6 “Trees and Nodes”). At the top of the screen, general information is displayed about the Node Element to which the user is going to add a new idea, in order to help the user stay oriented in the interface.

Notification Concept

Whenever a user saves a new idea with the mobile application Ideaflow, all other clients of the collaborators get a notification from the Android system on their smartphones. This concept is supposed to force attention to the work of others and therefore encourage awareness of the current project. By viewing the ideas of colleagues, a designers' inspiration is triggered and thus new creative ideas are encourages.

In order to draw more attention to new ideas of others it was decided to implement a push instead of a pull service for the notifications. Whenever the server registers a new saved idea, he essentially pushes a message to all clients about the event. To realize this, Google´s Cloud to Device Messaging (C2DM)[12] was used.

[12] https://developers.google.com/android/c2dm/ / Latest access: 20.02.12

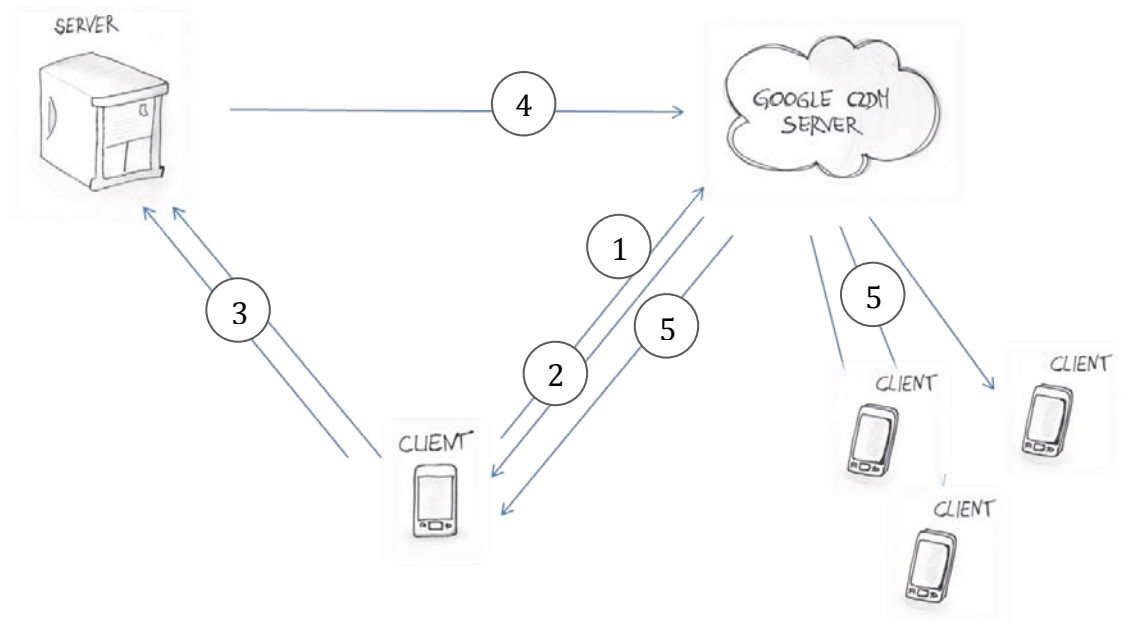


FIGURE 9 - CONCEPT SCHEME OF COMMUNICATION PROCESSES BETWEEN IDEAFLOW ARCHITECTURE AND C2DM SERVER

Case

If a designer saves a new idea, the smartphones client submits in code predefined information to the C2DM server (Figure 9, Step 1). If the registration is successful, the Google C2DM server sends a specific registration Id back to the application (Figure 9, Step 2). This registration Id is then saved on the Ideaflow Server (Figure 9, Step 3). The server then sends a defined message to the Google server together with the registration Id of the client and a specific authorization token for identification of the application (Figure 9, Step 4). If Google's C2DM server receives the message with the correct information, it will immediately send messages to all registered clients for this specific application (Figure 9, Step 5). As a result, all Ideaflow clients get a system notification, likely to a SMS message notification, about the newly saved idea (see Figure 10).

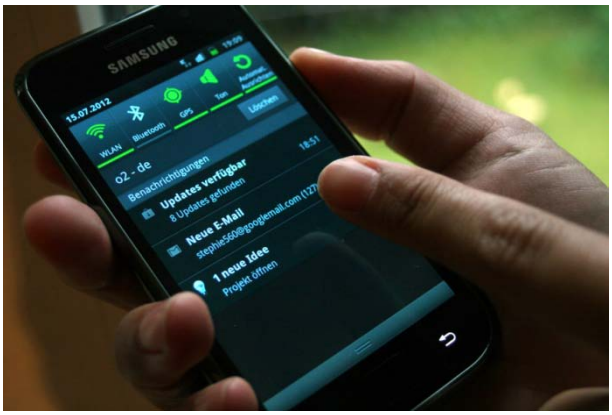


FIGURE 10 - IDEAFLOW SYSTEM NOTIFICATION

If the user now opens the notification he is taken to an Ideaflow interface where the Node Elements (data of the idea) are presented as a List, similar to the one in the Ideaflow Archive (see 8, 3). He has the possibility to modify or add a new idea by pressing the edit button right next to the Node Element. This opens the next interface where the user has all previously discussed options for capturing new data (see 8, 4).

4.2.6 TREES AND NODES

The act of capturing data in Ideaflow leads to creating an "Idea Node". Such a Node consists of several more Node Elements and can be assigned to a project. The resulting hierarchical construct is similar to the binary tree concept[13] in computer science (see Figure 11).

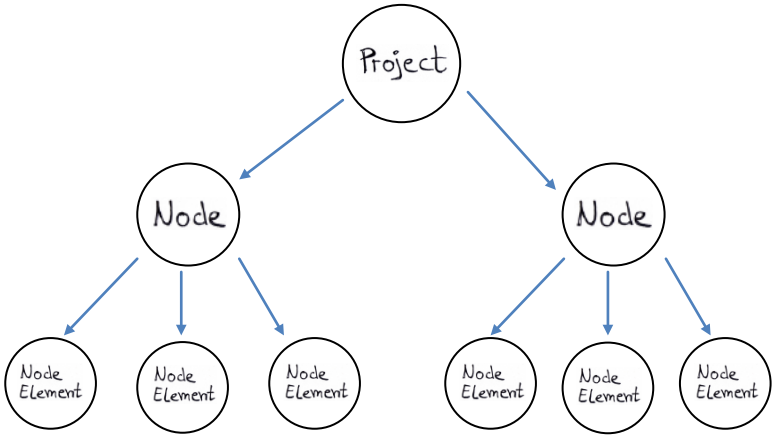


FIGURE 11 - SCHEME SKETCH OF THE IDEAFLOW TREE STRUCTURE

[13] http://www-cs-faculty.stanford.edu/~eroberts/courses/cs106b/chapters/13-trees.pdf/ Latest access: 19.02.13

Once an Idea Node is saved and uploaded to the Ideaflow server database, each Node Element receives a unique Id as well as its parent Node's Id. Thus the elements within a Node are linked to each other and to their parent Node. The parent Node itself belongs to a specific project. With this concept, Nodes can be saved linked and structured, a helpful organizational concept useful for later reflection (Dalsgaard 2012, Oehlberg et al. 2011) (see sections 4.2.6 “Trees and Nodes”). The idea of linking ideas that belong together by their Ids supports the Linkography approach of Van der Lugt (2001). This approach provides the possibility of evaluating the quality of the idea generation process (see section 5.5.1 “Measurement of the effectiveness of the collaborative work”).

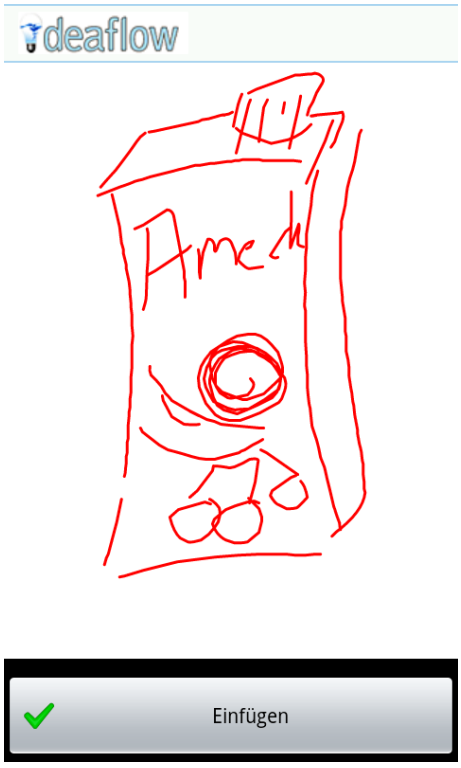


FIGURE 12 - IDEAFLOW SKETCHING MODE

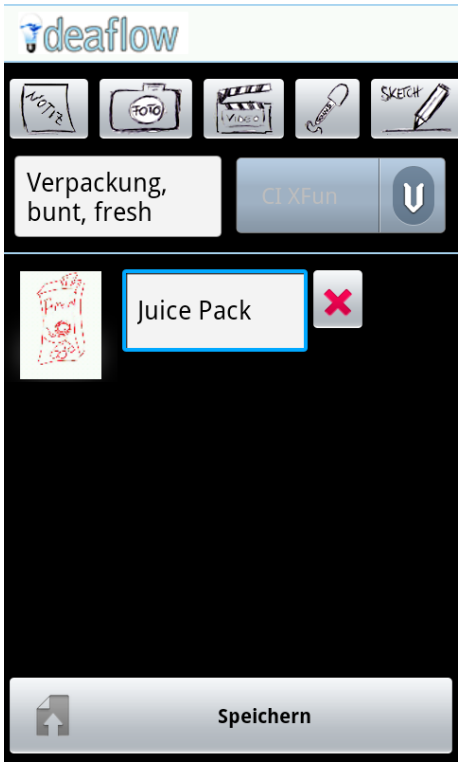


FIGURE 13 - IDEAFLOW START INTERFACE WITH ONE ADDED NODE ELEMENT

Case

Consider a situation in which a designer is on the go and is inspired by a simple juice pack, which pertains to one of its current running projects. He swiftly opens the Ideaflow

application through the Home Screen Widget on his Android smartphones. At the start interface he presses the Sketch Button and starts sketching his idea in the sketching mode (see Figure 12).

When he is satisfied with his drawing he confirms his entry and returns to the start interface, where now a thumbnail picture of his sketch is added as Node Element. Next to this thumbnail is a text field in which the designer can add explanatory text to the sketch. There is also the possibility of removing the created Node element from the Node by pressing the "remove" button situated next to the text field. (see Figure 13)

This process can be repeated for each additional Node Element. If the designer wants to add, for example, a photo of the real juice pack to the sketch, he can do so by pressing another media Button. Each additional Node Element is further listed below the previous one (see Figure 5 Right). If the designer believes the idea is recorded in sufficient detail he can add keywords and assign it to the specific project (see Figure 7 Right. Green circled part.)

The tree concept in this case provides the user with the possibility of creating media-rich nodes, which represent the externalized idea. This leads to creative ways of communication within a design team, as the member of the design group can interact with the idea, react to it, negotiate around and build upon an idea (Mougenot et al. 2008).

The user can also add new Node Elements to an existing one. Right next to the text view of each Node Element there is an edit button. Pressing this button takes the user to an interface that provides the same functionality as the start interface for data gathering (see Figure 5 Right). He can use the media capturing functions to add a new idea to the previously selected. By touching the edit button the Id from the corresponding Node Element is determined by Code and temporarily saved. If the user decides to save and therefore make public his newly created Idea Note Elements, all Elements are assigned with the Id of the parent Node Element and thus linked with each other.

Node Identity

One of the research questions in the case study later presented in this work is whether there is an effect of the archive and system notifications on the idea generation processes. The hypothesis is that the number of linked ideas produced in Ideaflow with the Archive is different than the ones used via the extended system notification functionality. In order to test this hypothesis, we distinguished between ideas extended in the Archive or in a System Notification. In order to facilitate the data analysis to this effect, the system recognizes the actual state (Archive or

Notification) of the application and changes a Boolean value to true or false if there is a Notification Event or not. This state is saved together with each Node Element.

4.3 BRINGING IT ALL TOGETHER

One guideline of Oehlberg et al. (2012) for supporting a shared understanding in design teams is "supporting shared meta-analysis of information". Consistent with the work of Oehlberg et al. 2012, it was found that the next logical step after collecting ideas on the go in a collaborative manner is to discuss the results later when the team gets together again. Before designers achieve concrete results, the early stages in the creative process are best concluded by viewing ideas and further discussing them. It was decided to support this final task with different visualisation concepts of the collected data. The metaphor of having a meeting with the design team in a meeting room was used. There are already different promising approaches (Hunter et al. 2011, Oehlberg et al., 2012, Widgor et al. 2009) that attempt at this simulation by having the data visualized on a single screen or electronic table. In this study, we have decided to implement these approaches by developing a solution for a big touch capable screen.

The data visualization concepts were realized with ZOIL (Zöllner et al., 2011), .Net and WPF[14] (Windows-Presentation-Foundation). ZOIL is a "Zoomable Object-Oriented Information Landscape" developed at the University of Konstanz to support designers and developers with the development of multi-touch or tangible User Interfaces distributed over multiple displays. One important feature of ZOIL is the development support for Semantic Zooming. Semantic Zooming is the possibility of zooming into a virtual landscape by showing different details of the data on different Zoom Levels (see Figure 14, 15). How this technique was used is later described in the different visualization concepts.

[14] http://msdn.microsoft.com/de-de/library/ms754130.aspx/ Latest Access: 20.02.13

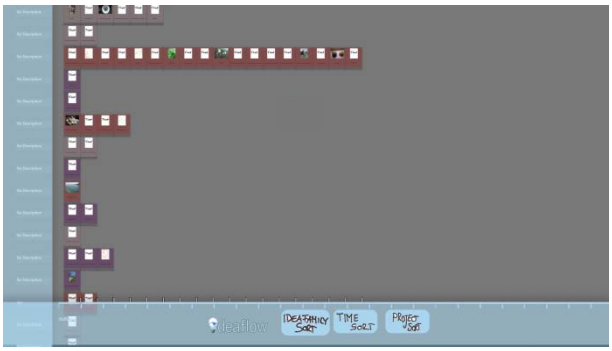


FIGURE 14 - OVERVIEW OF THE IDEAFLOW INFORMATION LANDSCAPE

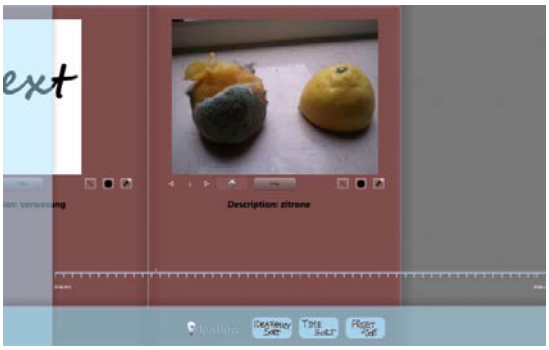


FIGURE 15 - ZOOMED-IN VIEW OF AN IDEAFLOW DATA OBJECT

Another important advantage of ZOIL is that the described Information Landscape is not restricted to the visible screen size. This type of display encourages the user to engage with the interface, scrolling through the data set by touching the landscape and moving his finger in the desired directions. The user can scroll through the screen using vertical, horizontal, and even diagonal strokes. ZOIL supports the use of the .NET class libraries as well as the integration of WPF elements for rich user interaction (Zöllner et al. 2011).

4.3.1 VISUALIZATION CONCEPTS

The visualization concepts were designed with the goal to support the design team by choosing and discussing the best ideas that are worth further development. The visualizations are designed to be digital metaphors of the natural working behaviour in the task of browsing ideas in a group meeting. We tried to add special orderings and overviews of the data that are not possible in the natural working environment and are therefore an advantage of digital support. Thus, four different visualization concepts were implemented.

The start state

Once the application is launched, all data collaboratively collected by Ideaflow clients are placed sequentially in the information landscape. The goal is to simulate the natural starting point of a creative team meeting.

> *Case*
>
> Each designer physically takes his produced artefacts, such as photos and sketches, to a meeting where they will be presented and discussed. In the meeting room the team meets at a large conference table on which each designer spreads his ideas. The physical objects make for a starting point for each designer to present his ideas so that others subsequently discuss

them together. Each designer can illustrate an idea by placing the physical artefact in the middle of the table so that it is visible to all.

FIGURE 16 - IDEAFLOW VISUALIZATIONS START STATE

Figure 16 shows the starting state after launching the Ideaflow Visualization Application. The data points associated with a designer are grouped together and placed randomly within a defined area. This data arrangement should simulate each designer's placing his own physical artefacts on the table. The data objects of each designer are represented by a different colour. With this colour coding scheme the distinction between the producers of the ideas is indicated while anonymity is preserved. Anonymity here satisfies the requirement “Elimination of inhibitory Social Factors [4.1.6]”. Anonymity in social settings is assumed to prevent Social Apprehension (Warr et al. 2005), as it eliminates the fear of negative evaluation whilst presenting one's own ideas to others.

Designers can rearrange their idea objects within the information landscape before and during discussion just like they would do on a physical table. A designer can touch an object and move it with his pressed finger to the desired destination in the landscape. Touching and moving an object leads to the display additional information, such as the time and date the idea was captured. Tapping on an object leads to zooming into it (see figure 15), providing the user a detailed view of the information associated with the specific object in addition to the capture date and time information. In addition, the user can interact with the idea by highlighting an area of interest by

touching and moving the pressed finger along this area. The user can also choose different highlighting colours. These interaction features are possible in all four visualization modes.

At the lower edge of the information landscape, the buttons representing the four different visualizations are located. By clicking on one of these buttons in order to change the data´s visual arrangement, the idea objects fade out and then fade in, this time with their newly computed positions. In order to implement this animation, a From/To/By Double Animation[15] was implemented within a Storyboard[16] available with the .NET Framework.

Visualizing the linked ideas

The button that leads the user to this visual data arrangement was named "Ideafamily Sort". The concept of Idea Family is that linked ideas are regarded as semantically related, since they have the same origin and thus belong together. The technical origin is the same Node Id for all linked objects. This concept is further described in section 4.2.6 "Trees and Nodes". The goal of this data arrangement is to give the team an overview of how individual ideas were developed and by which other ideas they were inspired. For the researcher, this visualization has the benefit of easily identifying related ideas and thus supporting the analysis of the idea generation process.

[15] http://msdn.microsoft.com/en-us/library/aa970265/Latest Access: 21.02.13
[16] http://msdn.microsoft.com/en-us/library/ms742868/Latest Access: 21.02.13

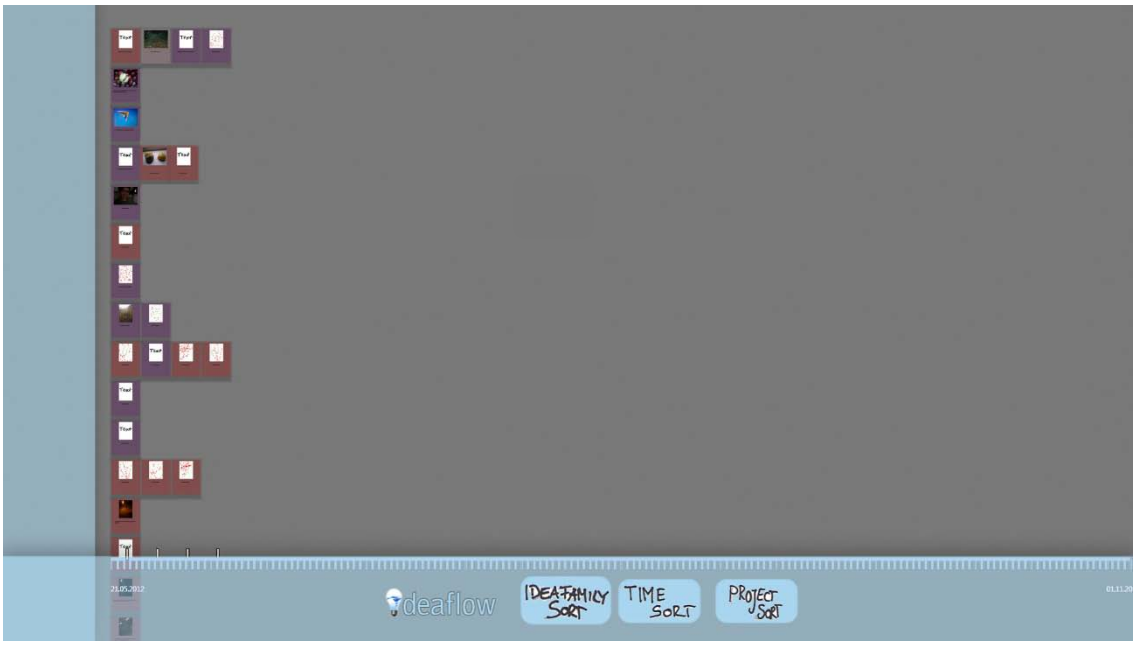


FIGURE 17 - IDEAFLOW VISUALIZATIONS IDEAFAMILY SORT

Figure 17 shows the visual arrangement of the idea objects in the Ideafamily Sort Mode. All objects are vertically arranged by Node Id. The relating algorithm compares the Note Ids of two successive elements. If they have similar Ids the elements are placed side by side. If the Note Ids of the elements are different the unrelated element is placed in the next row and so on. In order to give the observer the possibility to identify the sequence in which the ideas occurred, the objects are arranged horizontally along a timeline.

Sorting ideas by time

This third visualization concept (see figure 18) is based on the time each idea was produced. This kind of visualization has already been implemented in Guang et al.'s system (2012) “SketchComm”, which was designed to support rich and flexible asynchronous communication of early design ideas, and in Dalsgaard et al.'s system PRT (2012), which supports documentation and later reflection on the design process (see also section 3.2 “Research Tools”). This kind of data arrangement provides a chronological overview of the produced ideas and, helps the observer to identify periods of productivity or lack thereof. The biggest advantage of this type of visualization is, therefore, instrumental in the research of the idea generation process.

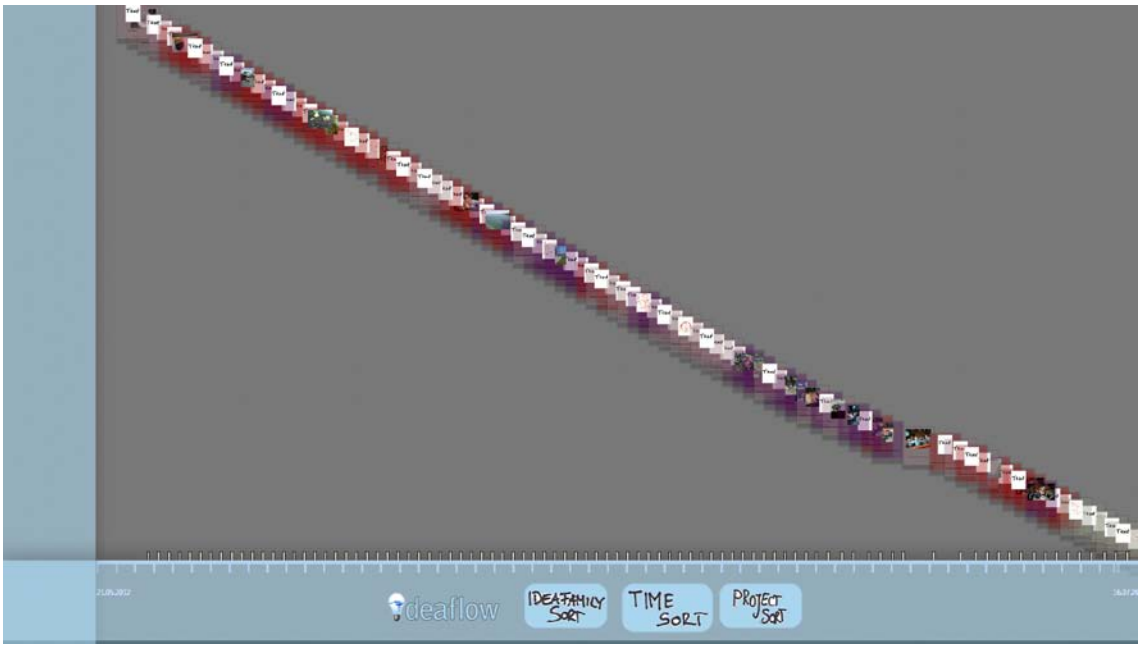


FIGURE 18 - IDEAFLOW VISUALIZATION TIME SORT

Giving a project overview

The fourth visualization gives the observer a kind of project overview and is therefore named "Project Sort".

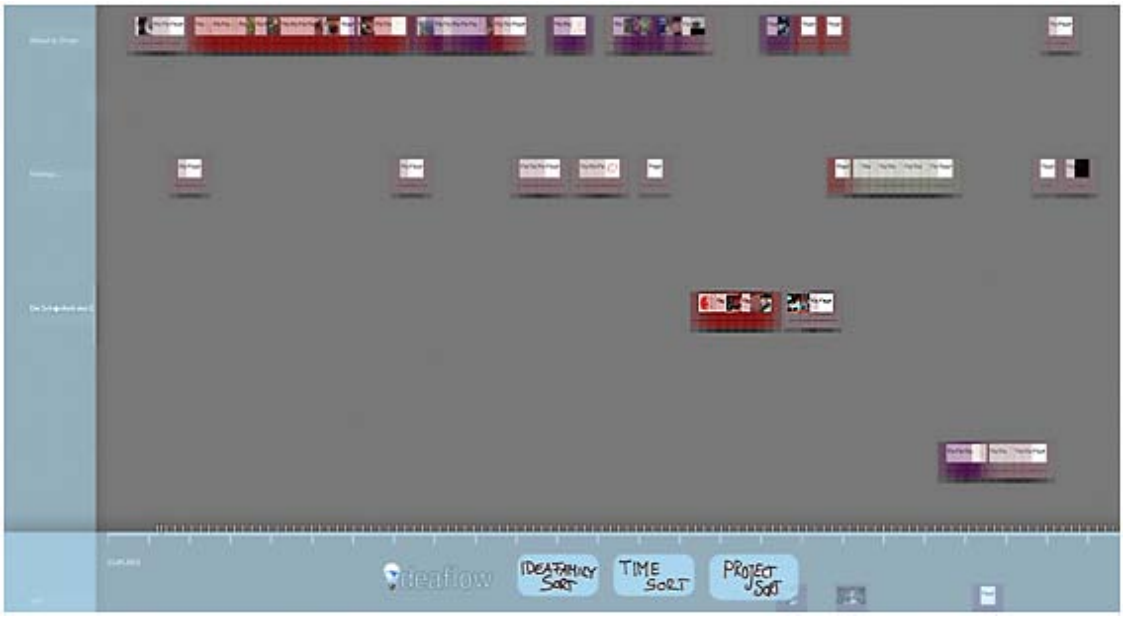


FIGURE 19 - IDEAFLOW VISUALIZATION PROJECT SORT

This visualization illustrates the current state of the project (see figure 19) and shows which ideas belong to which project. The names of the different projects are vertically arranged at the grayish

light blue left-hand edge of the information landscape. The related data objects are arranged horizontally on the same line as the project String, and, in order to depict the time component, the objects are also ordered along a computed timescale.

As explained in section 4.2.4 "Gathering the data", each idea Node is assigned to a specific project. To identify the right position of each object for this visualisation the information is retrieved from the Ideaflow database and saved in a Dictionary. Two kinds of data can be saved In a Dictionary, and so each element was placed in this Dictionary array together with its project String. As a result, the algorithm detects whether a string united with an object in the dictionary matches a project string on the y-axis, and if so, takes the element out of the dictionary and places it in the appropriate position on the y-axis.

The Time Scale

In order to give the observer the possibility to identify the sequence in which the ideas occurred, the objects in the three Visualizations "Ideafamily Sort", "Time Sort" and "Project Sort" are arranged horizontally along a timeline, which is indicated at the bottom of the information landscape (see Figure 18).

For the "Time Sort" and "Project Sort" (see Figure 18/19) data arrangement the relative position of each element to the time scale was implemented by using a "min-max normalization method" [17].

4.4 LOAD TEST UNDER FIELD CONDITIONS

Following the implementation of the application Ideaflow, a Pre-Test in the field was conducted to ascertain the functionalities and stability of the system under real-life conditions. The results from the first study highlighted some drawbacks that were repaired. In this chapter, the process, results, and consequences are discussed.

4.4.1 PRE-STUDY DESIGN

Three students from the University of Konstanz were recruited to participate in the pre-study. Each participant got a smartphone that ran Ideaflow. The participants first got a quick introduction to the system and then were instructed how to complete the tasks in the study. There were two main tasks in the study, given below:

Task 1: Collaboratively collect ideas for the design of a book cover with the title "The natural course of things".

[17] http://interscience.in/IJCCT_Vol2Iss8/paper8.pdf (Min Max Normalization: p. 3) /Latest Access: 21.02.13

Task 2: Collaboratively collect ideas for the design of a book cover with the topic "The beauty of chaos".

It was ensured that the content of the two tasks was similar to prevent theme-based differences in the outcome of the study. In each task the participants were advised to go out individually and capture ideas by using the application. They were told to communicate over the system in order to collaboratively come up with ideas.

In order to explore if time pressure could influence the idea generation, the work time of the first task was set to 30 minutes and the second to two days.

4.4.2 Results and Consequences

The number of ideas in the 30-minute task was almost twice as large as in the two-day task. In both tasks most of the ideas were captured by photo or as textual notes. If we took into account all ideas from both tasks, 60% were textual. The sketch function was the third-most frequently used function. Video and audio were very rarely used to capture ideas. It was observed that the response times on ideas also differed in the two tasks. During the 30-minute task feedback on ideas over the system took from 1 minute to 41:23 [18] minutes, whereas in the two-day task responses took from 15 minutes to 9 hours.

In addition to capturing ideas, participants were asked to record problems and assign them to a "Findings" project, which had been created in advance in the system (see chapter 4.2.2 "Settings in the application core"). The problems recorded in the Findings project revealed that participants had high performance losses due to unreliable internet connections. As a result, transfer of a lot of data took a long time or was unsuccessful. For the same reason it was often not possible to open a project in the archive and view ideas of others, which lead to frustration. To solve this drawback three small changes were made in the way data were updated on the clients. The first problem was the slow URLConnection[19], which was used for downloading the data. Therefore, an HttpClient [20] was implemented to simplify the process and free associated resources. The second problem was that whenever data were requested they were always downloaded from the server, a process that took a long time for downloads of big data sets. This led to the loading time of 9 minutes and 39 seconds for 69 media data. The solution to this issue that was later implemented was that when a user suggested data for the first time all data would be downloaded and locally stored on the clients. If

[18] Some participants exceeded the time limit set for the first task.
[19] http://developer.android.com/reference/java/net/URLConnection.html/ Latest Access 12.03.13
[20] http://developer.android.com/reference/org/apache/http/client/HttpClient.html /Latest Access 12.03.13

the user requested the data for a second time, the system would first check if the data already existed on the local storage and if not, only the missing files would be downloaded onto the local storage. In addition, a recording time limit was set for audio and video files. These two changes led to a performance optimization of 99.3%; that is, the display time of 69 media data was reduced to 6 seconds.

Another issue was identified, this time with viewing the collected data via one of the Ideaflow visualizations. As illustrated in Figure 20, in the "Ideafamily Sort" visualization (see section 4.3.1 "Visualization Concepts"), all linked idea objects got the same colour independently of the producing client.

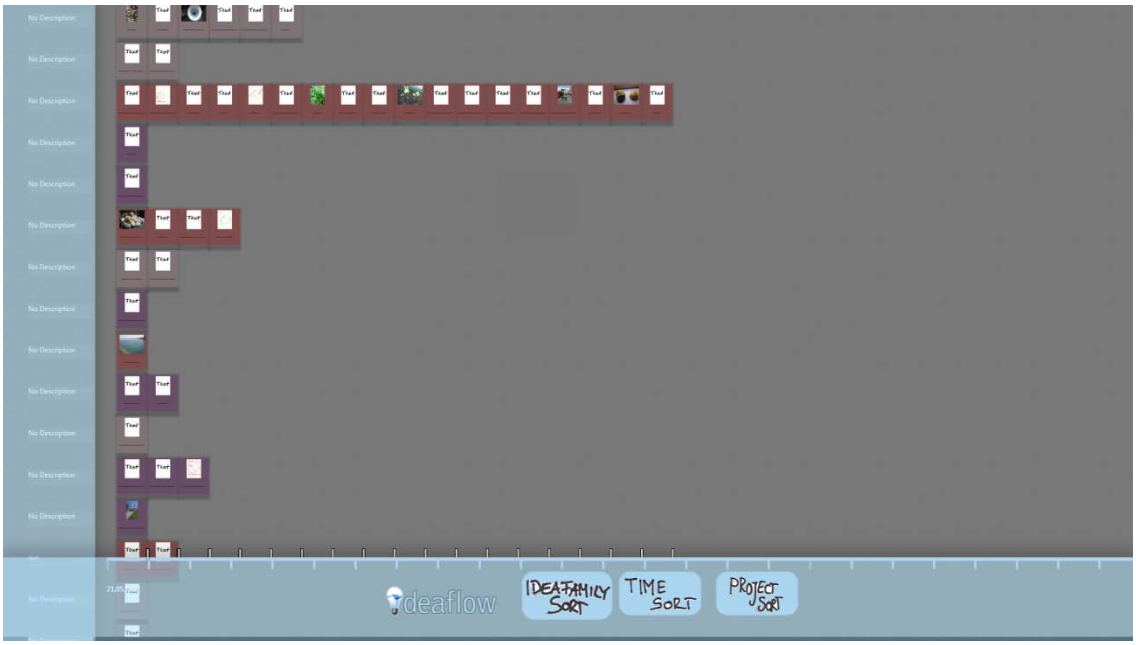


FIGURE 20- ERROR IN THE COLOR CODING OF THE IDEA OBJECTS

The error was caused by the act of editing an idea, which led the saving of a new Node Element but not the relating client Id. When the data were loaded onto the visualization it was not possible for the system to identify the client Id of the objects and therefore it displayed the wrong client colours. Adding a new table row in the corresponding database solved this issue. The code was changed such that in the case a new node element was saved, the client Id too was added to the database.

4.5 SUMMARY

Ideaflow was developed with the main goal of supporting creative design teams. The system should provide designers with features for collecting and discussing design ideas together in teams even when they are not at their working places and on the go.

In this chapter the Requirements for the system were defined and the implementation concepts of the system, which should meet designers' needs when they are on the go, was explained.

The focus of the design of Ideaflow is on the early design phases. In order not to overwhelm the user with “fancy” features, as is often the case with commercial tools, only the features that directly meet the specific requirement of the working process were implemented.

Additional focus was placed on the implementation of issues that help to answer research questions, such as what influence an idea archive and the Notifications concept (see section 4.2.5 “Approaches to stimulating collaborative work on the go”) have on the idea generation process.

5 CASE STUDY IDEAFLOW

The main question in this study is whether the collaborative idea generation process of distributed design teams can be supported in such a way that it resembles their office work routines. The goal was to identify whether and how System Notifications of new ideas or the use of an idea archive on smartphone can support designers’ collaboration. To test and distinguish between these different options, it was decided to design a case study. To get proper results, multiple cases were conducted with participants that differed in age and their experience in using smartphones. All participants recruited for the research had a design background. When participants are instructed to gather ideas on a specific topic within a short time limit they attend to the task and application much more avidly than they would normally do (Höhn 2012). This hasty behaviour, however, may lead to wrong results and reduced creativity (Shalley et al. 2004). Due to the disadvantages of implementing a task under time constraints and because our goal was, first and foremost, to offer the temporally-unconstrained possibility to capture spontaneous ideas on the go, it was decided that this question could be examined most closely by a longitudinal field study. To provide corroborating evidence, proper data triangulation [21] was used. The collected ideas, logging data, observation and movie recordings of the participants’ behavior as well as interviews and surveys were collected to answer the research question. In this chapter the detailed study, design, and results will be presented.

5.1.1 STUDY DESIGN

[21]Data Triangulation is the use of multiple sources in case studies to provide corroborating evidence. (Lazar et al. 2010, p. 148 ff.)

Warr et al. (2005) hypothesize that real time notifications increase the motivation to produce ideas in a collaborative team task. The main objective of this study was to verify whether this hypothesis is borne out.

The study was realized with communication and interaction designers from the Hochschule and the University of Konstanz. In order to exclude group- and person-specific dependencies, the investigation was carried out three times, with teams of three designers each. The study was split into three parts in order to individually identify how system notifications, an idea archive, and the common options for collecting ideas influenced the creative design process differently.

Before the study, participants were given a Pre-Test questionnaire, in which they were asked about their technical knowledge, current work, and general behavior in the idea generation process on the go (see Appendix 1).

In the first part of the actual study the designers had the task to collect ideas collaboratively to the topic of mortality. The instructions were phrased as given below:

> *"A publisher asked your design team to find ideas for a book cover with the title Mortality"*

(see Appendix 1). In this task designer were advised to work as they normally would, without the support of Ideaflow. After two days of idea collection the team met again to sift through all of the ideas and discuss them. The purpose of the meeting was to agree on an idea which would then be presented to a potential customer. During this follow up meeting the study leader followed and observed the discussions of the design team to identify the patterns that emerge in the collaborative design work. The meeting was additionally filmed for later review. Once they'd agreed on one idea, they were asked how they arrived at their ideas. In the second part of the study, the team was given a task that included the collection of ideas on the damage of drug use, as the instructions below illustrate:

> *"A pharmaceutical company wants to launch a poster campaign showing the damage caused by drug use, in real-life metaphors."*

For this task each study, participants got Samsung Galaxy S smartphone with the application Ideaflow installed. For this task, Ideaflow was handed over with just the archive function and the functionality of the system notifications disabled.

The design team was instructed to generate the ideas to the topic together within two days by using the application. After these two days, the participants were instructed to meet again and find five ideas that they would present to the potential customer. This second meeting was held at the University of Konstanz in a specific room where the second part of Ideaflow, the data visualization functionality, was running on a big touch-capable display. Participants were advised to use the idea visualizations for revising and discussing the collected ideas. This meeting was also recorded for later review.

After this meeting the participants got a new version of Ideaflow with full functionality on their smartphone's. This time, if a participant stored an idea on the server all colleagues would receive a system notification on their cell phones and the new idea would be available in the archive. In this third phase of the study the topic was website design for a clothing company, focusing on autumn, as detailed in the following instructions:

> *"Autumn impressions. A customer wants to have a website design for his clothing company. The design should adapt to the seasons. He wants a first collection of ideas from your design team for the season autumn."*

For this exercise the team again was advised to work on the task for two days. The ideas were then discussed together, again by using the data visualization of Ideaflow. Following this last meeting a Focus Group like the one described in (Lazar et al. 2010) was conducted as an opportunity to ask the participants questions on the topic. A final survey was done to confirm the quantitative data collected during the study and to clarify additional qualitative questions that could not be answered solely by the data gleaned from the recorded activity on the application.

There were some uncontrollable variables, such as faulty internet connections, which affected the results. In the conclusion part we will discuss these variables and the problems they caused.

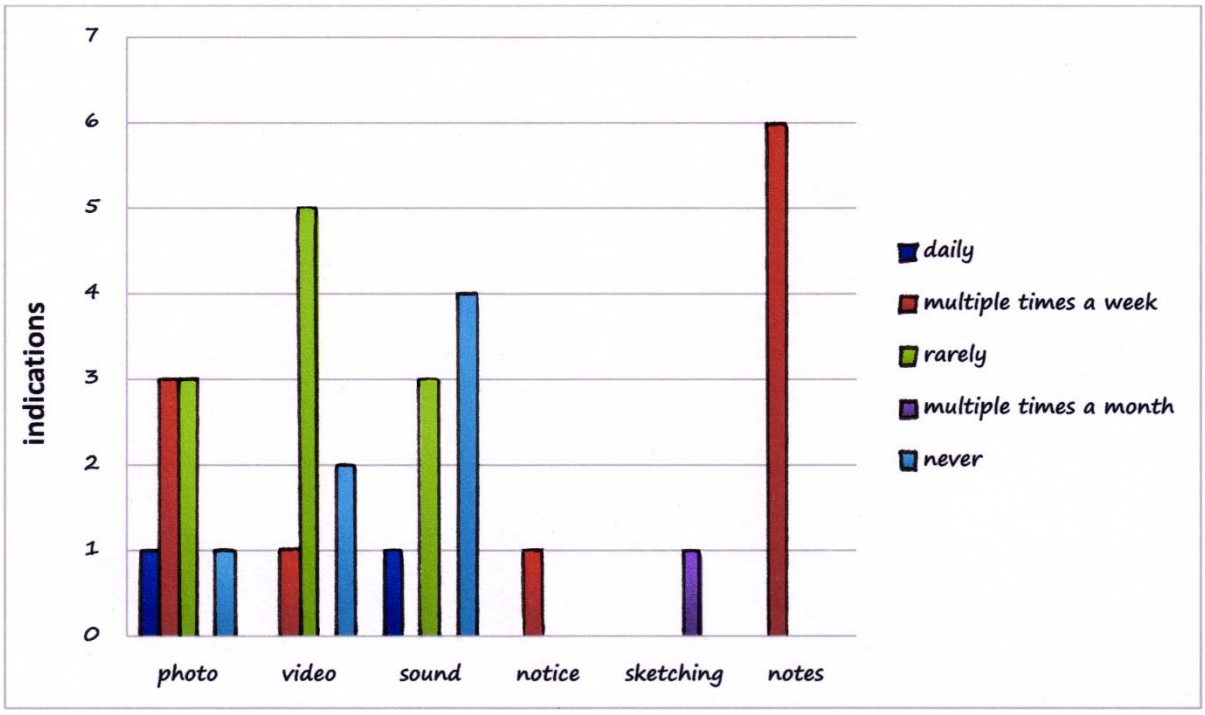
5.2 RESULTS

We present in this chapter the results of the case study. We begin with the information collected in the Pre-Test, and then proceed to the details of the execution of the case study in the field. Then we present the quantitative data collected from the system as well as related node elements identified through linkography (Van der Lugt, 2001). The chapter closes with information obtained by final interviews in focus groups.

5.3 Pre Test Results – Section over Designers

The goal of the Pre-Test was to cover the prior technical knowledge relevant to the study. In addition, the basic behavior involved in generating first ideas was prompted in the pre-test to verify the utility of Ideaflow.

All Designers were students in ages 20 to 28 years old. In each of the three groups there was one female and two male participants. The first set of questions served to identify their experiences with computers and computer-like mobile devices. All participants stated that they worked on a computer every day. All (but one) participants already had their own smartphone. Participants were asked to identify which media they already used for idea capturing whether they used other types of media for other uses. Except from the one who did not have his own smartphone, all designers were using the smartphone media Photo, Video, Sound and others (see graph 1).



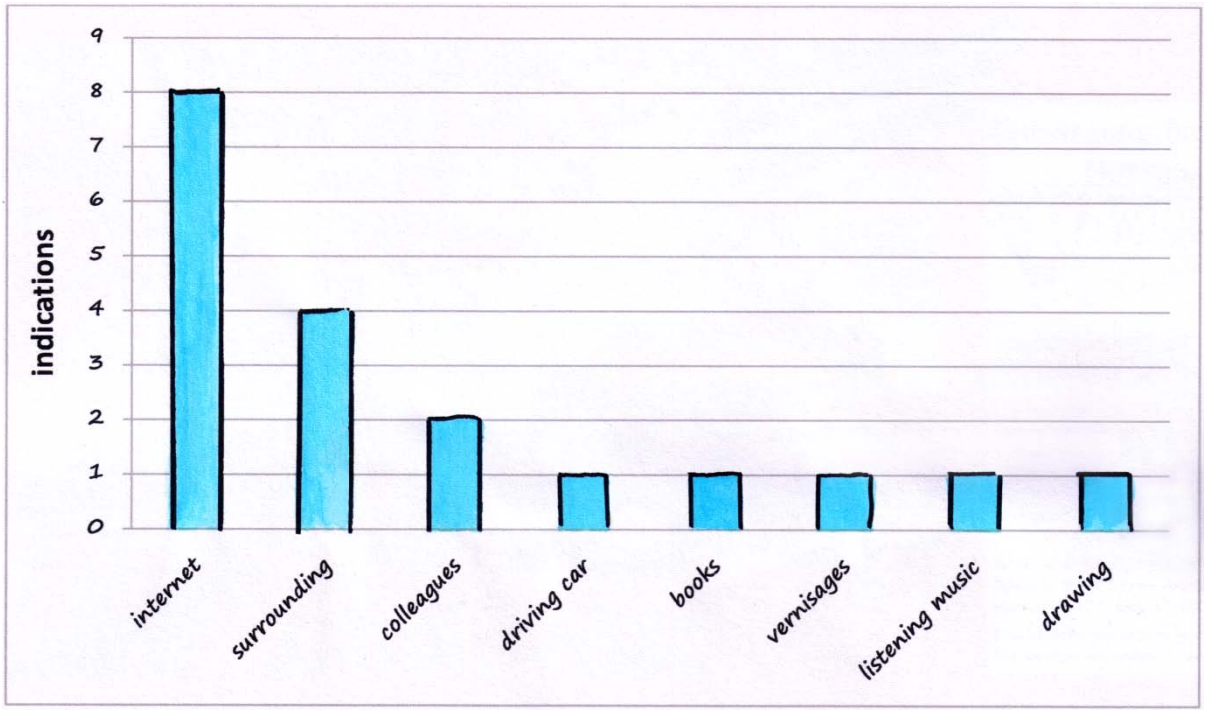
Graph 1 - Answers to Pre-Test Question "How often do you use Smartphone/Tablet Media)?"

One of eight participants stated that he used the photo function daily. Three of the eight used it multiple times a week. Three of the eight reported that they used this function only rarely and one said he never did.

Just one participant stated that he used the video function on the smartphone several times per week. Five of eight participants used the video function only rarely and two – never.

One participant stated that he used the sound function every day. Three out of eight used sound rarely and four stated they never used the sound function. One participant stated that in addition to the common media types he also used the notice function two times a week on average and a sketching function one to two times per month. Another participant stated that he also used different players. Six out of eight participants stated that they occasionally or even frequently created notes on their smartphones. However, only three out of eight stated that they record design ideas using their smartphone or tablet. These participants reported that they took photos or made notices of ideas when they got inspired. Eight of nine participants stated that they used the Internet to generate ideas for design projects.

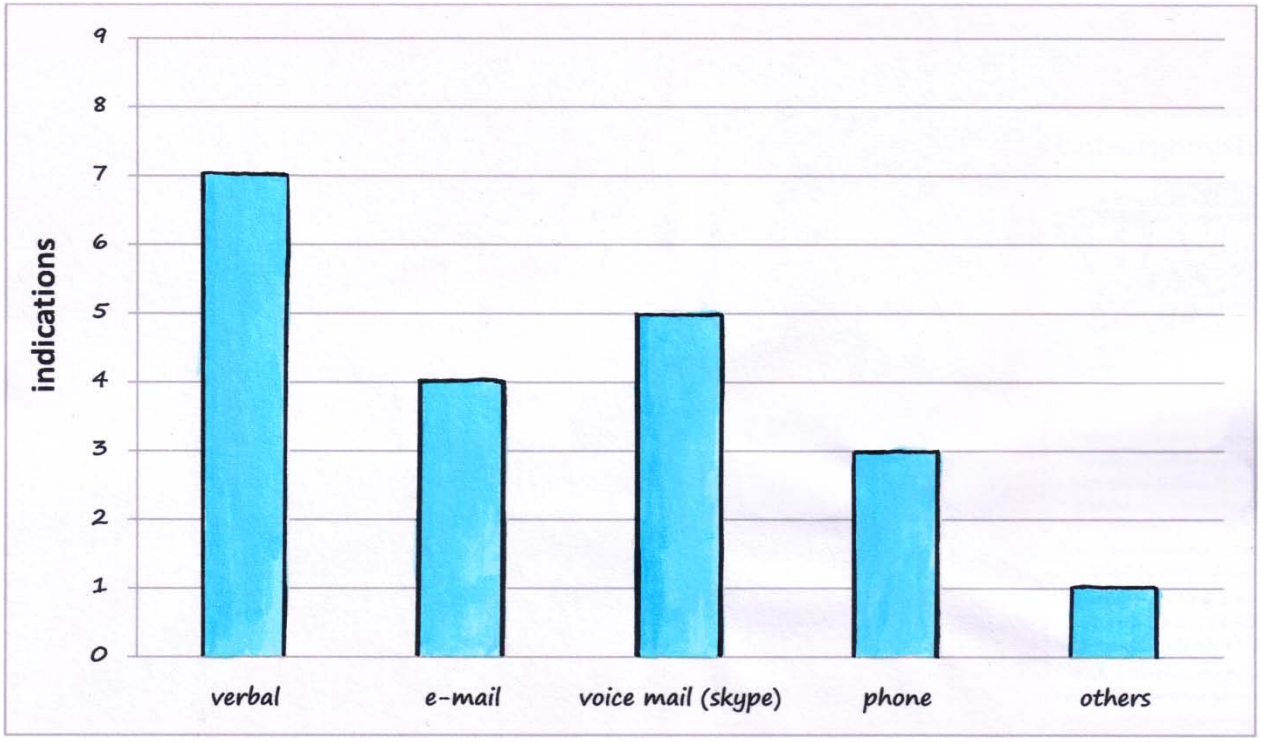
As for sources of inspiration, four participants stated that they often got ideas when they were in the nature or when driving a car. Two reported that they often got inspired by colleagues. One reported that he got inspired by books and another one said he visiting in art exhibitions inspired him (see graph 2).



GRAPH 2 - ANSWERS TO PRE-TEST QUESTION "HOW DO YOU GET INSPIRATION FOR DESIGN IDEAS?"

Six participants regularly work in teams and three commented that they were more likely to work alone. Those who regularly worked in teams stated that after the initial briefing, the process would start with a brainstorming session where each team member collected ideas and shared them with the others.

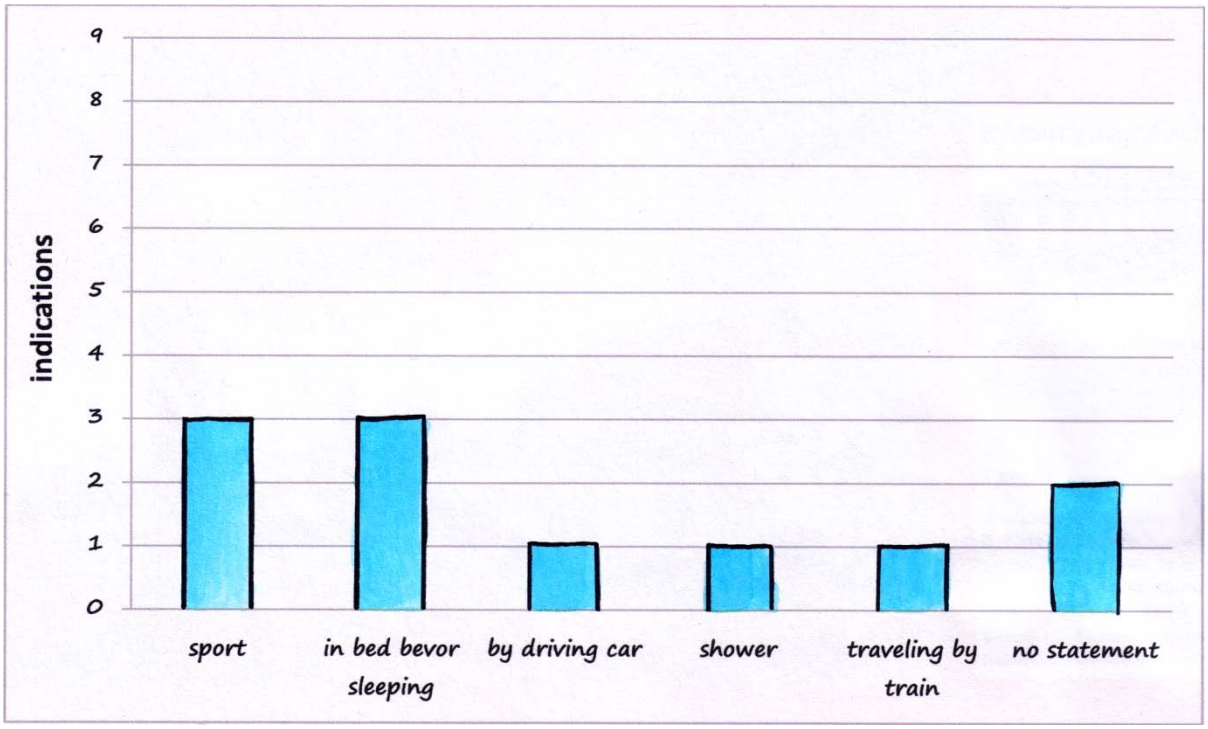
To the question on the importance of feedback, six of the nine participants stated that they liked to have feedback to their ideas from colleagues. All stated that they preferred to get feedback verbally and as often as possible. Feedback over voice mail like Skype was often used instead. Mail was used if no other means of communication was possible. Two participants reported that they would often get feedback via phone (see graph 3).



GRAPH 3 - ANSWERS TO PRE-TEST QUESTION "HOW DO YOU LIKELY GET FEEDBACK TO DESIGN IDEAS FROM COLLEAGUES?"

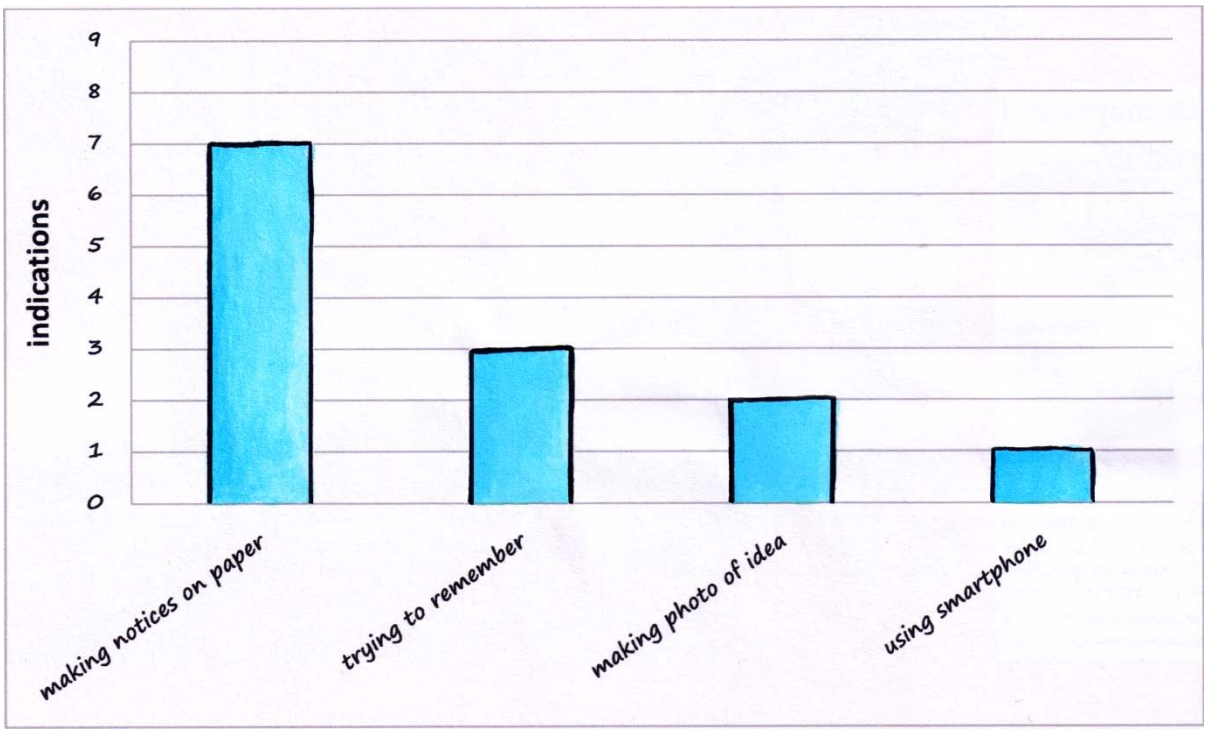
Participants were also asked if there were situations where spontaneous ideas arose more often. Most stated that those would happen frequently during exercise or in bed just before falling sleep

(see graph 4).



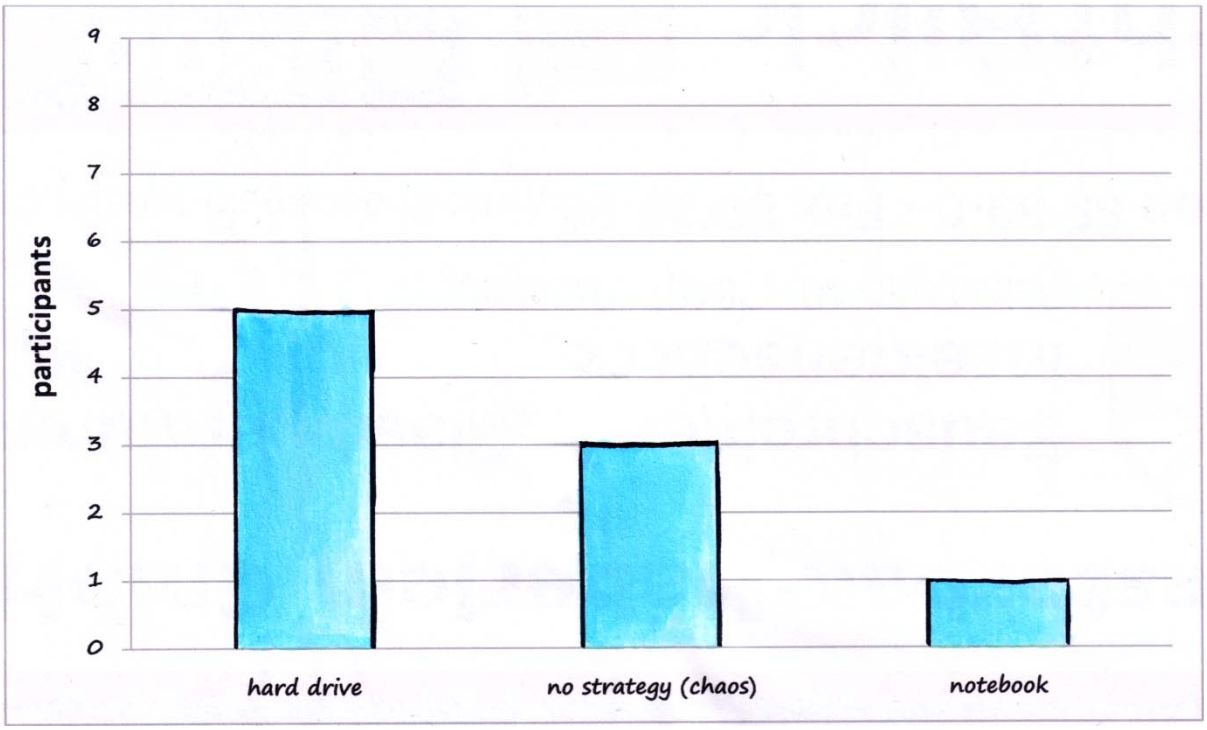
GRAPH 4 - ANSWERS TO PRE-TEST QUESTION "ARE THERE SPECIFIC SITUATIONS WHERE MOST OFTEN CREATIVE IDEAS ARISE?"

In response to the question how they would capture spontaneous ideas if no computer were at hand, seven participants stated that they would write their ideas down on paper. Three participants stated that they would try to remember their ideas. Two also reported that they would take a picture of the idea and one would use his smartphone to record the idea, as he previously said (see graph 5). Eight of nine designers reported that they would forget good ideas due to the unavailability of recording devices. Most of them indicated they would more likely forget less important ideas than important ones.



GRAPH 5 - ANSWERS TO PRE-TEST QUESTION "HOW DO YOU HOLD ON TO IDEAS WHEN YOU DO NOT HAVE A COMPUTER AT HAND?"

In response to the question how they would organize their ideas, participants stated they would most likely save them on a hard drive (see graph 6). Three explained that they did not have any organizational strategy, which corroborated our own previous work as well as Sharmin et al.'s (2009).



GRAPH 6 - ANSWERS TO PRE-TEST QUESTION "HOW DO YOU ORGANIZE OLD IDEAS AND PROJECTS?"

Opinions varied on the importance of the traceability of the idea making. Half of the participants noted that this aspect was very important for their work and the other half did not find it important at all. Almost all participants stated that they revisited ideas from old projects, but only four did so frequently. In the last question we asked participants to report if they already used tools to capture ideas on the go, and if so to identify them. One participant stated he used a notice function on his Sony Ericson mobile phone and another one stated he used Evernote and Sketchbook mobile. All of the others had no experience with these or similar tools.

5.4 MAIN PART OF CASE STUDY

After each task team meetings took place. The reason was to compare the results of the different cases in order to better understand the work behavior of creative designers during the early stages of ideas generation as well as validate the utility of a tool like Ideaflow. The results from the meeting would provide information useful for the recommendation of future tools supporting the early design phases.

The first meetings with the groups were always held at the HTWG Konstanz. For the presentation of their ideas the teams sat facing each other so that they could all see and hear each other. To complete their first task the designers were advised to communicate with each other, as they would normally do in a similar design job. In the two other tasks they had to communicate their ideas

using the application. The second and third meetings were held at the University of Konstanz after they finished their tasks. The teams met in a room where the Ideaflow visualization was running on a large touch screen. In most cases, all participants sat around this screen to discuss the collected ideas. The ideas were presented via small icons on the screen as described in the section 4.2.4 "Gathering the data".

In the following passages, the three groups will be named Design Team One, Design Team Two and Design Team Three. The same naming scheme goes for the designers of each Team. Design Team One explained that they communicated over e-mail to exchange ideas during their first assignment. Participant 1 explained that she started the conversation, and then all members shared and discussed their ideas. Thus they the team members had agreed on the resulting idea via email before the team meeting. When the team members were asked how they produced their ideas, participant 3, who came up with the idea adopted ultimately, explained that he individually brainstormed to get to the idea. He was thinking about the term "mortality", which was the topic of the design job, and how this could be interpreted in a new and different way. Participant 2 expressed that he shared the first idea that came into his mind with the others. After that he got other interesting ideas and responses on the own idea. Participant 1, who initiated the communication via e-mail, adopted the ideas generated by the two others and mainly tried to further develop them. She researched the topic over the internet and collected photos to get inspired. In this group, the communication via e-mail worked well. Since participant 3 had an idea that excited the other team members very early, the online communication did not take very long and the number of ideas produced was not large. Therefore they felt no need to introduce their ideas to the other team members during the face-to-face meeting, and so the meeting was over in a few minutes.

In order to start the discussion of the ideas in the second meeting, participant 2 walk over to the screen and started to work with the visualization and thus assumed the role of the moderator. He first started with the "Project Sort" (see section 4.3.1 "Visualization Concepts") Mode and moderated the team workflow to find five ideas that should be presented to a potential customer. He zoomed in on the display and went through all data sequentially. Whenever the moderator showed a new idea icon, the producer of that idea started explaining the background of his inspiration. Once all ideas have been reviewed, the moderator minimized the workspace so that all participants had an overview of all icons. The team members then discussed the idea and chose the five best ones. The moderator used the visualization in this task to form clusters of good and bad ideas. The second meeting was ten minutes long.

The third meeting, as mentioned before, occurred after the design team used Ideaflow with its complete functionality. The third meeting of this group was almost similar to the second meeting in its procedure. Participants again chose the "Project Sort" view, viewed the ideas in their clustered organization first, and then discussed them. We have observed that while explaining and discussing their ideas, participants were already starting to produce new ideas still, which superseded the existing ones. This behavior was only observed during the team meetings in which the Ideaflow visualization was used. The third meeting was five minutes long.

Design Team Two reported that they had continuously communicated their ideas during the first task via the application "Whats-App [22]", which runs exclusively on smartphones. They used this application to share their ideas in a textual format and sent it to the other team members. Participants explained that they had come up with ideas while thinking about the task. Only participant 1 reported that he had searched for products with similar topics over the web to get inspiration. The members of this design group had also decided on their best ideas before they met. And thus, in their first meeting, it took them three minutes to bring all together.

At the beginning of the second meeting, participant 1 spontaneously decided to use the Ideaflow application. He asked others which of the four visualization possibilities they should use. This group decided on the "Ideafamily" (see section 4.3.1 "Visualization Concepts") sorting algorithm. The moderator selected individual ideas and enlarged them for further discussion. All ideas were discussed in detail. Some new ideas or extensions to existing ones were created in the course of the discussion. Again, the group grouped together clusters of interesting ideas in a sub region of the display. The second meeting was four minutes long, only slightly longer than the first.

The third meeting of design team two lasted for eight minutes and twenty seconds, much longer than the previous two. During the third meeting, all participants stood right in front of the display, but just one acted as a moderator and used the application. This group again used the "Project Sort" algorithm to choose their favorite ideas. In all other respects, the behavior this design team exhibited was similar to that in their second meeting.

Design team three collected ideas differently than the other two groups. Participant 1 presented ideas in the form of sketches. He explained that he had started the idea discovery process with individual brainstorming. He wondered what would be of interest to the topic and drew the ideas down on paper. Participant 2 presented ideas in the form of printed photographs. She explained that she had looked through all the pictures in her own archive and got inspired by some. (see Figure 21)

[22] http://www.whatsapp.com/

Participant 3 had no tangible results with him. He just described an idea he had come up with while jogging, during which he got inspired by his surroundings.

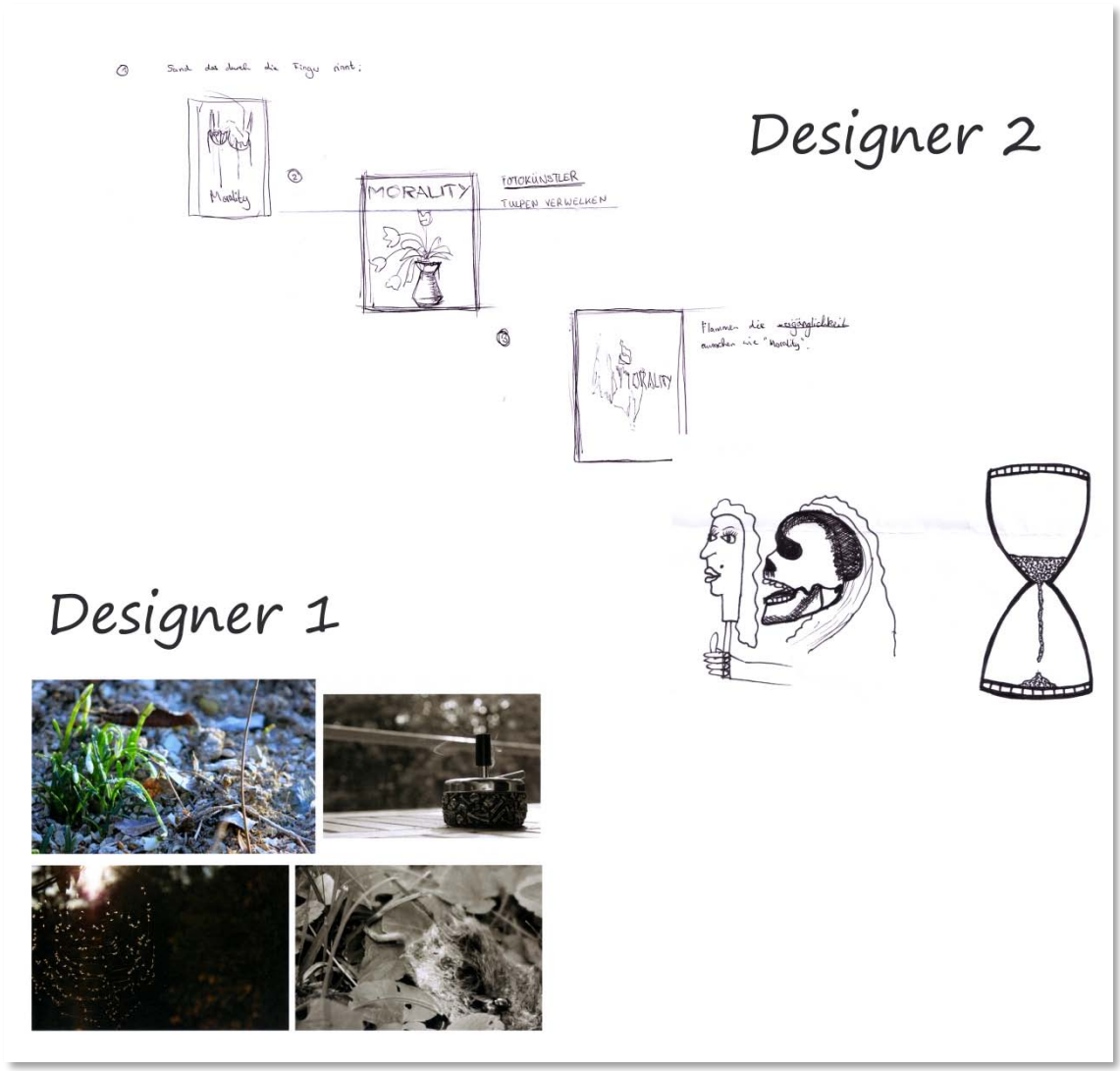


FIGURE 21- IDEA ARTEFACTS TO TASK 1 OF DESIGN TEAM 3

This group had had no communication before they its members first met.

After the presentation each participant listed his most and least favorable ideas. After a short discussion, the member of this design team agreed on one idea. The entire meeting lasted four minutes.

The moderator in the second meeting started by present his own ideas first. He clicked on the idea in on the display to enlarge it and to explain its meaning to the other team members. After he finished explaining his own ideas, he spontaneously clicked on an idea of another participant,

whereupon that participant started commenting on this idea. Continuing in this manner, all ideas were discussed. By looking at the ideas in this way, the designers were clearly more motivated than in the meeting without support by Ideaflow. They had more discussion about ideas and therefore more cross products during the meeting. Following the idea presentations, members of this design team discussed their most favorite idea. The entire meeting was eight minutes long, nearly double the time of the first meeting, which lacked the support of the Ideaflow visualization.

Comparing all the meetings, it seems that the meeting following the first task, which did not include the support of Ideaflow, was on average very short. The second and third meetings, which were supported by the Ideaflow visualization, took significantly longer overall and included more lengthy discussion of ideas. The longer discussion times also corresponded to the generation of new ideas and cross-products.

The use of the visualization scheme highlighted certain patterns of behavior in the teams'. One observed pattern was that in the second and third meetings, there was always one participant who took the reins and initiated the discussion of ideas using the visualization. This participant then assumed the role of a moderator during the entire meeting. When participants searched for a specific idea, they required the overview of all the data and when they wanted to discuss specific ideas, they separated the idea of interest from the others by zooming in on it. If the focus of the group were drawn to a particular idea, the producer of the idea immediately began to explaining the genesis of the idea and the connection to the task. This was a recurring group behavior. Another behavioral pattern that was shared by all designers was the clustering of ideas. They first grouped the ideas with the most potential and then built a subset of that group containing the best ones. At the end of the idea discussion meeting participants always zoomed out in the visualization interface in order to get an overall view of the collected data.

5.5 Facts and Data

Logging data about participants' activity while conducted their tasks were collected by the application and saved on the database. Each time an idea was saved with the Ideaflow client application, additional data like time, client ID, Node ID, reaction on idea notification or archive (see section 4.2 "Implementation Concepts") was stored. This quantitative data can help distinguish between the different task cases and application modes.

An average of 28% participants responded on notifications of new ideas in the study, in contrast with 19% of participants who responded on ideas with Ideaflow in the archive mode. That means that with notifications of new ideas, the probability of a feedback from other team members is

significantly higher than without. There are also differences in the reaction times on ideas: More than half of the responses triggered by notifications occurred in less than five minutes following the notification. The reactions on saved ideas in the archive took as little as 40 minutes and as long as hours. Through the short response times with idea notifications, smaller discussions could be recorded over Ideaflow. Due to the short response times with notifications in the exchange of ideas the communication became a kind of chat. One can say the application was temporarily used as an "idea chat". No clear statement can be given on the impact of Ideaflow with its different modes on the number of collaboratively produced Ideas. In some groups participants produced significantly more ideas in the archive mode than in the notification mode and vice versa. Also during the first task, when designers were free to choose which way to generate their ideas, different amounts of data where produced. For example, the first group produced significantly less without Ideaflow, than with it, where as the third group produced almost the same amount of ideas in both conditions. Cross-products from ideas were mainly developed through notifications. In general, more discussion-like communication happened in the notification mode of Ideaflow. However, the number of ideas that were produced that way was very small.

5.5.1 MEASUREMENT OF THE EFFECTIVENESS OF THE COLLABORATIVE WORK

In order to analyze the effectiveness of collaborative work and to evaluate the quality of the communication in Ideaflow, the linkography measure was used. Van der Lugt (2001) developed a way to use linkography to measure the effectiveness of creative group meetings. He measures the link density (LD), which consists of the number of links created between ideas (within a defined part, for example, a special topic), divided by the number of produced ideas.

The formula for computing the LD is as follows:

$$LD = \frac{[Number\ of\ Links]}{[Number\ of\ Ideas]}$$

According to Van der Lugt (2001), evidence of connections can be found within the content of an idea. Another possible clue is the context of the produced ideas. This context can be, for example, the articulation of a designer while introducing a new idea linked to another.

In addition to the LD, the Self-link index (SLI) measures the number of personal links. High SLI means the designer produced a lot of individual links while developing new ideas based on his previous creations. A low SLI means that more shared links were produced, when ideas are connected in between different designers. In order to compute SLI, the personal links must be smaller or equal to $1/n$, where n is the number of group members (Van der lug 2001, p. 70).

The formula to compute the SLI is as follows:

$$SLI \leq \frac{1}{n}$$

Identified links can be categorized in three link-type indices (LTI) (Van der Lugt 2005). These LTI are:

- "Tangential" links, which indicate new ideas that lead to different directions, but are based on previous ideas,
- "Modification" links, which indicate variations on older ideas, and
- "Supplementary" links, which mean small alterations and repetitions.

In order to provide a graphical overview of the produced links in the case study, link matrices (Van der Lug 2001) of each case and for each group were produced (see table 1).

			P1 1	P2 2	P2 3	P2 4	P3 5	P2 6
P1	1	alte Lebensmittel		X	X	X	X	
P2	2	grüne / welke Bäume		X			X	
P2	3	verdorrte/verdorbene Lebensmittel					X	
P2	4	Barocke alte Formen/Stil						
P3	5	vergängliches Cover						X
P2	6	Tinte						

X	Links
X	Self-Links

TABLE 1 - LINK MATRIX DESIGN TEAM ONE / TASK1

In current work, two techniques are used to identify connected ideas. For the identification of the tangential and supplementary links all media that were saved to communicate an idea are analyzed. In order to ensure that the links are not perceived subjectively, two examiners analyzed the data independently. In order to identify the modification links produced while using Ideaflow, every idea is saved as note containing node elements (see section 4.2.6 “Trees and Nodes”). Each node contains a unique idea. An idea can be edited and saved with the same node id as the parent node. So the connected ideas can be identified by their common node id.

	Task 1	Task 2	Task 3
LD	1,33	0,39	0,42
SLI (<= 0,33)	0,14	0,66	0,25

TABLE 2 - DESIGN TEAM ONE: COMPUTED LD AND SLI VALUES FOR THE THREE DIFFERENT TASKS

	Task 1	Task 2	Task 3
LD	0,44	0,5	0,66
SLI (<= 0,33)	0,14	0,66	2,33

TABLE 3 - DESIGN TEAM TWO: COMPUTED LD AND SLI VALUES FOR THE THREE DIFFERENT TASKS

	Task 1	Task 2	Task 3
LD	0	0,5	0,62
SLI (<= 0,33)	0	3,5	0,5

TABLE 4 - DESIGN TEAM THREE: COMPUTED LD AND SLI VALUES OF THE DIFFERETN TASKS

Tables 2 to 4 show the computed LD and SLIs compared for all three tasks in the case study. In Design Team One (see Table 2) the LD value is higher than 1. That means that participants' performance produced more links than unique ideas. Such a situation arises when ideas are linked to several previous ideas.

The members of Design Team Two had no communication during their first task and therefore produced no linked ideas (see Table 3). The SLI values of this group are higher in task 2 than in task 3, suggesting that the interpersonal group communication was higher in task 3 than in task 2. What this means is that the alerts with system notifications have a greater affect at triggering communication than the idea archive.

LD	Task 1	Task 2	Task 3
Team One	1,33	0,39	0,42
Team Two	0,44	0,5	0,66
Team Three	0	0,5	0,62

TABLE 5 - COMPARED LD VALUES

Looking at LD values across all groups (see table 5), the values in task 3 are overall higher than in task 2. This means that on average more cross-ideas or linked ideas were produced with the notification function (task 3) than without (task 2).

SLI (<= 0,33)	Task 1	Task 2	Task 3
Team One	0,14	0,66	0,25
Team Two	0,14	0,66	2,33
Team Three	0	3,5	0,5

TABLE 6 - COMPARING SLI VALUES

Looking at SLI values (see table 6), we can see that Design Team One was the only team that reached an ideal interpersonal communication rate (SLI smaller or similar to 0,33), and did so only in task 1 and task 3. In comparison with the communication rate during task 1 and 2, Design Team Three reached a good communication rate during task 3.

In conclusion, except for Design Team Two, the interpersonal communication of team members was much better in task 3 (with the system notifications on new saved ideas), than in task 2 (without).

5.6 FOCUS GROUP

After the last meetings all groups were asked several questions about the study. The function of these Focus Groups is to underpin the quantitative results and in addition clarify questions that could not be answered with the data of the main study. The decision to do the inquiry in focus

groups was motivated by the several advantages focus groups have over individual interviews. Answering questions and voicing opinions when in a group setting may lead to highlighting similarities and differences between opinions and perspectives and this may lead to informative discussions. These dynamic situations may bring participants to raise issues they would not have mentioned when answering survey questions individually and thus to gain in relevant and important insight (Lazar et al. 2010).

The interview was semi structured: The interviewer had read questions on a survey, which had been prepared in advanced, and in the order they had been written, but there was enough space to allow discussions new questions or interesting insight to spontaneously occur. Attention was given to the way the questions were asked. When detailed responses were needed, open-ended questions were formulated. Open-ended questions allowed participants to answer in depth and to explore any aspect of the issue at hand that can be of interest (Lazar et al. 2010).

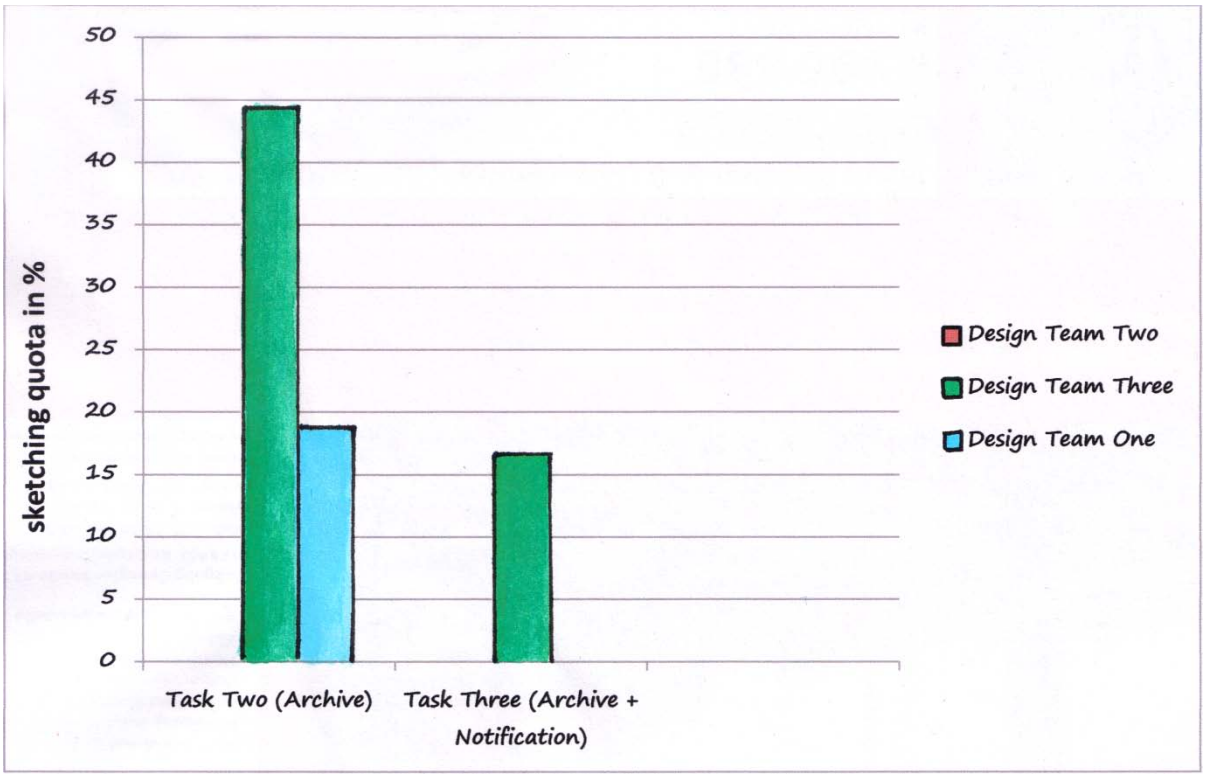
Most of the questions concerned the comparison between the relevance of the idea archive in and the system notifications for the work tasks. The value of collecting ideas with the smartphone in general was also queried. Questions were aimed at identifying the value of the functions provided by the application. The answers to these questions may inform principles for the development of applications that support designers in the early phases of design on the go. Finally, the Ideaflow data visualization was discussed and evaluated.

The first and second groups used the idea archive for contributions and further development of the ideas of others and in order to avoid duplicates. The third team in contrast declared that they had rarely used the archive because they did not want to get influenced by the ideas of others. They feared that the use of the archive would hinder their idea generation efforts; to them, the archive had no great value. Only one participant of the third group declared that he had occasionally used it to see what the others had done and whether their ideas were overlapping with his own.

Additional questions were asked in order to find out whether system notifications of new ideas or browsing through the idea archive encouraged participants to continue making their own original contributions. The first group said that this had happened more than once during the study with the archive. The second group stated that this was always the case. In contrast to the first two, the third group said that this never occurred. All groups declared that the notification function had led them to give more attention to colleagues' ideas. Most participants said that they had been inspired by ideas they had become aware of through the notifications. In general, all groups said that the notifications, rather than the archive, had made them aware of ideas from other group members.

At the end of the interview participants talked about the functionalities they would add in order to improve the usability of the tool. All groups wished there were an import function for data from the internet or the smartphone's internal memory. To improve the uploading functionality they suggested that a local cache would be useful if there were no internet connection. Other suggestions made by individual persons were:

- a synchronization option with the computer
- more information about the time and the identity of ideas
- the possibility of creating subfolders
- the possibility to save an idea without sharing it
- more details in the chat history and its chronologic order
- more colors in sketching



GRAPH 7 - FREQUENCY OF USE OF THE SKETCHING FUNCTION FOR IDEA CAPTURING

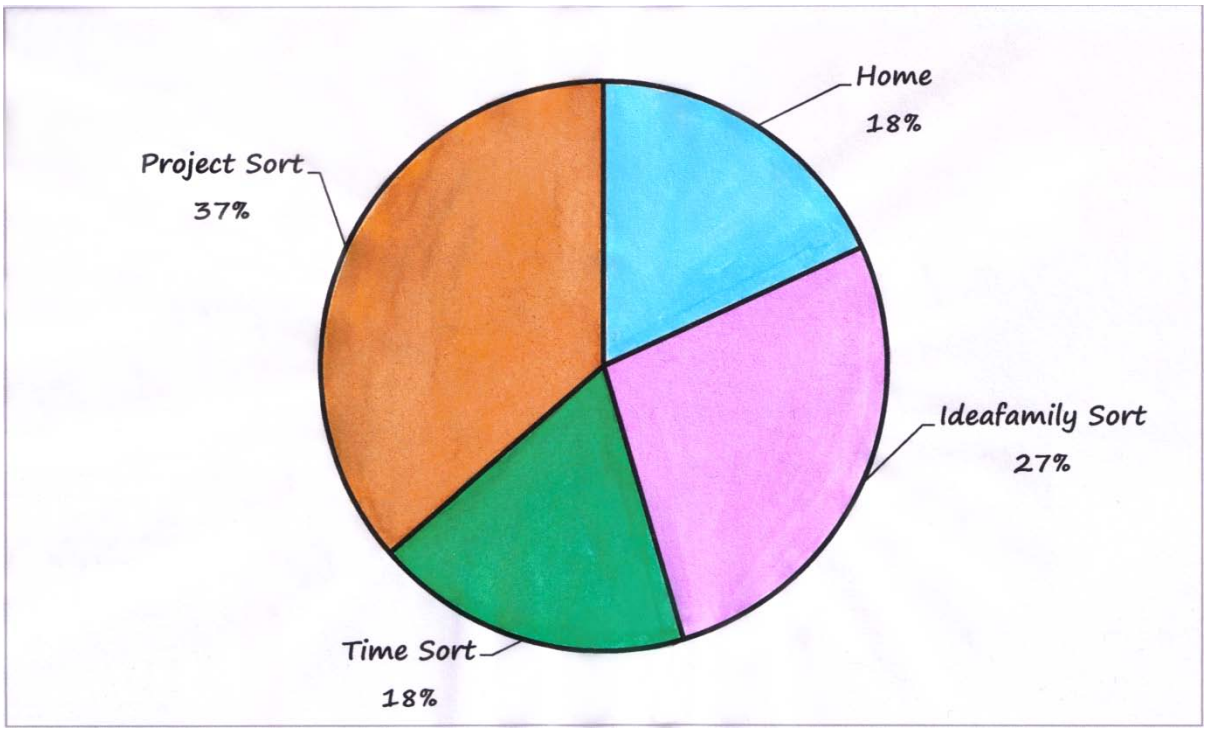
Some participants said sketching was not a useful option in the context of tasks given in the study. The first group rarely used the sketching functionality. Only one participant in the first group used the function for the second task and only for 18.7 percent of the overall ideas (see Graph 7). Design

Team Two never used the sketching function. The member of the second team explained this fact by claiming that the function was not useful on small screens. In contrast, the third group used sketching for 44.44 percent of the ideas in the second task and for 16.7 percent of the ideas in the third task across all team members.

Participants were also asked for their opinion on the use of smartphones for idea generation in general. Opinions on this issue varied widely. Most of the participants stated that they would not use smartphones for idea capturing because they preferred to use pen and paper instead. However, they found using smartphones useful for collaboration and for capturing spontaneous ideas. Some said that they would like to use it when they are on the go and have no other option to capture ideas quickly. One declared that he thinks it is the ideal way for capturing and sharing ideas because it supports collaboration, it is interactive, and it enables ad hoc work based on the ideas of others.

A major goal of Ideaflow was to keep the team members anonymous during the process of idea collection. This should prevent the negative social factors that can inhibit idea generation. Almost all participants, however, would prefer to know the identity of the idea producer. When asked whether they sometimes had inhibitions when publishing ideas, they all denied it.

Further questions were aimed at underpinning the observations made during the idea review sessions with the Ideaflow visualization. The participants were encouraged to rate each of the four Idea Flow visualizations with a five-point Likert scale, starting from (1) "not at all useful" to (5) "very useful". As illustrated in Graph7, the Project Sort data arrangement was considered to be the most useful at 36.4%. This Algorithm was rated by five participants as useful and by three as very useful. Only one participant rated the project sort visualization with 3, which means he found it not very useful. That particular participant preferred the Ideafamily Sort algorithm.



GRAPH 8 – POPULARITY SCALE OF THE VISUALIZATIONS

The participants were also asked for their opinion on visualizations on large displays for team meetings. Only one participant said that he would prefer creative team meetings conducted on tables with haptic artefacts. This participant in general prefers to write or sketch ideas down on a sheet of paper. All other participants liked the idea of team meetings with the support of a data visualization tool on a large touch screen. Most participants were of the opinion that this would improve their workflow by speeding up the process and make changes and editing's a lot easier. Many also liked the fact that this could actually save paper. Some stated that idea visualization made the workflow more flexible and clearer because it provided an overview over all produced data and many opportunities to interact with it. One summarized the general opinion very well. He explained that if designers had this opportunity they would clearly use it. The idea visualization parallels the common workflow that includes putting ideas down on paper and hanging them on a whiteboard for discussion and further development. He further explained that with this workflow digitalized, designers could do that task much faster and additionally save paper. During the interview, participants also expressed a lot of ideas on how such idea visualizations could be further improved to support the collaborative idea reviews. These statements will be presented and discussed in Future Work chapter.

5.6.1 SUMMARY

In this chapter the design and results of the case study on the system Ideaflow was presented. The study's goal was to methodically collect data that can answer the question whether a system like Ideaflow could support the collaborative work on the go as it is designed to.

Early in this chapter the design of the study was presented. Then, the conducted pre-test with the "junior" designers provided relevant personal information about the participants themselves and further information about their general habits in the examined work processes. Also hypothetical questions about aspects of inspiration were asked. The Pre-Test was conducted with the goal of verifying the results of the literature research (see chapter 2 "Background") and of getting deeper insight into a theory of inspiration. The description of the field study included observations and qualitative data. In the Facts and Data section the quantitative data gathered through the system and results from the Linkography analysis (Warr et al. 2005) of the data were presented. The chapter closed with results from the focus groups. Through these interviews additional information on the gathered findings were given and additional insights for future work were produced.

6 CONCLUSION

In this thesis, we have identified the following important tasks that any tool used by design teams needs to support (Höhn 2011):

- Spontaneous idea capturing,
- Communication of ideas to colleagues, and
- Awareness of the work of collaborators

Since no tool currently on the market was found to satisfactorily answer the needs identified in this thesis, the system Ideaflow was developed to support designers on the go. The main features of Ideaflow are uploads of ideas using various, rich multimedia, archiving them in a principled, informative and browsable way, a notification system to increase awareness to the work of other, and easy access ideas from all project partners, all done on a mobile device. In addition to the archiving and capturing features, different data arrangement visualizations were developed and designed to for use on large touch capable screens to support a simplified and structure review of the ideas during subsequent team meetings.

A case study was conducted to answer the following questions:

1. Can collaboration and idea generation of creative design teams on the go be effectively supported by system notifications?
2. Does the Ideaflows idea archive encourage more awareness on the work of colleagues?
3. Are more related ideas produced through the awareness of the work of team members precipitated by the archive and the system notifications?

The participants in this study were divided into three creative design students. A pre-test was first conducted to test the validity of previous claims in the literature about the behaviour of designers. The results showed that designers often get inspired when they are not in their working places, but are nevertheless often get inspired by other designers and their work as well as from old ideas from previous projects. Results from the pre-test also show that mobile devices are infrequently used to capture spontaneous ideas, and relatedly that designers do not use any specialized software for capturing ideas on the go. Also, it was found that designers prefer feedback to be given in person.

In sum, none of the participants uses or knows of a satisfactory software tool that can provide efficacious support for the creative work of distributed design teams during early design phases.

The actual case study was split into three phases. In the first case ("the general mode") the designers were advised to collect ideas on a specific topic and to solve the design problem collaboratively as a distributed team. In the second case ("the archive mode") the designers worked on a design problem again, but this time used the Ideaflow client application with the archive functionality but without the notification one. In the third case ("the notification mode"), the system notifications were enabled. Each case was followed by team meetings for the review of ideas and the decision of the final concept. The study concluded with focus groups to gauge participants' thoughts about the usefulness of the Ideaflow system.

The results of the case study were used to evaluate the following hypotheses.

H1: There's a difference between the numbers of linked ideas produced by the use of Ideaflow without vs. with the system notification function.

H2: The reaction times on ideas are shorter with the trigger of Ideaflows system notification than just with Ideaflows archive.

H3: The number of produced unique ideas is greater when using Ideaflow than when not using it, especially when system notifications are enabled.

H4: The meetings with digital support through the Ideaflow data visualizations triggers rich discussions and inspire the participants to come up with further development of ideas.

The participants stated that they used the archive to look on the ideas and to follow the idea generation process of others. System notifications were assessed to draw more attention to ideas than the archive only. This statements could be validated with the facts that in case 2 (archive mode) while supplying the archive mode only, about 1/5 of the ideas got feedback while in case 3 (notification mode) with the support of notifications this could be raised to 1/3. In addition, comparing the Node Ids of the Node Elements, we found more similar Ids and therefore more linked ideas were produced during the notification mode than in the archive mode. We also applied the data analysis method of Linkography (Van der Lug et al. 2001), which confirmed the conclusion that indeed there were more linked ideas in Case 3 than in Case 2. These results support H1.

With the use of Ideaflow we had more linked ideas in general but less interpersonal links. The most interpersonal links were produced by using the application WhatsApp and via e-mail. This suggests that the quality of the discussions would be better supported with these services. This possible

conclusion could be evaluated in more detail in future studies that focus on the comparison of different tools with respect to their ability to produce links.

The average response times also differed in Case 3 and in Case 2. In the archive mode they took much longer than in the notification mode. In both cases the gathering and communication of ideas was an ongoing process during the predetermined time. In contrast, these tasks in case 1 (general mode) were one-time discussions about ideas and resembled a brainstorming meeting. Therefore almost all ideas got a response. These results support H2. This suggests that the designed system notifications draw attention to ideas, thus promoting rapid feedback.

We found no support for H3 in this study because the amount of produced unique ideas varied across cases. This leads to the conclusion that tools like Ideaflow cannot influence the quantity of collaboratively produced ideas on the go.

We developed Ideaflow with the additional aim of mitigating a few negative social factors discussed by War et al. (2005), namely social apprehension, free riding, and production blocking. However, in the focus groups participants said that there those social factor had no effect on their performance. Geyer & Reiterer (2011) arrived at similar results in their case study on Evernote used in collaborative creative processes. This raises the question whether social factors should be considered in the creative design area. If they should, a more nuanced perspective is warranted. For example, some participants in the current study suggested that anonymity benefits one who shares the idea but not his collaborators, who would like to know where the idea was originated. It is conceivable that better ideas are produced when the collaborators think they are anonymous, and it is possible the anonymity is important to some designers but not others. Also, recall that participants reported that the system notifications on new ideas had an encouraging effect on the project, suggesting that system notifications can help to reduce “free riding”. Some yet not be explored social factors can be examined in future studies, where social factors would be investigated by comparing the behaviour creative designers and non-designers with respect to collaborative idea generation tasks.

The team meetings in Cases 2 and 3, which include the Ideaflow visualization, were longer on average than the meetings in Case 1. These longer meetings include lengthier constructive discussions of the ideas than in the meetings in Case 1. In addition, more ideas were generated and further developed during the meetings in Cases 2 and 3 than in the meeting in Case 1. The discussions in the focus groups support these findings: Participants preferred the Ideaflow

visualizations in Cases 1 and 2 over the analog version on a physical table in Case 1. Taken together, these results support H4.

Observations from the focus groups suggest ideas for future work in the effort to develop additional and more sophisticated tools. The ideas are discussed below.

In the current study all participants criticized long loading times and sometimes information loss during the use of the Ideaflow client application. These drawbacks were caused by varying internet bandwidth. Information loss due to no internet connection is a problem for other mobile commercial systems like Evernote [5] as well (Geyer & Reiterer 2011). The software must therefore provide extensive internet access. Extensive internet service, however, is not available everywhere today, and therefore an alternative solution to the problem must be found. A possible solution would be a cache function. Idea Nodes should be saved locally if there is no proper internet connection available and be shared automatically once there is a connection. In the focus group, half of the participants expressed the desire to load pictures from the smartphone gallery. Some liked the idea of importing screenshots of websites or images from the internet into the Ideaflow system. They also wanted to have the gathered data automatically synchronized with their computers. For this functionality a desktop component of the Ideaflow application would be necessary, and so, aspects similar to the application Evernote [5] could be considered.

The participants mentioned ideas to improve Ideaflows sketching functionality. Some said that they would like to have different colors for sketching. Others would appreciate an “undo” or “eraser” function. Some participants expressed the desire for more contextual information to ideas. Therefore information on when and who an idea was produced should be reachable in the client application.

Participants also suggested a distinction between simple comments and modifications of ideas, and thus a tree-like presentation could be useful. In the design of Ideaflow such visualization was considered and ruled out because of the small screen size of the smartphone. It would, however, be useful for a representation of Ideaflows Archive on other mobile devices such as tablet PCs.

Some stated that they would like to have the possibility of modifying ideas without the need to share them. The aspect of privacy and control over one's own data in the support of collaborative tasks is discussed in current research (Greenberg et al. 1999, Widgor et al. 2009). Allowing individuals to selectively present design information to their team members is one of the design guidelines of Oehlberg et al. (2012). Users should have the possibility of deciding whether they want

to keep information private or share it with others. Ideaflow did not include this feature; rather, the goal was to simulate a kind of face-to-face brainstorming session in which all ideas are presented to the team.

The Ideaflow data visualization was considered by all participants to be very useful. It could be observed that creativity as well as communication was improved by the use of this application. During the Focus Groups participants had some ideas for further improvements like ranking and marking notes which could be valuable features for the further development of Ideaflow. It could be observed that all groups started to build clusters of ideas. It is assumed that these clusters were build to show relationships of ideas (Oehlberg et al. 2012) or to rank ideas on importance to solve the design problem. In the "Focus Groups" the participants explained the desire for a possibility to fix idea clusters. They also stated that the possibility to assign idea objects to each other would be very helpful. This could be visualized in a kind of "Mindmap" [23].

Another mentioned improvement of Ideaflow would be a sorting functionality. Groups could also build upon different ranks or media types. This could help with building common ground on the data.

Some participants stated that they would like to have the possibility of deleting or hiding data objects. Deleting idea objects contradicts with the basic principles of Ideaflow, because it is assumed that every idea can have an influence on the process of solving a design problem. But the possibility to hide specific objects could be a valuable feature for future development. This could help users to focus on the essential ideas.

One participant suggested that the selection and data presentation of individual projects would be useful. For future development, simultaneous presentation of data from selected projects is conceivable. This would support the goal of the Ideaflow Archive to reuse ideas of old projects by opposing the data objects in the visualization the connection between ideas may be easier imaginable. All participants wanted to always have the relation between ideas and projects visualized. This is currently missing in three of four provided visualizations.

Also the desire for further interaction in the data was identified. One group explained that they would like to have the ability to separate time sections in the "TimeSort Visualization" and get further information on this section.

[23] http://www.mindmapping.com/de/mind-map.php/ last access 04.03.2013

Also with the Ideaflow Data Visualization some usability issues were identified. Participants stated that they did not like overlapping pictures. This was implemented to give the user an overview on the data without the need of scrolling. This overview is no longer given when the amount of data is too large. Therefore a maximum picture overlapping should be added in code to verify that the picture information is given with large amounts of data as well.

On the other hand, participants stated that when only a few ideas are given, the object size should be automatically decreased. Therefore objects could be automatically enlarged or shrinked relative to the amount of ideas and the available screen resolution. Participants also stated that the time scale at the bottom of the visualizations should be more dominant.

In conclusion, the client application of Ideaflow was deemed useful for fast idea capturing and sharing on the go. In particular, the use of system notifications has proven to be a valuable support for designers work. It could be found that some designers liked to work with digital data and some still preferred to work with physical artifacts. Those latter designers are in principle against digital support for their design work. But even those designers appreciated the enhanced possibilities when using digital tools and digital data. The collaborative idea review with the digital support of Ideaflows data visualizations was deemed as very useful by all participants. After analyzing the results of current case study it was found that Ideaflow supports the creative design process. But further research and development are needed to adequately replace face to face collaboration in design offices.

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8 APPENDIX

8.1 PRE-TEST QUESTIONNAIRE CASE STUDY

Pre-Test Fragebogen Studie Ideaflow

Geburtsjahr: _____

Geschlecht: männlich weiblich

Wie häufig arbeitest du am Computer:

Besitzt du momentan ein eigenes Smartphone oder Tablet?

Ja Nein

- **Wenn ja, seit wann:**

Wie häufig nutzt du die Smartphone oder Tablet Medien?

Photo:
Video:
Soundrecorder:
Andere:

Wie häufig machst du dir Textnotizen mit dem Smartphone oder Tablet?

Nutzt du die Smartphone oder Tablet Medien um Designideen festzuhalten?

Ja Nein

- **Wenn ja, welche und wie häufig kommt das vor:**

Wo holst du dir Inspiration für Designideen?

Arbeitest du an Designideen eher im Team oder alleine?

- **Wie könnte man den Ablauf einer solchen Teamarbeit beschreiben:**

Holst du dir gerne zu Design Ideen Feedback von Kollegen?
Ja Nein

- **Wenn ja auf welche Weise und wie häufig kommt das vor:**
  Mündlich:
  Per Mail:
  Per Skype:
  Telefon:
  Andere:

Gibt es Situationen (beim Autofahren, Baden etc.) wo du besonders häufig kreative Ideen hast?

Wie hältst du Ideen fest wenn du gerade keinen PC zur Hand hast?

Kommt es vor das du gute Ideen wieder vergessen hast weil du sie nicht rechtzeitig festhalten konntest?
Ja Nein

- **Wenn ja, wie häufig ungefähr:**

Wie organisierst/verwaltest du alte Ideen und Projekte (Archiv, Ausdrucke in Ordnern etc.)?

Wie wichtig ist es für dich den Prozess der Ideenfindung mit allen entstandenen Artefakten bis zum abschließenden Produkt nachvollziehen zu können?

Überhaupt nicht wichtig nichtwichtig wichtig sehr wichtig

Werden ältere Ideen oder Ideen aus anderen Projekten neu aufgegriffen und für andere Projekte verwendet?

Ja Nein

- **Wenn ja wie häufig kommt das ungefähr vor:**

Nutzt du bereits Anwendungen um Ideen festzuhalten wenn du unterwegs bist?

Ja Nein

- **Wenn ja welche:**

8.2 TASKS OF CASE STUDY

STUDIE IDEAFLOW

Aufgabe 1:

Ein Verlag hat euch beauftragt für ein neues Buch mit dem Titel "*Mortality*" ein Buch Cover zu gestalten. *(Mortality = Vergänglichkeit)*

Hierbei geht es nur darum Grundideen zu sammeln aus denen euer Team ein passendes Buch Cover, mit besagtem Titel, gestalten könnte.

Bearbeitungszeit ist beliebig. Es soll am Ende eine brauchbare Idee zustande kommen.

Ideenbesprechung am _____ um _____.

Viel Erfolg!

STUDIE IDEAFLOW

Aufgabe 2:

Ein Pharmaunternehmen möchte eine Plakatkampagne starten welche die Schäden verursacht durch Drogenkonsum in „Real-Life“ Metaphern darstellt.

Bsp.: Rauchen -> vertrockneter Apfel.

Euer Designteam soll hierzu 5 Ideen präsentieren. Bitte nutzt die Anwendung um in Teamarbeit Ideen zu erarbeiten.

Nach einem Tagen sollen die mit der Anwendung gesammelten Ideen gemeinsam an der Uni Konstanz im Raum C203 besprochen werden. Außerdem sollen dort die 5 Ideen, die ihr dem Pharmaunternehmen präsentieren wollt, ausgewählt werden.

Neues Projekt anlegen:

1. Anwendung Auswählen
2. Master-Passwort eingeben (siehe unten)
3. Neues Projekt erstellen.
4. Neuen Projektnamen eingeben.

Falls Probleme mit der Anwendung auftreten:

Check:

- Ist Internet Verbindung vorhanden?
- Ist GPS eingeschaltet?

Problembehebung:

1. Anwendung neu starten.
2. Telefon aus und wieder an schalten.
3. Ansonsten bitte so schnell wie möglich bei mir melden:

   Stephanie Höhn

   Tel: 017620745475

Name:

Master-Passwort: asdfg

Benutzer-Name: client1

Identifikator: 12345

STUDIE IDEAFLOW

Aufgabe 3:

Herbsteindrücke. Ein Kunde möchte für seine Bekleidungsfirma eine Website gestaltet haben die ihr Design den Jahreszeiten anpasst. Er möchte eine erste Ideensammlung von eurem Designteam zum Thema Herbst. Euer Designteam soll hierzu Ideen präsentieren. Bitte nutzt die Anwendung um in Teamarbeit Ideen zu erarbeiten.

Nach 2 Tagen sollen die mit der Anwendung gesammelten Ideen gemeinsam an der Uni Konstanz im Raum C203 besprochen werden. Außerdem sollen dort die Ideen, die ihr dem Pharmaunternehmen präsentieren wollt, ausgewählt werden.

Neues Projekt anlegen:

5. Anwendung Auswählen
6. Master-Passwort eingeben (siehe unten)
7. Neues Projekt erstellen.
8. Neuen Projektnamen eingeben.

Falls Probleme mit der Anwendung auftreten:

Check:

- Ist Internet Verbindung vorhanden?
- Ist GPS eingeschaltet?

Problembehebung:

4. Anwendung neu starten.
5. Telefon aus und wieder an schalten.
6. Ansonsten bitte so schnell wie möglich bei mir melden:

Stephanie Höhn

Tel: 017620745475

Name:

Master-Passwort: asdfg

Benutzer-Name: client1

Identifikator: 12345

8.3 Focus Group Questions

Wie hast du das Archiv genutzt?

1:

2:

3:

Notizen:

Kam es vor, dass du durch das Betrachten von Ideen im Archiv dazu angeregt wurdest selbst auf Ideensuche zu gehen?

1: *Nie* *mehr als 1mal* *ständig*

2: *Nie* *mehr als 1mal* *ständig*

3: *Nie* *mehr als 1mal* *ständig*

Notizen:

Kam es vor, dass du durch Systembenachrichtigungen von Ideaflow dazu angeregt wurdest selbst auf Ideensuche zu gehen?

1: *Nie* *mehr als 1mal* *ständig*

2: *Nie* *mehr als 1mal* *ständig*

3: *Nie* *mehr als 1mal* *ständig*

Notizen:

Auf einer Skala von 1-5; wie sehr haben dich Systembenachrichtigungen auf Ideen von Anderen aufmerksam gemacht?

1: Skala 1 2 3 4 5

2: Skala 1 2 3 4 5

3: Skala 1 2 3 4 5

Notizen:

Auf einer Skala von 1-5; wie sehr haben dich die Ideen im Archiv bei der Generierung eigener Ideen inspiriert?

1: Skala 1 2 3 4 5

2: Skala 1 2 3 4 5

3: Skala 1 2 3 4 5

Notizen:

Auf einer Skala von 1-5; wie sehr haben dich die Ideen in den Systembenachrichtigungen bei der Generierung eigener Ideen inspiriert?

1: Skala 1 2 3 4 5

2: Skala 1 2 3 4 5

3: Skala 1 2 3 4 5

Notizen:

Was hat dich auf die Ideen deiner Kollegen stärker aufmerksam gemacht, Archiv oder Systembenachrichtigungen?

1:

2:

3:

Notizen:

Haben dir Funktionen gefehlt?

1:

2:

3:

Notizen:

Welche Funktionen waren für dich überflüssig?

1:

2:

3:

Notizen:

Wie sinnvoll findest du es generell über ein Smartphone Ideen zu generieren?

1:

2:

3:

Notizen:

Was hältst du davon dass die Ideengenerierung anonym war?

1:

2:

3:

Notizen:

Hattest du Hemmungen Ideen zu speichern?

1:

2:

3:

Notizen:

Hattest du Schwierigkeiten bei der Bedienung der Anwendung? Wenn ja welche?

1:

2:

3:

Notizen:

Findest du generell die Ideenvisualisierung auf einem großen Display zur Besprechung von Ideen sinnvoll?

1:

2:

3:

Notizen:

Wie sinnvoll haltet ihr die Ideensortierung in Home (Skala nicht sinnvoll – sehr sinnvoll)?

1: Skala 1 2 3 4 5

2: Skala 1 2 3 4 5

3: Skala 1 2 3 4 5

Notizen:

Wie sinnvoll haltet ihr die Ideensortierung in IdeaFamilies (Skala nicht sinnvoll – sehr sinnvoll)?

1: Skala 1 2 3 4 5

2: Skala 1 2 3 4 5

3: Skala 1 2 3 4 5

Notizen:

Wie sinnvoll haltet ihr die Ideensortierung in TimeSort (Skala nicht sinnvoll – sehr sinnvoll)?

1: Skala 1 2 3 4 5

2: Skala 1 2 3 4 5

3: Skala 1 2 3 4 5

Notizen:

Wie sinnvoll haltet ihr die Ideensortierung in ProjectSort (Skala nicht sinnvoll – sehr sinnvoll)?

1: Skala 1 2 3 4 5

2: Skala 1 2 3 4 5

3: Skala 1 2 3 4 5

Notizen:

Würdet ihr eine solche Visualisierung gerne immer bei Gruppenarbeiten nutzen?

1:

2:

3:

Notizen:

Wenn ja, wie würde das den Arbeitsprozess der Ideensichtung verbessern?

1:

2:

3:

Notizen: