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User Experience Patterns in the Early Stages of a Design Process

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Abstract

While human-computer interaction design patterns are created to support the design of user interfaces, there is lack of substantial evidence to support these promises. This thesis reports two exploratory observational studies, conducted to understand how patterns are used and whether they are of any benefit. Professional designers were encouraged to take advantage of a collection of user experience (UX) patterns while designing a social media application. Data on pattern reading were collected with eye-tracking. In Study 1, it was found that pattern use varied considerably amongst individual designers. All subjects found the patterns inefficiently presented, but designers who read them while designing saw them as helpful for getting inspiration. It was noted that varied use of patterns is a potential explanation to the minor effects of patterns in previous research. The procedure was repeated in Study 2, which gave similar results. Furthermore, it was shown that the extent to which patterns were read strongly correlated with design quality in a small sample of five expert designers. Causality was explained. No trend was identified among four novice designers. In Study 2 it was concluded that UX patterns can improve design quality with respect to UX when used for generation of ideas.

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1 Introduction

1.1 Motivation

Human-computer interaction (HCI) focuses on the communication between computers and humans. Recently there has been a shift of focus in the HCI community from designing effective and efficient interfaces to designing interfaces which users find enjoyable, entertaining and that they get emotionally attached to. In the continuation of this, there is also a paradigm shift from traditional *usability* to a different and broader perspective commonly referred to as *user experience* (UX). While a shared definition of UX still is lacking, some research indicates that practitioners and researchers across cultures consider UX as dynamic, context-dependent and subjective (Law et al., 2009).

The shift has gained a growing interest in how to design products and services with respect to UX (Ruud, 2009). Based on experience from other fields (architecture (Alexander et al., 1977; Alexander, 1979), software engineering (SE) (Beck et al., 1987) and traditional HCI (Tidwell, 1999)), *UX patterns* have been proposed as a means to facilitate communication and reuse of successful design solutions with respect to UX (Obrist et al., 2008; Crumlish et al., 2009; Ruud, 2009; Obrist et al., 2010). Patterns for designing software user interfaces are however not widely accepted; one of the most obvious weaknesses is the lack of substantive evidence of the suggested benefits when used. Furthermore, there is lack of deeper understanding of how they are used (Dearden et al., 2006). Although a few studies have been conducted to explore the helpfulness of patterns in HCI, the studies have focused on usability patterns rather than UX patterns. Additionally, they have resulted in contradicting findings (Wania, 2008). To this end, more research is needed to explore UX patterns in use, in order to understand to what extent they are used, how they are used and finally whether their use is beneficial. It is thought a deeper understanding can be useful for pattern authors and researchers when creating and evaluating patterns.

1.2 Objectives

The introduction of social networking sites like Flickr, Facebook, MySpace and YouTube has changed the way people use new media. The applications provide networking opportunities for members and are related to audiovisual, user-generated content (Obrist et al., 2010). In order to document knowledge on how to design for a positive UX in such *networked audiovisual applications*, a collection of 30 UX patterns has been created (Obrist et al., 2008; 2011). The pattern authors see UX as a combination of eight *UX factors* named "usability," "fun," "motivation," "user engagement," "user involvement," "co-experience," "emotion" and "sociability" (Obrist et al., 2007). Each of the 30 patterns is designed to address one or more of these factors.

Although the UX patterns are identified and evaluated through several iterations with 17 different methods (Obrist et al., 2008; Karahasanovic et al., 2009; Ruud, 2009; Wurhofer et al., 2009; Obrist et al., 2010; Obrist et al., 2011), they have not been examined in use, although this has been proposed (Ruud, 2009; Wurhofer et al., 2009). The objectives of this research were twofold.

- First, it was to examine whether and how the UX patterns are used during the early stages of a design process.
- Second, it was to examine whether such use is of any benefit.

1.3 Research method

Two exploratory observational studies were conducted with eight and nine professional user interface designers respectively. Design tasks were assigned to individual designers. Participants' eye-movements and design activities were observed and logged with eye-tracking, in order to carefully examine whether and how the UX patterns were read during the experimental sessions. Data were additionally gathered with surveys and qualitative interviews.

1.4 Research context

The UX patterns were developed as a part of a three-year Citizen Media research project (2006-2009). They were based on a profound literature survey and investigations of 8000

potential and actual users' experiences with ten different audiovisual applications developed in three different European countries (Obrist et al., 2008; Obrist et al., 2010). The purpose of the patterns was to share successful solutions, so that stakeholders can be assisted in designing for a positive user experience in social media and networked audiovisual applications in particular (Obrist et al., 2008). The patterns are also created to inspire designers to account for positive UX when designing audiovisual applications (Obrist et al., 2010).

1.5 Contributions

1.5.1 Identification of previous research on the impact of patterns

A systematic review of previous work related to the impact of patterns in the early stages of a design process was conducted. The review showed that previous research has given contradicting results, but overall few statistical significant effects of patterns on design quality have been shown. Nevertheless, researchers have reported patterns to be beneficial.

1.5.2 Identification of pattern reading strategies

Four different pattern reading strategies were identified: "no use," "quick orientation," "systematic orientation" and "as needed." It was argued the "orientation" strategies are related, while "no use" is related to "as needed." The strategies correspond to previous findings. It was concluded that the extent of patterns reading varied extensively. Thus, such variation should be expected when exploring the potential effects of patterns on a design process or design quality. Furthermore, it was suggested actual pattern reading can be taken into consideration when doing so.

1.5.3 Identification of rationales and effects of pattern reading

Rationales and effects of reading of UX patterns, or lack thereof, were identified. Rationales for not reading patterns were mostly related to inefficient pattern presentation. The rationales for reading patterns were found to be "identify candidates" or "look for ideas." The effects were "idea generation" and "time saving" on the subjective level. It was found that these were independent of the pattern user's rationale for reading them. Pattern reading could also cause evaluation and support design decisions. It was suggested patterns should be presented to facilitate the identified rationales as efficiently as possible.

1.5.4 Analysis of the correlation between pattern use on design quality

Gathered prototypes were heuristically evaluated in order to measure design quality with respect to UX. Quality measures were then correlated with the number of patterns read per participant. Although sample size was small, this was done in order to approach the subject matter differently than in previous research. A strong and statistically significant correlation was identified among expert designers. Causality was explained with "idea generation." There was no trend among novice designers. The analysis indicated patterns can cause higher design quality when used for "idea generation." The correlation method was seen as useful.

1.5.5 Recommendations on pattern presentation

Based on feedback from participants, a collection of recommendations on how to better present the UX patterns were given. They were: make it easy to navigate, use imagery at navigation level, assign visual examples and shorten the verbal text and make it easily digestible. The recommendations were thought to be applicable to other pattern collections as well.

1.5.6 Recommendations on the use of eye-tracking as a data gathering method for pattern evaluation

To the author's knowledge, this was the first project in which eye-tracking was used as data collection method for evaluation of design patterns in HCI. To this end, lessons learned from the use of the method were discussed. Recommendations for future use of the method were given.

1.6 Thesis overview

The remainder of this thesis is organized as follows:

Chapter 2

Design patterns in HCI This chapter gives a presentation of design patterns in HCI.

Chapter 3

Related work Identified work related to the goal of this thesis is presented in

this chapter.

Chapter 4

Study 1

The method, results and discussion for Study 1 are presented in this chapter. Threats to validity are discussed. Finally it is concluded and suggestions for future work are presented.

Chapter 5

Study 2

Based on findings from Study 1, a second study was conducted. The method, results and discussion for data in Study 2 are presented in this chapter. Threats to validity are discussed, followed by a conclusion and recommendations for future work.

Chapter 6

Other findings and lessons learned

This chapter first provides recommendations for pattern presentation. Second, lessons learned with eye-tracking as a data collection tool for pattern evaluation are presented.

Chapter 7

Conclusion and future work

This chapter summarizes findings from Study 1 and Study 2 and gives a conclusion. Finally, recommendations for future work are presented.

Chapter 8

References

This chapter lists references.

Chapter 9

Appendixes

This chapter presents appendixes related to Study 1 and Study 2.

2 Design patterns in HCI

2.1 What is a pattern?

Within the fields of SE and HCI, it is widely accepted that a pattern is *a structured description of an invariant solution to a recurrent problem in a context* (Dearden et al., 2006). Patterns have been seen in the middle on a continuum ranging from universal guidelines to highly specific style guides (Connelly et al., 2001). A pattern should provide concrete and sound solutions to problems, so they can be applied immediately and thus solve the problem. A pattern should also be abstract enough to be applied to different situations (Seffah, 2010).

Bayle et al. (1998) distinguished between *design patterns* and *activity patterns*. The former describe successful solutions proven in the field, while the latter simply explain current activities which are not necessarily successful. The distinction corresponds to Borchers' point of view (Borchers, 2001). He pointed out a *design pattern* describes a *proven* solution to a recurring problem. On the other hand, Grill et al. (2008) did not distinguish between design patterns and other patterns in terms of the solution. They simply stated, "a pattern needs to have a proven solution" (Grill et al., 2008); thus a pattern cannot be called a pattern until its solution is proven. The following will be focused on what Bayle et al. (1998) called *design patterns*.

2.1.1 Patterns, pattern languages and pattern collections

Authors of pattern literature often refer to *patterns, pattern collections and pattern languages*. Different authors seem to agree that pattern languages and pattern collections both constitute a group *of multiple patterns,* but the difference between a language and a collection is not necessarily as clear. It appears however that a pattern collection needs an extra dimension in order to be considered a pattern language. Mahemoff et al. (2001) saw this dimension as *the network;* a pattern language is arranged into a network of independent patterns, "especially where higher patterns yield contexts which are resolved by more detailed patterns." This

notion was also supported in Alexander's original work on patterns (1977; 1979), as well as by others (Salingaros, 2000; Borchers, 2001; Pemberton, 2003).

2.2 A brief history of patterns

The modern concept of patterns was first introduced in the field of architecture (Alexander et al., 1977; Alexander, 1979), although the idea of systematically collecting and documenting successful architectural design solutions was first suggested by the master builder Francesco di Giorgio (1439-1501) (Borchers, 2001). Alexander et al. (1977) created a network of more than 250 urban patterns describing how to design a town. The authors organized the patterns in a hierarchical manner, with neighborhoods above buildings, buildings above cafes, cafes above rooms, etc.

2.2.1 Patterns in SE

Beck et al. (1987) were inspired by the work of Alexander when they first introduced the idea of patterns to the field of SE (Gamma et al., 2002; Crumlish et al., 2009). They argued that computer users should be able to design their own software and created a collection of five patterns for object oriented programming to facilitate this activity. Later, it has turned out that SE patterns are rarely used by computer users, while they are almost always used by professionals (Borchers, 2001). Nevertheless, practitioners and researchers have reported successful use of patterns in the domain of SE (Prechelt, 1997; Gamma et al., 2002; Prechelt et al., 2002; Golden et al., 2005; Buschmann et al., 2007).

2.2.2 Patterns in HCI

The concept of patterns was adapted from architecture to HCI by Coram et al. (1996), although the early SE patterns also included solutions to interface design (Dearden et al., 2006; Kruschitz et al., 2010). Gradually, HCI patterns were recognized as a separate area and the interest in HCI patterns in the pattern community grew. Dearden et al. (2006) demonstrated this by listing organized workshops and published papers on patterns in HCI, as well as published pattern collections and languages. The fact that HCI patterns continue to be published may indicate that they are still a popular concept. Some books on patterns published the last two years include "Web Application Design Patterns" (Vora, 2009), "Designing Web

Interfaces" (Scott et al., 2009), "Designing Social Interfaces" (Crumlish et al., 2009) and "Search Patterns: Design for Discovery" (Morville et al., 2010).

2.3 Suggested benefits of patterns

Patterns are introduced to HCI in order to benefit the field in various ways, of which the most important are presented below.

2.3.1 Reuse of successful design solutions

As patterns are supposed to describe a solution to a recurring problem within a context (Dearden et al., 2006), one of their claimed advantages is reuse of successful design solutions. In fact, this is seen as a basic assumption underlying the design patterns philosophy (Ruud, 2009). In HCI it has been suggested patterns are derived from sufficient examples of good practice; thus it is likely that "a usable design will result from applying patterns" (Cowley, 2009).

2.3.2 Support of communication

It has been suggested patterns can support communication in multiple levels, for example between different stakeholders in a design project (Bayle et al., 1998). The stakeholders may have different vocabularies because they have different backgrounds. It has been argued stakeholders "share little or nothing in the way of a core discipline, practice, or theoretical basis" (Erickson, 2000). Patterns are thus suggested as a *lingua franca*; a common vocabulary, to support communication. Tidwell (1999) pointed out participatory design may especially benefit from patterns as a common vocabulary. Designers and users can talk about the same concepts, by referring to them using the pattern names. Thus, it is believed, fewer misunderstandings will arise.

2.3.3 Educational aid

Finally, patterns are in HCI suggested as an educational aid, to facilitate the transfer of design knowledge from teachers to students (Borchers, 2002; Griffiths et al., 2004; Kotzé et al., 2006; Koukouletsos et al., 2006; Koukouletsos et al., 2009). This potential benefit can be seen as closely related to those above, as it involves reuse as well as communication of design solutions.

2.4 Suggested challenges of patterns

There are however several challenges with patterns, presented below. The challenges establish a need for more research.

2.4.1 Production of patterns

It has been argued pattern creation has been relatively ad hoc and only based on the authors' experiences rather than extensive research (Dearden et al., 2006; Wania, 2008). To this end, patterns are created by relatively few authors and the quality of the patterns varies.

2.4.2 Usability of patterns

There is lack of standards on how to best organize a collection of patterns so that the patterns are usable for their potential users (Seffah et al., 2002; Deng et al., 2005; Dearden et al., 2006; Bernhaupt et al., 2009a; Cowley, 2009). Also related to usability is the fact that there is no agreement on which format patterns should follow. Several formats have been suggested, more or less inspired by the original format proposed by Alexander (1977; Ruud, 2009). It has been suggested the lack of standardized format is "one of the main obstacles to pattern usability and accessibility" (Seffah et al., 2002).

2.4.3 Evaluation before publication

There has been some discussion whether a proposed collection of patterns should be evaluated before use (Wania, 2008). According to the difference between design patterns and activity patterns (Bayle et al., 1998; Dearden et al., 2006), the solution of an activity pattern should be verified in some way before the pattern can be called a design pattern. However, it has been claimed this is rarely done for patterns; instead they are identified, documented and then published (Kohler et al., 2008; Petter et al., 2010).

2.4.4 Patterns in use

It has been argued the biggest challenge with patterns is lack of knowledge on *patterns in use* (Dearden et al., 2006). This critique can be split into two groups: knowledge on the helpfulness of patterns and the more general knowledge on how patterns are being used.

2.4.4.1 The benefits of patterns

It is claimed more research is needed to investigate the benefits, or *usefulness*, of patterns (Dearden et al., 2006; Wania, 2008; Ruud, 2009). Although some studies have been conducted to examine this, they are still relatively few, both within HCI and other disciplines such as architecture and SE. Additionally; patterns as a design aid are not always compared to alternative means, such as guidelines, standards, claims or principles. Instead, the use of patterns is not compared, or it is compared to nothing (Dearden et al., 2006).

2.4.4.2 The use of patterns

Are patterns used by professionals? If so, how are they used? These questions are hardly addressed (Dearden et al., 2006; Kruschitz et al., 2010). Instead of longitudinal observations on the use of patterns in "real world situations," the use of patterns is often studied in artificial settings, such as controlled experiments (Dearden et al., 2006; Bernhaupt et al., 2009a; Bernhaupt et al., 2009b). Previous work is also criticized for having focused on the use of patterns in early iterations of a design process; more research is needed on patterns in later iterations (Wania, 2008).

2.5 Summary

Patterns are a way of documenting successful design solutions. Adapted from architecture and SE, patterns have gained interest within the field of HCI. There are some challenges with patterns, of which the biggest is the lack of evidence for their benefits when used. Furthermore, there is lack of knowledge on how they are used (Dearden et al., 2006). Consequently, this thesis will be focused on these issues.

3 Related work

This chapter was delivered as an assignment in an independent study course at the University of Baltimore, USA, in the spring 2011 semester. The assignment constituted 50 % of the course workload. The course itself constituted 7.5 ECTS, i.e., 25 % of a full semester workload. The course is not included in the credits of the MSc degree which this thesis is a part of.

3.1 Potential types of benefits

Several aspects are related to the *benefits of patterns*. It is assumed *benefits* are related to what extent patterns are *useful* or *helpful*. However, as discussed above, there are several suggested benefits with patterns. In reviewing four collections of quality criteria for patterns (Borchers, 2001; McGee, 2007; Khazanchi et al., 2008; Niebuhr et al., 2008), Wurhofer et al. (2009) proposed what they called "a Comprehensive Quality Criteria Framework for Validating Patterns," consisting of five quality criteria with sub-criteria for patterns. The top-level criteria are "findability," "understandability," "helpfulness," "empirical verification" and "overall acceptability." *Helpfulness* has the following quality sub-criteria (Wurhofer et al., 2009):

- **Improvement of design/architecture**; a pattern should help the development or improve the design of an application.
- **Problem solving**; a pattern should help the user avoid common problems.
- **Support of communication**; a pattern should provide a common basis for designers, developers and researchers and thus support (interdisciplinary) communication.
- **Capturing of knowledge**; a pattern should capture previous knowledge and this knowledge should appear relevant to the pattern user.
- **Memorability**; a pattern should be easy to remember.
- **Feasibility**; a pattern should be easy to implement in practice.

Thus, helpfulness is presented as a multi-faceted term. According to the quality criteria framework, patterns should fulfill all the sub-criteria in order to be considered helpful (Wurhofer et al., 2009). This thesis will however be focused on the *improvement of design/architecture* sub-criterion. This sub-criterion was selected based on suggestions in previous research. Here it was recommended to test whether the UX patterns are useful in practice. An experimental design was also suggested. The design focused on investigating designers' performance when using patterns or not (Ruud, 2009). The setup suggests that it by usefulness was meant the impact of patterns on task performance, i.e., whether patterns can cause "improvement of design/architecture."

It was assumed a high-quality pattern should be supportive in all stages of a design process in order to fulfill the "improvement of design/architecture" quality sub-criterion. The scope of this thesis will however be focused on a certain part of a design process. *The early stages* part was selected, because the UX patterns are designed to be "inspirations for design" (Obrist et al., 2010). Thus, it was thought it would be interesting to see whether they work as intended in the early stages of a design process where inspiration is most needed. A general research question was consequently: *Do patterns improve design/architecture in the early stages of a design process?*

3.2 Method

A systematic search for related work was performed in May 2011. A protocol for the search was developed based on a set of recommendations for systematic literature reviews in the domain of SE (Brereton et al., 2007). Searches were conducted in Google Scholar, IEEE Explore, ACM Digital Library and Citeseer Library, as recommended (Brereton et al., 2007). The following criteria for acceptable literature were used:

- Findings must relate to patterns in HCI
- Findings must be based fully or partially on data from patterns being used by designers
- Findings must relate to
    - Whether patterns improve design quality
    - Whether patterns benefit a design process
- Findings must not relate to

    - Whether patterns support communication in the design process (as "support of communication" is a separate quality sub-criterion in the framework)
- Findings must relate to early stages of a design process (thus, findings from patterns used for evaluation and redesign should be rejected)
- Findings must relate to patterns in general, i.e., the research must not report findings solely relevant to one specific pattern or pattern collection

The following queries were used in Google Scholar (with quotes):

- "Design pattern" quality HCI
- "Design pattern" eval* HCI
- "Design pattern" creativity HCI
- "Design pattern" benefit HCI
- "Design pattern" help* HCI
- "Design pattern" useful* HCI

As a pilot search indicated the other three engines gave fewer results, the set of queries was modified to be more general:

- "Design pattern" HCI

The queries gave a total of 8,856 results (however, some articles appeared as results in multiple engines). Five of the queries gave more than 1,000 results in Google Scholar, but only the 1,000 first could be displayed, due to restrictions in the engine. Therefore, the number of results was reduced to 5,956. The procedure followed with number of publications per step is described in Table 1. When finished, 15 publications remained, presented in Appendix A.

Table 1 Steps for identifying publications (based on Brereton et al. (2007))

Step number	Step description	Total number of publications identified at this step
1	Perform searches based on query list	8,856/5,956
2	Consider relevance from title. Reject if irrelevant. Accept if relevant or in doubt.	83
3	Consider relevance from abstract and conclusion. Reject if irrelevant. Accept if relevant or in doubt.	20

4	Consider relevance from complete article. Reject if irrelevant. Accept if relevant or in doubt.	11
5	Read reference list and “cited by” list. Perform steps 1-4 for identified publications.	14
6	Finally add known, non-identified articles and perform steps 1-4 for these as well.	15

3.3 Do patterns improve design/architecture?

In the following, identified studies conducted to investigate whether patterns improve design/architecture in the early stages of a design process are presented.

3.3.1 Controlled experiments

A method used to investigate whether patterns generate better design is to conduct a controlled experiment. Controlled experiments are presented in Box 1. Six controlled experiments were identified, presented in Table 2.

Box 1 Controlled experiments

Controlled experiments are commonly used when the researcher wants control over the situation, so that behavior can be manipulated directly, precisely and systematically. In an experiment, two or more treatments are usually used to compare an outcome by the means of quantitative analysis. Experiments can be used to investigate different aspects, such as to test hypotheses, to validate measures and confirm relationships (Wohlin et al., 2000).

Table 2 Designs of identified experiments conducted to explore whether patterns improve design/architecture in the early stages of a design process

Study ID	Publication(s)	Subjects	Task duration	Groups	Pattern familiarization technique	Task
1	(Chung et al., 2004)	Nine design pairs, novice and experts	80 min.	▪ Patterns[1] ▪ Nothing	Participants provided with patterns two days in advance	Design a location-enhanced service for a shopping mall
1	(Chung et al., 2004)	Seven design pairs, novice and experts	80 min.	▪ Patterns ▪ Nothing	▪ 15 min exploration of patterns ▪ Quiz	Design a location-enhanced service for a shopping mall
2	(Lin, 2005; Lin et al., 2008)	Eight designers, >5 years of experience in the industry	90-120 min.	*Within subjects:* ▪ Patterns (and layers) ▪ Nothing	▪ Demonstration ▪ 15 min exploration ▪ Quiz	Design an online music/book store for the desktop and smartphone
3	(Koukouletsos et al., 2006; Koukouletsos et al., 2009)	39 individual students	120 min.	▪ Patterns ▪ Guidelines	Teaching through design patterns or guidelines	Design a small, one-level deep website
4	(Saponas et al., 2006)	22 design pairs, >2 years of experience in the industry	120 min.	▪ Patterns ▪ Nothing	▪ Instructional video ▪ 10 min exploration ▪ Quiz	Design a solution for a home food inventory system
5	(Wania, 2008; Wania et al., 2009)	52 individual students	19-23 min.	▪ Patterns ▪ Guidelines ▪ Nothing	▪ Card sorting of patterns ▪ Review of guidelines	Design an information retrieval system for a library
6	(Cowley, 2009)	33 individual students	One week	▪ Patterns ▪ Guidelines	Participants got suggestions on applicable patterns	Design a new E-commerce website

[1] Chung et al. (2004) and Saponas et al. (2006) used in fact *pre-patterns*, i.e., patterns that "are still emerging and

3.3.1.1 General experimental procedure

A common procedure has been to assign a design task to a group of participants, split into two or more groups. One of the groups is asked to complete the task by the help of patterns and another group is to complete the task with the help of either alternative means, such as guidelines (Koukouletsos et al., 2006; Wania, 2008; Cowley, 2009; Koukouletsos et al., 2009; Wania et al., 2009), or nothing (Chung et al., 2004; Saponas et al., 2006). One study had three groups; a patterns group, a guidelines group and a control group (Wania, 2008; Wania et al., 2009). One study had a within subjects design, where designers first solved a task with patterns and then solved a similar task without patterns on a later occasion (or vice versa) (Lin, 2005; Lin et al., 2008). Data on participants' perceptions and use of patterns have also been gathered by the means of questionnaires, interviews and project diaries.

Both students and professional designers have been recruited as subjects. Subjects have solved the tasks both in pairs and individually. Designers in patterns groups were typically given some time before the tasks in order to familiarize themselves with the patterns or guidelines. In one study, patterns were provided before the experimental session (Chung et al., 2004). In some of the studies, participants had to answer a quiz about patterns as well (Chung et al., 2004; Lin, 2005; Saponas et al., 2006; Lin et al., 2008). The duration of the experiments varied between on average 19-23 minutes (depending on participants' group belonging) (Wania, 2008; Wania et al., 2009) and one week (Cowley, 2009). Participants were asked to design a variety of different applications, but all studies had tasks designed to fit the domain of the patterns provided.

3.3.1.2 Heuristic evaluation

After the experimental sessions, the qualities of the resulting artifacts, such as designed prototypes or video recordings of participants' presentations thereof, were judged and rated with heuristic evaluation (the method is presented in Box 2). Then the ratings were compared to identify statistical significant differences across groups and thus get an indication on whether patterns improved design quality. Table 3 summarizes how heuristic evaluation has been used in previous pattern experiments.

Box 2 Heuristic evaluation

Heuristic evaluation is an analytical evaluation method which is based on common-sense knowledge and usability guidelines and standards (Sharp et al., 2002). Suggested strengths are that potential end users of the evaluated product do not have to be involved. Instead, an expert evaluates a product based on the person's theoretical knowledge and practical experience with design of the products, as well as a set of heuristics. To this end, the method is relatively cheap, it is applicable to early design stages and does not require advanced planning (Nielsen et al., 1990). A drawback is however that findings sometimes turn out not to be as accurate as they seemed at first (Cockton et al., 2001, cited in Sharp et al., 2002). Three to five evaluators are recommended (Nielsen et al., 1990).

Table 3 Heuristic evaluation of design quality in pattern experiments

Study ID	Study reported in	Evaluators	Evaluation measures
1	(Chung et al., 2004)	Three HCI graduate students	Presentations of designs were evaluated. Creativity, completeness and quality rated on a seven-point scale.
1	(Chung et al., 2004)	One student and two researchers	Ten statements to be rated on a seven-point Likert scale. Presentations of designs were evaluated.
2	(Lin, 2005; Lin et al., 2008)	Each design evaluated by three professional designers, randomly selected from a pool of 12 or 18 designers	Layout of pages, linking between pages and overall rating to be rated on a five-point Likert scale.
3	(Koukouletsos et al., 2006; Koukouletsos et al., 2009)	Three academics with web design experience	Predetermined set of measures to be rated on either a 0-9 scale, or a different scale which at the end was converted to 0-9.
4	(Saponas et al., 2006)	Three experienced evaluators	Heuristics compiled based on three sets. Heuristics were evaluated through expert review and pilot test. Subjective evaluation of each design, rating detail, completeness and quality on a seven-point Likert scale.
5	(Wania, 2008; Wania et al., 2009)	Two professors in HCI	Ease of use, detail, completeness and overall quality rated on a seven-point Likert scale.
6	(Cowley, 2009)	Two usability experts	Various heuristics to be rated with

N/A or on a five-point Likert scale.

Evaluators recruited for previous experiments have had various professional titles such as professors, academics, students, designers, usability experts and researchers. The heuristics previously used had different degrees of complexity ranging from relatively simple statements to be rated (Chung et al., 2004) to more complex heuristics (Saponas et al., 2006). The more complex heuristics were based on other heuristics and were subject to evaluation before they were used to assess the gathered designs. Three evaluators were used in all but two studies (Wania, 2008; Cowley, 2009; Wania et al., 2009); in which two evaluators were used. Lin (2005; Lin et al., 2008) recruited 18 and 12 evaluators to the respective phases of their study, but ensured each gathered design was only evaluated three times. The numbers of points on the scales used to rate designs were five, seven or ten.

3.3.1.3 Findings from controlled experiments

Chung et al. (2004) recruited eight expert and ten novice designers. Designers were grouped in pairs and pairs were split in two categories based on experience. They were also split in two conditions, one with patterns and one without. In the first round, they found that design pairs who were provided with patterns on average performed better than those who were not, in measures on "creativity" and "completeness." The situation was the same among novice designers for the "quality" measure, while no such difference was identified among designers with high experience. None of the differences were statistically significant; "possibly due to the low number of judges and low number of participants" (Chung et al., 2004).

The patterns and experimental design were slightly modified before the second round. Participants were given time to read through the patterns right before the experimental session and they were asked to answer a quiz about them. Furthermore, the heuristic evaluation was done differently, as explained in Table 3. Seven design pairs were recruited, of which six were given patterns. Measured design quality was then compared to the qualities of the pairs in the control group of the first round and the single pair without pattern in the second round. Some differences between groups were statistically significant on the $p < 10$ % level, although most of them were statistically non-significant. The authors explained that evaluators for seven of ten measures rated novice designer pairs with patterns lower than those without. Experienced pairs with patterns were however rated higher than or equal to those without. Nevertheless, the biggest differences were observed between high and low

experienced design pairs, rather than which condition participants were in. The authors noted a possible interpretation was that having experience is more important to performance than patterns, but that experts know how to apply patterns and therefore have more benefit from them (Chung et al., 2004).

Lin (2005; Lin et al., 2008) developed a prototyping software allowing designers to design interfaces for various devices. The software had 90 predefined patterns from "The Design of Sites" pattern collection (Van Duyne et al., 2002). Of these, 11 patterns were within the tool extended to fit multiple devices. Furthermore, designers could use layers to specify which parts of the interface were common across devices and which were device specific. The author conducted a within-subjects experiment in two rounds. In the first round, eight designers were asked to individually solve two similar tasks related to designing interfaces for various devices by using the software. Four participants solved the first task with patterns and layers enabled, while they solved the second task without patterns and layers. The remaining participants did it vice versa. A similar setup was used for the second round of the study, this time with four participants. A variety of measures related to layout, the use of links, completeness, overall rating and perceived skill of the designer were used for quality evaluation. For three of the measures, statistical significant differences were identified on the $p < 5\ \%$ level. The three measures related to overall rating, layout of shopping cart/checkout and completeness. The authors reported the lack differences for the other metrics perhaps was because the aspects were easy to address without using patterns, or because they were not well covered by the 11 patterns extended to fit multiple devices (Lin et al., 2008).

Saponas et al. (2006) recruited 44 professional designers and split them randomly into a patterns group and a control group of 11 design pairs each. The gathered designs were evaluated objectively (i.e., by identification of different issues) and subjectively (i.e., by judging "quality," "detail" and "completeness"). The authors found that the patterns group had fewer heuristic violations than participants in the control group. Participants in the control group, however, had a higher level of detail than the patterns group, which Saponas et al. reported to be a surprise (2006). The authors concluded patterns aided in creating higher quality designs and helped designers in generating ideas and get specific information for the tasks they solved.

Koukouletsos et al. (2006; 2009) split 39 students in two comparable groups based on how they scored in a pre-test. They taught one of the groups with patterns, while the other was taught with guidelines. Then the students were given a design task, which they completed under controlled conditions. The authors had three evaluators judge the designs based on a defined set of measures, split into categories. The measures were designed to assess "the degree to which they followed design principles and advice given by the patterns/guidelines used in the tutorial" (Koukouletsos et al., 2009). The authors found that the patterns group scored better than the guidelines group in all but one category labeled "lists." For "lists," the guidelines group scored better[2]. Overall, the patterns group performed better. The difference was statistically significant on the $p < 5\ \%$ level, in favor of the patterns group.

Wania (2008; Wania et al., 2009) recruited 52 students to individually perform a design task, aided by patterns, guidelines or nothing (a control group). The gathered artifacts were evaluated by two evaluators on four measures. For all measures, including "overall quality," the patterns group scored on average better than the guidelines and control groups. The authors did however report the differences were small and non-significant on the $p < 5\ \%$ level. Nevertheless, they believed patterns are helpful and suggested a shift of focus and thinking for future work. They brought forward it should be investigated whether patterns have an impact on *the design process*, rather than solely the design product.

Cowley (2009) used stratified sampling to split 33 students into two comparable groups. The author had subjects perform three different tasks with patterns or guidelines, including evaluation, redesign and design from scratch. Participants spent one week on the design from scratch task and the task was submitted by 28 of the 33 students participating. Subjects in the patterns group scored on average higher than those in the guidelines group, but the difference across groups was statistically non-significant ($p = 44\ \%$ for one-tailed case, $p = 89\ \%$ for two-tailed case). The author also found that the patterns group scored better than the guidelines group statistical significantly on a redesign task ($p = 4\ \%$ for one-tailed case, $p = 8\ \%$ for two-tailed case). The author concluded "[p]atterns should […] be used for early

[2] The publication is contradicting regarding the name of the category in which the guidelines group scored better. The verbal text says the category is named "links," while a table shows that the category is labeled "lists." The table provides different data for the "links" category. As the name of the category was considered irrelevant, the contradiction was not further investigated. Instead, results presented in the table were used.

conceptual design and later physical design, as this could produce better conceptual models and physical designs" (Cowley, 2009).

3.3.2 Case studies

Another way to examine whether patterns can improve design/architecture in the early stages of a design process is to conduct a case study to investigate whether patterns improve design. For a presentation of the case study methodology, see Box 3.

Box 3 Case study

In a case study, the case is studied in depth by methods like observation, interviews and document analysis. The interest in a particular case can be grounded in the uniqueness of the case or because the case is seen as representative for a group. The former has been called intrinsic case studies and might be harder to generalize from than the latter, called instrumental case studies. An instrumental case study can even be extended to include several cases and is then called multiple case study or collective case study (Stake, 2005).

Some case studies were identified, but many were based on the researchers' own experiences with patterns, rather than designers'. Several were dealing with redesign rather than design from scratch. Therefore, the studies were not accepted according to the requirements presented initially and the list of case studies was reduced to one study.

In exploring three ways of using patterns in education, Griffiths et al. (2004) did small-scale exercises teaching HCI design principles through the patterns in the "Common Ground" pattern language (Tidwell, 1999). The authors reported the qualities of design products were considerably improved after they started using the patterns. They also stated their findings were informal and referred to them as an impression. Hence they noted the validity of their finding was limited.

3.3.3 Discussion

Dearden et al. (2006) suggested the effectiveness of patterns should be evaluated. The general tendency in previous research seems to be that designers provided with patterns perform better than designers without patterns, but not always significantly better. Still, some

noteworthy differences have been identified in favor of patterns (Chung et al., 2004; Lin, 2005; Koukouletsos et al., 2006; Lin et al., 2008; Koukouletsos et al., 2009).

Identifying statistical significant difference is generally difficult when sample sizes are small. This is a possible explanation to the lack of evidence for the effects of patterns. However, there are other potential explanations. A general critique can be raised to some of the identified experiments. Whilst some of them were designed to ensure participants familiarized themselves with the patterns before they started designing, *they were not always planned to guarantee participants actually read the patterns before or during the design process*. While a quiz was used in some studies, participants' quiz scores were not reported. Furthermore, some authors reported participants referred the patterns to a various degree (Lin, 2005; Saponas et al., 2006; Lin et al., 2008). It is possible to imagine an extreme situation, where some participants did not refer to the patterns at all, while others referred to them frequently. A consequence of this is that the participants received different amounts of treatment. This could have reduced the reliability of the implementation of treatment, which is a threat to conclusion validity (Wohlin et al., 2000).

In favor of this critique is the fact Chung et al. (2004) identified more statistical significant differences between groups after they introduced a quiz to their experimental design. Koukouletsos et al. (2006; 2009) taught students with patterns and guidelines. As this was done by the authors themselves, it is assumed the knowledge captured in the patterns and guidelines was actually transferred to participants through the selected means. Koukouletsos et al. (2006; 2009) did also identify statistically significant differences between groups. A possible explanation is that it was the only study in which researchers could control that knowledge was transferred; thus they ensured participants properly received treatments. Lin et al. (2008) reported participants used on average eight of the 11 multi-device patterns and they also found some significant differences in favor of patterns. This may indicate patterns may improve design/architecture when they are familiar with them.

In contrast, Wania (2008; Wania et al., 2009) did not identify any difference, although participants were asked to review guidelines or sort patterns before they solved a task. It is likely participants familiarized themselves with the means through this process. The study can, however, be criticized for not being realistic, which is a threat to external validity (Sjøberg et al., 2003): Participants were asked to design an information retrieval interface. It

is likely they were already familiar with such interfaces through the use of popular search engines like Yahoo! and Google. Thus, students were probably familiar with the domain which they were asked to design for. It is likely they could easily recall recurring design practices and design the interface based on those, rather than on the patterns or guidelines. This was also noted by the authors. It may indicate the participants were not given a representative task, but an excessively "toy task." Additionally, participants were not given any maximum time limit to design the interfaces, but spent on average 19-21 minutes to complete it (depending on which group they belonged). The short duration also supports the "toy" nature of the task in this study.

3.4 Research question revisited

Based on her own and previous research, Wania (2008; Wania et al., 2009) suggested a shift in thinking when investigating the impact of patterns. One of her suggestions was to shift from exclusively examining the impacts patterns may have on the final product to also exploring the impact of patterns on *the process* that leads to the product. Thus, the question "Do patterns improve design/architecture in the early stages of a design process?" can be extended to "Do patterns improve a design process?" While this question raises a range of questions relating to what is a design process, what constitutes an improvement to a design process and how can it be measured, the question also raises a more fundamental question: How are patterns used during a design process? Based on this, the following questions were proposed:

- To what extent are patterns used?
- How are patterns read?
- How can pattern reading benefit a design process?

Some of the research conducted in this respect is presented in the following.

3.4.1 To what extent are patterns used?

To introduce this sub-section, it should be noted Kruschitz et al. (2010) did what they believed was the first online survey to investigate whether HCI design patterns are really used in the industry. Although the findings were based on data from a survey, rather than observation of actual pattern use, it is included in this review, as it gives some indication on

use of patterns. A total of 311 respondents were recruited through various mailing lists with relevant topics (HCI, SE, etc.). Among those, 286 were completely filled out. Of the completed responses, 59.79 % said they had previously used or were using patterns, of which 67.86 % were working in the industry.[3] The findings of Kruschitz et al. (2010) are interesting, but respondents were not asked to what extent they used patterns. They were only asked whether they used them or not.

In the controlled experiment of Saponas et al. (2006), it was found that design pairs spent on average 26 minutes (standard deviation = 9 minutes) of the 120 minutes provided on pattern reading. The authors reported this represented 11 % of their total design time. One outlier was identified; this pair spent three minutes on pattern reading. Saponas et al. (2006) also found that 70 % of what they called "idea generation" pattern use instances (the act of looking through patterns to discover ideas which may assist in solving high level design problems (Saponas et al., 2006)) were actually realized in the final designs.

The approach of Saponas et al. (2006) is interesting. Professional designers were recruited and data were gathered while tasks were being performed, rather than in retrospect. Time spent on patterns seemed to vary to a relatively high extent.

Wania et al. (2009) took a slightly different approach. They examined whether the solutions and design principles explained in the patterns actually appeared in the prototypes gathered in their experiment. They identified patterns among all participants, but more patterns were identified in the designs made by participants in the patterns group than those in the guidelines and control groups. The difference was statistically significant on the $p < 5$ % level. The authors concluded "subjects who were exposed to a pattern language before a design task used more patterns than those who were introduced to design guidelines or those who received no intervention. But, subjects in all three conditions used patterns." (Wania et al., 2009)

[3] Contradicting findings are reported in the paper; thus, the author of this thesis has been corresponding with Kruschitz to have them clarified. In an email on May 7th, 2011, Kruschitz confirmed contradicting findings were reported due to a mistake. On May 10th, 2011, he wrote the findings presented in this thesis should be correct.

As previously noted, however, this study suffers from the "toy" nature of the problem, which threatens its external validity (Sjøberg et al., 2003). Thus, findings should be examined further, with representative subjects solving realistic problems.

Bernhaupt et al. (2009b; 2009a) conducted a field study in order to understand the practical implications of design patterns in organizations. The authors found that the patterns were used to a limited extent and explained this with the general usability of the pattern collection. Relevant patterns were hard to find, they could not be modified and the users had missing knowledge on what the patterns could offer in terms of solutions. They also suggested patterns should evolve to meet users' needs; otherwise they would not be used.

The study of Bernhaupt et al. (2009b; 2009a) is interesting, as it appears to be the only study of patterns used in a real-world situation. As it is the only study of its kind, more work is needed.

3.4.2 How are patterns read?

Two identified studies have reported findings relevant to this question. Díaz et al. (2009) performed an exploratory study to identify pattern reading goals and corresponding browsing strategies. A total of 21 students were recruited. They had 45 minutes to complete a design task by the means of patterns. They were asked to mark which patterns they applied. Data on browsing strategies were gathered in retrospect, with questionnaires and interviews. They identified three types of goals designers had while reading patterns:

- **Adhering to design goals**; this was the goal which designers had initially, while keeping the general goal of creating a usable interface in mind.
- **Looking for ideas**; designers browsed through the patterns with no defined goal.
- **Recreating similar systems**; some designers went through the patterns looking for services and structures they had seen being used before.

The authors also identified four different reading strategies:

- **Skim through information**; some participants looked for information on whether a pattern should be applied or not.
- **Flip through pages looking for images**; some participants used imagery (pictorial examples and visual representations of the solutions).

- **Read one-by-one**; some participants went through all patterns as a first strategy to identify candidates and look for ideas.
- **Use of category index**; some participants read the index as an initial strategy to identify candidates that matched their concerns.

They found the strategies were related to their design goals. For instance, if participants were "looking for ideas," they were more likely to "skim through information," whereas if they were looking for services and structures they had seen being used before (i.e., "recreating similar systems"), they were more likely to pay attention to visual representations of the patterns and thus apply the "flip through pages looking for images" strategy. Finally, if they were "adhering to design goals," they were more inclined to "skim through information" (Díaz et al., 2009).

The study of Díaz et al. (2009) is interesting, but lacks rigor as data on pattern reading were gathered in retrospect with interviews and surveys and not during the design process. Furthermore, students were recruited as subjects. Although students are more accepted in exploratory studies than those which seek to be externally valid (Sjøberg et al., 2003), they are not fully representative of the industry.

Cowley (2009) told participants they were required to use patterns and guidelines when designing a new website, but they did not provide instructions on *how* to do so. After having used patterns and guidelines, participants described their use in a questionnaire. By thematic analysis of responses from 14 participants, two different themes were identified:

- **Patterns-first patterns-based new design**; 50 % of the participants identified and reviewed patterns. Then they designed using the selected patterns.
- **Website-first patterns-based new design**; 50 % roughly designed some or all the elements required, by applying "pure" design knowledge. Then they identified patterns and continued designing.

The extensive study of Cowley (2009) is hard to criticize. It is however limited because designers were explicitly instructed to use patterns. This might have affected how they used them. Furthermore, subjects were students, not fully representative to the industry. Thus more research is needed.

3.4.3 How can pattern reading benefit a design process?

By mapping recordings of participants' screen to video recordings of subjects while designing and referring patterns, Saponas et al. (2006) attempted to do qualified guesses in order to investigate why participants referred to patterns while working on a design task. They piloted their method and concluded it was sufficient. The authors identified four activity categories:

- **Discovery**; participants looked through patterns in order to find applicable candidates to the design task. The category was recognized by quick browsing, done in the beginning of a design task.
- **Idea generation**; participants looked through patterns to discover ideas which may assist in solving high-level design problems.
- **Issue clarification**; participants read through a pattern to discover a specific solution to a specific and articulated problem.
- **Re-reference**; participants looked back to reference something encountered earlier.

It was also found "idea generation" and "issue clarification" constituted 31 % and 35 % of the instances respectively. "Discovery" and "re-reference" accounted for 17 % of the activity each. The authors concluded patterns "are not only effective in aiding in the generation of ideas, but designers are also able to go back to the pre-patterns to get specific questions answered" (Saponas et al., 2006).

Although Saponas et al. (2006) piloted their guessing method, it is possible their findings were inaccurate, as they still were based on guesses and not certainty. Thus more research is needed.

Some additional findings are valuable to understand how patterns can benefit a design process. Chung et al. (2004) reported patterns could be used as a checklist. Dearden et al. (2002b), Finlay et al. (2002) and Kruschitz et al. (2010) reported similar findings. Lin et al. (2008) mentioned patterns were considered beneficial among participants who used them extensively, because they could reuse design solutions from the patterns. Some of the participants in the study of Díaz et al. (2009) said they could pick up ideas from the patterns. Finally, pattern-using respondents in the survey of Kruschitz et al. (2010) believed patterns can speed up the design process.

3.4.4 Summary

Some authors have reported to what extent patterns are used, how they are used and the possible benefits pattern use may bring to a design process. Still, the external validity of these studies is threatened by having recruited students rather than professionals fully representative of the industry. Additionally, some studies are based on data which might be inaccurate, as they are based on surveys, interviews and qualified guesses. To this end, more research is needed to explore whether and how patterns are used and their potential support in a design process.

3.5 Summary of related work

Research has been conducted to explore whether patterns improve design/architecture. The studies have given contradicting results. Most of them suggested designers with patterns perform better, but not always significantly better statistically. Nevertheless, researchers agree patterns are supportive. A shift of focus has been suggested towards understanding the role of patterns in the design process, rather than their impact on the final product. In the continuation of this, it was asked: how are patterns used? Are patterns used? How can patterns support a design process? Some studies have been conducted in this respect, but their validities are threatened by the use of students and they are based on data which perhaps are inaccurate. Thus, more research is needed to understand how patterns are used in a design process and whether it is beneficial.

3.6 Research questions

Based on the review of related work, an exploratory study was proposed. Its goal was to better understand how patterns are read during the early stages of a design process and which benefits they may bring to it. It was thought such insight could give information on the effects of patterns (or lack thereof) on either a design process or a design product. Furthermore, it was thought it could provide information how to create patterns which facilitate how they are used. Finally, it was thought the insight could give directions for future full-scale studies. The following research questions were proposed:

- RQ1: To what extent are patterns read?
- RQ2: Which strategies exist for pattern reading?

- RQ2.1: Why do designers choose the particular pattern reading strategy that they use?
- RQ3: How can pattern reading benefit a design process?

4 Study 1

*Parts of this chapter were reported in an assignment in an eye-tracking course at the University of Baltimore, USA, in the fall 2010 semester[4]. The assignment constituted 35 % of the course workload. The course itself constituted 7.5 ECTS, i.e., 25 % of a full semester workload. The course is included in the credits of the MSc degree which this thesis is a part of. Parts which were fully or partially reported in the assignment are marked with a * symbol.*

4.1 Method

Based on related work, a controlled experiment with the following goals was conducted:

- To understand how patterns are used in a design process
- To understand how patterns can benefit a design process

The experiment was an exploratory study and used a *non-experimental design*. This is also known as a correlation or passive observational design (Shadish et al., 2002). It was aimed towards observing size and direction of a relationship.

4.1.1 Rationale for choice of method

A practical method was chosen because it was thought the research questions were best explored through observation of actual use of patterns, rather than interviews or surveys. Additionally, the specific UX pattern collection had not been evaluated practically prior and there was an articulated need for this (Ruud, 2009; Wurhofer et al., 2009).

[4] Assignment 5 - Personal project. See assignment description at http://iat.ubalt.edu/courses/idia750.185_fa10/assignments.html

Previous research has been criticized for exploring the use of patterns over short durations in artificial settings, instead of with longitudinal studies in realistic contexts (Dearden et al., 2006; Wania, 2008; Bernhaupt et al., 2009a; Bernhaupt et al., 2009b). It has also been suggested more comparative studies should be conducted (Dearden et al., 2006). These critiques can be applied to Study 1 as well. However it was assumed detailed and accurate insight in pattern reading could hardly be obtained in a real-world situation. An early iteration was chosen, because the UX patterns are created to be "inspirations for design" (Obrist et al., 2010). Finally, research questions did not address whether patterns are used in a different manner than other design means. Instead, it was sought understanding how patterns are used.

4.1.2 Participants and setting*

Table 4 Methods of recruiting participants

Recruiting method	M	F	Total
The author's social network	7	0	7
The author's academic network	1	3	4
Phone calls to design companies in Baltimore identified through Google Maps	1	0	1
Mailing list for interaction design professionals in the Washington DC area	1	0	1
In total	**10**	**3**	**13**

The participants were 13 professional interface designers (three females) with a minimum one-year experience in the industry. Recruitment procedures are listed in Table 4. Data were collected from all 13 participants. However, five of them (two females) were excluded:

- One participant was delayed and had therefore significantly less time to perform.
- One participant misunderstood tasks.
- There were technical problems with three participants, resulting in incomplete data.

After exclusions, Study 1 consisted of data from eight participants (one female). Demographic data are listed in Table 5. All participants in the following are referred to as "he," to ensure anonymity.

Participants individually attended experimental sessions at a usability lab at the University of Baltimore, USA. The experiment was conducted over six separate days distributed over a

period of two weeks in November 2010. Sessions took place at different hours determined by the subjects' availability. One to three subjects per day participated.

Table 5 Participants
Incl = Included participants; Excl = Excluded participants; All = All participants

	Age			Years of experience in the industry			Relevant education[5]			Self-reported pattern knowledge[6]		
	Incl	**Excl**	**All**	**Incl**	**Excl**	**All**	**Incl**	**Excl**	**All**	**Incl**	**Excl**	**All**
N	8	5	13	8	5	13	8	5	13	8	5	13
Mean	28.4	30.4	29.2	5.1	5.6	5.3	1.1	.6	.9	4.6	5.2	4.8
Min	23	26	23	1	3	1	0	0	0	1	1	1
Max	36	35	36	8	9	9	2	2	2	7	7	7
S.D.	4.1	3.6	3.9	2.7	2.7	2.6	.6	.9	.8	1.7	2.5	2.0

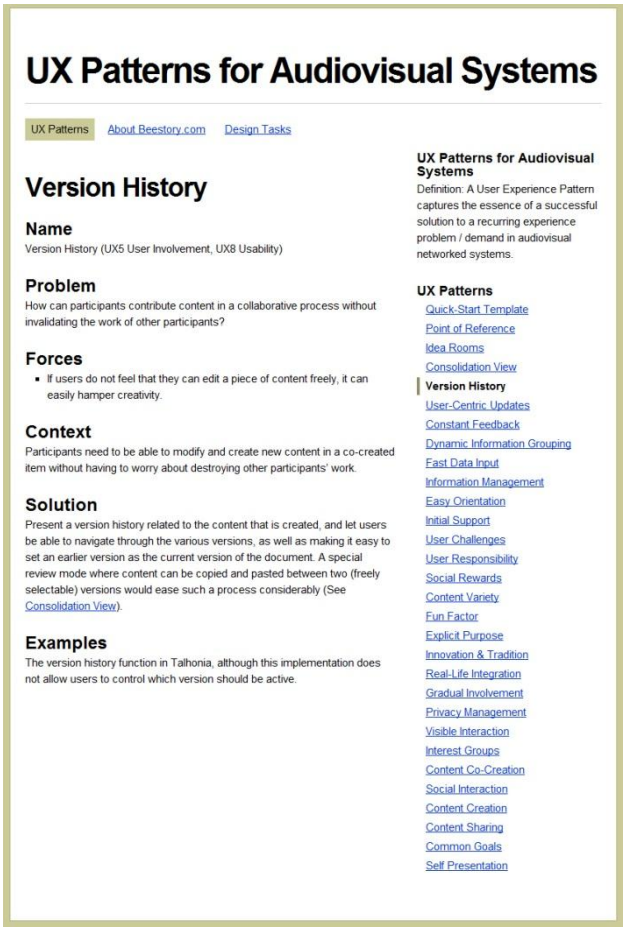
4.1.3 Treatment*

The treatment was the collection of UX patterns for networked audiovisual systems. The patterns were presented online, as shown on Figure 1, akin to the presentation format on the official collection website (Obrist et al., 2011).

[5] 0 = no education, 1 = undergraduate, 2 = graduate, with "some" or "a lot" of relevance to current profession.

[6] Participants were asked to rate the statement "I have designed with patterns before" on a 1-7 scale, 1 means false, 7 means true.

Figure 1 "Version History" – an example pattern



4.1.4 Data collection and supporting tools

4.1.4.1 Data on pattern reading

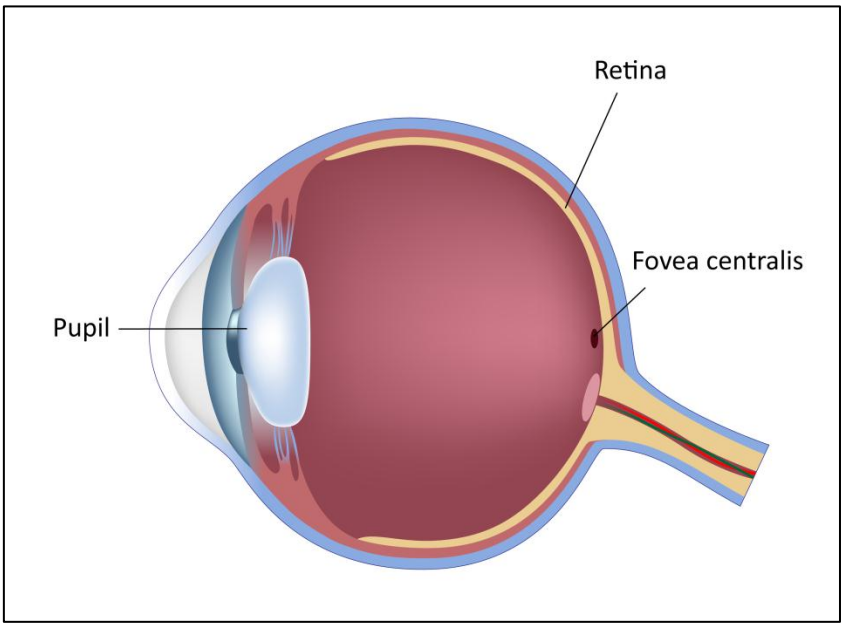
A more detailed and accurate insight in pattern reading was needed than previously obtained (Saponas et al., 2006; Díaz et al., 2009). *Eye-tracking* can be used to measure the direction of a person's gaze in order to examine his or her visual attention (Duchowski, 2007; Nielsen et al., 2009). The method has successfully been used in studies of reading behaviors (Rayner, 1998; Bednarik et al., 2007). Furthermore, it has been used in SE, which can be considered a relevant parallel to HCI. Here, eye-tracking is seen as a suitable method, as data can be collected while a task is being performed, rather than in retrospect (Kagdi et al., 2007; Guéhéneuc et al., 2009). Eye-tracking has also been used for usability studies (Ehmke et al., 2007; Nielsen et al., 2009). Based on these experiences and recommendations, eye-tracking was chosen. Eye-tracking data were gathered with a Tobii T60 eye-tracker with Tobii Studio 2.2.6 Enterprise edition eye-tracking software.

Eye-mind hypothesis

An assumption made with eye-tracking is that people look at what they find interesting (Duchowski, 2007). A challenge is that they are not necessarily thinking of what they are looking at. There is however a general adherence to the validity of the *eye-mind hypothesis*. It is assumed what a person is looking at indicates the thought "on top of the stack" of cognitive processes, although this cannot be guaranteed (Just et al., 1976). From the hypothesis, it was assumed the content of a pattern was "on top of the stack" of a person's cognitive processes as he read a pattern.

Eye-tracking terminology

Figure 2 The human eye[7]



This thesis uses some terms commonly used in eye-tracking:

- **Fixations**; ocular dwells, where the *fovea centralis* of the retina (see Figure 2) is stabilized over a stationary object of interest (Goldberg et al., 2002; Duchowski, 2007). The fovea centralis is responsible for our highest visual acuity.
- **Saccades**; rapid eye movements between fixations, used to reposition the fovea centralis to a new location (Goldberg et al., 2002; Duchowski, 2007; Kagdi et al., 2007).

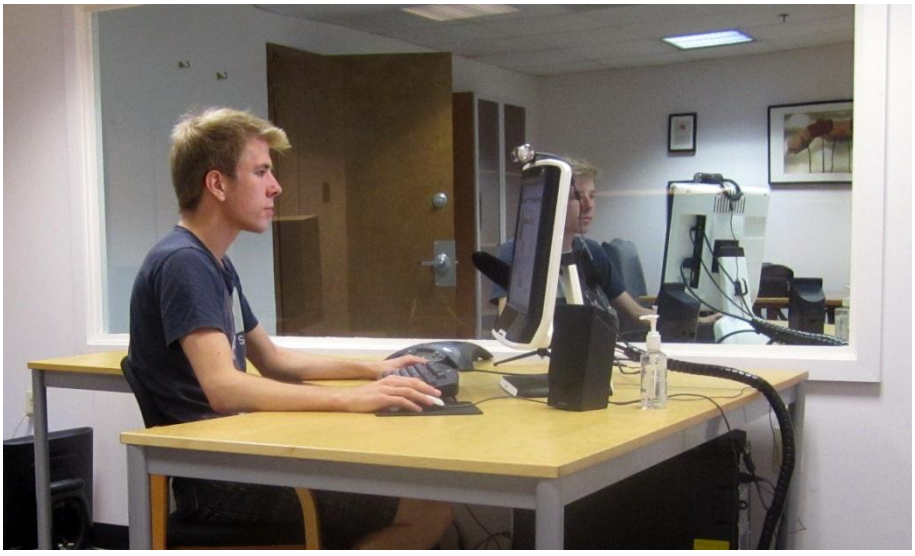
[7] The illustration was purchased from 123RF Stock Photos, http://www.123rf.com

- **Foveal vision**; the really high-resolution area of our visual field. It covers about 2 degrees of the field, which correspond to one or two words on a computer screen under normal circumstances. This is as much we are able to see clearly (Nielsen et al., 2009). The so-called "useful" visual field does however extend to about 30 degrees (Duchowski, 2007).
- **Peripheral vision**; the vast majority of our visual field, with crummy resolution (Nielsen et al., 2009). The resolution smoothly degrades within the periphery (Duchowski, 2007).

How modern eye-tracking works

A modern eye-tracker looks like a regular computer monitor, as shown on Figure 3. It takes advantage of the retina's ability to reflect infrared light much better than the rest of the eye. When the eye-tracker emits infrared light towards the eye, the light is reflected by the retina. Visual light is absorbed. Thus, the eye-tracker can identify the positions of the pupils and the direction of a user's gaze can be calculated with geometry (Nielsen et al., 2009). The foveal vision is recorded, through recording of fixations. A combination of fixations and saccades gives insight in scanpaths as well. Peripheral vision is not recorded.

Figure 3 The eye-tracking technology is built into the monitor; thus the computer works like a regular computer. The mirror on the wall is a one-way window



4.1.4.2 Other data collection methods

Demographic data were gathered through a pre-test survey. Questions are listed in Appendix B[8]. Designers used an Internet-connected PC running Windows 7 to read UX patterns and solve tasks. Tasks were solved in the software which each participant normally would use for wireframing. Qualitative data on participants' experiences with UX patterns were collected through a post-test survey and qualitative interviews, recorded to video. Appendix C lists the questions asked in the post-test survey and Appendix D provides the interview guide.

4.1.5 Tasks*

Participants were asked to design low-fi prototypes for an online community for people interested in the history of Baltimore city, named "Beestory." An online community was chosen, as the UX patterns are designed to address this kind of networked audiovisual systems. Requirements were open-ended, in order to encourage participants not to be too focused on them when designing. Based on previous research (Díaz et al., 2009) it was thought this could motivate subjects to use patterns instead. Requirements were linked to the UX factors which the patterns addressed, as shown in Appendix E. Four tasks were given to put pressure on participants, and thus increase realism, as recommended by Sjøberg et al. (2003) The tasks were:

1) Design the first page after login
2) Design a page where a user can create a new story
3) Design a page presenting a story from the past (for a logged-in user)
4) Design the user profile page for the user "John Doe"

4.1.6 Procedure*

Initially the participant was given practical information and a consent form to sign. The eye-tracker was calibrated and a pre-test questionnaire was filled out. A presentation about UX and patterns was given, in order to ensure the participant understood these concepts. The participant was then left to perform the design activities, which were monitored from a separate room, as shown on Figure 3 and Figure 4. After ~45 minutes of task solving, the

[8] *Age* and *relevant education* were re-gathered via email in retrospect, due to bad question wording in the initial survey.

participant was interrupted and asked to fill out a post-test questionnaire. This was followed by a ~15 minutes semi-structured qualitative interview about the design process and the participant's use of patterns. The full session lasted for ~90 minutes and is described in detail in Appendix F.

Figure 4 Participants' activities were monitored from a separate room. The screens displayed the participants' gazeplots and design activities

4.1.6.1 Modifications after pilot study

A pilot study was conducted prior to Study 1. It resulted in the following modifications, included in the procedure described in Appendix F.

- Participants were verbally encouraged to use patterns. This modification was done because the pilot participant did not understand he was expected to use patterns.
- Participants were told they were not expected to complete all tasks. This modification was done, as the pilot participant rushed, since he thought he had to complete all tasks.

4.1.7 Analysis model

In order to answer the above-stated research questions, quantitative data on performance gathered throughout "the design process" and qualitative data from interviews were analyzed. "The design process" was defined as the design activities related to Task 1, as this was the only task all participants worked on. Research questions were answered as explained below.

4.1.7.1 RQ1: To what extent are patterns read?

RQ1 was answered by investigating time spent on patterns and number of patterns read.

*Time spent on patterns**

In order to investigate time spent on patterns versus other design activities, eye-tracking data were manually logged. Activities on screen were split into four predefined categories.

- **Task solving**; opening design software, designing, saving files, web browsing, etc.
- **Pattern related**; pattern reading, pattern looking and pattern navigation.
- **Requirements reading**; reading or scanning of the text on the requirements page.
- **Task reading**; reading or scanning of the tasks.

Number of patterns read

In order to investigate number of patterns read, eye-tracking recordings were manually analyzed. Each instance of pattern reading was placed into one of the following categories.

- **Pattern visit**; the number of times a participant read or scanned patterns.
- **Unique pattern visit**; the number of unique patterns read or scanned by a participant. If a pattern was read more than once, it was only counted as one "unique pattern visit."
- **Pattern looking visit**; the number of times a participant looked at a pattern.

Patterns read or scanned were counted as "pattern visits" and "unique pattern visits." Examples of "reading" and "scanning" are shown on Figure 5. Patterns which were only "looked at" were counted as "pattern looking visits." These "looking" visits were identified by a few fixations and long saccades randomly spread out on a page. This behavior makes it difficult to obtain meaningful information from the text as information can only be visually obtained during a fixation (Rayner, 1998; Nielsen et al., 2009). Figure 6 shows examples on "looking."

Figure 5 Examples on “reading” and “scanning”
Dots represent fixations; dot size increases with fixation duration; lines represent saccades

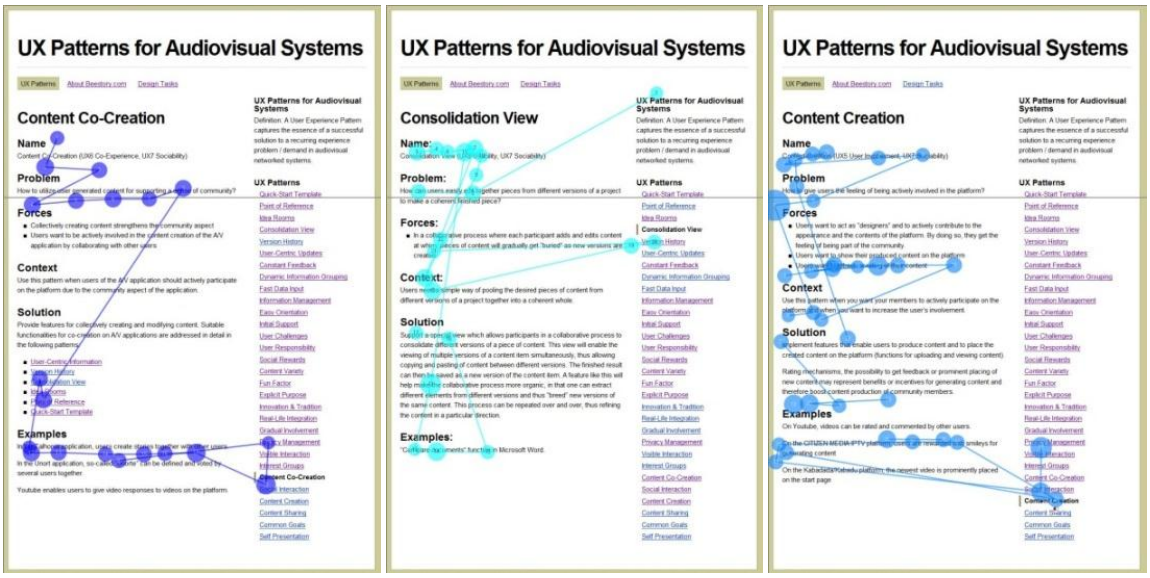
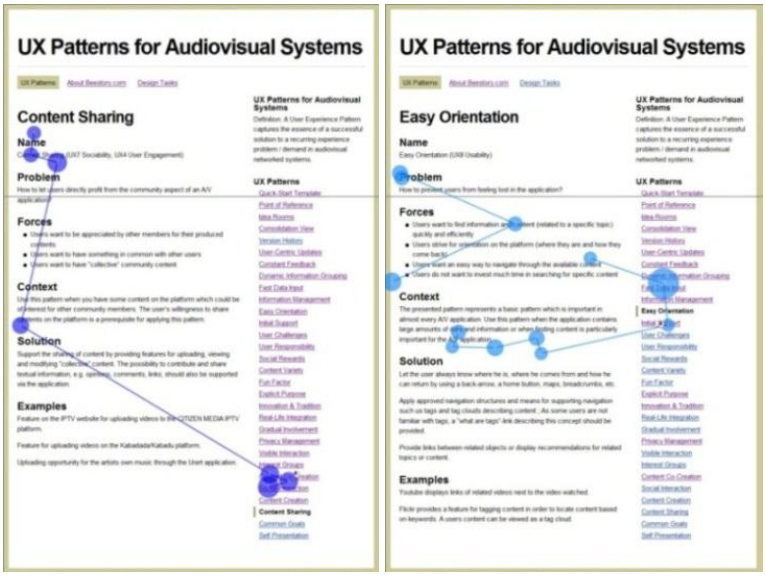


Figure 6 Examples on “looking”



4.1.7.2 RQ2: Which strategies exist for pattern reading?*

In order to answer RQ2, the logs from *time spent on patterns* (RQ1) were simplified. This was done by merging “task solving,” “requirements reading” and “task reading” into one activity labeled “task performance.” “Pattern related” was kept as a single category. The simplified logs were then visualized as custom-made timelines in Adobe Illustrator. The visualizations were grouped into strategy categories. The categories were not predefined.

4.1.7.3 RQ2.1: Why do designers choose the particular pattern reading strategy that they use?

In order to answer RQ2.1, video recordings of interviews were transcribed with HyperTRANSCRIBE 1.5.3 software. Then transcriptions were coded and re-coded with HyperRESEARCH 2.8.3 software. Codes were not predefined. While coding, transcriptions were triangulated with eye-tracking data. This was done in order to reveal potential mismatches between what subjects said they did and what they actually did, as recommended by Silverman (1998). Finally, codes were categorized, as described by Crang et al. (2007)

4.1.7.4 RQ3: How can pattern reading benefit a design process?

In order to answer RQ3, qualitative interviews with participants who used patterns were analyzed. This was done following the coding and categorization procedure described above.

4.2 Results and discussion

Time spent on Task 1 and total time given are listed in Table 6.

Table 6 Time spent on Task 1 and total time given

	Mean	S.D.	Min	Max
Task 1	37 min. 21 sec.	7 min. 29 sec.	27 min. 47 sec.	47 min. 54 sec.
Total	46 min. 50 sec.	3 min. 57 sec.	43 min. 23 sec.	51 min. 6 sec.

4.2.1 RQ1: To what extent are patterns read?

4.2.1.1 Results

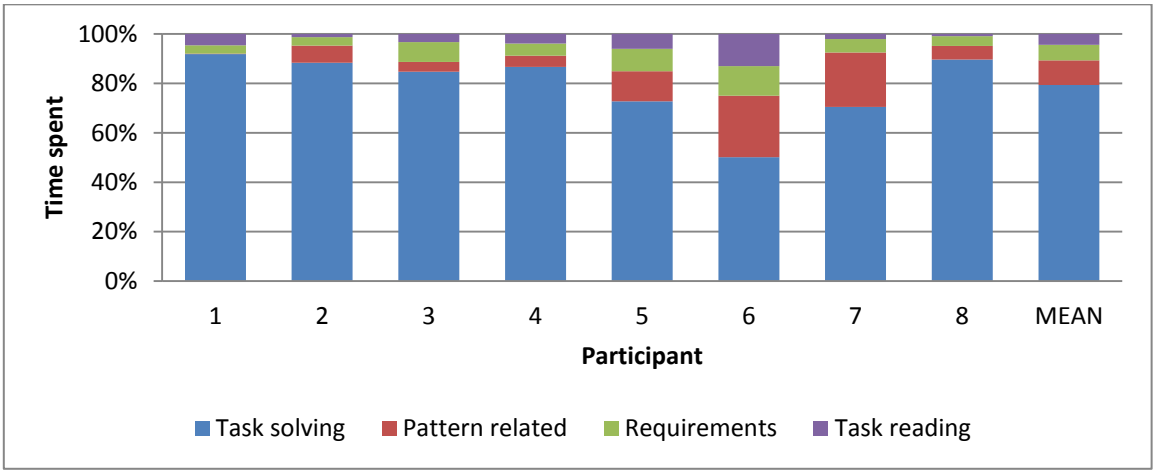
Time spent on patterns*

Time spent per activity for the whole group is listed in Table 7. Time spent per activity for each participant and the mean are shown on Figure 7.

Table 7 Time spent on various design activities for all participants

Activity	Mean	S.D.	Min	Max
Task solving	79.3 %	14.1 %	50.1 %	91.8 %
Pattern related	10.0 %	9.0 %	.2 %	24.8 %
Requirements reading	6.3 %	3.1 %	3.4 %	12.0 %
Task reading	4.4 %	3.9 %	.9 %	13.0 %

Figure 7 Time spent on different design activities per participant and on average[9]



Number of patterns read

Table 8 presents the results for the whole group. Figure 8 shows the results for each individual participant as well as the mean. "Pattern looking visits" are included to give an indication of the value of using eye-tracking to monitor pattern reading[10].

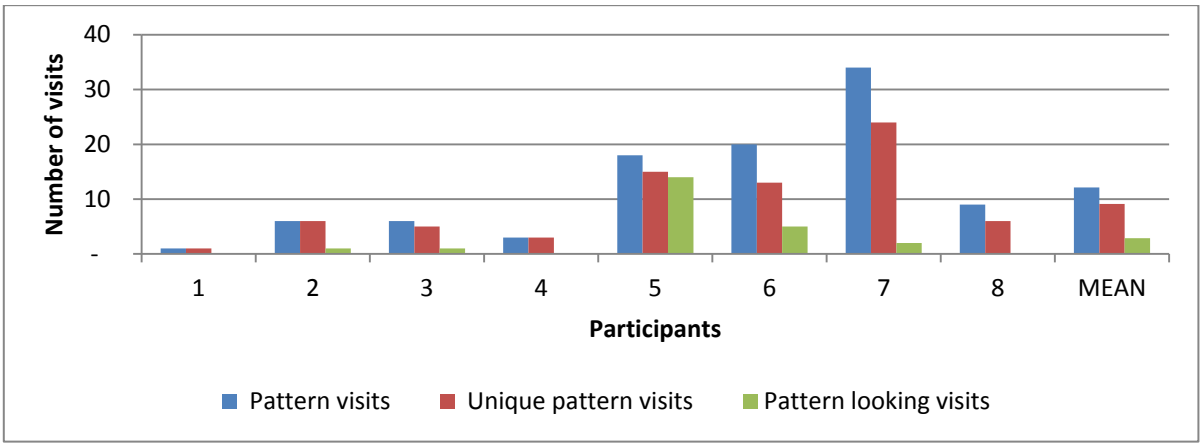
Table 8 Number of "pattern visits," "unique pattern visits" and "pattern looking visits" for all participants

Measure	Mean	S.D.	Min	Max
Pattern visits	12.1	11.1	1	34
Unique pattern visits	9.0	7.7	1	24
Pattern looking visits	3.5	4.7	0	14

[9] Participant numbers are based on the grouping presented in the next sub-section

[10] This is discussed in chapter 6 – "Other findings and lessons learned."

Figure 8 Number of "pattern visits," "unique pattern visits" and "pattern looking visits" per participant and on average



4.2.1.2 Discussion

On Task 1, participants spent on average 10.0 % of their time on pattern reading and they visited on average 9.0 unique patterns. They visited patterns on average 12.1 times. The range is large for both measures, as shown in Table 7, Table 8, Figure 7 and Figure 8. The means are similar to those in previous research. Although the distribution was large in previous research, it proved to be larger in Study 1 (Study 1: mean = 10.0 %, S.D. = 9.4 %; previous research: mean = 26 minutes/11 %, S.D. = 9 minutes (Saponas et al., 2006)).

Previous studies have disagreed on the effects of patterns on design quality. When conducting controlled experiments, it is important that subjects receive treatment similarly (Wohlin et al., 2000). Study 1 may suggest a possible reason to the disagreement is different use of patterns during the design process. When there is minor use of patterns, they can hardly cause major effects. Based on the results, future studies should expect a large variety of pattern use. When exploring whether patterns improve design/architecture or the design process, actual pattern use could potentially be taken into consideration.

4.2.1.3 Summary

Patterns were read to a varied extent; hence providing participants with patterns does not necessarily mean they will be used. Thus, the patterns can hardly affect neither design process nor design quality. This is a possible explanation to contradicting findings in previous research. A varied amount of pattern use should be expected when exploring potential effects of patterns.

4.2.2 RQ2: Which strategies exist for pattern reading?

4.2.2.1 Results*

Visualizations of simplified loggings with categories are shown on Figure 9. Identified categories with formal definitions are described in Table 9.

Figure 9 Visualizations of pattern reading in the design process
A = No reading; B = Quick orientation; C = Systematic orientation; D = As needed

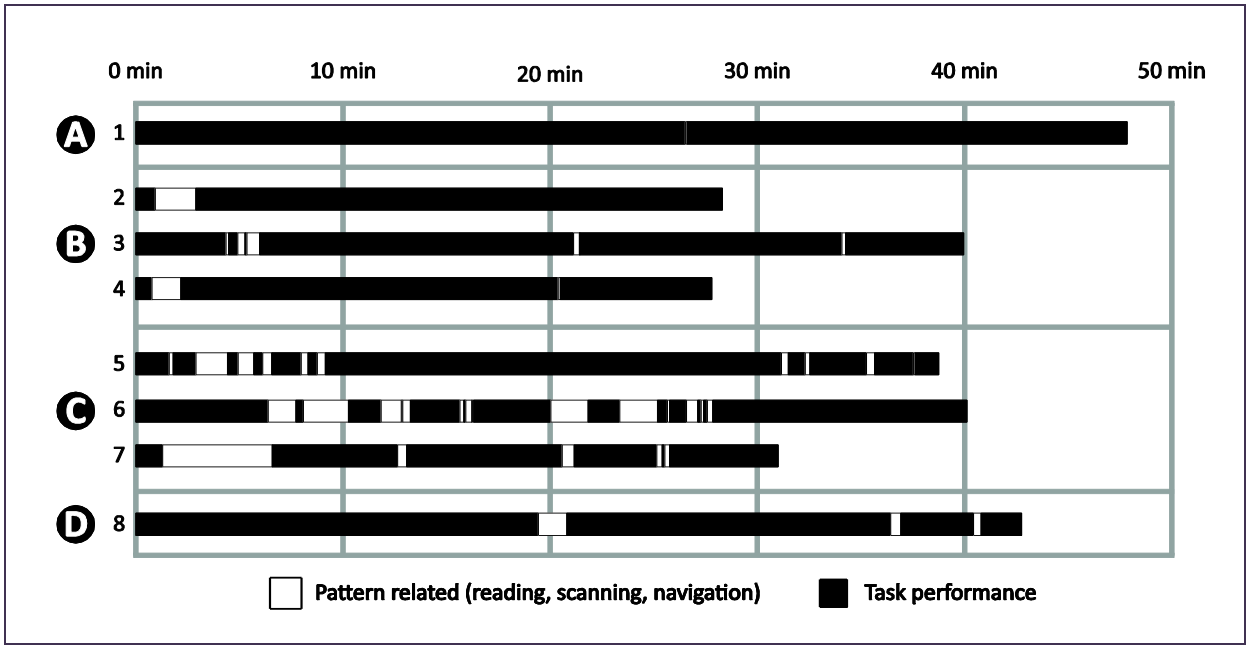


Table 9 Description of identified pattern reading strategies

ID	Strategy name	Formal definition	Description
A	**No reading**	Zero pattern visits during the first 15 minutes and less than three pattern visits after that.	The participant in this group (number 1) did not use the patterns in his design process. He read them only for 5 seconds, by reading one line of the IDEA ROOMS pattern very quickly and randomly in the middle of the process.
B	**Quick orientation**	Between one and six pattern visits during the first 15 minutes and less than three pattern visits after that.	Participants in this group (number 2, 3 and 4) read a limited number of patterns early in their design process. Then they decided to not refer to them again. Participant 3 referred the patterns a couple of times after the initial pattern reading, but eye-tracking data indicated none of the references were on purpose.
C	**Systematic orientation**	Seven or more pattern visits during the first 15 minutes.	Participants in this group (number 5, 6 and 7) went systematically through the patterns early in their design process. Some participants did this before they started

			designing. Others designed some basic page layout before they went through the patterns systematically. The participants referred the patterns again later in the process, akin to "as needed" as described below.
D	**As needed**	Zero pattern visits during the first 15 minutes and three or more pattern visits after that.	The participant in this group (number 8) worked heavily on the design tasks before he referred the patterns. Then he continued designing.

4.2.2.2 Discussion

Four pattern reading strategies were identified; "no reading," "quick orientation," "systematic orientation" and "as needed." Categorization of strategies made it obvious some subjects did not use patterns. One participant barely read them at all and three participants in the "quick orientation" group only referred to them very briefly in the beginning of their design process. The varied strategies supports what was brought forward: Different results regarding the impacts of patterns might be a result of varied pattern use. Variation in pattern use should be expected when exploring their impact and can be taken into consideration when doing so.

Quick and systematic orientation

Results indicate participants in the "quick orientation" strategy in fact planned to apply a "systematic orientation" strategy, but stopped reading patterns quite early and never referred to them again. This turned the chosen strategy into "quick orientation," and indicates the two "systematic" strategies are related. Six of the eight participants (75 %) used either of those strategies. The strategies fall under the "patterns-first" theme identified by Cowley (2009). For pattern reading, Cowley found however that 50 % chose "patterns-first" themes for the design from scratch tasks. The differences across studies can probably be explained from the sample sizes.

The "systematic orientation" strategy also overlaps with the "discovery" pattern use activity. This is defined by "looking through […] [the patterns] to determine what content might be relevant to the design task" (Saponas et al., 2006). Second, it overlaps with the browsing strategy named "read one-by-one" (Díaz et al., 2009). Here, participants "went through all the patterns as a first strategy to identify candidates and look for ideas" (Díaz et al., 2009). These two ways of using patterns are related, as both focus on the goal of *identifying patterns*. Thus, results from this study are consistent with several previous studies.

As needed and no reading

It is likely the participant who did not read patterns eventually would have applied the "as needed" strategy if there was more time to perform tasks. With this logic, it can be argued that two participants choose "as needed," if more time was given. This indicates the two strategies are related. "As needed" corresponds to the various "website-first" themes, identified by Cowley (2009). The distribution across studies is however different: While Cowley (2009) found that 50 % chose a "website-first" strategy for pattern reading, "as needed" was chosen by 25 % of the Study 1 subjects. The differences can probably be explained from the small samples. Thus, results from this study are consistent with previous work.

4.2.2.3 Summary

Four pattern reading strategies were identified; "no reading," "quick orientation," "systematic orientation" and "as needed." These made it obvious 50 % of the participants decided not to use patterns, as they chose either "quick orientation" or "no reading." This might explain the various impacts of patterns in previous research. A large variety in pattern use should be expected. The two orientation strategies were related and were chosen by a majority of 75 % of the participants. "No reading" and "as needed" were related as well and were chosen by 25 %.

4.2.3 RQ2.1: Why do designers choose the particular pattern reading strategy that they use?

Codes relating to RQ2.1 are listed in Appendix G.

4.2.3.1 "No reading" and "quick orientation"

Participants who chose the "no reading" and "quick orientation" strategies decided not to read patterns; consequently their rationales are presented together. Identified categories of rationales for not reading patterns are shown in Table 10 and discussed below.

Table 10 Rationales for not reading patterns

Participant number	Strategy	Rationale			
		Time consuming	Too early for patterns	Self-confidence	Lack of pattern knowledge
1	No reading	-	X	X	-
2	Quick orientation	X	-	X	X
3	Quick orientation	X	-	-	X
4	Quick orientation	X	X	X	X

*Time consuming**

Three of the four participants explained that they avoided the patterns because they thought it would be time consuming. The participants briefly referred the patterns, but decided not to read them more (they used the "quick orientation" strategy), as they thought the patterns were presented inefficiently:

- **No grouping.** Lack of pattern grouping made it hard to identify applicable patterns. This was also indicated by eye-tracking data. A high *number of fixations* indicates less efficient search (Goldberg et al., 1999; Ehmke et al., 2007). For several participants, high numbers of fixations were observed when searching for patterns. Lack of grouping was pointed out by participants who applied "systematic orientation" and "as needed" strategies as well.
- **Unclear names.** Designers explained it was hard to grasp the core of a pattern by reading its name; thus they had to read the verbal text in order to understand what a pattern was communicating.
- **No pictures.** Participants who chose the "quick orientation" strategy said they expected visual representations of the patterns. When they saw nothing but text, they decided not to use them. The demand for visual representations was pointed out by designers who applied the "as needed" and "systematic orientation" strategies as well. They said visuals would enable them to quickly grasp the core of the patterns. The interest in imagery is consistent with previous research (Dearden et al., 2002a; Dearden et al., 2002b; Finlay et al., 2002; Kotzé et al., 2006; Díaz et al., 2009).

The "time consuming" rationale indicates it is needed to better integrate patterns in the design process, so that they appear more beneficial. Results are consistent with previous research,

which has suggested patterns should meet pattern users' needs in order to be used (Bernhaupt et al., 2009a; Bernhaupt et al., 2009b).

Too early for patterns

Two of the four participants explained they probably would have referred to the patterns later in the design process, in order to evaluate and refine what they had designed without patterns. Until this stage, they would rather use their previous knowledge to solve the tasks.

This rationale indicates that the participants would have applied the "as needed" strategy if they were allowed to design for a longer period of time. If so, results from Study 1 may scale badly. This is a limitation with this study, to be discussed later. It supports recommendations given in previous research; future research should investigate the use of patterns in later iterations of a design process (Dearden et al., 2006; Wania, 2008).

Self-confidence

Three of the four participants decided not to use the patterns because they relied on their own capabilities in the early stages of the design process. They saw the patterns as a design manual presenting concepts they already were familiar with. One participant e.g. said "[i]t was much easier to just use my own knowledge of what I felt were best practices."

The "self-confidence" rationale does not relate solely to patterns. Instead, it relates to *design means* in general, including alternative means. It is e.g. unlikely the participant in the "no reading" group would have referred more to patterns if the contents of the patterns were presented in a guidelines or claims format, or in a more efficient way. He decided not to refer to them, as he was confident he could solve the task without reading. He did however explain he planned to refer to them on a later stage of the process, but he was interrupted before he got that far. Thus, the "self-confidence" rationale is perhaps related to the "too early for patterns" rationale. His plan also supports the suggested relation between the "as needed" and "no reading" strategies, as he would have chosen "as needed" if he could fulfill what he planned.

Lack of pattern knowledge

Finally, three of the four participants were uncertain about what is a pattern. They admittedly explained the unfamiliarity in the interviews and it was further demonstrated by how they incorrectly referred to the concept. One participant e.g. compared patterns to the online

documentation of a JavaScript library, which is a wrong comparison. Participants who lacked knowledge about patterns fell back to familiar design methods.

4.2.3.2 "Systematic orientation" and "as needed"

Identified categories of rationales for reading patterns are listed in Table 11. They are described below.

Table 11 Rationales for reading patterns

Participant number	Strategy	Rationale	
		Identify candidates	Look for ideas
5	Systematic orientation	X	-
6	Systematic orientation	-	X
7	Systematic orientation	X	-
8	As needed	-	X

Identify candidates

Two of the three participants who applied the systematic orientation strategy said they did so in order to get an overview, familiarize with the patterns and identify patterns which were applicable to what they were going to design. Some participants said, they matched the requirements with the patterns. The rationale was identified among two of the participants who chose the "systematic orientation" strategy.

Look for ideas

Two participants said they read patterns to look for ideas. The strategy was identified among two participants. Participant 8, who chose the "as needed" pattern reading strategy, said he referred to the patterns when he came to creative standstill. Eye-tracking data indicated the same; he referred the patterns when was about to add a new feature. Participant 6 said he used the patterns as a brainstorming tool. This is akin to the "idea generation" category, "evidenced by a designer looking through the pre-patterns to discover ideas which may assist in solving high-level design problems" (Saponas et al., 2006).

4.2.3.3 Summary and closing remarks

Some designers decided not to read patterns because they were presented inefficiently and because they were self-confident and unfamiliar with the pattern concept. They decided to work as they normally did. This may indicate the extent to which patterns are used to some extent depends on how the patterns are presented and how beneficial they appear to be. Pattern users who not quickly realize their potential are inclined not to use them. This is consistent with previous research (Bernhaupt et al., 2009a; Bernhaupt et al., 2009b). It brings forward what might be obvious and also noted in previous research (Kotzé et al., 2008); HCI patterns should be designed to be more usable.

Designers who read patterns did so either to identify candidates or look for ideas. To this end, the results tend to be consistent with previous findings, an in particular the "read one-by-one" category, in which patterns are read to identify candidates *and* look for ideas (Díaz et al., 2009). Identified rationales indicate patterns should be presented to facilitate these goals as efficiently as possible.

4.2.4 RQ3: How can pattern reading benefit a design process?

4.2.4.1 Results

Codes relating to this research question are listed in Appendix G. The following categories were identified:

- Idea generation
- Time saving

Idea generation

All four participants referred to the patterns as a tool which provided inspiration or *idea generation*. They saw the patterns as a collection of features which potentially could be included in the "Beestory" application. They said the patterns changed the way they were thinking about the task. For instance, one participant said the first iteration of his design would probably not have included game dynamics, but since "the patterns were available, it was a lot easier to […] quickly add them to [the application]."

Time saving

Some participants were referring to the patterns in ways which relate to *time saving*. First, patterns saved time because participants could easily rely on the proven solutions instead of spending time on reinventing and testing features. Second, patterns were considered as a reminder of what could be included in the application. When participants were asked if they thought they would have added the same features without using patterns, they explained they probably would have done so *in time*, when eventually thinking of them. However, as the patterns reminded them of those features in an earlier stage of the design process, they explained they saved time.

4.2.4.2 Discussion

Patterns appeared to be beneficial for generating ideas. This confirms previous research (Finlay et al., 2002; Chung et al., 2004; Saponas et al., 2006; Díaz et al., 2009). Furthermore, results indicate the UX patterns give inspirations for design, as intended (Obrist et al., 2010). Patterns may consequently be supportive in a design process, even though they not necessarily bring benefits to the final design product.

For "time saving," it can be distinguished between subjective and objective time saving. While subjective time saving is each designer's *perceived* time saving, objective time saving can be measured. Data from Study 1 suggested some participants saved time on the subjective level. Thus, Study 1 is consistent with previous research, which has found that designers believe patterns make them design faster (Kruschitz et al., 2010). There is however lack of objective evidence for this perception. This question was not addressed in this study. Previous research which has measured time to task completion has found no effects of patterns in this respect (Wania et al., 2009).

The "time saving" benefit is interesting, because participants who not read patterns said they did so as they thought it would be time consuming. On the other hand, participants who read patterns said they actually saved some time. This brings forward patterns should be presented so that *appear* to be time saving. If it is true that use of patterns save time, an efficient presentation can cause more designers to use them and thus save time.

Rationale and effect

As suggested by Table 11, participants who selected the "systematic orientation" strategy read patterns to identify patterns applicable to what they were designing. This category overlaps with "discovery" (Saponas et al., 2006).The same participants also said patterns gave inspiration. This is a different way of using patterns, as it overlaps with "idea generation" (Saponas et al., 2006). Thus, it appears that these categories worked simultaneously:

- Patterns were read to get an overview of what was available in a pattern collection; i.e., for "discovery" (Saponas et al., 2006).
- The patterns gave simultaneously the pattern user ideas of possible features to include in his design; i.e., they provided "idea generation" (Saponas et al., 2006).

A more thorough analysis of Study 1 data indicated that the difference between the categories was more obvious when it was distinguished between *rationale* and *effect*. Table 12 extends Table 11 with a column titled "Effects." From the table, it seems like the effect of pattern reading is *idea generation*. A potential effect in its continuation is *time saving*. It appears as if these effects are independent of rationale and selected pattern reading strategy. This shows patterns can benefit a design process albeit they are used differently. Furthermore, it indicates the UX patterns fulfill their purpose independently of how they are used.

Table 12 Rationales and effects of pattern reading

Pattern reading strategy	Rationales	Effects
Systematic orientation	▪ Identify candidates ▪ Look for ideas	▪ Idea generation ▪ Subjective time saving
As needed	▪ Look for ideas	▪ Idea generation ▪ Subjective time saving

4.2.4.3 Summary

Participants who read UX patterns explained that the patterns were beneficial in the design process. They helped in generating ideas and saved time on the subjective level. Results indicate that these are potential effects of pattern reading, independent of the designer's rationale for reading. Thus, results suggest that the UX patterns fulfill their purpose; to be "inspirations for design" (Obrist et al., 2010), independently of how they are used.

4.2.5 Additional observation: Pattern use and design quality

Informal analyses of participants' design processes and prototypes indicated that some participants suffered from not using patterns. It was observed that the patterns could have helped them in solving problems. This has been observed in previous research as well (Chung et al., 2004). Observations also suggested some participants benefited from using patterns. However, it was additionally observed high design quality among participants who did not use patterns. Furthermore, some participants got no apparent support from rather extensive pattern use. These observations are interesting, but contradicting and informal. Thus, they should be further investigated.

4.3 Threats to validity

As Study 1 was assumed to be "applied research," the validity priorities were, in decreasing order, internal, external, construct and conclusion validity (Wohlin et al., 2000).

4.3.1 Internal validity

Internal validity is concerned with the casual relationship between treatment and outcome within an experimental context (Wohlin et al., 2000). Five participants were excluded. Dropouts are a potential source of error if they are not representative of the total sample (Wohlin et al., 2000). As differences between dropouts and the total sample were small, it is assumed they were representative. Furthermore, volunteers participated on different occasions. This may have affected their motivation and performance and is a *history* threat to internal validity (Wohlin et al., 2000). Additionally, volunteers are generally more motivated than the population they represent and are consequently perhaps not representative. This is a *selection* threat to internal validity (Wohlin et al., 2000). It is recommended subjects in future studies are paid, so they can participate on similar occasions and are perhaps more representative. In Study 1, this was not possible, due to financial restrictions.

4.3.2 External validity

External validity is concerned with generalization (Wohlin et al., 2000). In controlled experiments in SE, it can be increased by recruiting representative subjects, assigning realistic tasks with increased duration and providing subjects with familiar tools (Sjøberg et al., 2003). Although recommended to SE, it is thought the techniques were applicable to Study 1.

Professional designers with a minimum one-year experience in the industry were recruited. Thus, it is believed the subjects were representative to industrial contexts.

Participants commented that the tasks were more open-ended than they were used to. High-level requirements were however given to encourage participants to use the UX patterns. Even so, many participants decided not to use them. This might serve to *support* the suggestion that patterns may be used to a varied extent among designers, rather than threatening its validity.

In contrast to what has been recommended (Sjøberg et al., 2003), task duration was short. The tasks could however not last longer, as participants were unpaid. The potential limitation was addressed by telling subjects that they were not expected to complete tasks, although four tasks were given to put pressure on them (Sjøberg et al., 2003). Some participants explained they rushed in order to complete as much as they could. Thus, pressure may have been too high and patterns would perhaps have been read differently with lower pressure. Some participants also said they planned to refer to the patterns on a later stage of the design process, but they did not manage to reach this stage during the given time. If this is true, results from Study 1 will scale badly. More time should be given in future studies.

The environment was unrealistic to some extent, but it is thought this is a general weakness with the method. It was addressed by instructing participants to imagine that they worked for a real client and providing them with familiar design software. Participants commented however they would have preferred pencil and paper for the given tasks. Software was required, in order to record eye movements. Some subjects also said they normally were using a Mac computer. Most of them had no apparent problems working on the Windows 7 PC; thus it is assumed the PC was not a threat to validity.

4.3.3 Construct validity

Construct validity is concerned with the ability to generalize results of an experiment to the theory behind the experiment (Wohlin et al., 2000). Results are consistent with some previous findings. This might be a consequence of *experimenter's expectancies*. Avoiding this might be hard in a study in which data are gathered and analyzed by one person. Nevertheless, attempts were made to avoid the source of error, by re-analyzing and triangulating data.

4.3.4 Conclusion validity

Conclusion validity is concerned with the relationship between treatment and outcome (Wohlin et al., 2000). The results were based on data gathered from a small group of eight participants. Findings should thus be explored further with more participants.

Participants' level of education, self-reported pattern knowledge and experience in the industry varied. This is a *random heterogeneity of subjects* threat to conclusion validity. A homogenous group of participants is however a threat to external validity, which had higher priority (Wohlin et al., 2000). Thus, a heterogeneous group was recruited.

Finally, some *reliability of measures* threats to conclusion validity were identified (Wohlin et al., 2000). It is likely that the presentation format of the patterns affected the extent to which they were used. Furthermore, findings were based on data collected with open-ended interviews and questions were partially based on observations of each participant's performance. Thus, not all participants were asked the same questions. Some of the *reliability of measures* threats to conclusion validity were addressed by conducting a pilot study, albeit not all flaws were identified. Results should be explored further. The interview guide should be more targeted and the layout of the patterns should be enhanced.

4.3.5 Summary of threats to validity

The validity of Study 1 is threatened in several respects. Although it is believed subjects were representative, they were unpaid and they participated on different occasions. The environment was unrealistic. Tasks were perceived to be open-ended, but they were designed in this way in order to increase the use of patterns. Still, 50 % of the participants decided not to use them. This is assumed to strengthen the notion that patterns were used differently. Nevertheless, findings may scale badly due to short duration. Findings may also provide different results with a more efficient presentation format. Finally, the validity is threatened by the small number of participants.

4.4 Conclusion and future work

4.4.1 Conclusion

Results indicate a large variety in pattern use, in terms of time spent on patterns, number of patterns read and when in the process designers found it suitable to refer the patterns. Such variation should be expected when investigating the effects of patterns in a design process or on design quality. Potentially, each participant's use can be taken into account when doing so, instead of splitting participants in groups.

Results also indicate some designers decided not to read patterns, because they were inefficiently presented and because they were unfamiliar with the patterns concept. The extent to which UX patterns were used might have been different if they were presented differently. Participants who read patterns did so either to look for ideas or to identify candidates. Thus, patterns should be presented to facilitate these goals as efficiently as possible.

Participants who read patterns found them helpful, in particular for generating ideas. This suggests the UX patterns may serve as *inspirations for design*, as intended. The finding is consistent with previous research. Patterns also caused subjective time saving.

4.4.2 Future work

4.4.2.1 Improvement of patterns

It is needed to enhance the presentation of the UX patterns. Recommendations on how to modify the patterns are presented in chapter 6.

4.4.2.2 Replication with more participants and other methods

The results of Study 1 should generally be explored further. This can be done by replicating the study, although the experimental design should be slightly modified. Findings should also be investigated with other methods in more realistic environments.

4.4.2.3 Pattern reading and design quality

Informal observations indicated some participants produced high-quality designs, because they used patterns. Observations also indicated some participants appeared to suffer from not

using them. The opposite situation was observed as well. The observations should be explored more formally.

4.4.2.4 Patterns in later iterations

Some participants did not use patterns, as they considered them to be more helpful in a later stage of the design process. Thus, such use should be investigated. Studies have previously been conducted to understand the role of patterns in evaluation contexts, but there is need for more in this respect.

4.4.2.5 Comparative studies

Although patterns were perceived beneficial among participants who used them, it is needed to see whether patterns are used or benefit a design process differently than alternative design means. Some studies have been conducted in this respect (Koukouletsos et al., 2006; Wania, 2008; Cowley, 2009; Koukouletsos et al., 2009; Wania et al., 2009), but there is need for more.

5 Study 2

5.1 Method

A second exploratory experiment was conducted. The goals were as follows:

- To examine whether the variation in pattern reading was replicable.
- To better understand why participants apply a certain pattern reading strategy.
- To explore the impact of pattern reading on design quality.

The goals were based on results from Study 1. The experiment had a non-experimental design (Shadish et al., 2002). The research questions listed below were proposed.

- RQ1´: To what extent are patterns read?
- RQ2´: Which pattern reading strategies do designers choose?
- RQ2.1´: Why do designers choose the particular pattern reading strategy that they use?
- RQ3´: How can pattern reading benefit a design process?
- RQ4´: Does pattern reading improve design/architecture?

Table 13 shows research questions of Study 2 and reveals how they replicate and build upon questions from Study 1.

Table 13 Comparison of research questions in Study 1 and Study 2

Question	Study 1	Study 2
To what extent are patterns read?	RQ1	RQ1´
Which strategies exist for pattern reading?	RQ2	-
Which pattern reading strategies do designers choose?	-	RQ2´
Why do designers choose the particular pattern reading strategy that they use?	RQ2.1	RQ2.1´
How can pattern reading benefit a design process?	RQ3	RQ3´
Does pattern reading improve design/architecture?	-	RQ4´

5.1.1 Participants and setting

5.1.1.1 Participants

Table 14 Methods of recruiting participants

Recruiting method	M	F	Total
Online directories for design and technology professionals[11]	5	2	7
The author's social network	2	0	2
The author's academic network	0	1	1
Seminar for design and technology professionals	0	1	1
In total	**7**	**4**	**11**

Recruitment procedures are summarized in Table 14. Inclusion criteria in the study were being a professional interface designer with a one-year minimum professional working experience. Data were collected from 11 volunteers. Two of them turned out to be software engineers and excluded from further participation. Thus, a total of nine participants were included in the study. Demographics are presented in Table 15. All participants in the following are referred to as "he," to ensure anonymity.

Table 15 Participants
Incl = Included participants; Excl = Excluded participants; All = All participants

	Age			Years of experience in the industry			Relevant education[12]			Self-reported pattern knowledge[13]		
	Incl	Excl	All	Incl	Excl	All	Incl	Excl	All	Incl	Excl	All
N	9	2	11	9	2	11	9	2	11	9	2	11
Mean	28.7	37.0	30.2	6.1	7.0	6.3	.9	0	.7	4.7	1.0	4.0
Min	24	31	24	1	3	1	0	0	0	1	1	1
Max	37	43	43	14	11	14	2	0	2	7	1	7
S.D.	4.4	8.5	5.9	4.4	5.7	4.3	0.8	.0	0.8	2.6	.0	2.8

[11] http://www.cahoots.co and http://www.baltimoretech.net

[12] 0 = no education, 1 = undergraduate, 2 = graduate, with "some" or "a lot" of relevance to current profession.

[13] Participants were asked to rate the statement "I have designed with patterns before" on a 1-7 scale, 1 means false, 7 means true.

The study was conducted over seven days distributed over a period of nine days in February 2011. Otherwise, the setting was the same as in Study 1.

5.1.2 Treatment

The treatment was the same as in Study 1.

5.1.3 Data collection and supporting tools

5.1.3.1 Pattern reading and design products

The methods and setup for collecting design products and pattern reading data were generally the same as in Study 1, with the following minor alterations:

- The interview guide was modified to be more focused, based on experiences from Study 1. While questions in Study 1 were based on observations of designers' performance and topics to be examined, questions were in Study 2 asked to get a deeper understanding of why designers chose a certain pattern reading strategy and whether patterns were beneficial. Furthermore, participants were asked to comment the tasks, in order to judge their realism. The new interview guide is presented in Appendix H.
- Participants were provided with a printed booklet consisting of the UX patterns when interviewed. This was done in order to avoid articulation problems, as recommended by Crang et al. (2007)

5.1.4 Tasks

The tasks and requirements were the same as in Study 1.

5.1.5 Procedure

The procedure for collecting design products and pattern reading data were the same as in Study 1 (presented in Appendix F). For evaluation of design quality, the evaluators were emailed collected solutions to Task 1, instructions and heuristics as shown in Appendix I and evaluation forms. An example form is presented in Appendix J. The evaluators were asked to complete the evaluation within two weeks.

5.1.6 Analysis model

Answers to the abovementioned research questions were determined by analyzing both quantitative data on performance gathered throughout "the design process" and qualitative data from interviews. Also, semi-quantitative data regarding measured design quality were analyzed. Below, it is explained how this was done.

5.1.6.1 RQ1´: To what extent are patterns read?

This question was answered similarly to RQ1 of Study 1. In Study 2, some participants copied tasks and requirements into the design tool. In these cases, "requirements reading" and "task reading" were logged whenever participants read the copied requirements and tasks as well.

5.1.6.2 RQ2´: Which pattern reading strategies do designers choose?

In order to answer RQ2´, eye-tracking recordings of participants' performance were logged and analyzed to fit into the strategy categories identified and defined in RQ2 of Study 1.

5.1.6.3 RQ2.1´: Why do designers choose the particular pattern reading strategy that they use?

RQ2.1´ was answered through analysis of qualitative interviews, following the same coding and categorization procedure as explained in Study 1.

5.1.6.4 RQ3´: How can pattern reading benefit a design process?

RQ3´ was answered through analysis of qualitative interviews, following the same coding and categorization procedure as explained in Study 1.

5.1.6.5 RQ4´: Does pattern reading improve design/architecture?

In order to answer this question, it was needed to measure design quality *with respect to the UX factors* which the patterns addressed. Doing so was expected to be challenging, since UX is considered a highly subjective and context-dependent variable (Law et al., 2009). Based on related work, a heuristic evaluation scheme was chosen. The method has also been used for UX evaluation (Väänänen-Vainio-Mattila et al., 2009; 2010). To the author's knowledge, it has not been used to evaluate *design quality with respect to UX*, which is a different property than UX in itself. Even so, heuristic evaluation was considered suitable, as it is cheap,

applicable to early design stages and does not require advanced planning (Nielsen et al., 1990).

An analysis of the UX factors indicated that some of them overlapped. To avoid confusion in the evaluation process, UX factors were merged:

- Co-experience and sociability both address a social activity. Both factors are overlapped by user involvement, which goes "towards a social/community experience" (Obrist et al., 2007). These factors were merged into *sociability*.
- Motivation and user engagement also overlapped to some extent, as both relate to contribution (Obrist et al., 2007). They were merged into *motivation*.

Heuristics

Statements to be rated on a 1-5 Likert scale were used as heuristics. Each statement corresponded to one of the merged UX factors, except emotion, as none of the requirements addressed it. Based on previous research (Chung et al., 2004; Lin, 2005; Lin et al., 2008; Wania, 2008; Wania et al., 2009), one extra statement was added, relating to *completeness*. The Likert scale and the UX factors were explained, in order to facilitate a mutual understanding amongst evaluators of what to judge and what the ratings on the scale implied. The heuristics are presented in Appendix I.

Evaluators

Three evaluators volunteered[14]. Their backgrounds and how they were recruited are listed in Table 16. All evaluators are in the following referred to as "he" to ensure anonymity.

Table 16 Evaluators
Author = Author's professional network; Advisor = Author's advisor's professional network

Evaluator number	Current profession	Recruit method	Relevant completed education	Years of relevant experience
1	Web designer	Author	BSc	6
2	Interaction designer	Author	MSc	4.5
3	PhD candidate	Advisor	MSc	3.5

[14] One more evaluator was recruited from academia, but he was unable to complete the evaluation.

Selection of UX factor

For the purpose of further analysis, it was decided to focus on *one* of the merged UX factors. Selecting a factor was done by first identifying the main focus of the UX pattern collection. By counting patterns that addressed each of the factors, it was suggested sociability was its main focus (21 of the 30 patterns addressed this merged UX factor, followed by motivation which was addressed by 10 patterns). Second, the main focus of the requirements proved to be sociability and usability, with three requirements each. As sociability was an important UX factor in the requirements and the patterns, it was focused on design quality with respect to sociability.

Design quality measure

"Measured design quality" was the mean sociability score among the evaluators.

Pattern reading measure

Study 2 was designed to give detailed insight into the amount of patterns read and thus how much treatment was received. Possible measures to use in the RQ4´ analysis were:

- Time spent on patterns
- Number of pattern visits
- Number of unique pattern visits

Of these, *number of unique pattern visits* was chosen. It was thought that the potential effects of reading a given pattern would be the same independently of how many times it was read. Time spent was not considered as an appropriate measure, as designers read with different speed.

As it was focused on design quality with respect to sociability, *unique pattern visits* were split by the merged UX factors which the visited patterns addressed. Only patterns which addressed sociability were included in the measure used in the analysis. The measure is in the following referred to as "unique sociability pattern visits."

Grouping of participants

Participants were split in two groups, based on years of experience in the industry. Although an "expert" can be considered as "the product of a decade or more of maximal efforts to

improve performance" (Ericsson et al., 1993), participants were in Study 2 considered "expert designers" with five years or more of experience, as only two had above ten years of experience. Participants with four years or less of experience in the industry were considered "novice designers." Each group was analyzed separately.

Calculation of correlation

Study 1 suggested that individual designers' use of patterns can be taken into consideration when exploring the impact of patterns, as a varying use of patterns should be expected. Thus, correlation was calculated between unique sociability pattern visits and measured design quality with respect to sociability. Although the sample size was very small and a statistical method admittedly was inappropriate and to some extent unnecessary, it was performed to provide a quantitative indication of how a full-scale study may turn out. It was thought findings from a different method than previously used could indicate directions for future research. Several limitations to the results of a calculation of correlation apply, to be discussed later.

Data were not assumed to be normally distributed. Consequently the Spearman rank-order correlation coefficient r_s was used (Siegel et al., 1988; Wohlin et al., 2000). The rank-order procedure described by Siegel et al. (1988, p. 244) was followed. The following formula was used to compute correlation coefficients:

$$r_s = 1 - \frac{6 \sum d_i^2}{N^3 - N}$$

Explanation of causality

"Causality must be demonstrated by an argument outside the statistical analysis." (Dowdy et al., 2004) As Study 2 was an exploratory study, it was sought discovering possible explanations to correlation, when correlation was identified. Qualitative methods are primarily suited to explain causality when this is intended (Shadish et al., 2002). Thus, qualitative interviews were analyzed, triangulated with qualitative eye-tracking data, following the coding and categorization procedure described above. Furthermore, comments from evaluators were analyzed when it was needed to understand why they gave a certain rating.

5.2 Results and discussion

Time spent on Task 1 and total time given are listed in Table 17.

Table 17 Time spent on Task 1 and total time given[15]

	Mean	S.D.	Min	Max
Task 1	38 min. 14 sec.	8 min. 27 sec.	25 min. 56 sec.	45 min. 53 sec.
Total	45 min. 16 sec.	1 min. 6 sec.	44 min. 7 sec.	47 min. 37 sec.

5.2.1 RQ1´: To what extent are patterns read?

5.2.1.1 Results

Time spent on patterns

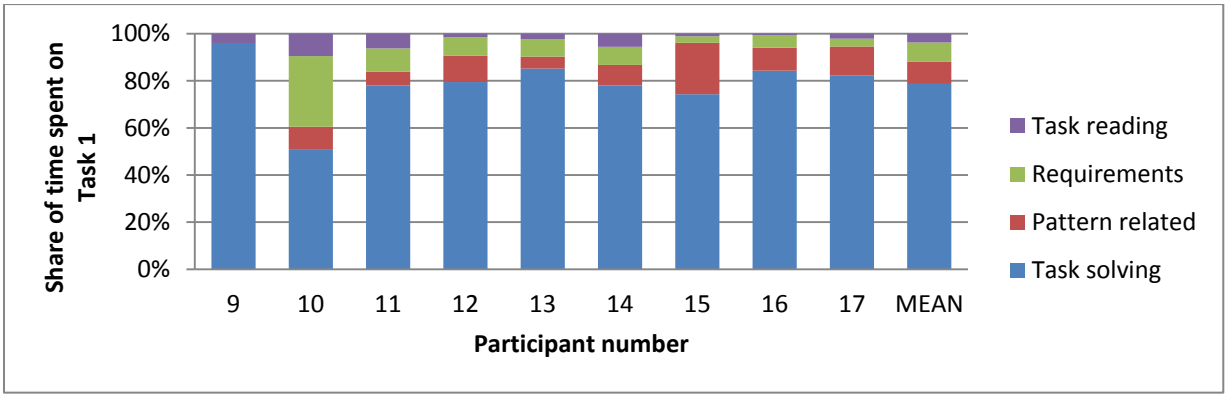
Results for all participants are presented in Table 18. Figure 10 presents time spent per participant, as well as the mean.

Table 18 Time spent on different design activities for all participants

Activity	Mean	S.D.	Min	Max
Task solving	78.7 %	12.0 %	51.0 %	95.6 %
Pattern related	9.4 %	6.0 %	.0 %	21.8 %
Requirements reading	8.2 %	8.7 %	.0 %	30.0 %
Task reading	3.7 %	2.9 %	.7 %	9.5 %

[15] One participant started on Task 2 before he had completed Task 1 and consequently skipped back and forth between the two tasks for a while. The stop of Task 1 was for him defined as the point where he did the last modifications to his Task 1 solution.

Figure 10 Time spent on various design activities per participant and on average



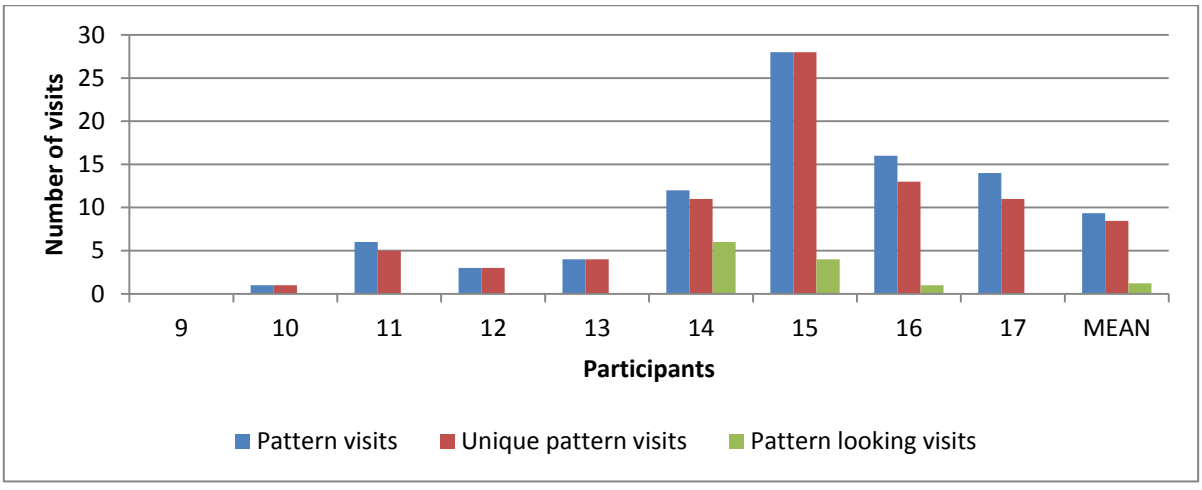
Number of patterns read

Results for all participants are listed in Table 19. Figure 11 presents results for each participant as well as the mean.

Table 19 Number of "pattern visits," "unique pattern visits" and "pattern looking visits" for all participants

Metrics	Mean	S.D.	Min	Max
Pattern visits	9.33	9.07	0	28
Unique pattern visits	8.44	8.69	0	28
Pattern looking visits	1.22	2.22	0	6

Figure 11 Numbers of "pattern visits," "unique pattern visits" and "pattern looking visits" per participant and on average



5.2.1.2 Discussion

Figure 12 Comparison of time spent on various design activities across studies

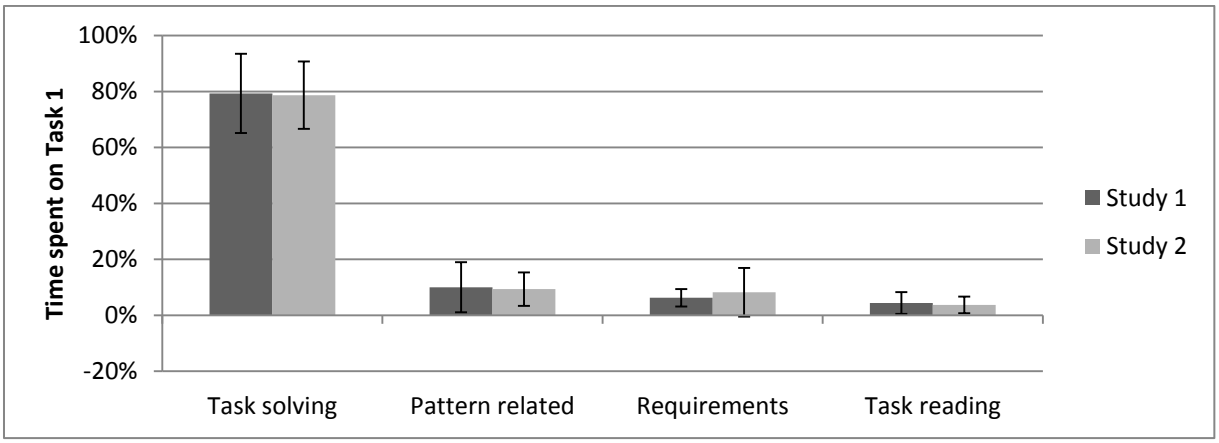


Figure 13 Comparison of "pattern visits" and "unique pattern visits" across studies

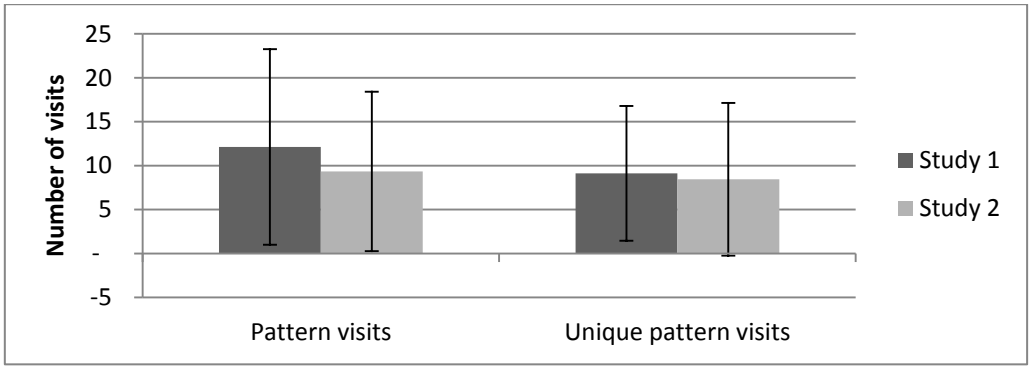


Figure 12 and Figure 13 compare results from Study 1 and Study 2. The figures indicate the results are relatively consistent between the studies. The small differences can probably be explained by the small sample sizes. As shown in the next sub-section, the "quick orientation" strategy of Study 2 gained one more participant than in Study 1. This might have been enough to decrease the average time spent on patterns, as participants who used this strategy read a rather low number of patterns.

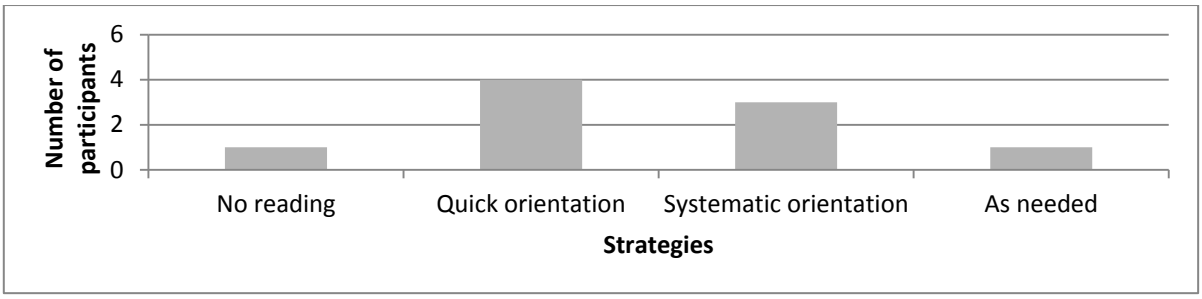
Study 2 strengthens what was brought forward in Study 1; pattern reading may vary to a high extent. This is suggested by the large standard deviations, and is a potential explanation to the contradicting findings in previous work regarding the impact of patterns on design quality. Varied use of patterns should be expected and potentially taken into consideration when investigating the effects of patterns.

5.2.2 RQ2´: Which pattern reading strategies do designers choose?

5.2.2.1 Results

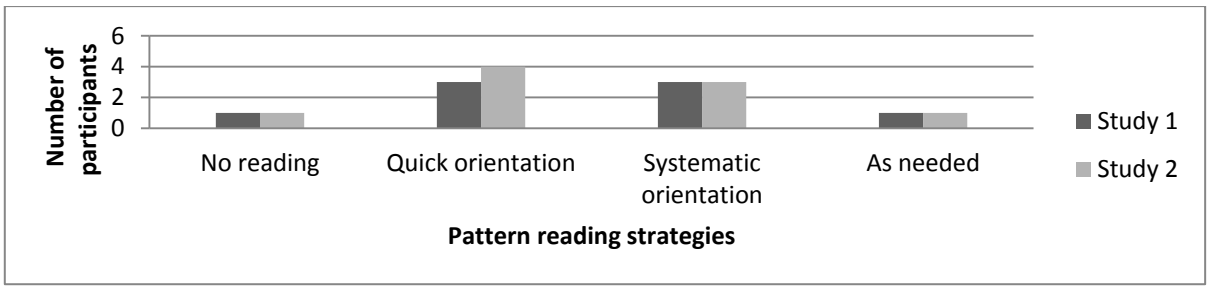
Figure 14 shows the pattern reading strategies chosen among participants in Study 2.

Figure 14 Chosen pattern reading strategies



5.2.2.2 Discussion

Figure 15 Comparison of chosen pattern reading strategies across studies



Study 2 is consistent with Study 1 in terms of chosen pattern reading strategies. As shown on Figure 15, the overlap between the studies was high. All categories gained the same numbers of subjects, except "quick orientation" which gained one more participant in Study 2 than in Study 1. This is however logical, as one more participant was included in Study 2 than in Study 1. Results from Study 2 support what was brought forward in Study 1 and repeated in the RQ1´discussion above: Varied use of patterns should be expected.

5.2.3 RQ2.1´: Why do designers choose the particular pattern reading strategy that they use?

Codes relating to RQ2.1´ are presented in Appendix G.

5.2.3.1 "No reading" and "quick orientation"

Participants who chose the "no reading" and "quick orientation" strategies decided not to read patterns. Their rationales are consequently presented together. Identified categories of rationales for not reading patterns are shown in Table 20 and discussed below.

Table 20 Rationales for not reading patterns

#	Strategy	Rationale				
		Time consuming	**Too early for patterns**	**Self-confidence**	**Lack of pattern knowledge**	**Disturbing**
9	No reading	X	-	X	X	X
10	Quick orientation	X	-	X	X	-
11	Quick orientation	X	X	-	-	-
12	Quick orientation	X	-	-	X	X
13	Quick orientation	X	-	-	-	X

Categories previously identified

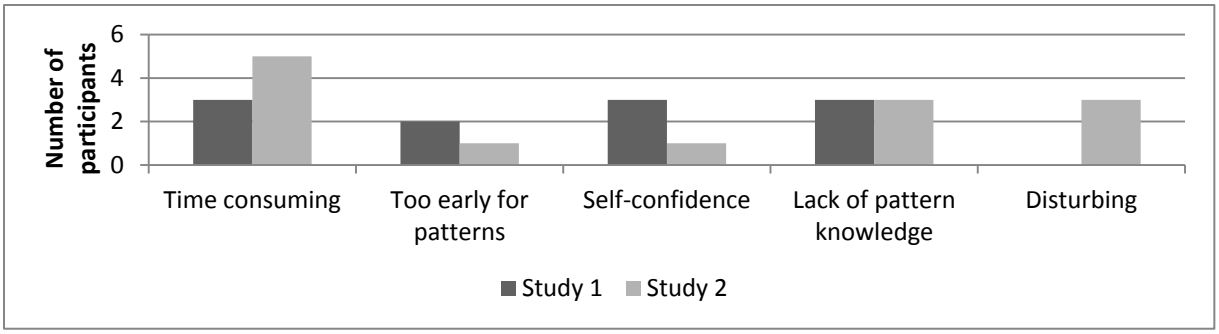
All categories except "disturbing" were also identified in Study 1; thus they are not repeated.

Disturbing

Participants explained that the UX patterns were unfamiliar. Therefore, they decided to spend their time on designing rather than learning and applying unfamiliar concepts. Some said they would have used the patterns more if they were familiar with them beforehand. They said it would be easier if they were given access to the patterns a day or two before. Then they could read through every single pattern while not being observed or simultaneously asked to solve design tasks. This would allow them to mentally reference the patterns when working on the tasks later on. They considered this as easier than skipping between design software and the web browser which presented the patterns.

Discussion

Figure 16 Comparison of rationales for not reading patterns across studies



Identified rationales for not reading patterns are consistent with Study 1, as shown on Figure 16. There are however some differences. First, "disturbing" is new to Study 2, but strongly related to "time consuming." Second, the distribution is slightly different. This can probably be explained by the small sample size.

The "disturbing" and "time consuming" rationales indicate it is needed to explore better ways to present patterns. Furthermore, it is needed to get a deeper understanding of how to integrate patterns in a design process. When patterns are presented separately and inefficiently, they will probably not be used. Study 1 indicated the same and previous research has reported similar findings (Bernhaupt et al., 2009a; Bernhaupt et al., 2009b).

Findings from Study 2 support the relation between the two "orientation" strategies, noted in Study 1. Participants initially referenced the patterns in an effort to apply the "systematic orientation" strategy. Then they fell back to familiar methods, as they in particular found the patterns to be time consuming. Results regarding pattern use could consequently have been different with a more efficient pattern presentation. First, it is likely the "systematic orientation" category would have gained more participants and thus would stand out as the most popular strategy, in line with previous work (Cowley, 2009). Second, it is possible participants on average would read patterns more if they were easier to digest.

5.2.3.2 "Systematic orientation" and "as needed"

Categories of rationales identified among participants who read patterns are listed in Table 21

Table 21 Rationales for reading patterns

Participant number	Strategy	Rationale	
		Identify candidates	Look for ideas
14	Systematic orientation	X	-
15	Systematic orientation	X	-
16	Systematic orientation	-	X
17	As needed	X	X

Both rationales "identify candidates" and "look for ideas" were identified in Study 1 and are thus not repeated. In Study 2, however, the "look for ideas" category was slightly broader than in Study 1. Participants said they visited the patterns in order to see if they mentioned features which they had not added to their design already. This kind of pattern use could also have been named "evaluate design," as participants actually were matching up their design with the patterns and modified it depending on what they read in the patterns. However, since participants explained they were looking for other features applicable to their application, it was named "look for ideas."

Discussion

Identified rationales for reading patterns overlap with Study 1. Previous research has suggested selected reading strategy is a function of the user's goals (Díaz et al., 2009). From Table 21, there is little of evidence for this. "Systematic orientation" was selected by participants who wanted to get familiar with the patterns and see which were applicable. The participant in the "As needed" group did however have the same rationale, but chose a different strategy. Furthermore "look for ideas" was a rationale among participants from both strategies. This may suggest a strategy can be chosen for various reasons. The sample size was however small; hence care should be taken when interpreting results. Nevertheless, results suggest patterns should be presented in ways which facilitate both "identify candidates" and "look for ideas." Some suggestions on how to do so are presented in chapter 6.

5.2.3.3 Summary

Five participants skipped patterns because they found them inefficiently presented. Four read patterns in order to either to find applicable candidates, or to look for ideas. The rationales correspond to findings from Study 1, as well as previous research (Díaz et al., 2009). Results suggest it is needed to get a deeper understanding of how patterns can be better integrated in a design process. Patterns should be presented to facilitate the goals "identify candidates" and "look for ideas."

5.2.4 RQ3´: How can pattern reading benefit a design process?

5.2.4.1 Results

Codes relating to RQ3´ are presented in Appendix G. The following categories were identified:

- Idea generation
- Time saving
- Evaluation
- Support of design decisions

Categories previously identified

"Idea generation" and "time saving" were identified in Study 1 and are not repeated.

Evaluation

Some participants decided to initially use their previously gained design knowledge. They referred to the patterns in order to see if they could add features to their application or refine their design so that it better matched with the patterns. This rationale for pattern reading is primarily referred to above as "look for ideas," although it has elements of "evaluation" in it, as noted. A potential consequence of this kind of use was evaluation. The participant in the "as needed" group of Study 2 modified his design to make it better correspond to what he had read in the patterns.

Support of design decisions

Some designers said the patterns confirmed what they had done was considered good practice. They explained the patterns put scientific weight behind what would have been done anyway. Although participants were not told how the UX patterns have been identified, some of them took it for granted that the patterns were based on research and that the solutions in them were proven to work. Thus, they could easily rely on them and apply suggested solutions. One participant pointed however out that anything which can inform design is helpful; thus, patterns are not necessarily more helpful than other sources of design aid.

A related way of using patterns, brought forward by subjects in Study 2, was to use them as an argument for design decisions when discussing with other stakeholders. One participant said he then expected the business folks to better understand and rely on his design solutions. This being said, this kind of use did obviously not appear in the experimental setting.

5.2.4.2 Discussion

Participants in Study 2 explained patterns were helpful for "idea generation" and "time saving" on the subjective level. These are consistent with Study 1 and previous research and show that the patterns to some extent give inspirations for design, as intended (Obrist et al., 2010).

Furthermore, participants in Study 2 extended the benefits of pattern use with two more categories; "evaluation" and "support of design decisions." Some previous studies have indicated patterns may be a helpful tool in evaluation contexts (Wesson et al., 2003; Chung et al., 2004; Wesson et al., 2005a; Wesson et al., 2005b; Cowley, 2009), although some of them have suggested guidelines are more helpful in this respect (Wesson et al., 2003; 2005a; Wesson et al., 2005b). More research is needed to explore the use of patterns in later iterations of a design process – as also brought forward in Study 1 and by others (Dearden et al., 2006; Wania, 2008; Wania et al., 2009).

In reviewing previous work on how patterns can be used, Dearden et al. (2006) found that "[t]here is general agreement that patterns provide some rationale for particular design decisions." There is e.g. some indication that patterns appear valid and credible because they are documented (Finlay et al., 2002). "Support of design decisions" corresponds to this way of using patterns. The category indicates patterns not only are supportive when seeking

inspiration, but also can provide pattern stakeholders with a sound rationale for *why* a solution is successful and should be applied in certain contexts.

The category also relates patterns as a communication facilitator, since it was brought forward that they can be used to justify decisions when communicating with stakeholders. A few studies have indicated patterns are helpful in this context (Borchers, 2001; Finlay et al., 2002). This kind of pattern use is however more related to the "support of communication" quality sub-criterion of Wurhofer et al. (2009), rather than "improvement of design/architecture." Hence it should be explored in a study with a different focus.

Rationale and effects

In Study 1 it was distinguished between rationale and effects of pattern reading. The results from Study 2 can be summarized in the same way, as shown in Table 22. The table suggests little difference in rationale and effects between "as needed" and "systematic orientation" across pattern reading strategies. The only difference is "evaluation," which only is an effect for the "as needed" strategy. This is logical, as it can be argued a prerequisite for evaluation is the existence of an artifact to evaluate. Thus, "evaluation" cannot be an effect of "systematic orientation," as this strategy often takes place before anything has been designed.

Table 22 Pattern reading strategies with rationales and effects

Pattern reading strategy	Rationale	Effects
As needed	▪ Identify candidates ▪ Look for ideas	▪ Idea generation ▪ Subjective time saving ▪ Evaluation ▪ Support of design decisions
Systematic orientation	▪ Identify candidates ▪ Look for ideas	▪ Idea generation ▪ Subjective time saving ▪ Support of design decisions

5.2.4.3 Summary

Nearly all participants who read patterns explained the patterns sparked creativity – independently of why they read patterns. This is consistent with previous findings and results from Study 1. Additionally, patterns can be used to support design decisions and to support evaluation, also consistent with previous research.

5.2.5 RQ4´: Does pattern reading improve design quality?

5.2.5.1 Expert designers

Results

Five participants were considered expert designers (N = 5). The numbers of unique sociability pattern visits and measured design qualities with respect to sociability are listed in Table 23.

Table 23 Average measured design quality with respect to sociability and number of unique sociability pattern visits per expert designer

Participant number	Unique sociability pattern visits	Average quality measure	S.D.
9	0	1.33	.58
12	1	2.33	.58
14	6	2.33	1.15
15	21	3.67	.58
16	9	2.67	.58

Results indicate there was a strong correlation between pattern reading and design quality with respect to sociability; $r_s = .98$. A one-tailed test showed the correlation was statistically significant on the $p < 5\ \%$ level (Siegel et al., 1988). Due to the small sample the results on correlation should be treated cautiously. Computation of correlation is shown in Appendix K. Codes relating to explanation of causality are presented in Appendix G.

Discussion and explanation of causality

Although there was a strong and statistically significant correlation between pattern reading and measured design quality, care should be taken when interpreting the results, as the sample size was very small. If a couple of participants were added to it, the r_s value could have been drastically reduced. However, results in this particular sample state that pattern reading and (measured) design quality were strongly correlated. This indicates that a correlation may be true also in a larger sample.

More interesting is however what *caused* the high r_s value in the sample. Analysis of qualitative interviews indicated a possible explanation to the strong correlation was that reading of UX patterns caused "idea generation." Four (of five) expert designers read patterns

to at least some extent. They explained patterns provided focus and augmented the high-level requirements. As put by participant 12: “I was […] using the patterns as sort of like a guide and then sort of using them as a diving board or something you can jump off from. […] Like a start of an idea.” The comment illustrates the patterns provided inspiration. Furthermore, some participants explained how the generated ideas were transferred to the prototypes. There is some evidence in previous research that patterns support designers in generating ideas (Chung et al., 2004; Saponas et al., 2006; Díaz et al., 2009). Analysis of data related to RQ4´ indicates that this benefit in turn may cause higher design quality.

Participant 16 explained that he read patterns after he had designed certain features. He e.g. said he focused on a voting system and explained the patterns confirmed that a voting system was good practice. If so, the patterns could hardly affect design quality, as they were read after he had designed. Eye-tracking data indicated he not did what he said he did. The sociability pattern SOCIAL REWARDS mentioned voting and the participant read this pattern more or less right before he added the voting system. Thus, eye-tracking data indicated that the voting system was added because the SOCIAL REWARDS pattern generated the idea of such a system. Participant 16 said he probably would have added a voting system anyway, albeit this is hard to tell.

A different question is whether the voting system affected design quality with respect to sociability. On average, his design quality was rated 2.67 on the 1-5 scale (S.D. = .58). One of the evaluators commented the voting system as an aspect which provided sociability. Another commented “I only feel like rating, not writing or helping out,” which may indicate the voting focus could make the end user less inclined to use the application for social purposes. If so, the patterns were perhaps not as beneficial to participant 16, as they caused narrow focus on one particular aspect. Nevertheless, it may well be the focus would have been broader if he had read more than nine patterns. Participant 15 supports this notion; he read 21 sociability patterns and scored highest among the five expert designers (3.67, S.D = .58). Furthermore, it may well be he would have been less focused on sociability without having read any patterns.

Participant 9 supports the latter notion. He read zero patterns and design quality with respect to sociability was for him on average rated the lowest (1.33, S.D. = .58). When rating his design, evaluators commented the lack of sociability facilitating features. This might have been because he read no patterns. An alternative explanation is that he took a different

approach to Task 1 page than the others. His intention with it was apparantly not to present the sociability features of "Beestory," but, as he said, "[…] to get them to contribute immediately." Contribution relates to *motivation*; thus he focused on this UX factor. He scored high on motivation (on average 4.00 on the 1-5 scale). He also scored high on usability (on average 4.67). These high scores indicate he was able to design with rather high quality with respect to certain UX factors, without reading any patterns. Thus, his design quality with respect to sociability can be explained with his own goals for the application, rather than the lack of pattern reading.

A legitimate question is: Why took did he take a different approach? Although he did not read any patterns, it can safely be assumed he was well aware of social aspects, as he in the interview talked about "comments and stuff" and how to follow other users. A possible reason is that he did not receive the same amount of inspiration as the other participants, as he did not read patterns. Consequently, he was focused on his own ideas on how to solve the task as the patterns did not guide his thinking. This might, in this case, perhaps have caused the design quality with respect to sociability to be lower.

Summary

The results indicate that there might be a correlation between pattern reading and design quality with respect to sociability for expert designers. The identified correlation was statistically significant, but sample size was small. Thus, great care should be taken when interpreting results and interpolating this correlation to the general population outside the experimental setting. More interesting is that causality could be explained with how pattern reading caused "idea generation," and the generated ideas were transferred to the prototypes to be designed. This shows that pattern reading can cause higher design quality, although a limited number of patterns read also can narrow the focus.

5.2.5.2 Novice designers

Results

Four participants were considered novice designers ($N = 4$). The numbers of unique sociability pattern visits and average design qualities with respect to sociability for these participants are listed in Table 24.

Table 24 Average measured design qualities with respect to sociability and number of unique sociability pattern visits per novice designer

Participant	Unique sociability pattern visits	Average quality measure	Standard deviation
10	1	3.00	1.00
11	5	4.00	.00
13	3	3.00	.00
17	9	3.00	.00

Results indicate there was no trend among novice designers. Computation of correlation is showed in Appendix K.

Discussion

The results can be interpreted in several ways. First, sample size was small; hence the results do not necessarily apply to a general population outside an experimental setting. Second, it is possible that patterns do not affect design quality with respect to UX when used by novice designers. Previous research has suggested novice designers do not know how to use patterns and therefore cannot benefit from them (Chung et al., 2004). This explanation is perhaps applicable to Study 2 as well, as participants scored the same independently of how many patterns they read. However, in contrast to previous research, novice designers in Study 2 were not students, but designers with on average 3.33 years of experience in the industry. Nevertheless, the explanation might be true.

A third explanation, based on eye-tracking data from Study 1, is however considered more plausible: Novice designers used patterns differently than expert designers. While three of them chose the "quick orientation" strategy, one chose the "as needed" strategy. This suggests only one of them actually used the patterns. For this particular participant, pattern reading caused "evaluation" rather than "idea generation." In the interview, he said he did some minor modifications to his design after he had read patterns. Eye-tracking data confirmed his comments. The modifications were however small and did hardly affect design quality with respect to UX. This suggests UX patterns not *necessarily* affect design quality with respect to UX when used for evaluation.

Summary

No trend was identified between pattern reading and design quality for novice designers. A possible explanation is solutions presented in patterns were not actually transferred to the designs, as they caused "evaluation" rather than "idea generation."

5.2.5.3 Summary

A strong statistically significant correlation between pattern reading and design quality with respect to sociability was observed among "expert designers." No such correlation was observed among novices. It was suggested pattern reading can cause higher design quality with respect to UX when used for "idea generation." Care should be taken when interpreting results, as they are based on very small samples.

5.3 Threats to validity

Study 2 was assumed to be "applied research;" hence validity priorities were, in decreasing order, internal, external, construct and conclusion validity (Wohlin et al., 2000).

5.3.1 Internal validity

Two designers were excluded as they were assumed not to be representative for the total sample. Thus, it is thought including them would be a larger source of error than excluding them.

The potential consequences of recruiting volunteers were the same as those presented in Study 1; *history* and *selection*. One participant did e.g. note he performed badly because he was tired after a long day of work. History is a threat to internal validity of the heuristic evaluation too. It is possible prototypes evaluated initially were rated differently than those which were evaluated lastly. This potential limitation was addressed by instructing evaluators to first go through all the prototypes to get an overview of the general level. Furthermore, they were asked to keep a consistent relative scale throughout the evaluation process. Still, it is possible that the scale changed throughout the evaluation. This could however have happened even with paid evaluators. The source of error may in the future be addressed by randomizing the order of prototypes to be evaluated.

The identified correlation among expert designers was statistically significant. However, perhaps designers with high measured design quality were more inclined to read patterns because of higher level of design knowledge, or because they were more motivated to do so. Design quality may have also been caused by other variables than whether they read patterns. If this was the case, we would have had a situation in which "X caused A and B" (Wohlin et al., 2000): *design knowledge caused pattern reading and design quality*. Table 25 shows all data for "expert designers" in Study 2. Participant 15 visited 21 patterns and his design was highest rated. However, he also had 14 years of experience, relevant education on graduate level and high self-reported pattern knowledge (7 on the 1-7 Likert scale). On the other hand, participant 9 read no patterns and had similar background variables with the exception of education. His design quality was on average rated lowest among evaluators. This may suggest the extent to which patterns was read was more important for the measured design quality than design knowledge.

Table 25 Various data for "expert designers"

Participant number	Unique sociability pattern visits	Average quality measure	Experience in industry	Relevant education	Self-reported pattern knowledge
9	0	1.33	13	0	7
12	1	2.33	5	2	1
14	6	2.33	5	1	5
15	21	3.67	14	2	7
16	9	2.67	5	1	7

As sample size was small, it is hard to decide whether A caused B, B caused A, or even X caused A and B (Wohlin et al., 2000). Nevertheless, Spearman-rank correlation coefficients r_s were calculated between background variables and measured design quality, following the procedure explained by Siegel et al. (1988, p. 244) The same was done for background variables and numbers of unique pattern visits. Results are listed in Table 26 and Table 27. Computations are shown in Appendix L. The results point towards weaker correlations than the one identified between pattern reading and measured design quality (.98). Among r_s values in Table 26 and Table 27, the r_s values for relevant education are the strongest. A possible interpretation is that level of education affects motivation to read patterns and (measured) design quality.

Table 26 Calculated r_s values between background variables and measured design quality

	Relevant education	Experience in the industry	Self-reported pattern knowledge
$\sum d_i^2$	6.5	13.5	12.5
r_s	**.68**	**.33**	**.38**

Table 27 Calculated r_s values between background variables and number of patterns read

	Relevant education	Experience in the industry	Self-reported pattern knowledge
$\sum d_i^2$	9.0	14.0	11.0
r_s	**.55**	**.30**	**.45**

5.3.2 External validity

As the nine participants were recruited from the industry and their experience varied from 1 to 14 years, it was assumed participants were representative candidates. Eight of them were provided with the desired design software. The ninth participant preferred software that was only available for Mac, but he said he was also comfortable working on different software available for Windows. Thus, he used this software. After initially struggling a bit with it, he got used to it; thus it is assumed it did not limit the external validity of the study. All participants of the study were asked what they thought about the tasks and they found them realistic. For the physical environment and the Windows 7 PC, the same can be said as in Study 1.

5.3.3 Construct validity

Generally, some people are afraid of being evaluated and some people to try to look better when they are being evaluated. A couple of participants in Study 2 expressed nervousness with designing while being observed. *Evaluation apprehension* is a social threat to construct validity (Wohlin et al., 2000). It was addressed by telling subjects the purpose of the study was not to measure and judge their performance, but to investigate their use of patterns. For *experimenter expectancies*, the same can be said as in Study 1.

5.3.4 Conclusion validity

Findings are limited because of the size of the study. This is a threat to conclusion validity (Wohlin et al., 2000). This is in particular the case for the identified correlation. Furthermore, treatments were implemented differently amongst subjects. This is a potential source of error as well (Wohlin et al., 2000). It was sought taking it into account, by analyzing by amount of treatment received. Albeit this was done in order to provide quantitative indication of how a full-scale study may turn out, it should be noted the method is weak. This is because subjects may have self-selected into receiving greater levels of treatment, based on e.g. motivation. Thus, the method should in future studies be combined with other methods (Shadish et al., 2002).

Some *reliability of measures* threats to conclusion validity were identified in Study 2 as well (Wohlin et al., 2000). While eye-tracking has been successfully adapted to studies of reading behaviors (Rayner, 1998) and may indicate what is "on top of the stack" of a subject's cognitive processes (Just et al., 1976), it does not reveal whether the subject comprehends what he reads. Thus, number of unique pattern visits is perhaps not a reliable measure. In a future study, it can be triangulated with a quiz to get insight into comprehension.

Design quality with respect to sociability was evaluated heuristically by three experts. This has, to the author's knowledge, not done before and the method is perhaps not valid. The experts disagreed to some degree (mean S.D. = .50) and the quality scores may have been different if another evaluation method was used. This could have been addressed by evaluating design quality with different methods as well, but time restrictions made this impossible.

The interview guide was modified, but questions were not always worded in the same manner and asked in the same order. This may have affected answers, although it is thought it did not. The backgrounds of subjects varied, similarly to the subjects in Study 1. A heterogeneous group was however recruited to increase external validity.

5.3.5 Summary of threats to validity

The validity of Study 2 is in particular threatened by small sample size. Design quality with respect to UX was measured with heuristic evaluation, which probably has not been done before. The method is not validated and might have provided invalid results. Finally, data

were analyzed by amount of treatment received, which is a weak method. Results should be further explored in a bigger study with more participants and different methods.

5.4 Conclusion and future work

5.4.1 Conclusion

Study 2 was conducted in order to replicate and extend Study 1. As in Study 1, patterns were used to a varied extent among individual designers, in terms of time spent on patterns, numbers of patterns visited and chosen pattern reading strategies. Thus, varied pattern use should be expected among individual designers and this variation can potentially be taken into consideration when exploring the potential effects of patterns.

Identified rationales for not reading patterns were mostly related to inefficient pattern presentation. Lack of pattern knowledge and self-confidence were identified rationales as well. Participants who read patterns explained that they did so either to identify candidates or to look for ideas. Thus, patterns should be presented more efficiently and they should in particular be designed to facilitate the mentioned goals. This is consistent with Study 1.

Participants who read patterns found them beneficial for generating ideas. Furthermore, they said the patterns saved time. This is consistent with Study 1 as well as previous research. Furthermore, results indicate that pattern reading caused evaluation and were considered to support design decisions. This is confirms previous work.

The nine participants' individual pattern reading was taken into consideration when exploring potential effects of patterns on design quality. A strong and statistically significant correlation on the 5 % level was identified between pattern reading and measured design quality among five "expert designers." This was explained by how pattern reading can cause "idea generation." No trend was observed among novice designers. A possible explanation is that patterns were read to a less extent and caused "evaluation" rather than "idea generation."

Findings are threatened by the small sample. This is particularly the case for the identified correlation, which is also threatened by the weakness of the chosen analysis method. Furthermore, a potential source of error is the various consequences from recruiting unpaid

volunteers. Findings should be further explored, with more participants, longer task duration and validated methods in more realistic contexts.

5.4.2 Future work

5.4.2.1 Improvement of patterns

Enhancements to the presentation of the UX patterns are necessary. Suggestions on how to do this are provided in the next chapter.

5.4.2.2 Replication with more participants and other methods

The validity of Study 2 was threatened in several ways. Thus findings should be explored further, with more participants in a more realistic setting.

5.4.2.3 Patterns in later iterations

It is needed to explore the helpfulness of patterns in later stages of a design process. This can be done by conducting longitudinal studies, or by asking stakeholders to use patterns for evaluating or refining an existing design, rather than designing from scratch.

5.4.2.4 Comparative studies

In order to get a true understanding about the impact of HCI patterns in a design process, it is needed to compare the use and benefits of patterns to alternative design means. Some studies have been conducted in this respect (Koukouletsos et al., 2006; Wania, 2008; Cowley, 2009; Koukouletsos et al., 2009; Wania et al., 2009), but more research is needed.

6 Other findings and lessons learned

This project provided findings which are assumed to be of interest for others, although they do not correspond to any of the research questions. The findings are presented in this chapter.

6.1 Recommendations for pattern presentation

Based on comments from subjects, a collection of recommendations for pattern format and presentation was made. These apply in particular to the specific collection of UX patterns, but are assumed to be applicable to other pattern collections as well.

6.1.1 Make it easy to navigate

The patterns should be modified to be easier to use. This can be done by grouping them in various ways and taking advantage of faceted metadata, such as tags (Wodtke et al., 2003). Then patterns can be searchable by not only their content, but also by key words and they can be navigated by category. More important, however, is to facilitate *recognition* rather than *recall* and to facilitate both exploratory and targeted search (Hearst, 2009). This is based on the finding that patterns are considered helpful for "idea generation;" hence it is likely pattern users do not know exactly what they look for when they browse through them when identifying candidates or looking for ideas. Furthermore, patterns should also be listed alphabetically, so that known patterns can be easily identified.

Grouping of patterns is also suggested by previous research (Segerståhl et al., 2006; Kotzé et al., 2008; Pontico et al., 2008; Bernhaupt et al., 2009b; Bernhaupt et al., 2009a). Multiple organization schemes have been suggested for the current UX patterns (Karahasanovic et al., 2009; Ruud, 2009; Obrist et al., 2010). The recommendation is related to the findability pattern quality criterion of Wurhofer et al. (2009)

6.1.2 Use imagery at navigation level

The importance of clear pattern names has been stressed by several authors (Wesson et al., 2003; Segerståhl et al., 2006; Kohler et al., 2008; Ruud, 2009). Although the names of the UX patterns have been evaluated in several iterations (Ruud, 2009), designers did not always grasp the core of a pattern by reading its name. Pattern naming seems however to be a challenging task, as several studies have reported it as an issue (Koukouletsos et al., 2006; Segerståhl et al., 2006; Wania, 2008; Koukouletsos et al., 2009; Wania et al., 2009). However, some participants pointed out that the pattern names would have been clearer if on navigation level they were accompanied by imagery. Then they could mentally link the pattern name to the image. This would make it easier to make meaning of the combinations, thus identifying relevant patterns more easily.

This relates to the *anchorage* function of verbal text in relation to images, introduced by Barthes (1977). Anchorage is "to point out w*hich of the many possible meanings that an image are thought to be the most important*" (Gripsrud, 2002, author's emphasis). Gripsrud (2002) noted however an *image also can anchor a text*; i.e., influence and shape how it will be interpreted. In order to increase understandability of pattern names, it is therefore suggested pattern names are accompanied by imagery to anchor them. Similarly, pattern names must be clear enough so that they can anchor the images, thus highlighting which of the many meanings in the image that the pattern is describing a solution to. The recommendation is related to the findability and understandability pattern quality criteria of Wurhofer et al. (2009)

6.1.3 Assign visual examples

This project is consistent with previous research, which has indicated interest in visual examples (Dearden et al., 2002a; Dearden et al., 2002b; Finlay et al., 2002; Kotzé et al., 2006; Díaz et al., 2009). Results indicated imagery was expected among participants and its absence caused in many cases patterns not to be used. Hence, imagery should be included in patterns. Finding suitable imagery may certainly be difficult and pattern writers should be aware of some pitfalls. First, imagery may make a given pattern being interpreted only as the solution of the illustration, while a pattern in reality is a more general solution.

Second, some users trust imagery exclusively (Díaz et al., 2009). This requires visual representations to be sufficiently clear about what they communicate. Otherwise they can be misinterpreted and applied incorrectly. This challenges the feasibility sub-quality criterion of patterns (Wurhofer et al., 2009). Again, it is apparently important that the imagery is sufficiently *anchored* by clear verbal text, e.g. captions. The recommendation is related to the understandability pattern quality criterion of Wurhofer et al. (2009)

6.1.4 Make the text shorter and easily digestible

Several participants pointed out they found the patterns too wordy. If verbal text within a pattern is short and precise, it may not seem as such a big effort to read it for pattern users. Some designers said they probably would have spent all the time on reading patterns if they were to read through all. Then they would not have had time left to design. Furthermore, the language of a given pattern should be easily digestible. Suggested techniques are to avoid academic terms and to use commonly known examples. The recommendations are related to the understandability pattern quality criterion of Wurhofer et al. (2009)

6.1.5 Summary

Based on Study 1, some recommendations on how to present patterns are suggested. The patterns should be grouped and organized so applicable patterns can be identified easily. This can be done by imagery, both within a pattern and on navigation level. Still, the imagery should be anchored with clear captions. Finally, verbal text within a pattern should be easily digestible. Commonly known examples are recommended.

6.2 Lessons learned about eye-tracking as a data collection tool for pattern evaluation

To the author's knowledge, eye-tracking has not been used to examine the use of HCI patterns previously. In the following, the experiences with this method are shared.

6.2.1 Unrealistic tool

The use of eye-tracking requires participants to use a computer when reading patterns. In this project, they were therefore also required to solve the design tasks using software. Some participants said they would prefer pencil and paper at the early stages of a design process,

rather than software. It can therefore be argued participants should have access to these tools, in order to increase realism and strengthen external validity.

This might be possible in a future study. Eye-tracking can still be used. Tasks, requirements and patterns can be presented on an eye-tracker, while the tasks can be solved on a piece of paper. Here a stand-alone camera can record design activities to video. A possible challenge with this setup is however that the participants' gaze plots during pattern reading can be hard to track, as the participants may move or change positions while solving the tasks. Consequently they should be instructed to not move too much away from the position they had when the eye-tracker was calibrated. Furthermore, video recordings of design activities will probably be less detailed than those obtained with a screen recorder or eye-tracker.

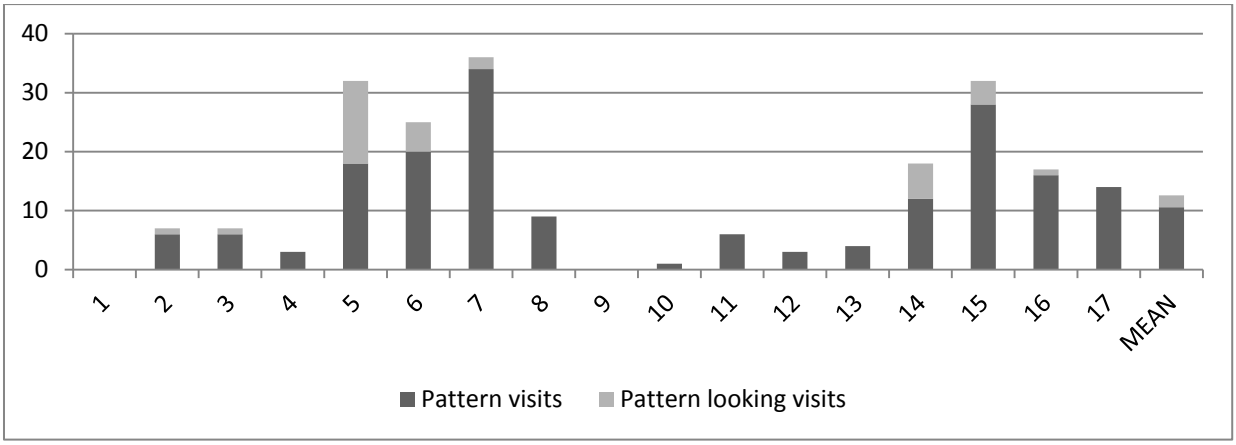
Eye-tracking might also be unrealistic in the sense that it can only be used by one person at a time. It is e.g. assumed that co-working occurs in real world situations. Co-working on an eye-tracker is impossible as long as each designer or pattern user uses one eye-tracker each. Finally, it is unrealistic because participants in many cases will have to come to a laboratory outside their professional context (although portable eye-trackers are available as well (Duchowski, 2007)).

6.2.2 Insight in pattern reading

The methods used to explore similar questions as those in the current study, such as observation (Dearden et al., 2002a; Dearden et al., 2002b; Finlay et al., 2002; Kotzé et al., 2006), screen recording (Saponas et al., 2006) and surveys (Díaz et al., 2009) make it difficult to examine pattern use in detail. This is possible with eye-tracking. Thus, detailed insight in amount of treatment received can be obtained.

Eye-tracking makes it possible to exclude pattern "looking" from the data set. A legitimate question is whether this is necessary. As shown on Figure 17, some instances of "looking" were identified in this project. Thus, tracking allowed excluding a substantial amount of patterns which were visited, but not read. This was the case for both studies. Insight in amount of treatment received is assumed to be the biggest advantage when exploring the effects of patterns.

Figure 17 "Pattern visits" and "pattern looking visits" in Study 1 and Study 2



Some results overlap with previous research which has explored similar questions without eye-tracking. It is for instance suggested designers on average spend a similar amount of time on pattern reading as the designers did in Study 1 and Study 2, by using screen recording (Saponas et al., 2006). To this end, some findings presented in the current research should be possible to identify with other methods as well. Researchers considering eye-tracking as a data gathering tool for pattern evaluation should consider whether the level of detail possible to obtain with eye-tracking is needed. The computation of correlation between pattern reading and design quality proved however to be useful and can be considered used in future full-scale studies. As previously suggested, however, it should be combined with an investigation of designers' comprehension.

6.2.3 Technical problems

Some technical problems occurred with the eye-tracker. The first few participants used design software shortcut key-commands which made the software stop recording. No feedback was given; hence the recordings were not restarted. This caused eye-tracking data to be incomplete and participants were excluded. This being said, technical problems can occur with all data gathering methods that involve electronic equipment (Crang et al., 2007). A lesson learned is that participants should be notified about which keys should not be pressed.

6.2.4 Summary

Using eye-tracking for pattern evaluation put participants in an unusual spot, as they were required to use software for the given tasks. This can however be avoided, with a different setup. An advantage with eye-tracking is it provides detailed insight into pattern reading.

Some technical issues occurred, but this can happen with all data gathering methods involving technology.

7 Conclusion and future work

7.1 Conclusion

Based on previous work related to evaluation of a collection of 30 UX patterns for networked audiovisual systems and a pattern quality criteria framework (Ruud, 2009; Wurhofer et al., 2009), the overall research question for this thesis was: *Do patterns improve design/architecture in the early stages of a design process?* A literature review was conducted. The review showed six experiments and one case study relating to the question have been conducted. The previous work has given contradicting results, but generally few effects of patterns have been identified. Some studies were however criticized, due to unrepresentative subjects, toy tasks and lack of exploration on how patterns are used during experimental sessions.

Grounded in a recommended shift of focus when investigating the role of patterns in HCI (Wania, 2008; Wania et al., 2009), the overall research question was modified to: *Do patterns improve a design process?* More specifically, it was explored to what extent patterns are read, how they are read and how pattern reading can be beneficial in a design process. Previous work related to the questions was presented. Several of the few studies however suffered from possibly inappropriate data collection methods.

Two exploratory studies were conducted, in which professional interface designers worked on a realistic task aided by UX patterns for ~45 minutes. Data collected with eye-tracking and semi-structured interviews were analyzed. Findings from the two studies are summarized below.

- **To what extent are patterns read?**
  This question was included in both studies. The question was answered by counting the number of patterns visits and time spent on patterns versus other activities. Results were relatively consistent across studies: Designers in Study 1 spent on average 10.0

% (S.D. = 9.0 %) of their time on pattern related activities, while designers in Study 2 on average spent 9.4 % (S.D. = 6.0 %). Results were consistent for other measures as well. The large standard deviations are notable and show that patterns were used to a varied extent among individual designers. Thus, it was concluded that a varied use of patterns should be expected when exploring their effects and that such variation is a possible reason to the contradicting results in previous research.

- **Which strategies exist for pattern reading?**
  Four pattern reading strategies were identified and defined in Study 1. The strategies were labeled "no reading," "quick orientation," "systematic orientation" and "as needed." The strategies made it clear that 50 % of the participants did not use patterns during the experimental sessions. It was argued the two "orientation" categories are related, while "no reading" was seen as related to "as needed." In Study 1, six of the eight (75 %) participants chose the "orientation" categories, while the remaining two (25 %) participants chose "as needed" and "no reading." It was found that the strategies overlap with previous work (Cowley, 2009; Díaz et al., 2009). They served to support the notion that a possible reason to the contradicting results in previous research is varied use of patterns between individuals.
- **Which pattern reading strategies do designers choose?**
  Based on results from Study 1, this question was proposed in Study 2. Designers distributed across strategies in the same manner as in Study 1. Thus, results from Study 2 confirmed the Study 1 results.
- **Why do designers choose the particular pattern reading strategy that they use?**
  This question was included in both studies. Participants decided not to use patterns in particular because they found them to be inefficiently presented. Wordy patterns, lack of navigation schemes and visual representations made participants fall back to more familiar design methods. Furthermore, participants were self-confident and unfamiliar with the pattern concept. Participants who read patterns did so either to identify candidates of applicable patterns, or to look for ideas. It was concluded patterns should be presented to facilitate the goals labeled "identify candidates" and "look for ideas." The importance of efficient presentation has also been stressed in related work (Bernhaupt et al., 2009a; Bernhaupt et al., 2009b).
- **How can pattern reading benefit a design process?**
  This question was included in both studies. In Study 1, patterns were seen as a helpful

design means, because they helped designers in generating ideas. "Time saving" on the subjective level was seen as a benefit in the continuation of this. Results from Study 2 overlapped those of Study 1. Furthermore, patterns were perceived helpful for evaluation and to support design decisions. The identified benefits corresponded to previous studies.

- **Does pattern reading improve design quality?**
  This question was based on informal observations from Study 1; thus only included in Study 2. In contrast to previous experiments, data were analyzed by amount of treatment received, as this varied considerably among individual designers. For expert designers, a strong correlation was identified between pattern reading and design quality with respect to sociability. The correlation was statistically significant on the $p < 5\ \%$ level. Due to the small sample the results on correlation should be treated cautiously. More interesting is that causality was explained; pattern reading tended to cause "idea generation," and ideas were in turn transferred to the artifacts to be designed. No trend was identified for novice designers, possibly because patterns were used to a limited extent and caused "evaluation." It was suggested pattern reading can cause higher design quality when used for "idea generation."

After having summarized answers to the six different research questions, it is needed to answer the overall research question of this project: *Do patterns improve design/architecture in the early stages of a design process?* Findings from this project indicate UX patterns benefit a design process in various ways, and thus improve it. A logical prerequisite is however that they are read which they not always were in this project. If the observed correlation between pattern reading and measured design quality also pertain to full-scale studies, it may indicate patterns also improve design quality with respect to UX in the early stages of a design process.

Based on designers' rationales for reading and not reading patterns, a set of recommendations on how to better present the UX patterns was made. Imagery should be added, the patterns should be organized so that they can be easily identified and verbal text should be easier to digest. It is believed these recommendations are applicable to other pattern collections as well. To the author's knowledge, this was the first project in which data on HCI pattern reading were gathered with eye-tracking. Thus, lessons learned about eye-tracking as a pattern evaluation tool were shared.

7.2 Future work

This section summarizes suggestions for future work.

7.2.1 Improvement of UX patterns presentation

The presentation of the UX patterns should be enhanced, as participants agreed on its inefficiency. Improvements can be based on results from this project and other studies which have given recommendations on pattern presentation. Furthermore, it can be based on general knowledge on information architecture and how users generally identify and digest information. It is believed findings from research on improvements of the UX patterns will be valuable to patterns in general.

7.2.2 Integration of patterns in a design process

Related to pattern presentation is knowledge on how to integrate patterns in a design process. Some pattern tools are suggested in this respect, both by academia and the industry. However, it is needed get a deeper understanding on how such tools should be designed, as well their implications while being used.

7.2.3 Comparative studies

Although the results of this project indicate that UX patterns are beneficial when used, it was not examined whether patterns are more beneficial than alternative means. In order to get a deeper understanding about whether patterns improve design/architecture, comparative studies should be conducted. Some research has been conducted in this respect (Koukouletsos et al., 2006; Wania, 2008; Cowley, 2009; Koukouletsos et al., 2009; Wania et al., 2009), but more research should be done.

7.2.4 Patterns in later iterations

Some designers decided not to use patterns because they thought it was too early to seek advice, but said they eventually would have used them if they could keep designing. Others said patterns were helpful for evaluation. The comments should be explored further. This can for instance be done by conducting longitudinal studies or by asking designers to evaluate or redesign a networked audiovisual system by the means of UX patterns.

7.2.5 Replication of this project with different methods

Finally, it is suggested that findings from this project should be further explored in a bigger study with more participants and longer task duration. It is also needed to investigate how patterns are used in natural contexts. This can be done with case studies, action research, grounded theory and ethnographical studies.

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9 Appendixes

9.1 Appendix A: Identified publications

BERNHAUPT, R., WINKLER, M. & PONTICO, F. 2009. User interface patterns: A field study evaluation. *IADIS international conference - interfaces and human computer interaction 2009.* Algarve: IADIS e-Society.

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Conference on Design Science Research in Information Systems and Technology. Philadelphia, Pennsylvania: ACM.

9.2 Appendix B: Pre-test survey

About you

Here we would like to collect some basic information about you.

1. Please enter your full name
2. Are you male or female?
3. How old are you?
4. What is your highest completed education?
5. Do you have education in human-computer interaction?

Design Experience

1. How many years of professional experience do you have with IX/UI/UX design?
2. What is your current job title?
3. What kind of web interfaces have you designed previously?
    - Landing pages
    - Corporate sites
    - Social media
    - Web applications
    - Other (please specify)

Patterns

Here, we want to know more about your experience with patterns. Please rate each of these statements as best as you can.

1. Previous experience with patterns.
    - I have designed with patterns before.
    - I have read about patterns before.
    - I know where to find patterns.
    - I design better products when I design with patterns.
    - I design faster when I design with patterns
2. What do you think about designing with patterns?

Other means

Here we want to know your experience with other design means.

1. Experience with other design means.
    - Guidelines
    - Claims
    - ISO Standards
    - Style Guides
2. Usefulness of other means
    - Guidelines
    - Claims
    - ISO Standards
    - Style Guides

9.3 Appendix C: Post-test survey[16]

Design Task

Please tell us a little bit about the task

1. How would you rate the difficulty of each of the tasks?
    - Design the first page after login
    - Design a page where a user can create a new story
    - Design a page presenting a story from the past (for a logged-in user)
    - Design the user profile page for the user "John Doe"

Use of patterns

Here, we want to ask you about your usage of the UX patterns.

1. Did the patterns help you to solve the tasks? Please give a rating.
    - Design the first page after login
    - Design a page where a user can create a new story
    - Design a page presenting a story from the past (for a logged-in user)
    - Design the user profile page for the user "John Doe"
2. Which patterns did you use for each of these tasks?
    - Design the first page after login
    - Design a page where a user can create a new story
    - Design a page presenting a story from the past (for a logged-in user)
    - Design the user profile page for the user "John Doe"
3. Please rate each of these statements
    - The information in the patterns was easy to understand
    - I found the patterns I needed for the tasks.
    - I will use patterns more in the future.
    - Designers should use patterns more.
4. Do you have other comments?

[16] No data from the post-test survey was analyzed for the purpose of this project.

Social Media

Here we want know more about your social media knowledge.

1. Which of these do you use?
    - Facebook
    - Twitter
    - Vimeo
    - Flickr
    - Gowalla
    - Windows Live
    - Foursquare
    - YouTube
    - Del.icio.us
    - Google Docs
    - Interactive TV
    - Wikipedia
    - Blogging tools (WordPress and similar)
2. Do you use other social media? Please specify.
3. Have you ever designed a social media platform before? Please specify what you did.

9.4 Appendix D: Interview guide for Study 1

Use the following question as a warm up question: *How do you think it went?* Then ask the questions to make participants elaborate on the following themes. Ask follow-up questions when necessary. Questions based on observations of design activities can be added. Finally, ask participants whether there is anything they want to add.

Appendix table 1 Themes and questions to be asked in Study 1

Theme	Questions
Helpfulness of patterns	• What did you use the patterns for? • Did the patterns help you in any way?
Justification of design decisions	Here you can mention elements and features from their designs, to help participants in remembering what they had done. Then you can ask questions like: • What was the rationale behind this? • What was the motivation behind this? • Why did you add this?
Presentation of the patterns	• Was there anything within the patterns that you didn't really like, or that you think could have been improved? • Do you think the patterns could have been presented differently? • How do you think they could have been presented differently? • Why do you propose this presentation?
Former pattern knowledge	• Have you used patterns before? • Are you familiar with patterns?
Pattern reading strategy	• Why did you read the patterns? • Which sections within a pattern did you read? Why? • How did you use the patterns now?

9.5 Appendix E: Requirements and corresponding UX factors

Requirements:

Beestory.com

Imagine that you have been hired as a **user experience (UX) designer for a site named "Beestory.com."**

Purpose of the Site

The site is an online community for people interested in the history of Baltimore.

The site supports the users in multiple activities, such as:

- Collaboratively documenting the history of Baltimore
- Getting access to the history of Baltimore
- Getting in touch with other people with the same interest

Overall the users should have a positive experience when visiting the site.

Design Goals

The owners want the number of users to grow as fast as possible.

The site has just launched and a few users have already added content.

The site should be fun to use, easy to use and involve the users.

User Group

The user group is everyone who is interested in the local history.

No prior experience with social media should be needed to use the site.

Using the site is free, but registration is needed.

Appendix table 2 Requirements and corresponding UX factor(s)

Requirement	Corresponding UX factor(s)
The site should support the users in collaboratively documenting the history of Baltimore	Co-experience, sociability, user-involvement, motivation, user-engagement
The site should support the users in getting access to the history of Baltimore	Usability
The site should support the users in getting in touch with other people with the same interest	Sociability, co-experience
The site should be fun to use	Fun
The site should be easy to use	Usability
The site should involve the users	User involvement, co-experience, sociability, motivation
No prior experience with social media should be needed to use the site	Usability

9.6 Appendix F: Procedure

Each participant was individually welcomed to a usability lab. First, he was told the purpose of the study was to examine the use of patterns. He was told he would be asked to work on four tasks related to an online community and was encouraged to use patterns when solving the tasks. He was told it was acceptable if he did not complete all the tasks and was encouraged to imagine he worked for a real client. Some more practical information was given and then he signed a consent form.

The eye-tracker was calibrated and a short pre-test questionnaire was filled out. The participant was asked to read a web page which presented the high level requirements for the "Beestory" application, together with information about where to save files, etc. Following this, a short presentation about UX and patterns was given. UX and the pattern concept was explained and it was by example demonstrated how patterns can be used to improve an interface. The patterns were presented on the same website as the tasks, requirements and practical information. The participant was asked to navigate to four patterns used in the example[17]. After this, he filled out another pre-test questionnaire.

The participant was left. His further activities were monitored from a separate room. Notes were taken. After ~45 minutes, the participant was interrupted. He filled out a post-test questionnaire and then a semi-structured interview about the design process and his use of patterns was conducted. The interview lasted for ~15 minutes. The full session lasted for ~90 minutes.

[17] PRIVACY MANAGEMENT, EXPLICIT PURPOSE, INITIAL SUPPORT and CONSTANT FEEDBACK.

9.7 Appendix G: Codes

9.7.1 RQ2.1: Why do designers choose the particular pattern reading strategy that they use?

9.7.1.1 Participants who not used patterns (“no reading” and “systematic orientation”)

- Categories
- Color code
- Colors
- Common knowledge
- Design focus
- Difficult to understand pattern
- Evaluate design
- Examples
- Figure out myself
- Knowledge missing
- Label of pattern
- More time
- No formal UI background
- No pattern knowledge
- Organization
- Overlap
- Pictures
- Quickly
- Reading
- Reorganize pattern
- Rush
- Solution
- Style guide confusion
- Terminology
- UI focus
- Useless

- Visual examples

9.7.1.2 Participants who used patterns (“As needed” and “systematic orientation”)

- Get overview
- Match patterns with requirements
- Next step of design
- Problem that the pattern would solve
- Applicable patterns
- Look for ideas
- Reference
- Quickly go through patterns

9.7.2 RQ3: How can pattern reading benefit a design process?

- Additional functionality
- Application of feature from patterns
- Brainstorming
- Changed view of application
- Early implementation of features
- Helped the process rather than where it ended up
- Idea
- Inspiration
- Next step of design
- Quickly
- Reference
- Reminder
- Time saving
- Trust in pattern solutions

9.7.3 RQ2.1´: Why do designers choose the particular pattern reading strategy that they use?

9.7.3.1 Participants who not used patterns (“no reading” and “systematic orientation”)

- Common knowledge
- Confusion
- Design focus
- Digest
- Examples
- Jump back and forth
- Knowledge missing
- Name
- Navigation
- No formal background
- Organization
- Part of commission
- Pictures
- Quickly
- Reference in my mind
- Second nature
- Time consuming
- Too early for patterns

9.7.3.2 Participants who used patterns (“As needed” and “systematic orientation”)

- Additional functionality
- Embrace
- Evaluate design
- Familiarize with patterns
- Get overview
- Match up application with patterns
- Patterns as a brief

- Problem that the pattern would solve
- Remind myself
- Responsible
- Thought it was expected

9.7.4 RQ3´: How can pattern reading benefit a design process?

- Changed view of application
- Checklist
- Creative direction
- Early implementation of features
- Evaluate design
- Guide thinking
- Helped the process rather than where it ended up
- Inform the design process
- Patterns as a brief
- Patterns as requirements
- Provide focus
- Reference
- Reminder
- Rigor to design decisions
- Theoretical background
- Time saving

9.7.5 RQ4´: Does pattern reading improve design/architecture?

- Creative direction
- Creativity trigger
- Diving board
- Early implementation of features
- Guide thinking
- Helped the process rather than where the design ended up
- Idea

- Inform design process
- Match up application with patterns
- Patterns as a brief
- Patterns as requirements
- Provide focus
- Reference
- Reminder

9.8 Appendix H: Interview guide for Study 2

Use the following question as a warm up question: *How do you think it went?*

Then ask the following questions in the order which is suitable to how the conversation emerges. Follow-up questions can be asked when needed.

- What did you think about the tasks?
- What did you think about the patterns?
- [Explain the observed pattern reading strategy, then ask any of the following questions]
    - Why did you decide not to use the patterns?
    - What made you stop designing and refer to the patterns?
    - What made you go through the patterns before you started designing?
- As I explained in the small presentation, the patterns consisted of the problem, the context, the forces, solution and examples. Which of these sections were you interested in? Why?
- Did the patterns help you in any way?
- Were there ways which the patterns did not help you?
- Do you think the patterns could have been presented differently to be more helpful? How?
- Did you miss anything in the patterns?

9.9 Appendix I: Heuristics

Evaluators were provided with the following instructions to complete their evaluation.

Introduction

Dear evaluator,

Thank you very much indeed for your willingness to evaluate a collection of interface designs with respect to user experience (UX).

Please complete the following:

1. Carefully read this document
2. Look through all the 17 designs (files named 01, 02, 03, … 17, placed in the "Designs" folder)
3. Go carefully through each design and rate to which extent they fulfill each of the statements listed in Table 3. There is one form for each design, all are available in the attached MS Word file "Evaluation Form").

It is important that you do the evaluation individually. You should *not* gather second opinions from others, such as colleagues.

Furthermore, it is important that the ratings across designs are relative to each other. Please keep the same level of standards throughout the whole evaluation process.

The evaluation should preferably be done and returned before April 1st.

Good luck and thank you again for your time and effort.

Sincerely yours

Helge Fredheim

Context

A group of professional interaction designers were asked to work individually on up to four different design tasks. They had ~45 minutes to complete the tasks. They were asked to do as best they could. They were also asked to take their time and that they were not expected to complete all the tasks. However they were expected to pretend they worked for a real client. They were provided with the following instructions:

Beestory.com

Imagine that you have been hired as a **user experience (UX) designer for a site named "Beestory.com."**

Purpose of the Site

The site is an online community for people interested in the history of Baltimore.

The site supports the users in multiple activities, such as:

- Collaboratively documenting the history of Baltimore
- Getting access to the history of Baltimore
- Getting in touch with other people with the same interest

Overall the users should have a positive experience when visiting the site.

Design Goals

The owners want the number of users to grow as fast as possible.

The site has just launched and a few users have already added content.

The site should be fun to use, easy to use and involve the users.

User Group

The user group is everyone who is interested in the local history.

No prior experience with social media should be needed to use the site.

Using the site is free, but registration is needed.

Practical Information

Your design should at this stage be a wireframe-like low-fidelity prototype.

Your design does not need to include any information on look and feel (graphic design, style, typography, colors), but it should be a sketch that gives the owner an idea of how the elements are supposed to look; their sizes, their shapes and their positions.

Labels and other textual element should be realistic. Do not use dummy text.

Tasks

1. Design the first page after login
2. Design a page where a user can create a new story
3. Design a page presenting a story from the past (for a logged-in user)
4. Design the user profile page for the user "John Doe"

Furthermore, the designers were asked to see if they could take advantage of a collection of UX patterns for networked audiovisual systems.

UX factors

In this study, you are asked to heuristically evaluate design quality with respect to design for UX. In order to do this, it is necessary to have a shared understanding of exactly how we can design for UX.

Formally, UX can be split into different *factors*. Here, UX is viewed as the sum of these factors. Suggested factors and possible ways to design for those factors are listed in Table 1.

Table 1 UX factors and possible ways to design for them[18]

UX factor	Description
Fun	Fun is related to enjoyment and entertainment. Designing for this is difficult because it will always depend on the user's willingness to be entertained and have a good time. However, applications designed for fun should support

[18] These are based on Obrist et al. (2007)

	enjoyment and entertainment.
Emotion	Emotions can be part of the stress that invites creative release, or the reward of the hedonic consequence labeled pleasure. To this end, applications designed for emotion should support these activities.
Motivation	Motivation is the proceeding to an action; hence a motivating application should give objectives and direction signs to take action.
User engagement	The application should be designed to give a high quantity and quality of contributions and participations. Furthermore, it should support users in pretending that the representations they interact with are real. It should be designed so that users don't stop and think on a meta-level about what the application wants to do.
User involvement	The application should support a social/community experience.
Co-experience	The application should encourage users to do things together, such as make distinctions and meanings, carry on conversations and share stories.
Sociability	The application should to support users in interacting with each other, via the application.
Usability	The application should be designed to be usable. Usability has been defined as the combination of effective, efficient, satisfaction, errors, learnability and memorability.

Instructions

Please complete the following after you have read the whole of this document.

1. In the "Designs" folder there are 17 solutions to Task 1 ("Design the first page after login"). Look through and study each designs to get an overview of the overall design quality and variations. You will not be asked to evaluate solutions to tasks 2, 3 and 4.
2. For each of the solutions, please rate the statements listed in Table 2 below, on a 1-5 scale. Please also make sure you understand what each of the ratings one the 1-5 scale means (see Table 3). The ratings should be filled in to the MS Word file named "Evaluation form." Each of the designs have one corresponding (numbered) form, so please make sure you use the correct form for each design. All the forms are available from the same file. You may print the forms and fill them out with a pen, or you may fill it out directly in the MS Word file. If you use a pen, make sure you write as clearly as possible.
3. When you have finished (preferably before April 1st) please return the form to Helge, by email: helgefredheim@gmail.com. If you decide to print the forms, you may scan and email them, or mail it using regular airmail.

Table 2 Statements

Statement	UX Factor(s)	Question
A	Usability	This application is designed to be easy to use
B	Sociability; Co-Experience; User involvement	This application is designed so that users can do things together (such as, but not limited to: get in touch with others, collaborate on stories via rating, comments or similar, discuss topics)
C	Motivation	This application is designed to encourage users to participate or use the application, though adding/modifying/using content
D	N/A	The design of this application is complete
E	Fun	The application is designed so that users might enjoy it
F	Fun	Based on what aspects of the design do you think this application is enjoyable to users? Please list up to three aspects. For each aspect, rate this statement: *This aspect will make the application enjoyable to users.*

Ratings

The ratings that you give have the following meanings:

Table 3 Meanings of ratings on a 1-5 scale

Rating	Description
1	None or very few aspects of the design makes this application fulfill this statement. Huge room for improvement.
2	Below average. Few aspects of the design make this application fulfill this statement. Big room for improvement.
3	Just average. The design makes this application fulfill this statement to neither a high nor low extent. Some room for improvement, but a couple of aspects makes the application fulfill this statement too.
4	There are some small bugs, but overall the design makes this application fulfill this statement to a high extent through several aspects. Above average.
5	This application is designed to fulfill this statement to a very high extent. The bugs, if any, are only cosmetic.

9.10 Appendix J: Example evaluation form

Design number:

16

A: This application is designed to be easy to use (UX factor: Usability)

Rating (1-5):

Please justify your rating:

B: This application is designed so that users can do things together (such as, but not limited to: get in touch with others, discuss topics, collaborate on stories via rating, comments or similar)

(UX factors: Sociability, Co-experience, User-involvement)

Rating (1-5):

Please justify your rating:

C: This application is designed to encourage users to participate or use the application, though adding/modifying/using content

(UX factor: Motivation)

Rating (1-5):

Please justify your rating:

D: The design of this application is complete (UX factor: N/A)

Rating (1-5):

Please justify your rating:

E: The application is designed so that users might enjoy it (UX factor: Fun)

Rating (1-5):

Please justify your rating:

F: Based on what aspects of the design do you think this application is enjoyable to users? Please list up to three aspects. For each aspect, rate this statement: *This aspect will make the application enjoyable to users.* Use the same 1-5 scale as previously. (UX factor: Fun)

Aspect 1: Rating (1-5):

Aspect 2: Rating (1-5):

Aspect 3: Rating (1-5):

Comments:

9.11 Appendix K: Computation of correlation

Pattern visits and design quality among expert designers

Appendix table 3 Ranking and ordering of data collected from expert designers, corrected for ties

Unique sociability pattern visits, x_i	Average quality measure, y_i	Rank x_i	Rank y_i	d_i	d_i^2
0	1.33	1	1	0	0
1	2.33	2	2.5	-.5	.25
6	2.33	3	2.5	.5	.25
9	2.67	4	4	0	0
21	3.67	5	5	0	0
					$\sum d_i^2 = .50$

$$r_s = 1 - \frac{6\,(.50)}{5^3 - 5} = .975$$

Pattern visits and design quality among novice designers

Appendix table 4 Ranking and ordering of data collected from novice designers, corrected for ties

Unique sociability pattern visits, x_i	Average quality measure, y_i	Rank x_i	Rank y_i	d_i	d_i^2
1	3	1	2	-1	1
5	4	3	4	-1	1
3	3	2	2	0	0
9	3	4	2	2	4
					$\sum d_i^2$ = 6.00

$$r_s = 1 - \frac{6\,(6.00)}{4^3 - 4} = .400$$

9.12 Appendix L: Computation of correlation in threats to validity

Background variables and measured design quality

Appendix table 5 Relevant education and measured design quality with respect to sociability; ranking and ordering of data corrected for ties

Relevant education, x_i	Measured design quality, y_i	Rank x_i	Rank y_i	d_i	d_i^2
0	1,33	1	1	0	0
1	2,33	2,5	2,5	0	0
2	2,33	4,5	2,5	2	4
1	2,67	2,5	4	-1,5	2,25
2	3,67	4,5	5	-0,5	0,25
					$\sum d_i^2 = 6.50$

$$r_s = 1 - \frac{6\,(6.50)}{5^3 - 5} = .675$$

Appendix table 6 Experience in the industry and measured design quality with respect to sociability; ranking and ordering of data corrected for ties

Years of experience in the industry, x_i	Measured design quality, y_i	Rank x_i	Rank y_i	d_i	d_i^2
13	1,33	4	1	3	9
5	2,33	2	2,5	-0,5	0,25
5	2,33	2	2,5	-0,5	0,25
5	2,67	2	4	-2	4
14	3,67	5	5	0	0
					$\sum d_i^2 = 13.50$

$$r_s = 1 - \frac{6\,(13.50)}{5^3 - 5} = .325$$

Appendix table 7 Self-reported pattern knowledge and measured design quality with respect to sociability; ranking and ordering of data corrected for ties

Self-reported pattern knowlege, x_i	Measured design quality, y_i	Rank x_i	Rank y_i	d_i	d_i^2
7	1,33	4	1	3	9
1	2,33	1	2,5	-1,5	2,25
5	2,33	2	2,5	-0,5	0,25
7	2,67	4	4	0	0
7	3,67	4	5	-1	1
					$\sum d_i^2 = 12.50$

$$r_s = 1 - \frac{6\,(12.50)}{5^3 - 5} = .375$$

Background variables and patterns read

Appendix table 8 Relevant education and patterns read; ranking and ordering of data corrected for ties

Relevant education, x_i	Unique sociability pattern visits, y_i	Rank x_i	Rank y_i	d_i	d_i^2
0	0	1	1	0	0
2	1	4,5	2	2,5	6,25
1	6	2,5	3	-0,5	0,25
1	9	2,5	4	-1,5	2,25
2	21	4,5	5	-0,5	0,25
					$\sum d_i^2 = 9.0$

$$r_s = 1 - \frac{6\,(9)}{5^3 - 5} = .550$$

Appendix table 9 Experience in the industry and patterns read; ranking and ordering of data corrected for ties

Years of experience in the industry, x_i	Unique sociability pattern visits, y_i	Rank x_i	Rank y_i	d_i	d_i^2
13	0	4	1	3	9
5	1	2	2	0	0
5	6	2	3	-1	1
5	9	2	4	-2	4
14	21	5	5	0	0
					$\sum d_i^2 = 14.00$

$$r_s = 1 - \frac{6\,(14)}{5^3 - 5} = .300$$

Appendix table 10 Self-reported pattern knowledge and patterns read; ranking and ordering of data corrected for ties

Self-reported pattern knowledge, x_i	Unique sociability pattern visits, y_i	Rank x_i	Rank y_i	d_i	d_i^2
7	0	3	1	2	4
1	1	1	2	-1	1
5	6	2	3	-1	1
7	9	3	4	-1	1
7	21	3	5	-2	4
					$\sum d_i^2 = 11.00$

$$r_s = 1 - \frac{6\,(11)}{5^3 - 5} = .450$$