CUX Patterns Approach: Towards Contextual User Experience Patterns

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***Abstract*—User experience (UX) is highly influenced and even changed by the context in which it occurs. So far, both concepts "user experience" and "context" have been discussed a lot to various extent and in different dimensions. Within this paper, we aim to bring these two important areas closer together by using patterns. We introduce the contextual user experience patterns (CUX patterns) approach. Precisely, we argue for using patterns to describe knowledge on how to influence the users' experience in a positive way by taking context parameters during the interaction with a system into account. To do so, we provide a detailed description of how to structure CUX patterns, referring to the context "car" as one of the two main application areas, which is investigated in our recently established laboratory on contextual interfaces.**

***Keywords*-user experience; context; contextual user experience; patterns approach; patterns structure; contextual interfaces; car application area**

I. Introduction and Motivation

In the field of Human-Computer Interaction (HCI) and related fields, it is increasingly recognized that apart from standard usability and ergonomic principles, the much broader concept of user experience (UX) needs to be considered intensively to design next generation interaction innovations [1]. This includes aspects such as fun, enjoyment, emotion, sociability, and other factors.

Moreover, there is an observable trend in HCI towards novel and alternative forms of interaction, moving away from traditional desktop computing to computing in various contexts with various interfaces. One general form of novel interfaces are so-called "contextual interfaces" (see [2][3]), which are designed according to the needs and behaviors of people in specific contextual situations and have the potential to be conceptually as well as technically adapted to the characteristics of the specific context. Thus, an in-depth understanding of the particular context is needed for designing contextual interfaces.

In addition to knowledge on the context, there is a need for insights into how a user perceives an interaction with a system. Thereby, evoking a positive feeling within the user through the usage of the system increases the potential for re-usage of the system. We thus claim that enabling the user a positive experience by considering the context parameters during an interaction is one important ingredient for the success of contextual interfaces. However, as far as we are aware, there are no such insights and best practices available yet for contextual interfaces.

So far, both concepts "UX" and "context" have been discussed a lot to various extent and in different dimensions. We aim to bring both concepts together to reach a more comprehensive understanding of contextual UX [3], which opens up different roads for research and challenges for the HCI community in all design and development phases. In particular, we bridge the two concepts by using the patterns approach. Patterns exist in many areas, ranging from architectural patterns (e.g., [4]) to patterns for human-robot interaction (e.g., [5]). However, despite the growing importance of contextual interfaces as well as UX, the patterns approach has not been applied yet for contextual UX design. Within this paper, we introduce "Contextual User Experience Patterns" (in short, CUX patterns). We propose a pattern structure and describe each part, but without giving a detailed description of CUX patterns themselves.

Building on our previous work on UX patterns for audio-visual networked applications [6], we again use the patterns approach for describing knowledge on how to influence the users' experience in a positive way when interacting with a contextual interface. CUX patterns represent a pattern collection for documenting and collecting best practices in the area of contextual user interfaces. Thus, developers and designers can be supported in producing high-quality user-centered applications. This research represents a main element of a recently started Christian Doppler Laboratory (CDL) on "contextual interfaces" at the University of Salzburg, Austria.

The present paper is organized as follows: Section II explains the background of our research on contextual interfaces and section III summarizes related work on (HCI) patterns, as well as clarifies the potential of patterns for contextual user experience. In section IV, the main idea of CUX patterns, and their structure are described and summarized in the final section.

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II. Research Context and Background

Within this section, we shortly explain the background of our research on contextual interfaces (basic research within our laboratory) and our understanding of UX factors and context parameters.

A. Laboratory on Contextual Interfaces

The overall goal of the laboratory on "contextual interfaces" is to further strengthen existing research and in particular to gain new insights into the multidimensional aspects of contextual interaction. Contextual interaction can be considered as situated human-computer/machine interaction, which is dependent on a multitude of factors. We investigate contextual interaction from a constructional and methodological viewpoint to develop a deeper understanding of optimal contextual user experiences and their influences.

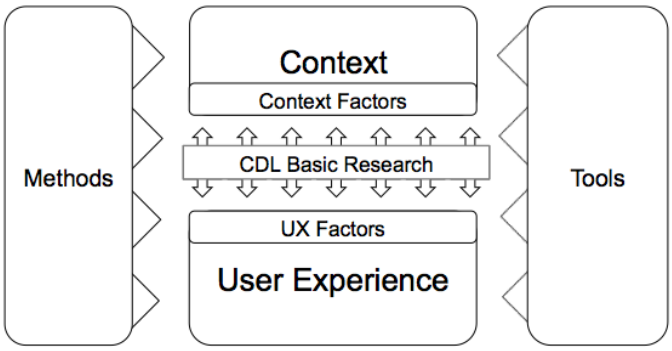

Figure 1. Basic Contextual Research Parts of our Christian Doppler Laboratory (CDL): Bridging User Experience (UX) Factors and Context Factors by doing Basic Research Activities on Methods and Tools.

The planned work is divided into two parts (see Figure 1). On the one hand, UX factors and context factors are investigated, and on the other hand, methods and tools to study contextual interfaces are addressed. Thus, these basic research parts will deliver a foundation for the second research part which addresses two specific application areas, namely car and factory. Both parts are related to each other and aim to increase the knowledge on contextual user experience. One main outcome of this research project (for the next seven years) are more generalizable UX patterns for contextual interfaces, i.e. CUX patterns. First of all, deeper insights on the main elements are needed and are shortly introduced in the following section.

B. Understanding User Experience and Context

The concept of seeing technology in terms of experience was originally introduced by McCarthy and Wright [7] and further extended by several attempts, models, definitions etc. (e.g. [8][9]). In our previous research we already investigated UX in different application areas (i.e. human-robot interaction and audiovisual networked applications) and identified a set of relevant UX factors to understand the aspects that make an experience more successful and valuable to users and contribute to positive contextual user experiences.

A small selection of these UX factors, which we conceive as relevant for the context car and factory, is provided below:

- Emotions (e.g., What emotions does the interaction with a system provoke?)
- Fun/Enjoyment (e.g., Do people enjoy interacting with a system?)
- Co-Experience (e.g., How do other people influence the experience?)
- Trust (e.g., To what extent do people trust a system?)
- Feeling of Security (e.g., How save do people feel?)
- Comfort (e.g., What is perceived as comfortable?)
- etc. (e.g., motivation, added value, engagement, etc.)

Based on empirical insights, the factors listed above will be further extended.

Moreover, in HCI, several definitions of context have been proposed during the last years. One of the most complete definitions of context, which we use as a starting point in our research, is provided by Dey [10]: "Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves". Overall, a common understanding of context is not fully developed up to now. Especially the influence and potential of context parameters for designing interaction innovations is poorly conceived and underpins the need for empirically grounded research. However, some relevant context parameters can already be extracted from [11] and are summarized as follows:

- Physical context (e.g., spatial location)
- Task context (e.g., task types, interruptions)
- Social context (e.g., presence of other people, culture)
- Temporal context (e.g., duration, time of day, week, and year)
- Technical and information context (e.g., other systems and services)

Overall, the focus on contextual user experience is not completely new in the history of patterns. The first who emphasized a focus on the human perspective was Alexander [4]. He argues that it is important to investigate how people experience architectural constructs, and to take the user's experience into account when constructing new buildings. Other authors (e.g., [12], [13], [14], [15] and [16]) also argue to consider human activity and experience and thus underpin the relevance of this topic.

The advancement of our approach is the strong combination of the two concepts "UX" and "context". Furthermore, our approach bases on empirical evidence from the two context application areas car and factory (see section IV-B).

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III. Related Work

Within this section, we will provide more insights on the idea of patterns and their application in the area of HCI as well as their potential for addressing contextual user experience.

A. The Idea of Patterns

Patterns exist in many areas. The concept of patterns was first described by Alexander [4] who developed more than 250 patterns showing best practices and thinking in architecture. Later, computer scientists captured the idea of patterns and successfully applied it to common problems in software engineering [17]. Over the past years, the area of HCI also adopted the idea of patterns for conveying principles and best practices of good interface design (e.g., [18][19][20][21][22]).

The concept of interaction design patterns is known under different names such as interaction (design) patterns, user interface (UI) patterns, usability patterns, web design patterns, workflow patterns or, less precisely, HCI patterns. In general, these patterns share a lot of similarities and all provide solutions to common usability problems in interaction and interface design. For a detailed review on patterns in HCI we refer to Dearden and Finlay [23].

As the wide usage of patterns shows, patterns have proven to be an effective tool for designing usable systems. The idea of "reusable" solutions for recurring problems is important for both novice and experienced designers.

B. Characteristics of Patterns

Already in 1977, the main characteristics of patterns were pointed out by Alexander [4], stating that "each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over". Newer definitions of patterns define them as "structured textual and graphical descriptions of a proven solution to a recurring problem" [24], as "tools for capturing useful design solutions and generalizing them to address similar problems" [12], as "devices for re-use, generalisation and design" [25], or simply as "descriptions of best practices within a given domain" [20]. These definitions illustrate one of the main characteristics of patterns – the characteristic of reusability.

Another characteristic of patterns is their context, i.e. the physical and social environment the pattern is embedded in. Furthermore, patterns represent a systematic approach to design which can be beneficial for a wide audience of practitioners [26] and thus can be considered as an "effective knowledge management tool" [16]. Patterns provide a collective vocabulary [27] or lingua franca [28] and thus facilitate communication between different stakeholders.

C. Special Application Areas of Patterns in HCI

Patterns are adopted in a variety of application fields. Recently, Zimmerman [29] used design patterns for describing how to apply the product attachment theory to the interaction design of a product. Kahn et al. [5] used patterns in the area of Human-Robot Interaction for explaining how to achieve sociality in Human-Robot Interaction. Patterns have been adopted for supporting innovative game design [30], for describing best practices in ubiquitous computing applications [31] and in the design of social interfaces [32], as well as for teaching HCI principles [33].

According to Zimmerman [29], patterns can also be used as a method for analyzing user research. This is illustrated, for instance, by Martin et al. [34] and Crabtree et al. [35], who use patterns for organizing and presenting ethnographic material. A recently published book targets the design of social interfaces [32]. Principles and patterns for social software are introduced by giving practical design solutions for improving the interfaces of social websites. In our recent research, we also successfully explored the patterns approach for audiovisual networked media (social media applications) by introducing UX patterns (see [36][37]).

D. User Experience Patterns

Designing for a good UX is an increasingly important topic in academia and industry (see [38][39]). In our previous research, we developed 30 UX patterns for audiovisual networked applications [37] based on a huge range of collected empirical data, which was further categorized into main UX problem areas. These areas cover the main UX issues in audiovisual networked applications. As advancement of this research, we intend to extend the application areas beyond audiovisual applications towards the application area car and factory. Thereby, we additionally want to strengthen the importance of context factors (the influence of contextual parameters) on the UX.

The multifaceted adoption of patterns illustrates their flexibility as well as their potential for storing and representing knowledge. We are convinced that the patterns approach can be further strengthened by putting a strong emphasis on the context and relevant context parameters for an application area, linked with relevant UX factors.

IV. The Potential of Patterns for Contextual User Experience

Within this section, we provide a structured overview on the details of our CUX patterns approach, including a definition as well as our strategy for structuring the patterns (see CUX Patterns Structure). Therefore, we selected the application area "car" as a case example to clarify our approach.

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A. Details on the CUX Patterns Approach

Best practices for designers and developers are needed to guide the development of contextual interfaces which, for instance, support user's trust and feeling of comfort. We suggest to transform such best practices into CUX patterns for contextual interfaces. In the following, we focus on "car" as an application area. We suggest the following initial list of UX demands (exemplary problem areas), which does not strive for completeness, and needs to be extended based on empirical insights:

- Trust: How to increase the user's trust in the car when interacting with in-car interfaces?
- Comfort: How to give the user a feeling of comfort when using in-car interfaces?
- Personal and social benefit: How to raise the personal and social benefit of using in-car interfaces?
- Feeling of Control: How to raise the users' feeling of control when using in-car interfaces?

For these UX problems, the CUX patterns for the application area car should provide proven solutions. One problem area can comprise more than one pattern, depending on how many different best practices exist for the problem addressed. The patterns subsumed under each problem area should address a more specific problem (which can be subsumed under the corresponding problem area) and provide detailed solutions for this problem.

In general, CUX patterns provide solutions on how to improve a user's experience when interacting with a contextual interface in a specific application area. More specifically, CUX patterns are characterized by combining two aspects, i.e. (a) the application area of the patterns including the most relevant context parameters and (b) the specific (recurring) UX problem (demand) which the pattern intends to solve. Thus, CUX patterns can provide useful support during the design and development phase of an application. They especially provide guidance in the initial steps of an experience-centered design approach, where the designer does not yet have a clear picture on the potential users and their expectations, that influence their experience with a new system. Thus, it is relevant to consider CUX patterns quite from the beginning as an additional pool for inspiration.

B. CUX Patterns Structure

As a starting point for developing the CUX patterns we build on the structure of Van Welie [16] and Borchers [38] and extend it in particular regarding UX factors and context parameters. Context is currently limited to the characteristics of the usage context for which the pattern can be applied, but does not link the context/context parameters back to the UX factors relevant for the particular application area. In the following, the suggested structure is described and illustrated by the exemplary pattern "Feeling of Security" for the application area car.

- *Name/UX Factors:* The name of a pattern is essential. It should describe the main idea of the pattern in one or a few words; it should be both descriptive and unique so that it helps in identifying and referring to the pattern. In other words, patterns should be easy to remember and communicate. Moreover, the naming strategy should be consistent across all patterns collected, also supporting better memorization and easier communication (about patterns). Finally, the user experience factors that are addressed by the pattern should be included along with the name in combination with the relevant context parameters. *An example for a CUX pattern name in the application area car can be: "Feeling of Security".*
- *Problem:* The problem states the major issue the pattern addresses, formulated as a question based on the experiences made by the users. Problems in CUX patterns are formulated from the users' perspective and are related to the usage of the system. *An example for a CUX pattern problem in the application area car can be: "How to raise the users' feeling of security when using the speed control?".*
- *Forces:* The forces further elaborate the problem statement. They depend on the application area and can describe various trade-offs, constraints, or concerns related to the use of the pattern. *Examples for CUX pattern forces in the application area car can be: "The user wants to see the status of the speed; the user wants to change the speed, etc.".*
- *Context Parameters:* The context section of a pattern should describe when it is appropriate to apply a particular pattern, giving information about the characteristics of the context of use, including the context parameters listed above for which the pattern can be applied. *An example for a CUX pattern context parameter in the application area car can be: "Use this pattern when you want to support the users' feeling of security while driving".* The context parameter, in this case the task context (see II-B), is applied for specifically addressing the UX factor "Feeling of Security".
- *Solution:* A solution must be described precisely and must not impose new problems. However, a solution describes only the core of the solution and the designer has the freedom to implement it in many ways. Other patterns might be needed to solve sub-problems; patterns relevant to the solution should be referenced, too. *An example for a CUX pattern solution in the application area car can be: "Support users to better estimate speed risks by using persuasive interfaces".*
- *Examples:* The example should show how the pattern has been used successfully in a system, i.e. refer to commonly known implementations of the pattern. Whether an example is commonly known or not can be difficult to determine, but this must be seen in relation

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to the intended target audience for the patterns as well. Examples for real-life systems are preferably used, so that the validity of the pattern is enforced. *Examples for an applied CUX pattern are not available yet*.

Having the same structure for the whole pattern collection makes it easy for people to use them. As patterns represent possible solutions, which can be extended dynamically, they are never complete; when new solutions appear, they can be easily integrated into the given structure. This is in particular relevant for contextual interfaces, as the influence of context parameters on UX is a relatively new area of research.

V. Conclusion and Future Work

Within the CHI community, several experts commented on the pattern approach (see [38], most recently [39]). It was pointed out that patterns can facilitate the communication among all stakeholders and are more than just a sort of poetic form of guidelines. Pattern languages are intended to be meta languages used to generate project-specific languages that are grounded in the social and cultural particularities of a given design domain.

Moreover, it can be stated that patterns are important as they provide a common vocabulary [28], they are structured around the problems the designers face, and they provide solution statements [40]. These pattern characteristics can reduce time and effort for designing new projects considerably [16] and support a better communication among different stakeholders. In sum, capturing useful design solutions and generalizing them to address similar problems [12] is one of the big advantages of patterns, in part because the documentation and use of best practices improves the quality of design.

Within this paper, we especially build on patterns to introduce the "Contextual User Experience Patterns" (CUX patterns) approach. Thereby, we bring together the two relevant and increasingly important concepts of UX and context. UX is highly influenced and even changed by the context in which it occurs. So far, both concepts have been discussed a lot to various extent and in different dimensions, however, there is no guidance on how to design for a good UX for relevant application areas addressed in our research (car and factory). Thus, the introduced CUX patterns approach takes the discussion a step further by highlighting the potential of the patterns approach for describing knowledge on how to influence the users' experience in a positive way by taking context parameters during the interaction with a system into account.

Based on this theoretical argumentation, we describe the structure for CUX patterns, referring mainly to the application area car. This paper builds the starting point for our research within the recently established laboratory on contextual interfaces and will be further elaborated based on insights gained by ongoing and future empirical research.

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