User Experience Patterns from Scientific and Industry Knowledge

An Inclusive Pattern Approach

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***Abstract*— Findings from scientific disciplines with close ties to the industry – such as Human-Computer Interaction (HCI) – can be useful for advancing both the scientific discipline itself as well as the associated industry. It is, therefore, an additional challenge to consolidate and convert the scientific knowledge gained into a format of which is applicable and understandable in practice in order to provide meaningful and usable tools for practitioners in their daily work routines. We used patterns to combine research results and industry know-how into solutions for distraction-related design problems in the automotive domain. In this paper, we present our pattern generation process that resulted in the creation of 16 patterns with input from scientists, as well as industrial stakeholders, in several key phases. Thereby, we discuss the advantages of patterns as a means to put scientific knowledge into practice. The contribution of this paper is a pattern generation and validation process and structure tailored towards combining scientific results and industry knowledge, as well as our pattern structure that resulted from this process.**

Kewords-basics on patterns; design patterns; pattern identification and extraction; validate patterns.

I. INTRODUCTION

Patterns are a method to capture proven design solutions to reoccurring problems. They are a structured description of best practices and, as such, highly problem-oriented and reusable [1]. The use of patterns in design can improve the design process (both with regards to time and effort spent) to a considerable degree [2][3][4]. Patterns are also a recognized way of facilitating communication between different stakeholders. Since scientific research in Human-Computer Interaction (HCI) is closely interconnected with the industry, patterns could serve as a tool to communicate scientifically proven solutions to industry stakeholders. In our work, we aimed at generating patterns for HCI researchers and industry stakeholders based on scientific findings and transform them – by directly involving industry practitioners – into solutions that are relevant for and usable by these stakeholders. The underlying research question is how scientific findings may be translated into design patterns usable for practitioners in their daily routines and how such patterns may be generated by including scientific and industry stakeholders.

The outcome of our efforts was a pattern structure that incorporates scientific results and fits industry stakeholder needs, as well as a first set of 16 automotive User Experience (UX) design patterns. We refer to UX design patterns as patterns that tackle user experience issues in their core. In this paper, we present the final pattern structure, as well as the phases of the pattern generation process involving both scientists and industry stakeholders (We use the term 'generation' to delineate our approach from pattern finding methods, which usually focus only on actual implementations, and not theoretical or scientific works). We begin with an overview of current pattern literature in Section II. In Section III, we describe our pattern finding process via the concrete pattern structure example and its development. In section IV, we provide a summary of the overall process, together with a brief discussion on the limitations and potentials of our approach.

II. RELATED WORK

In order to provide best practices and specific knowledge, the patterns approach has been well established in the domain of HCI [1]. Recently, specific domains in HCI, such as UX research, also deployed patterns to collect and structure their knowledge [3][4].

Köhne [6] (based on Quibeldey-Cirkel [7]) outlines specific steps for generating patterns. The process starts with discovering patterns, so-called *pattern mining*, by identifying whether a solution is valuable to solve a problem. The next step consists of *pattern writing*, where the problem solution is described in a defined structure. This is followed by *shepherding,* in which an expert provides support in improving the patterns content. Thereafter, a *writers workshop* is conducted. In such a workshop, a group of pattern authors discuss a pattern. Based on the feedback from the writers' workshop, the pattern author revises the pattern (*author review*). In a next step, the patterns are made public in a *pattern repository*, which is open to *anonymous peer review*. Finally, the pattern collection is published in a *pattern book* making the final patterns available for a large readership.

Similarly, Biel et al. [8] split the process of defining trust patterns for interaction design into four subtasks. The first task is *identifying a pattern* by analyzing the solutions used by designers. Second, the *pattern gets categorized* in order to

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make it reusable and accessible for designers. Third, the *pattern is described* following a specific structure. The fourth task is *evaluating the pattern* to prove its quality before it is introduced to a pattern library.

Aside from starting the pattern mining from designers' practical knowledge, patterns can also be harvested from scientific research findings. Martin et al. [9] use patterns to describe findings from ethnographies. For creating their patterns, they started by looking for specific examples in a particular domain in ethnographic studies and then tried to expand the observed phenomena to other domains (similar but different examples). Krischkowsky et al. [10] introduce a step-by-step guidance for HCI researchers for generating patterns from HCI study insights. According to them, the first step is giving novice and expert HCI researchers a *brief overview on the concept of patterns* and, more specifically, Contextual User Experience (CUX) patterns [4] (i.e., patterns to enhance user experience in a particular context). After this, the next step of the guidance concerns the *reflection and selection of relevant UX related results* from empirical studies conducted by the researchers. In a third step, HCI researchers *develop their own CUX patterns*, which are then internally *evaluated by researchers* following a checklist. In the last step, researchers give *feedback on the pattern generation process*.

Following a user centered patterns generation approach, we aimed at including industry designers within a specific domain (in our case automotive user interface design) in the patterns generation process in order to bring the target group as early as possible into the loop. Other approaches often miss to explicitly include industry stakeholders in the patterns generation process. In the following section, we outline and reflect on how we generated patterns. Further, we describe a seven-step approach that describes how we generated an initial set of automotive UX patterns from a scientific knowledge transfer workshop (step 1) to final pattern iteration (step 7). Based on a reflection of our work, we conclude with a novel patterns generation approach consisting of five phases. In addition, this paper presents an according pattern structure for distraction-related design problems in the automotive domain. Both, the patterns generation approach as well as the pattern structure for automotive UX patterns, are the main contributions of this paper.

III. The Pattern Generation Process

Within our research activities, the need for pattern guidance occurred within a national project focusing on contextual interface research in the automotive domain. In particular, the following section outlines the process of how we developed a pattern structure that provides insights, information, and guidance on how to design for a positive User Experience (UX) for the driver. This general aim (i.e., designing for a positive UX) was divided into more specific goals related to distinct UX factors (e.g., workload, fun, or trust). As the focus of our work was on the pattern generation process and the pattern structure, we decided to select one specific UX factor and improve the process and the structure by developing patterns for this factor. We chose to generate patterns for reducing workload that is caused by distraction, as this constitutes one of the most prevailing and severe problems in the automotive domain. In the next paragraphs, we outline each phase in the generation process in detail, reflecting on each step individually.

A. Phase 1: Starting from scientific knowledge

In this first phase, we started from pure scientific knowledge about distraction-related design problems in the automotive domain to create an initial draft set of patterns. This seemed like a logical first step, since we wanted to go from the science to the practice. As we would learn later on, however, a slightly different approach would have been even better. This will be reflected in the conclusion chapter. The first phase can be segmented into four sub-steps, outlined in the following sections.

B. Step 1: Scientific knowledge transfer workshop

Within the first step, a knowledge transfer workshop, organized by pattern experts and HCI researchers in the automotive domain, was conducted. Hereby, the main goal was to give experts in the automotive domain know-how on pattern generation. This know-how was provided by HCI pattern experts, in order to facilitate the development of an initial draft of patterns. The workshop lasted approximately four hours. Overall, six HCI researchers, all closely familiar with the automotive context, and two HCI pattern experts, who led the workshop, participated in this workshop.

In this initial knowledge transfer session, participants were introduced to patterns in general and the role of patterns in HCI in particular. This included aspects such as the usefulness of patterns as a tool for documentation, collection, communication, and representing knowledge [1]. They were also introduced into the distinguishing characteristics between patterns and guidelines. Thereafter, example patterns from other domains were presented (e.g., [11], [12], [13]). Subsequently, participants where shown the main goals for the development of patterns in the automotive domain (e.g., collect a number of UX related patterns, structured guidance on how to design for a good UX regarding advanced in-car systems). Thereafter, a presentation of the initial pattern structure was given, based on the CUX patterns approach [4]. This approach has already proved its value for collecting and structuring knowledge on UX [3]. The CUX pattern approach was chosen, as it explicitly considers the relation of UX and contextual aspects. In order to provide a better understanding of the CUX pattern approach, an exemplary CUX pattern reflecting on 'increased workload by font size' was shown to the participants. At the end of the workshop, participants were introduced to the entire, initially defined, pattern structure for UX patterns in the automotive domain (see Table 1, not-underlined parts).

C. Step 2: An Initial set of patterns

After the workshop, the HCI researchers (and pattern experts) received the task to create two patterns within the next 10 days based on literature and/or their own research activities. They received a template with the pattern structure as a guideline for creating a first set of patterns related to a car driver's workload caused by distraction. Furthermore, the HCI researchers were also encouraged to give individual feedback to the pattern experts about issues and problems concerning the generation process, as well as the given structure (i.e., CUX pattern structure template). More details about the identified issues and problems are outlined in the next section.

Within this first generation phase, 16 patterns focusing on workload caused by distraction were developed (i.e., two patterns per person). All patterns were derived on the basis of scientific literature (e.g., research articles or book chapters referenced in the pattern). Also, two pattern experts were involved in this process and generated two patterns each. The generated patterns were about one page each and exclusively dealt with design solutions (e.g., voice interaction, multimodal interfaces, or information presentations) addressing the problem of increased workload due to distraction.

D. *Step 3: First iteration based on participants feedback: identified problems in the generation process, resulted in a refined pattern structure*

The first round of pattern generation led to the identification of several issues with the initial pattern structure. During creating their patterns, the HCI researchers listed and forwarded encountered problems to the pattern experts. In a second workshop, the HCI researchers discussed their experiences with the provided pattern structure and the pattern creation process with the pattern experts and collected further problematic issues. The pattern experts then used the feedback for improving the pattern section structure and the related instruction for how to generate patterns based on the provided structure.

The refined pattern structure, as the outcome of the third step, is presented in Table 1. Changes to the section name and instruction are marked with an underline, parts not underlined are those from steps 1 and 2. The proposed pattern structure consists of nine parts: *name* (a description of the solution of the pattern), *UX factor* (the addressed automotive user experience factor), *problem statement* (a very short description of the problem which should be solved by the pattern), *forces* (a more detailed explanation of the problem), *context* (the application context of the pattern), *solution* (the proposed solution of the particular pattern), *examples* (concrete examples of best practices), *keywords* (phrases related to the pattern), and *sources* (origin of the pattern).

Most of the issues brought forward were concerned with what makes the pattern a high-quality pattern and what supports the comprehensibility of the pattern. More specifically, the HCI researchers had difficulties with *achieving the aim of a pattern to provide best practices*. The HCI researchers experienced it as challenging to judge if the provided solutions are the "gold standard". They also felt uneasy if "old" literature can serve as basis for pattern creation. Therefore, it would be more realistic to speak of providing existing knowledge to the best of one's judgment, i.e., preferably using the newest knowledge for underpinning a specific pattern and using as many potential evidences (studies, norms, etc.) as possible. Our patterns suggest solutions for specific UX demands in the car area based on existing knowledge (e.g., studies, best practices).

Another difficulty is related to *deciding on the abstraction level of a pattern.* The HCI researchers were unsure whether they should create very general patterns (global patterns) versus very specific patterns (sub-patterns, local patterns). They finally agreed on providing patterns that are abstract enough to make generalizations, while providing practical solutions at the same time. Thus, both elements (i.e., generalization as well as a concrete example) should be provided.

Identifying the stakeholders of the patterns was also an issue. It was unclear to the HCI researchers whom they should address with the patterns; whether the future users of the created patterns are designers (expert or novice), domain-specific users (e.g., industrial manufacturers), researchers, or developers.

TABLE I. INITIAL AND REFINED PATTERN STRUCTURE (ITERATION CHANGES UNDERLINED)

Instructions on Each Pattern Section		
#	***Section Name***	***Instruction on Each Section***
1	Name	*The name of the pattern should shortly describe the solution suggested by the pattern (2-3 words would be best).*
2	UX Factor	*List the UX factor(s) addressed by the pattern.*
3	Problem Statement	*As short as possible - the best would be to describe the problem in one sentence.*
4	Forces	*Should be a detailed description and further explanation of the problem.*
5	Context	*In general, our patterns should focus on the driver. Describe the detailed context in which the pattern can be applied in this section.*
6	Solution	*1) Can range from rather general suggestions to very concrete suggestions for a specific application area (e.g., " Presenting High-Priority Warnings"). 2) A successful solution is based on existing knowledge (e.g., state of the art solutions, empirical studies, guidelines, etc.). 3) More than one solution is no problem but even better than only one. 4) There can also be a general solution and more specific "sub-solutions".*
7	Examples	*Concrete examples underpinned by pictures, standard values (e.g., angle, size) etc. Examples should not provide a solution (this is done in the solution part) but rather underpin and visualize the solution presented above.*
8	Keywords	*Describe main topics addressed by the pattern in order to enable structured search.*
9	Sources	*Origin of the pattern (cf. the different ways to generate patterns)*

The HCI researchers also experienced difficulties in *creating a pattern name;* should the pattern name be formulated as solution or problem? It was eventually decided to opt for a solution orientation of the pattern name and modified the pattern instruction accordingly. Moreover, *using technical terms in the pattern name* lead to comprehensibility problems among the HCI researchers. A pattern needs to be easy to understand and quickly assessed. Consequently, very specific technical terms should not be used in the pattern name and, if they occur in the description of the pattern, they need to be explained.

Furthermore, the first round of pattern generation revealed that the HCI researchers deployed *different ways to generate their patterns*, which are based on existing state of the art knowledge/experience in the field, on own empirical studies, on literature (desktop research of empirical studies), as well as on existing structured knowledge. Therefore, the section on sources (#9) was supplemented with different ways to generate patterns.

E. Step 4: Participants iterate patterns based on refined structure

Finally, the HCI researchers task was to iterate their initially created patterns based on the refined pattern structure. Each researcher transformed the existing pattern he/she originally constructed into the new pattern structure. Parts were reformulated, where necessary, and other parts were added.

F. Step 5: Industry stakeholder pattern structure evaluation workshop

To further iterate and finalize the pattern structure, we involved the industry stakeholders in a workshop with the aim of evaluating the current pattern structure on the basis of two representative patterns. The workshop was conducted at our facility with five participants (one female and four male) from our industrial partner from the automotive domain. The participants' age ranged from 20 to 45 years, job experience from 7 months to 20 years. Their professional background was software developers, engineers, and designers. After a 10-minute general introduction to patterns and our pattern structure, participants received printouts of one of our automotive UX patterns with the instruction to read through it attentively (duration: 10 minutes). After that, they had to fill in a questionnaire regarding the quality and understandability of the pattern. Participants then received another pattern printout and were again given 10 minutes to read it thoroughly. This was done to ensure that the participants had a means of comparison and also to reduce bias regarding the quality (or the lack thereof) of the pattern structure based on only one pattern. After these preparations, the main part of the workshop, a discussion session (total duration: 1.5 hours), began. The moderated discussion was audio recorded and later transcribed for further analysis. During the course of the discussion, participants could voice concerns they had encountered when reading the individual patterns, together with suggestions for improvements to the pattern structure, as well as the existing automotive UX patterns in particular.

In the following section, we will outline the most important outcomes of the workshop, in reference to the iterated structure shown in Table 1. Participants were confused by the separation of *problem* and *forces*, stating that they did not understand why those were two separate categories and that they found the term 'forces' itself difficult to understand. Furthermore, participants found that they had to read quite far into the patterns before they knew what the patterns were exactly about. Generally, the participants desired an "abstract" for each pattern, containing scope, context, and possibly an outlook on the solution in a very compact format. In addition, the pattern should be re-structured, so that the most important information (at the very least: *name*, *keywords*, and *problem*) is at the very beginning of the pattern. Or, as one participant put it, "*If using a pattern collection is more cumbersome than using Google and produces lesser results, then there is little reason to use that pattern collection.*"

The writing style and vocabulary used in both patterns was perceived as very unusual by the participants and more "scientific" than what they were used to. More specifically, they were not used to citing sources for every claim and the rather high number of technical terms used in each pattern. While they found the scientific writing style an overall pleasing quality that should be kept, they suggested a minimal citation style (numbers only, full references only at the very end of the pattern collection). The issues identified in the workshop were then further discussed and transformed into concrete instructions for another pattern structure overhaul.

G. Step 6: Final pattern structure iteration

Based on the feedback gained from this workshop, the pattern structure underwent a final iteration, which would then become the basis for all further patterns (see Table 2). Similar to the pattern structure shown in Table 1, the final pattern structure consists of nine elements. The *name* of the pattern should again focus on the provided solution. The *intent* should include the main category of the pattern, a short problem statement, and briefly outline the context in which the pattern should be used. It replaces the problem statement (3) and the context (6) of the initial structure presented in Table 1. The new element *topics* is a structured list of keywords describing the problem scope. The element *problem* replaced the forces (4) section. The new element *scenario* gives a detailed description of the problem in a scenario like style. The *solution* again describes the solution to the problem. Within the final structure, we provide a structured approach how to present the solution. *Examples*, as before, should show best practices of the pattern. *Keywords*, again, should help to find related patterns. Finally, *sources* link to the origin of the pattern. The element UX factor (2) from the initial pattern structure was omitted at all.

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The new structure focuses on informing the reader as concisely as possible about whether the pattern is relevant for them. *Name*, *intent*, and *topics* are standardized and kept brief so that only a minimal amount of time is needed to read and process them. *Context* and *forces* are combined into the new Scenario-category, since the stakeholders had a hard time differentiating between them and found the distinction to be inconsequential in practice.

TABLE II. FINAL PATTERN STRUCTURE

Instructions on Each Pattern Section		
#	***Section Name***	***Instruction on Each Section***
1	Name	*The name of the pattern should shortly describe the solution suggested by the pattern (2-3 words would be best).*
2	Intent	*Short statement in three parts:* *a) Main category of pattern (e.g., visual information presentation)* *b) Short issue/problem statement (e.g., effective display position)* *c) Short context preview (e.g., while driving)*
3	Topics	*Max. 8 Keywords describing problem scope: 1) who is affected (driver, co-driver, etc); 2) which modalities are addressed (visual, haptic, acoustic)*
4	Problem	*Should be a detailed description and further explanation of the problem.*
5	Scenario	*Provide a detailed example of a case, in which the problem occurs*
6	Solution	• *First, provide a general (either high level or one that is applicable in the most cases) solution.* • *Then provide alternative solutions, together with delineating criteria to determine, when such alternative solutions apply.* • *Whenever possible, reuse (modified) figures, illustrations, etc. from other patterns, for a more consistent style and easier combination of pattern solutions.* • *A successful solution is based on existing knowledge (e.g., state of the art solutions, empirical studies, guidelines, etc).* • *More than one solution is no problem but even better than only one.*
7	*Examples*	*Concrete examples underpinned by pictures, standard values (e.g., angle, size) etc. Examples should not provide a solution (this is done in the solution part) but rather underpin and visualize the solution presented above.*
8	Keywords	*Describe main topics addressed by the pattern and related patterns in order to enable structured search.*
9	Sources	*Origin of the pattern, related literature, related patterns (if they are not part of the same pattern collection), norms and guidelines, other references. Citations format: Numbers and endnotes, to distract the reader as little as possible.*

H. Step 7: Final pattern iteration

The entire set of 16 patterns was then revised, based on the above-mentioned structure (see Table 2). *Scenario*, *Solution* and *Examples* specifically underwent an adaptation according to the stakeholders' requirements. If possible, solutions were also represented graphically or illustrations from cited publications were added. Concrete examples (state of the art) from recent production vehicles illustrated, if appropriate, the examples section. In general, care was taken to present the information in every pattern in a compact form, easily comprehensible and practicable. This final iteration was completed as a team effort by two scientists.

I. Validating the patterns

For the final validation of the iterated pattern set, we conducted a second workshop at our facility with seven participants (4 employees from our industrial partner and 3 researchers; 6 male and 1 female). Age ranged from 21 to 48 years, job experience from one month to eight years. Regarding their professional background, they were software developers, engineers, designers, and HCI experts. Part of the participants from the first workshop also participated in the second one. To have a good mix of informed and fresh views, we involved two stakeholders who had already participated in the previous workshop, and two who were completely new to the topic. The overall goal of the second workshop was to assess the quality of the first UX pattern set, as well as to iterate the pattern set based on the industry stakeholders' feedback.

In this workshop, the full iterated pattern set was presented to the participants and evaluated on a peer-pattern basis. Each of the 16 existing patterns was rated individually by each participant. To avoid serial positions effects and similar forms of bias, the patterns were presented to participants in different orders. After a 10-minute general introduction to patterns and explanations of the iterated UX pattern structure from the first workshop, a researcher explained the purpose and the agenda of the one-day workshop to the participants.

Then, each participant read thoroughly and rated each pattern based on the following slightly modified quality criteria checklist [14] that consists of four quality criteria (c_1, c_2, c_3, c_4). The first quality criterion (c_1) states that all parts of a pattern description should be reasonable to the pattern users. This means they should have a meaningful *name*, a clear formulated *problem* statement, and enough background information for the provided *scenario*, concrete *solutions*, as well as give plausible *examples*. The second quality criterion (c_2) addresses five aspects: (1) *completeness,* i.e., necessary information is given in the pattern; (2) *clarity of the language,* i.e., the style of the pattern is well-readable; (3) *problem-centricity,* i.e., the scenario, solutions, and examples are coherent and clearly related to the problem description; (4) *good balance* between concreteness and abstractness; and (5) *helpfulness,* i.e., the presented patterns support stakeholders to develop better interactive systems. The third criterion (c_3) requested an *individual overall assessment of*

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the patterns from a more general perspective. C_4 states that the whole collection of patterns captures *relevant knowledge* about User Experience and provides a *suitable common basis* for designers, developers, and researchers. C_4 applies to the whole collection and not to individual patterns. It was, therefore, excluded from the questionnaire and instead discussed in plenum at the end of the workshop for a qualitative, *overall assessment* of the pattern set quality and applicability.

After the rating of the patterns, a moderated discussion session took place. During the discussion, participants could voice all concerns they had encountered when reading the 16 existing patterns, together with suggestions for future improvements to the existing UX patterns. In order to trigger the discussion, two questions of criterion (c_4) from the quality framework were asked to the participants: Do you think that the presented patterns support the communication of designers, developers and researches by providing common basis? Do you think the presented patterns capture relevant knowledge about user experience? The discussion session was audio-recorded and later on transcribed for further analysis.

Due to the low number of participants, the questionnaire results were analyzed in descriptive form. The results of the first quality criterion (c_1), rated on a scale from 1 (absolutely agree) to 5 (do not agree at all), show that the pattern set had a meaningful name (M=1.86, SD=1.08), a clear stated problem (M=1.48, SD=0.80), and enough background information of the stated scenario (M=2.03, SD=1.02). The two last categories of c_1, i.e., the solution (M=2.69, SD= 1.15) and the examples (M=2.60, SD=1.16), were rated as neutral.

The questionnaire responses of the second quality criterion (c_2) indicated a very positive overall picture with mean values all in a positive spectrum (lowest was 1.55) and the most negative responses being neutral ones (2.78). The responses were also rated on a scale from 1 (absolutely agree) to 5 (do not agree at all). Lowest mean values were identified clarity of the language used in the pattern (M= 1.55, SD=0.73) and the problem-centricity (M=2.16, SD=0.88).

In total, the participants perceived only one pattern as implausible (c_3). As mentioned by the participants during the discussion (c_4), the presented patterns support the communication of designers, developers and researchers, provide a common basis, and capture relevant knowledge about user experience.

One recurring problem, which had sporadically been voiced during the previous workshop as well, was the relevance of the problem statements in the discussion. The participants felt that the problems stated in some patterns were only partly relevant for them and while they appreciated the solutions, they would often have desired to be part of the problem statement beforehand. This led us to modify our pattern generation approach to involve the industry stakeholders already during the very first step in the pattern generation process. The list of design problems that patterns are then generated for should, together with a rating regarding relevance and importance, come from the industry stakeholders themselves. Ideally, this should happen with guidance and assistance from researchers. Contextual inquiries or brainstorming with subsequent problem rating sessions with the industry stakeholders are both suitable methods to achieve this.

IV. CONCLUSION, LIMITATIONS AND FUTURE WORK

In this paper, we have described a seven-step approach how to generate (automotive) UX patterns. It started with a scientific knowledge transfer workshop (step 1), which led to an initial set of patterns (step 2). A first iteration based on participants' feedback and the identification of problems in the generation process resulted in a refined pattern structure (step 3). An iteration of the patterns led to a refined pattern structure (step 4), with which we conducted a pattern structure evaluation workshop with industry stakeholders (step 5). Another pattern structure iteration (step 6) led to a final pattern iteration (step 7).

By involving industry practitioners directly in the pattern generation process, we were able to translate scientifically proven results into proven solutions for industry stakeholders. As mentioned earlier, it might have been beneficial to include industry stakeholders before the first patterns were generated. We experienced that not all of the patterns we initially produced were urgent problems for our practitioners from the industry. They mentioned that an approach where they could identify problems of high priority to them would be better. Nonetheless, the insights we gained have resulted in a pattern structure suitable for industry stakeholders' needs in the automotive domain. The structure focuses on clarity and brevity and should, with slight modifications, be adaptable for other industry domains as well. Furthermore, we have documented our pattern generation process, together with both scientists and industry stakeholders. A high level overview of the process can be seen in Figure 1. It includes a first phase with industry focus, in which industry problems are identified, and where patterns

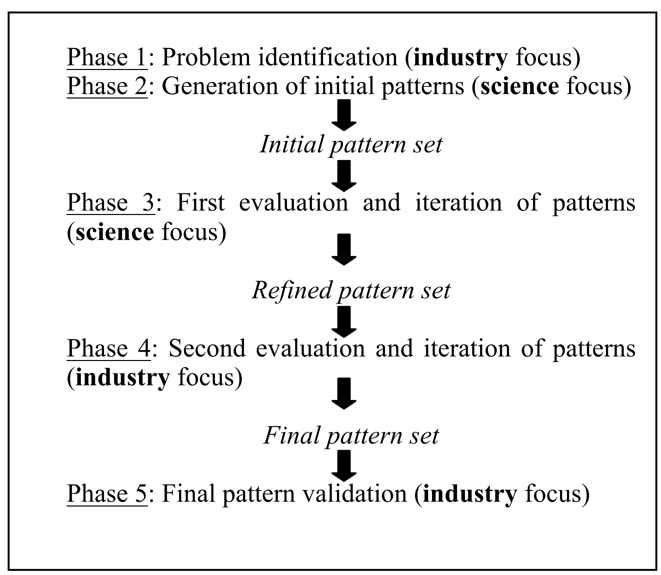

Figure 1. Final inclusive patterns generation process.

might be a beneficial way of helping to solve these problems. In phase 2, we suggest generating an initial set of patterns. Phase 3 includes evaluation and iteration through a scientific lens. Phase 4 includes evaluation and iteration with a focus from industry and, in phase 5, patterns are validated.

Apart from the patterns generation process, this paper presents a structure for automotive user experience patterns. It consists of nine elements (*name, intent, topics, problem*, *scenario, solution, examples, keywords*, and *sources)*, which proved to be a useful way to structure UX patterns in the automotive domain.

The approach described in this paper is a departure from the common practice of documenting already working solutions, to a way to convert (proven) scientific results to working problem solutions. The evaluation of the described approach was based mainly on feedback of practitioners from the HCI car domain. Furthermore, we did not compare the quality of our patterns' problem solutions to those of other HCI patterns in our research. While the positive assessment of the overall process and its results (the patterns) provides a positive outlook, further evaluations (and possible iterations) are certainly needed to fully validate it as a reusable standard procedure in the community.

Overall, the pattern generation process and structure we gained will be used for generating additional UX patterns for the automotive domain. More specifically, we intend to also cover the factors *perceived safety* and *joy of use* and generate patterns for these. We have already begun the generation process by identifying common design problems related to these factors in a workshop together with the industry stakeholders. In the future, we intend to implement the full pattern collection as an online database based on the pattern framework proposed in [15]. We will continue using our inclusive pattern generation process to translate scientifically proven results into proven solutions for industry stakeholders and encourage others to employ and further refine our proposed method.

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