Design pattern based decision support

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ABSTRACT
We improved a tool to support design experts and non-expert engineers to share design knowledge. Our approach is a systematic and iterative design of a new tool variant, including high fidelity prototyping and assessment with students in real design cases. Iterative design allowed us to improve the learnability of the tool. Patterns libraries commonly are provided through relatively unstructured lists (“collections”). Tools will help engineers by making the design space (including an overview of context dependent relevance of available design patterns) explicit.

Keywords
Pattern, interaction design, decision support tool, pattern rating, pattern relations, knowledge base.

INTRODUCTION
Design patterns and their users
Since Alexander, many design domains have been enriched by the availability of reusable design knowledge (Borchers, 2001). Several authors continue this patterned approach in the field of User Centered Design (Borchers, 2001; Tidwell, 2006, van Welie). Most of these pattern experts share their knowledge in such a way the patterns are usable for other experts though the use of these by most engineers is found too difficult and time consuming (Hennipman et al, 2008). The main issue seems to be the gap between the design knowledge and skills of the experts and the lack of this, and, at the other hand, the need to identify potentially relevant design knowledge and selection of the best options in the context of an actual engineering case. Our current project aims precisely at bridging that gap. Our decision support tool is intended for the pattern designers to structure their generic knowledge of pattern collection structure and pattern applicability in relation to design context, on the one hand, and for the engineer pattern user who does not know what patterns to select and why to apply them depending on the context, on the other hand. Our tool is, generally speaking, a tool for collaboration between two rather different types of professionals, transferring the relevant knowledge at the right moment without enforcing any user of that knowledge to invest more in learning than is considered relevant for that user.

Why do we need a tool?
Borchers & Thomas (2001) report of a CHI workshop where Alistair Sutcliffe stated that possibility to share is the essence of patterns. To accommodate this, the use of a tool in an open platform, like the internet, is advised. Díaz, Aedo, & Rosson (2008), as well as Segerståhl & Jokela (2006) claim that no efficient tool exists. Janeiro, Barbosa, Springer and Schil (2009) suggest a good knowledge base should be made that would ‘facilitate search, comparison and adaptation’.

DEVELOPMENT PROCESS
Incremental design
Hennipman et al (2008) concluded in previous research that small companies did not use patterns primary because their lack of time. At the same time, knowledge of patterns was considered important to increase the use of design knowledge. Hennipman developed a tool for identifying patterns that may apply in an actual design context. His tool served questions sequentially and gradually added patterns to a selection. His approach has been elaborated for user centered design (UCD) patterns.
only, which limits the generic applicability of the structure he created. When assessing the approach in practice, he found that using his wizard requires the designer to trust the system’s choices, and, on the other hand, needs the designers to act like being sure about the answers to each subsequent question the wizard is asking. By adding the patterns in a fixed sequence the tool was experienced to be a ‘black box’. Consequently, the interface limited the creative role of designers and prevented them of feeling in control.

Structuring Design knowledge

At least in the domain of UCD or Cognitive ergonomics, several authors are aware of a need for structure to support the “non-expert” designer. Experts use pattern templates to be able to maintain structure in their index. Both van Welie and Tidwell organize patterns based on category. Patterns are described in terms of what, when, why and how. Additionally, examples form a crucial part in explaining the pattern. Applying this structure is not trivial, and can be quite confusing for a beginner in the trade. For our tool we need new abstraction that can comply to all variations and soothe these experts. The first basic abstraction is to see the two most important elements of a pattern: attributes and criteria. Attributes give content to the pattern, where criteria creates meaning and how it would fit in context. For the abstraction of the criteria the chosen rationale is the QOC model because of its simplicity. Patterns can easily be decomposed into questions, options and criteria. Questions can be seen as forces of the context, where criteria will be the effect on the options (or patterns). (Janeiro, Barbosa, Springer, & Schill, 2009).

The applicability of this generic abstraction was validated by consulting a pattern developer who considers using the tool. Based on a presentation followed by an interview no complications were found using this abstraction.

Structuring the design space for engineers

Based on a tentative sketch of Hennipman for a potential design space exploration tool, we developed an interactive environment, intended for various different design domains. In addition, the threshold to find out more about the pattern should be lower, preventing the user to divert from his primary task of configuring for his design context and be trapped in reading detailed knowledge. This means no use of the hyperlink paradigm. By making the tool interactive the designer feels free to use the tool as an advice rather than a rule and the designer is motivated to use his own creativity.

Functionality for exploring the design space

In an ideal world we would describe our design decisions along the levels of Moran (1981). So this section in fact focuses on functionality. The core functionality of our tool is based on activities related to exploration and choice: tentatively configuring pattern sets for the chosen context. When changing criteria, a different set of patterns is suggested. In addition, the user can browse through the patterns without being redirected to a new interaction space.

The visual representation of the design space for non expert engineers

For the representation and dialogue of our interface we practice what we preach and we used all relevant design patterns found at Borchers (2001), van Welie (2001), and Tidwell (2006) in order to specify our own user interface. The layout contains a panel for selecting the variables to characterize the context for pattern selection, and an accompanying panel to display the total pattern library that clearly indicates the currently selected pattern subset. The interaction that specifies a single criterion immediately results in a change of this subset of selected patterns.

In Figure 1 we sketch the grouped configuration aspects in the left panel. With use of extendable grouping of the criteria we allow users to select only criteria relevant for their design context. On the right the patterns are displayed as thumbnails. In order to develop our design...
for a real pattern set we chose the same pattern set Hennipman used. This set has 29 patterns and 19 criteria, all of which could be reused.

**The interaction with the design space**
The new visual design and layout allows multiple decisions on criterion values without a total change of the screen, with a faster dialogue in accordance with Spence’s (2007) claim that a higher speed strengthens the experience of a continuous interaction. The change in the pattern selection is represented in a slow animation to let the user smoothly notice its results and to directly challenge considering if he/she agrees with this change. Continuous interaction follows Norman’s Action Cycle (Norman, 1998). The goal of the users is translated by the gulf of execution which results in a change in the world. This change needs to be understood by the users to choose new actions if the goal is not yet reached (Spence, 2007). Our tool is designed in line with these interaction rules, see Figure 2. Where the left panel is used for execution of the user, the right panel is used for the evaluation.

![Figure 2. Stages of the Action Cycle related to the tool](image)

Each pattern element has two actions: mouse-hover activates simple information, mouse-click activates more extensive information. The popup is placed over the left frame that is not needed while viewing this information.

**First assessment of usability aspects for engineers**
To test the tool, we used two groups of 110, resp. 18, students in design courses, working on real design cases. The main goal of the test was to prove the anticipated improvements on the old tool were met and no problems were found in the new advanced interaction. Multiple groups allowed us to use multiple iterations and validate our findings. To identify improvements in our development they were asked to use the old tool before the new tool was introduced. To test our first proposal we used a high fidelity prototype. This version included all functionality, and additionally all events were logged. When a user finished using the tool, a survey collected information about usability.

The interaction was considered fluid and easy to work with, but students identified some problems with the interface: lack of information and of feedback. The first problem was surprising. The logs (57% of the ‘serious’ sessions) as well as the comments in the survey showed that many students did not understand they could click on the patterns. Secondly most students did configure all criteria even if some were not relevant for their context (80%) and some even expected feedback or a final report when all criteria were selected, implying they did not notice the continuous interaction between the panels, that was experienced to be in discrete steps (Spence, 2007). The slow fading of selection changes was proven not be enough and perception was effected by change blindness (Rensink et al., 2000, as sited by Spence, 2007).

**REDESIGN BASED ON ASSESSMENTS**
The most important problem was that the users did not find it intuitive to click on patterns to retrieve additional information. The solution was to add a hint callout when hovering over a pattern to let the user learn that they can also click on these elements (see Figure 3). We decided to remove this suggestion once user had actually used this functionality. To clarify the interaction mode an animation was introduced to let the users notice the interaction between both panels. This stimulates the attention of the users and intends to let the user experience continuous interaction. Finally the users had to be aware of the possibility to configure exclusively for their context. We solved this with three small modifications. First of all no default category was opened in the tool at the start, forcing the user to actively select his/her focus. Secondly the user was informed about the possibility to only configure relevant criteria both in the introduction slideshow and as a message when starting the tool. Finally it became optional to delete criteria, implying it does not need to be set. The results of the second group validated the result of the changes made and small improvements on the animations were made to make them less disturbing.
Our tool can now be used by pattern authors and non-expert engineers to communicate pattern knowledge. The tool is currently used by design students in several countries, and we continue to collect feedback aiming at further development. Several pattern authors have opted to use our tool to communicate their findings to non-expert engineers.

**Research agenda and future developments**

**Advanced pattern rating** - Our abstraction would not suffice to describe all complexity of the patterns. The degree in which a criterion has effect on the selection can be more demanding. This complexity can also be called advanced pattern rating. Our claim is that our tool can benefit from advanced and more specific pattern rating by giving more useful results and therefore helping the designer to make better decisions for his/her context.

**Pattern relations** - Pattern relations are effects of choosing one pattern on the application of another. With minor modifications in the interface we could add a feature to explore how each pattern relates not only to the context but also to other patterns.

**Use by experts** - A major goal of our research is to create and validate a generic framework for use with any pattern library. Expert interviews and student experiments suggest the feasibility of this goal. Real integrations of the next version of our tool with some of these libraries will aim at proving this.

**REFERENCES**


