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PATTERNS AND PATTERN SITES IN HCI: AN ANALYSIS

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ABSTRACT

Interest in patterns and pattern languages in Human Computer Interaction (HCI) continues. However, many of the questions and concerns in this area have yet to be addressed. These questions and concerns include lack of empirical evidence to support the claimed benefits, lack of a standard pattern format, and lack of an organizing principle. This paper describes an analysis of the design of pattern websites and their respective patterns. A systematic online search using multiple search engines and multiple search phrases was conducted in attempt to further understand the current state of affairs, including pattern format and organizing principles. The results suggest that the community has yet to adopt a standard pattern format. Although, the essence of Alexander's patterns was found in most patterns. The findings highlight the progress that we, as a community, have made in some areas, but remind us that there is work to do in other areas.

Keywords

Patterns, pattern languages, design patterns, interaction design patterns, Human Computer Interaction patterns

INTRODUCTION

In the past few decades we have seen a growing and continued interest in patterns and pattern languages in Human Computer Interaction (HCI). This is reflected in the number and variety of papers, books, websites, workshops, panels, and pattern libraries we see today (Saponas, Prabaker, Abowd, and Landay, 2006; Tidwell, 2006; Todd, Kemp, and Phillips, 2011; van Welie; Vora, 2009; Wania and Atwood, 2009). Many resources on this topic can be found on <http://www.hcipatterns.org/>. There are many benefits of patterns and pattern languages described in the literature including the reuse of quality solutions and improved communication, among other things (Pemberton, 2000). There has also been some discussion about the problems with patterns including: lack of a standard format, lack of an organizing principle, and the misunderstanding about the difference between a pattern and a pattern language (Borchers, 2000; Casaday, 1997; Pan and Stolerman, 2013; Todd, Kemp, and Phillips, 2004; van Welie and van der Veer, 2003). There has also been little empirical work to support the claimed benefits (Dearden and Finlay, 2006). Although some studies have shown promising results (Koukouletsos, Khazaei, Dearden, and Ozcan, 2009) others have shown limited benefits (Pan and Stolerman, 2013). In this work, using a systematic method, the availability of patterns online, the format of the patterns published online and the organization of the patterns on each pattern website was investigated. The terms format and organization deserve more explanation. When referring to the format of a pattern we are referring to the elements included in each pattern. In other words, the form the patterns take. When referring to the organization of the patterns we are referring to how the patterns are organized, divided and displayed on each website. This work is an effort to extend previous research by analyzing the format of patterns found online and the organization of those patterns within the websites where they are published. Also of interest was determining the kinds of information that might be found by practitioners, researchers, students and anyone else searching for patterns online. The results of this analysis are discussed after a brief summary of related work. Due to page limitations the discussion of related work is limited and citations to related work are also limited.

RELATED WORK

For decades patterns and pattern languages have been discussed, researched, documented, and applied in HCI. In 1977 Alexander, Ishikawa, Silverstein, Jacobson, Fiksdahl-King, and Angel introduced patterns and a pattern language, for architecture. Although *A Pattern Language* is Alexander's most cited work, pattern-like structures were described by Alexander (1964) prior to the publication of *A Pattern Language*. Patterns and pattern languages have since been documented in a variety of disciplines outside of architecture, including software engineering (Gamma, Helm, Johnson, and Vlissides, 1994) and HCI (Dearden, Finlay, Allgar, and McManus, 2002; Dearden and Finlay, 2006). A citation analysis of Alexander's work revealed the breadth of this influence (Wania, 2015). Much of the work in HCI and software engineering has involved the capture and sharing of patterns, pattern libraries and pattern languages.

A pattern, according to Alexander 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, without ever doing it the same way twice" (1977, p. x). The intention of a pattern language, according to Alexander (1977), was to capture the heart of solutions to recurring design problems in architecture and provide a process and a language that architects and non-architects could use to communicate. In *The Timeless Way of Building*, Alexander (1979) describes a theory and a

process of building where the products of this process are of a particular quality. This process was intended to be applied using a combination of the 253 patterns described in *A Pattern Language* to design buildings and towns that are alive, whole, and contain what Alexander refers to as the quality without a name (Alexander et al., 1977). Each of Alexander's patterns contains the following elements: a name, a number, a picture, an introductory paragraph (sets the context and explains how the pattern helps complete larger patterns), three diamonds (beginning of the problem), headline (the essence of the problem), body of the problem, a solution, a diagram, three diamonds, and references to smaller patterns that are needed to complete a pattern. Each pattern in *A Pattern Language* is labelled according to certainty or confidence in a solution (noted by asterisks). Alexander and his colleagues spent several years documenting and validating these patterns. They each also had some type of advanced degree and several years of experience.

In the 1990s the software engineering community began exploring the use of software patterns to document quality solutions to software problems and to promote the reuse of those solutions. One of the most well-known and highly cited works in this area is *Design Patterns: Elements of Reusable Object-Oriented Software* by Gamma et al. (1994). In 2016 the well-attended Pattern Languages of Programs Conference was held for the twenty-third time. There have been several motivations for exploring pattern languages in HCI (Erickson, 2000; Fincher et al., 2003). Two of the most often cited reasons for the use of pattern languages are reuse and quality (Erickson, 2000). In HCI, architecture, and quite possibly every other design discipline, we strive to design quality artifacts that people will use and enjoy using. And we try to do this without having to reinvent the wheel each time. Pattern languages address both quality and reuse. The participatory processes of design in HCI and in architecture, as described by Alexander, also share many similarities. These have been some of the motivations for other disciplines to explore pattern languages.

In HCI there is no agreed upon definition of a pattern, a pattern language, or the form a pattern should take. However, there are common characteristics found in various definitions (Wania and Atwood, 2009). Patterns in HCI, as defined by van Duyne et al., "communicate insights into design problems, capturing the essence of the problems and their solutions in a compact form. They describe the problem in depth, the rationale for the solution, how to apply the solution, and some of the trade-offs in applying the solution." (2003, p. 19). A pattern language in HCI, as described by Mahemoff and Johnson is "formed when a collection of patterns is arranged into a network of interdependent patterns, especially where higher-level patterns yield contexts which are resolved by more detailed patterns." (2001, p. 351). In Alexander's work the concept of a pattern language is clear. In HCI and other disciplines this concept is not reflected in all work. Many pattern collections and pattern libraries lack the 'language' aspect.

Much of the focus in HCI has been on the possible benefits or promises of pattern languages (Pemberton, 2000). However, several problems have also been discussed including: lack of a standard format, lack of an organizing principle, and the misunderstanding about the difference between a pattern and a pattern language (Borchers, 2000; Casaday, 1997; Todd et al., 2004; van Welie and van der Veer, 2003). Dearden and Finlay (2006) reviewed the benefits, problems, and (lack of) empirical work in their critical review. At that time little empirical work had been done. Since the 2006 review, empirical work has continued (Pan and Stolerman, 2013; Wania and Atwood, 2009), but more empirical work must be done. Some of the recent work in this area has included frameworks for evaluating patterns (Petter, Khazanchi, and Murphy, 2010), using pattern languages as communication tools (Denef and Keyson, 2012), exploring possible organizing principles (Hübscher et al. 2011) and identifying ways of classify the relationships between patterns (Janeiro et. al, 2010). The publication of patterns has also continued in online and print formats.

This work is part of a systematic exploration of some of the questions raised by Dearden and Finlay in their 2006 review. Similar analyses of pattern format and organizing principles have been described in literature. However, these approaches have not been methodical (Kruschitz and Hitz, 2010; Hübscher et al. 2011). By systematically searching for patterns and systematically analyzing the format of the patterns and the organization of the patterns published on websites, this work extends the work of others in this area. There are several other ways to explore this question. This approach is one of many possibilities. The methods are described in the next section.

METHOD

Systematic, detailed online searches were conducted using the three most widely used search engines in the United States: Google, Bing and Yahoo. The searches were performed by utilizing various phrases expressing the concept of interaction design patterns, including several variants such as interaction design pattern language, interaction design pattern library, user interface design patterns, user interface design pattern language, user interface design pattern library, design pattern library, and so on. The decision was made to include searches with the term 'library' and not just language due to the fact that this term has been adopted in some prominent collections of patterns, including the Yahoo Design Pattern Library. The searches were conducted in September 2016. At the time of each search the first page of search results was captured. This analysis was limited to the first page of results in recognition that the majority of users do not navigate beyond the first page of search

results (Jansen and Spink, 2006). All the search results were stored in one spreadsheet that was then de-duplicated. In other words multiple instances of unique URLs were reduced to one instance. The de-duplication was necessary due to the fact that one URL was retrieved by different search terms and/or one URL was retrieved multiple times using a different search engine. Each webpage on the de-duplicated list was then examined to determine if it was in fact a website that contained HCI patterns. A website was said to contain HCI patterns if the patterns on the website contained the elements commonly found in common definitions of patterns in HCI, as described above. Websites containing HCI patterns were then analyzed.

RESULTS

This process yielded 134 webpages to be reviewed. The content of the webpages varied. Each webpage was examined and classified into one of the categories seen in table 1. These categories emerged and were refined as the webpages were reviewed. The largest category of webpages included information *about* patterns in HCI, not patterns themselves. Of the 55 resources *about* patterns in HCI, 29 were scholarly or peer reviewed sources. Others were blogs, discussions, personal webpages and other similar resources. Many of the webpages contained information about software design patterns, which in retrospect is not surprising due to the history of patterns in HCI, software engineering and architecture. It was expected that information about interaction design in general and information about Alexander's pattern language would be retrieved, although the amount and type could not be predicted. Several websites that appeared in the search results contained what the authors of the websites referred to as patterns. However, these 'patterns' do not contain the common elements of a pattern in HCI – problem, context and solution. Therefore, here these have been labeled as self-proclaimed patterns. The patterns on the websites in this category contained content that more closely resembled a style guide, not a pattern. In most cases the self-proclaimed patterns only contained pictures of things that might be examples of a pattern. The self-proclaimed patterns were therefore excluded from this analysis. However, these websites offer some insight into how this term has been interpreted and used.

	Number of Webpages
HCI Pattern Resource	55
Software Design Patterns or Software Design Pattern Resource	20
HCI Patterns	16
Resource about Alexander's A Pattern Language	15
Self-Proclaimed Patterns	14
Interaction Design Resource	9
Miscellaneous	5

Table 1. Webpages Retrieved from Systematic Searches

Sixteen webpages found in the search results contained HCI patterns. Those 16 webpages corresponded to 6 unique websites. Four of those 6 websites contained patterns that included the common elements found in the HCI definition of a pattern as described above. The four websites seen in table 2 and the patterns found on these websites were included in this analysis.

Website	Number of Patterns
Welie [http://www.welie.com/]	131
Tidwell [http://designinginterfaces.com/patterns/]	124
UI-patterns [http://ui-patterns.com/]	96
Yahoo Design Pattern Library [https://developer.yahoo.com/ypatterns/everything.html]	59

Table 2. Number of Patterns

Tidwell's older and newer websites both appeared in the search results. The newer website was included in this analysis. The Pearson pattern library was also one of the six websites. This collection contains 80 items that are referred to as patterns, however some, but not all, of the Pearson patterns contain the essential or common elements of a pattern in HCI. Therefore, the Pearson pattern collection was not included in this analysis. Several other publically available pattern websites are available that did not appear in the results of the systematic searches. The four websites included in this analysis contained a total of 410 patterns (at the time of this analysis). As a point of comparison, Alexander's pattern language contains 253 patterns. For each website all patterns were examined, but this analysis focused on the most complete patterns. For example, not all Yahoo patterns include an accessibility section, however some do.

All four websites included a name or title for their pattern, a picture, a description of the problem, and a solution. As mentioned above these are the common elements found in definitions of patterns in HCI. Alexander includes numbers for each pattern, however none of the websites included pattern numbers. Alexander's patterns also include references. Alexander described these references as essential to the language and the use of the language. None of the 4 websites in this analysis included references with the same intention of Alexander's references. In table 3 we see the variety of names used for each pattern element. For comparison the elements in Alexander's patterns are seen in the first column this table. The elements for the respective websites are seen in the other columns. The elements were not presented in this order on the pattern websites, but have been arranged in this way to aid in comparison. In looking at the pattern elements we see that many of the websites are using the same or similar names. Nevertheless, it is possible that the slight differences in the names of the elements and the order in which they are presented in each pattern collection might contribute to confusion when looking for patterns and applying patterns. In fact, Dearden et al. (2002) argue that the form of a pattern is significant. Dearden (2002) also argued that more examples are better than fewer examples. Three out of the four collections included several examples in their patterns. The Yahoo patterns mostly contain only one example.

Alexander	Welie	UI-patterns	Tidwell	Yahoo
Picture (example)	Picture	Picture	Picture	Picture
Introductory paragraph (context)	Use when	Usage	Use When	When to use the pattern
Body of problem	Problem	Problem Summary	What	What problem does this solve?
Solution	Solution	Solution	How	What's the solution?

Table 3. Pattern Elements

Another interesting finding is that many of the websites included elements in their patterns that are not in Alexander's patterns and not explicitly mentioned in definitions of HCI patterns. Considering the difference in the disciplines of architecture and HCI is not surprising to see some variation. However, again there was no consensus or consistency across the pattern websites. Welie patterns include among other things: literature (related to the pattern), implementation details, a place for comments, links to code examples and links to similar patterns on other websites (labeled: also known as). UI-patterns also include a place for comments (which appears to be disabled) and a rating system (thumbs up/ thumbs down). Tidwell patterns include, among other things, links to similar patterns on other websites. Yahoo patterns include, among other things: code (from Yahoo products), accessibility information, links to similar patterns on other websites and links to Yahoo blogs.

The other focus of this research was on the organization of the patterns, or the organizing principle. In examining websites this manifests as navigation. All four websites provided some form of structured navigation and a search function. Welie's patterns are organized into three categories: User needs, Application needs and Context of design. These categories are further subdivided. Tidwell's patterns, as presented on the website, are not organized. However, in the companion book the patterns are organized into eight categories: Organizing the content, Getting around, Organizing the page, Commands and action, Showing complex data, Getting input from users, Builders and editors, and Making it look good. UI-patterns contains two types of patterns: User Interface Design patterns and Persuasive Design patterns. User Interface Design patterns are organized into six categories: Getting input, Navigation, Dealing with data, Social, and Miscellaneous. The persuasive design patterns although interesting are not relevant to this analysis. The Yahoo Design Pattern Library is organized into five categories: Layout, Navigation, Selection, Rich Interaction and Social. Some of these categories are further subdivided. It appears as though the organization of the patterns is somewhat important to all the pattern authors, but there does not appear to be any agreement across collections about how to organize the patterns. In each pattern website there are patterns at different levels of scale and there is at least some type of hierarchy (although limited) in each pattern website, as illustrated in the navigation and groupings. However, the 'language' aspect or a formal organizing principle is not clearly present.

Another aim of this analysis was to learn more about the pattern discovery and validation process as well as the experiences of the author(s) of the patterns. As indicated on the websites, the authors of the pattern collections have diverse discovery and validation processes, and backgrounds. Martijn van Welie has a PhD in HCI and several years design experience. Jennifer Tidwell has over 20 years of design experience and acknowledges that the patterns are based on best practices encountered over the years. UI-patterns was created by Anders Toxboe a developer with several years of design experience. The Yahoo design pattern library was designed by a team following a pattern curation process (Malone, Leacock, and Wheeler, 2005). Welie has a comment feature on each pattern to allow for feedback from the wider community and also encourages pattern suggestions. Tidwell does not appear to provide a mechanism for feedback on the website. The Yahoo design pattern library

in addition to following a curation process has a rating system for patterns that includes three levels: Beta, Working solution, and Best practice. UI-patterns has a comment feature that allows feedback from the wider community (but it appears to be disabled) and also includes a voting feature (thumbs up/thumbs down). Patterns on UI-patterns are also identified as mini patterns (which appear to simply be incomplete patterns, but an explanation could not be found on the website). The results are further discussed in the next section, but due to space limitations this discussion is limited.

DISCUSSION

This work is a report of a systematic analysis of patterns and pattern websites in HCI. This analysis may be viewed as the current state of affairs as seen on pattern websites. Reflecting back on the issues identified ten years ago by Dearden and Finlay in their critical review we, as a community, have made some progress, but based on the results of this analysis we suggest that more work must be done. Although the design patterns analyzed contained similar elements, a common pattern format was not seen. There does not appear to be a common organizing principle, or a common discovery and validation process. Based on the results of this analysis we urge the community to continue working towards establishing a standard format. This work is one more step in moving towards a standard format. As reflected on the websites analyzed, it appears as though the organization of the patterns is important to all the authors, but there does not appear to be any agreement across collections about how to organize the patterns. Further work is needed in this area. Although each author has experience in the field, the discovery and validation process is not fully explained and quite possibly might be overlooked, or perhaps deemed not important. Other concerns include that the language aspect – the relationships among patterns (that Alexander stressed as so important) are not widely accepted, acknowledged or utilized, the hierarchy and patterns at various levels of scale are not explicit, and the quality of a pattern is not of utmost importance. The results of this analysis also raise additional questions for the community to consider, specifically whether these issues might be inhibiting the successful use and application of patterns and pattern languages in HCI.

CONCLUSION

There appears to be a continued interest in patterns and pattern languages in HCI, as reflected in the number of websites, books, and other resources dedicated to this topic. However many fundamental questions about patterns and pattern languages in HCI have yet to be addressed. The results of this systematic search and analysis of HCI patterns reveals that the community has yet to adopt a standard pattern format. There is also no obvious agreement about the importance of an organizing principle or a discovery and validation process. The results of this analysis reinforce the concerns expressed by several others in the literature and remind us that there is still more work to do to ensure that we, as a community, benefit from the promises of patterns and pattern languages in HCI. We urge the community to continue this conversation and use this analysis as one point of reference in this ongoing conversation.

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