# CAPTURING BEST PRACTICES IN WEB DEVELOPMENT

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**ABSTRACT**

This paper describes capturing design experiences by applying grounded theory to pattern mining. The presented approach aims at inducing expert development knowledge and its subsequent packaging into domain-specific design patterns, which could later be used by both experienced and novice developers in the field. The method was evaluated empirically in a domain of Web development.

**KEYWORDS**

Web development, pattern, pattern mining, grounded theory.


## 1.  INTRODUCTION

In recent years we have observed World Wide Web to gain entry into our lives. With the advent of World Wide Web, multimedia becomes the standard way of presenting information in a globally distributed environment. It is a rapidly developing area, Now non-programmers have access to tools supporting development of Web pages and they actively use these products for a variety of purposes, e.g. teachers create interactive Web-based learning environments, businesses publish high quality multimedia marketing material, technical writers enhance on-line manuals, and documentation. Nevertheless, Web sites suffer from many problems, from poor user interfaces and navigational problems to technological issues (Johnson and Nemetz, 1998). The reason for these problems may be found in the ad hoc design approaches applied to Web development.

Over years several multimedia design methodologies emerged based on hypertext model (Halasz and Schwartz, 1994, Hardman et al., 1994), database design methods (Garzotto et al., 1993, Isakowitz et al., 1995) and object-oriented paradigm (Boll and Klas, 1999, Schwabe et al., 2000). However, a study conducted by Barry and Lang (Barry and Lang, 2001) revealed that practitioners in their majority do not use multimedia design methodologies.

This study with the help of grounded theory is set to investigate real concerns of practitioners and their best practices – what issues are considered in the process of decision-making while a typical design task is performed? These issues are to be recorded in the format of patterns

### 1.1  Patterns and pattern languages

In general, "a *pattern* is a named, instructive and insightful nugget of information that captures the essence of a successful family of proven solutions to a recurring problem that arises within a certain context" (Appleton, 1997)

A good pattern:
- solves a problem;
- is a proven concept;
- is not obvious.

A *pattern language* is a collection of interrelated patterns that together help solving problems in a given domain.

"Patterns" and "pattern languages" are created to describe successful solutions to common recurring problems and facilitate reuse of successful solutions.

The concept of patterns was derived from the writings of architect Christopher Alexander (Alexander, 1979). Patterns found their way into a great variety of fields, from computing (Gamma et al., 1995, Kim and Benner, 1996, Larman, 1998) to education (Anthony, 1996). Multimedia and Web development are not exceptions (German and Cowan, 1999, Rossi et al., 2000).

## 1.2 Pattern mining

Pattern discovery is called *pattern mining*. There is a small group of active pratitioners who spend time mining domain experience and formalising their best practices. However, the majority of the practising community does not contribute to this process and this results in the loss of a large body of experience. The motivation for pattern mining can be simply expressed by a question: "What knowledge would be lost to the company if this employee were to leave tomorrow?" Pattern writers make sure that their experience is not lost. They are sharing it through patterns and pattern languages.

Currently pattern mining involves the following procedures (Cf. Figure 1). An expert in the field or a cohesive group of experts (e.g. members of the same work team) craft a pattern reflecting their experience in solving a recurring problem. The author(s) submit this pattern for review, called *shepherding*. A shepherd is usually an experienced pattern writer who may also have some understanding of the domain to which the pattern refers. The purpose of shepherding is to help the author(s) improve quality of the patterns. Then the completed pattern is evaluated at the pattern mining workshop where experienced members of the pattern writing community share their opinions on positive aspects of the pattern and suggestions on how the pattern could be improved. Using this information the author improves the pattern and after that the pattern is published. (Appleton, 1997)

Various approaches to pattern mining have been used by the patterns community: Mining by Interviewing, Mining by Borrowing, Mining by Teaching Patterns Writing, Mining in Workshops, Mining Your Own Experience, Mining in Meetings, and Mining in Classes (Rising, 1999). However, these approaches usually take place within one organisation.

Currently pattern crafting is done by a single author or a cohesive group of inter-related people which means that a pattern produced reflects experience of one person or a team in an organisation. Evaluators discussing patterns at pattern mining workshop are pattern mining experts, however they may have rather superficial understanding of the problem domain. As a result the approved pattern currently represents rather narrow expertise instead of reflecting the knowledge across domain.

Literature review and practical observations allowed to identify the following problems in the pattern mining process:
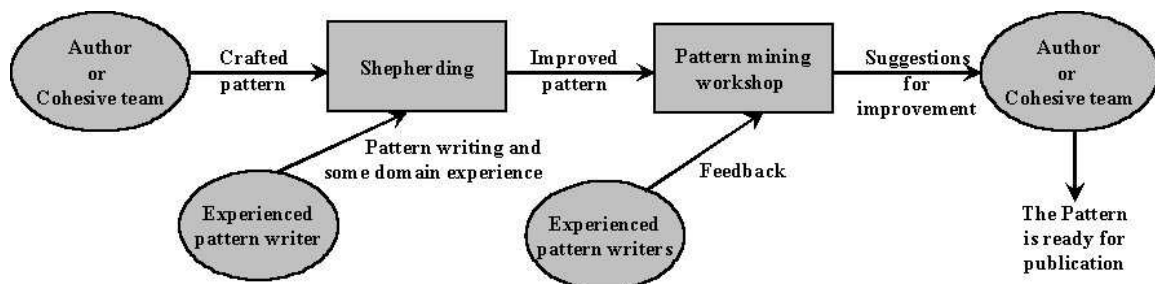


Figure 1. Current pattern-mining process

- A pattern usually reflects an opinion of a single person or a cohesive group of people – other practitioners may be able to enrich the pattern.
- Pattern mining relies on active participation of pattern developers – quite often there are no domain experts among them and evaluators of the pattern have only superficial knowledge of the field.
- Practitioners need to actively participate in the process of formalization of best practices, however practitioners often don't have time or interest in participation in the formalization process (it does not mean they are reluctant to share their experience – quite the opposite).
- To participate, a practitioner has to learn pattern writing and become patterns' author – it is time consuming and not everyone is interested.
- For practitioners to be actively involved in pattern mining they have to be taken away from their working environment.
- Pattern mining gets isolated from the problem context - contradiction to the concept of patterns as advising on solving problems *in context*.

There is evidence that the whole process of pattern mining can be improved (Rising, 1999). Expertise needs to be collected across problem domain, not within one team or organization.

## 2. APPLICATION OF GROUNDED THEORY TO PATTERN MINING

As opposed to current practices, this research proposes to collect practitioners experience across the domain (rather than from one expert or a cohesive group of people), formalise this experience by applying grounded theory strategies, record it using pattern format and evaluate this body of knowledge in pattern mining workshops involving patterns experts and practitioners together (cf. Figure 2). So the major change of the pattern mining process in Figure 2 is represented by the box "Analysis using grounded theory"

Pattern-mining supports recording of best practices using the pre-defined format. Pattern writers concentrate not only on a *problem* and its proposed *solution* but relate it to a certain *context* (situations within which the problem occurs repeatedly), *forces* (reflect things that create the problem) and *consequences* of using the proposed solution to the problem.

Interviews, meetings, and observations are known approaches to experience mining (Rising, 1999). These data collection approaches result in huge amounts of unstructured textual data, which needs to be analysed. Grounded theory strategies of data analysis naturally lend themselves to formalising this step from mining domain experience to crafting draft patterns.

The grounded theory method (Charmaz, 2000, Strauss and Corbin, 1998) is a qualitative research method that prescribes a systematic iterative activities to inductively derive a theory about a phenomenon from data. Grounded theory prescribes systematic guidelines for data collection and analysis with the purpose of inductive building of a framework explaining the collected data (Charmaz, 2000). Grounded theory strategies
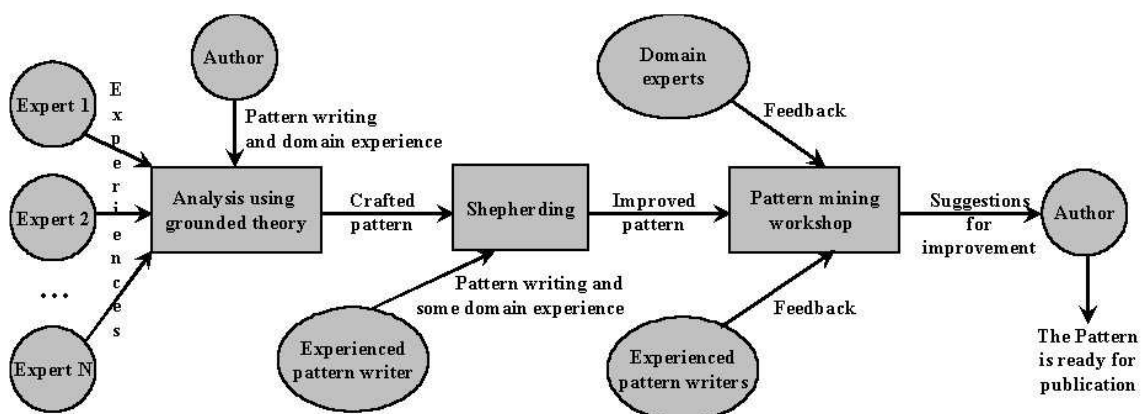


Figure 2. Suggested pattern-mining process

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suggest collection and analysis of large amounts of unstructured textual material coming from various sources, such as formal and informal interviews and observations, then developing a theory on the basis of the data material. Although grounded theory methods do not dictate data collection rules, the rigor of the analytic process helps building a strict explanatory framework. Some researchers emphasize that the strength of grounded theory is in the fact that concepts and theories developed on the basis of data material are more empirically grounded (Strauss and Corbin, 1998).

In relation to this study it means that the researcher can use data obtained from interviews, observations, developers meetings and focus groups to demonstrate successful pattern mining.

Practitioners love talking about their problems. Huge amounts of textual material can be collected. This text needs to be analysed to extract first outlines of a pattern language. This is when grounded theory comes into place. By scrutinizing text line by line (or even word by word) the text is coded and split into manageable chunks. This *open coding* technique allows detecting main themes or categories that are to become *concepts* for *theory building*. As the analysis moves on, the process becomes more focused on commonalities – practitioners' concerns are categorised; context around the problem, forces, solution approaches and consequences of choosing one or another solution are coded as *dimensions* of the concept. As the intense analysis around each concept is performed, the analysis process gradually transfers into the stage of *axial coding*, the essential aspect of open coding.

Grounded theory emphasizes the importance of the situation context, which have to be incorporated into an understanding of the phenomenon (Pettigrew, 1990). At the same time a pattern "expresses a relation between a certain context, a problem, and a solution." (Alexander, 1979) Again we see correlation between grounded theory strategies and pattern mining.

During this process it is very important to identify "the variety of conditions, actions/interaction, and consequences associated with a phenomenon." (Strauss and Corbin, 1998) This is reflected in forces, context and consequences sections of a pattern.

Pattern mining is an iterative process because patterns are refined in the process of understanding of the problem and its contexts. Grounded theory prescribes iterative approach to data analysis and collection.

Existing approaches employed for pattern mining overlap with the ones prescribed by grounded theory (see Table 1). The above arguments clearly show that grounded theory seems particularly suitable for formally supporting pattern mining processes.

# 3. EMPIRICAL WORK

The goals of this empirical study are
- to describe repeating situations in the design process;
- to identify problems in the design process and note how authors deal with those problems;
- to find common solutions to recurring problems within certain context.

Empirical work involves an iterative process of data collection through interviews, observations and design team meetings (either by recording the meetings or by studying meeting minutes). By triangulating several data collection strategies internal validity is ensured. Grounded theory strategies are applied to data analysis which focuses further data collection for draft pattern writing. During empirical work a **method** facilitating pattern induction is being developed.

Table 1. Correlation between pattern mining and grounded theory strategies

| Pattern Mining | Grounded Theory |
|---|---|
| Experience mining during interviews, meetings, and observations | Sources of empirical data: interviews, focus groups, participant observation |
| A problem and its solution are considered within a certain context. | Importance of the situation context, which have to be incorporated into an understanding of the phenomenon. |
| Pattern mining is an iterative process because patterns are refined in the process of understanding of the problem and its contexts. | Grounded theory prescribes an iterative approach to collection and analysis of data. |

7 subjects have been interviewed. They discussed 14 projects. While mining domain experience it was important to avoid accidental omission of important issues in Web development. The subject of patterns was not discussed with practitioners. In these interviews, multimedia designers were asked to talk about a project of their choice and in the process to explain the design process and decisions made, discuss different drafts, and reflect on their best practices.

Soon the researcher discovered that there were commonalities between procedures, issues and concerns addressed by practitioners. These issues were grouped into categories and their dimensions. This approach allowed identifying common tasks performed by practitioners, e.g. applying pre-existing (business) context, resolving usability issues, designing menus, selecting color schemes, etc. For each task related concerns and issues were identified and classified.


# 4. FINDINGS

The most important finding is that patterns can be induced from interview data even when practitioners are not familiar with the notion of patterns.

Every practitioner when talking about a task performed in the process of product development shared various aspects that needed to be considered whether derived from requirements, or pre-existing context, or his/hers experience, or sometimes influenced by the tools used in the process. In the process of data analysis these concerns were generalised and joined into categories relevant to a design task. For example, for the

Table 2. Design context for a "menu design" task

| Design issues | Aspects of design tasks to be considered |
|---|---|
| Menu Look | <ul><li>Menu layout</li><li>Non-ortho linear vs. tabular menu items layout</li><li>Visual representation of menu items</li><li>Menu context indication</li><li>Menu persistence during navigation</li><li>Temporal effects</li></ul> |
| Menu Structure | <ul><li>Consistency between menu and site/information structure</li></ul> |
| Menu Buttons | <ul><li>Tool-specific menu design facilities</li><li>Creating reusable menu styles</li><li>Menu image representation (vector vs. bitmap)</li><li>Editing ability of menu components</li><li>Inter-tool communication and compatibility</li></ul> |
| Menu Behaviour | <ul><li>Visual effects (transitions)</li><li>Navigation behaviour</li><li>Mouse-click effects</li></ul> |
| Menu Rollovers | <ul><li>Mouse-over effects</li><li>Inclusion of rollovers in menu design</li><li>Duality of rollover visual and behavioural design</li><li>Time required for uploading rollover scripts</li><li>Visualisation of rollover behaviour in text readers</li><li>Representation and initialisation of menu states</li><li>Export and slicing of images used in menus</li><li>Script compatibility between different browsers</li><li>Use of images to indicate mouse over effects</li><li>Selection of a highlight colour in mouse over effects</li><li>Use of animation for rollovers</li><li>Keeping track of menu components</li></ul> |
| Menu Drop-Downs | <ul><li>Use or scripts and style sheets to design fly out menus.</li></ul> |

"menu design" task issues such as look, buttons, rollovers, and drop-downs were identified. For each of these issues important "aspects to be considered" were recorded and these aspects formed the design context for the "menu design" task (see Table 2). This table gives an indication of patterns that may be developed for a "designing menu" task.

Although in most cases we do not get full patterns, we induce pattern skeletons which recapture the essence of practical knowledge in multimedia design, with gaps to be iteratively filled with follow-up interview data and later disseminated in the community of multimedia practitioners. Table 2 lists menu rollovers as a design issue which is to be associated with the set of patterns. The following statements derived from the data demonstrate examples of context and consequences of patterns on rollovers:

> Context: Expectations of users today are different from those a few years ago – they expect more fancy mouse over effect than just change of the mouse pointer.

> Consequence: People with slower machines often turn images off to speed up the loading of the page; vision impaired people use text readers, which means they cannot "read" the rollovers. Thus if there is no alternative menu, some information on the site will be inaccessible to these groups of users.

In a similar fashion other elements relating to the different parts of patterns can be induced and subsequently analyzed and reconciled into a small collection of highly focused patterns. (We also show examples of coding as related to elements of patterns in subsequent citations.)

Another interesting finding relates to existing Web design methodologies. Results of data analysis were compared with some of these methodologies, namely the Dexter model (Halasz and Schwartz, 1994), AHM (Hardman et al., 1994), RMM (Isakowitz et al., 1995), HDM (Garzotto et al., 1993), OOHDM (Schwabe and Rossi, 1995), ZyX (Boll and Klas, 1999) and Visual Composition Models (Mey et al., 1992) These models address important aspects of multimedia design. These aspects may be classified in three major groups: conceptual design, navigational design and abstract interface design. However, while most of the models thoroughly cover conceptual design and navigational design issues, only some of the cover user interface design issues and sometimes these issues are only partially addressed. At the same time collected data shows some aspects that are of serious concern to practitioners are not addressed by multimedia design methodologies at all. Existing methodologies lack in capturing designers' concerns as related to technology compatibility, tool support for design (and later implementation) process, pre-existing business context and HCI issues (see Table 3). Such gaps identify the areas of possible extensions to the models, which may lead to better methodological support of multimedia design processes.

The identified gaps could be explained by a number of factors (which need to be further investigated), such as:

- Prototypical nature of multimedia development, which calls upon the use of specialized authoring and design tools;

Table 3. Comparison of design models with observed practices

| Design Aspect | Dexter | AHM | MPDM | HDM | RMDM | OOHDM | ZyX | VCM | Observed Practice |
|---|---|---|---|---|---|---|---|---|---|
| Conceptual design | F | F | F | N | F | F | F | F | C |
| Navigation design | P | F | F | F | F | F | F | F | C |
| User interface design | N | P | F | N | F | F | F | N | C |
| Technology compatibility | | | | | | | | | C |
| Tools support | | | | Gaps | | | | | C |
| Contextual issues | | | | | | | | | C |
| HCI issues | | | | | | | | | C |

F – fully addressed; P – partially addressed; N – not addressed; C – area of concern

> *Graphic Designer 1: "Image Ready does actually simplify the process a fair bit, because you can actually preview the rollovers."* (Rollovers Resulting Context)
> *Web Developer 2: "I use Fireworks for all of my buttons..."* (Menu Solution)

- Potentially non-homogenous community of multimedia (especially web) users, thus forcing designers to anticipate non-uniform technology to facilitate delivery and use of multimedia products.
  > *Web Developer 1: "And the reason why we needed a different version for Netscape and for Internet Explorer was because..."* (Common Force)
  > *Web Developer 1: "And the reason why we detected screen resolution was because on an 800 by 600 screen which we were using as the lowest common denominator in this case, the bottom part of the movie would not be visible on browsers that had all of the available menu bars and things fully open up at the top."* (Common Force)
  > *Web Developer 2: "For general text I always use something like Verdana or Arial or something like that as opposed to Times, because Times works best on printers."* (Text Solution)

- User-centric design approach which heavily depends on the external context and which focuses closely on usability and accessibility issues of the resulting products;
  > *Graphic Designer 2: "I think people's eyes do tend to stay towards the top of the page."* (HeadBanner Context)
  > *Graphic Designer 1: "They also are very text heavy documents so I need to have a lot of white space."* (Text Context and Solution)

Multimedia design methodologies emerged from the software engineering tradition and thus they commonly focus on products function.[1] However, interviews with multimedia and web designers show that they are more concerned with the products form and information contents rather then their function. The main focus of multimedia design seems to be on the details of user interface and their related issues. Multimedia systems, and in particular web sites, have limited functionality, whereas features of multimedia products seem to have unlimited choices and this causes major difficulties for designers. The following quote from an interview with the graphic designer shows that even for simple tasks, such as creating a home page where a company's logo imposes some limitations on the choice of shapes and colors, there are great many issues still to be resolved.

> *"The home page in a way should be simpler because there are less elements on it, but we actually ended up with more versions of that because we don't have a clear graphic, all we really have is the logo, so we came up with various versions of that"*

Multimedia designers talk about their views on visual aspects of a product, such as layouts and colour schemes, usability and accessibility and user – product interaction. As one graphic designer put it "I want it to be visually interesting".


## 5.  SUMMARY AND CONCLUSIONS

Since domain experts hardly ever contribute to pattern mining, we need a facilitator who would actively seek opinions of practitioners, analyze the collected experience and summarize on the format of patterns. It is possible and has been practiced by Linda Rising in AGCS. Linda Rising described her experience of being the "patterns champion or the self-proclaimed patterns "princess" at AGCS (Rising, 1999). She focuses on recording best practices within this organization. This research is looking at extending her work by looking beyond one organization and collecting expertise from multiple sources across a domain. It proposes a systematic way of looking at the domain as it is practiced with the focus on domain patterns rather than generic design patterns. Using this approach the whole pattern language can be developed, not just individual patterns because the data is collected about projects and thus development issues are discussed in context. We get a more global picture - all concerns and successes can be recorded and then analyzed. As a result emerging patterns are grounded in empirical data.

From practitioners perspective the benefit is in the fact that they contribute their experience without having to go away from their work environment. In the end best practices are formally recorded. As a result

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[1] A product function is interpreted as value given to a user from the task performed by a software product.

any practitioner whether a novice or an expert may benefit from this pre-packaged experience collected across a domain.

This study produces the following benefits:

- Pattern produced with the proposed approach no longer reflect a single opinion, but expertise collected across domain.
- Practitioners are able to participate in pattern mining without going away from their working environment.
- Practitioners are able to share their expertise without learning pattern writing skills or actively participating in the formalization of their experience.
- The developed method adds substantive content to our understanding of pattern mining processes and decision-making when performing certain tasks in multimedia development.

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