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Making Expert Knowledge of Adaptations of E-Learning Material Available with Patterns

Birgit Zimmermann
(SAP Research, SAP AG , Germany
birgit.zimmermann@sap.com)

Christoph Rensing
(TU Darmstadt, Germany
Christoph.Rensing@KOM.tu-darmstadt.de)

Ralf Steinmetz
(TU Darmstadt, Germany
Ralf.Steinmetz@KOM.tu-darmstadt.de)

Abstract: Adapting E-Learning material allows re-using existing material even in changed usage scenarios. But this adaptation is a complex task. To achieve a perfect result expert knowledge is needed. Often adaptations have to be performed by persons who are not experts in performing these tasks. To enable those persons to achieve a satisfying result they need to be supported. Patterns are one possibility to make expert knowledge on certain tasks available to other persons. In this paper an approach is presented how expert knowledge of performing adaptations of existing E-Learning material can be collected and made available with patterns. This approach can also be used to collect knowledge of other processes, e.g. in companies.

Keywords: Knowledge Transfer, Patterns, Adaptation, Re-Purposing, Re-Use
Categories: D.2.10 – Design, D.2.13 - Reusable Software

1 Introduction

As the creation of E-Learning material is a costly task the re-use of existing material is an important topic in current research [Duval, 03]. But it is often not possible to re-use existing material as the usage scenario has changed and the existing material does not completely fit the new needs. It is then necessary to adapt the material to the changed requirements.

Adapting existing E-Learning material to changed requirements is a complex task: There exist lots of different adaptations like layout changes, translations, didactical changes etc. Often a combination of several adaptations has to be executed to achieve good results. In addition E-Learning material uses quite a lot of different formats [Zimmermann, 06b]. To be able to work with all formats users need knowledge of the tools used to work with the particular formats. This means that expert knowledge is needed to achieve a perfect adaptation result. But often persons have to perform the adaptations who are subject matter experts but not experts in performing all needed adaptations. To be able to achieve a satisfying result nevertheless, those persons have to be supported in performing the adaptations.

Patterns are a widespread methodology to provide expert knowledge and best practices. A pattern describes a proven solution to a recurring problem that occurs in a specific context. Patterns document expert knowledge of the topic they deal with. In this paper an approach is presented how to use patterns to capture the existing knowledge of adaptations and to make this knowledge available to those persons who have to perform adaptations without having expert knowledge.

The structure of the paper is as follows: The second chapter provides an introduction on adaptations of existing E-Learning material; a short overview of patterns is presented in chapter three. Chapter four describes how expert knowledge of performing adaptations can be collected with patterns and how the resulting patterns can be used to transfer the collected knowledge to other persons. Finally a summary and an outlook on future work are given.

2 Adaptation of Existing E-Learning Material

As mentioned before the adaptation of existing E-Learning material in order to make it suited for changed requirements is complex. In this chapter an overview of this task will be given.

The adaptation of existing E-Learning material often is a prerequisite for a reasonable re-use of existing material: Whenever the new usage scenario differs from the original scenario an adaptation is needed. There are a lot of different aspects in respect of which the material can be adapted. In [Zimmermann, 06a] 15 different kinds of adaptations are identified as an outcome of a user survey.

Having a closer look on the changes done during the adaptations you will see that the adaptations can be grouped. There are three major categories of adaptations:

- Adaptations that primarily change the appearance, the *layout* of the material
- Adaptations targeting on changing the *content* of the material
- Adaptations that can have an effect on layout or content but that are primarily *caused by technical requirements*

In [Zimmermann, 06b] the 15 adaptations have been assigned to the three categories. The following figure shows this assignment.

Layout	Content	Technical reasons
• Design • Printability • Screen resolutions • Accessibility	• Translation • Learning objective • Terminology • Degree of interaction • Semantic density • Learning strategy • Difficulty of the course • Duration of the course	• Transformation into several formats • End devices • Bandwidths

Figure 1: Classification of adaptations

An accurate analysis of the adaptations [Zimmermann, 06a] has shown that there are some adaptations that are performed in a very structured way. Most of these adaptations can be performed at least partly automated by a tool. But there are also some unstructured adaptations that are performed mainly based on experiences. For these adaptations it is not possible to specify exactly what has to be done in which order. In addition it is mostly not possible to offer a reasonable automated tool support. But for both kinds of adaptations (structured and unstructured) it is possible to detect best practices, describing what has to be taken into account when performing the adaptations.

There are several other approaches dealing with re-use or re-purposing of existing E-Learning content like [Hörmann, 05] or [Obrenovic, 04]. But these approaches do not take into account that the usage scenario might have changed and the existing material is not completely suited for the new scenario. Other researchers concern the adaptation of material with respect to the learner like the work in the AHA project [Stash, 06]. All these approaches do not take into account that it might be necessary to adapt the existing material before re-using it.

3 Patterns

Patterns represent a well accepted method to capture expert knowledge on best practices. Originally patterns were invented by the architect Christopher Alexander to describe the solution to recurring problems in urban planning and building architecture. By now patterns are used in many different areas as software design, security, pedagogy, etc to provide best practices.

Patterns have a long history in documenting best practices and expert knowledge. Alexanders's pattern language [Alexander, 77] documents knowledge of designing towns, buildings, and construction. The POSA book [Buschmann, 96] covers the knowledge of the authors, leading practitioners in software development, of software architecture. The Gang of Four (GoF) has collected best practices in object oriented software design [Gamma, 95]. Martin Fowler's analysis patterns "*are groups of concepts that represent a common construction in business modeling*" [Fowler, 96]. Schumacher et al. published a collection of patterns on basic security problems and their solutions [Schumacher, 05].

Patterns are written in natural language. Mostly a certain structure is used to provide the information a pattern captures. A lot of different formats exist but there is a certain agreement on the mandatory elements of a pattern [Meszaros, 96]: A pattern has to be identified by its *name*. A pattern describes a *solution* to a *problem* occurring in a certain *context*. *Forces* describe the trade-offs that must be considered when applying the pattern. In addition there are several other elements that can be used to describe a pattern.

We started working on a pattern language describing the adaptation of existing E-Learning material in order to make it suited for changed requirements. A first set of patterns of this language has been published in the proceedings of VikingPloP06 [Zimmermann, 06c]. In this paper it is described how these adaptation patterns have been created and how they can be used to transfer the collected expert knowledge to other persons.

4 Pattern Based Knowledge Transfer

As explained before expert knowledge is needed to achieve a perfect outcome of E-Learning material adaptations. But there exist also persons who are experts in the domain covered by the material but who only occasionally deal with adaptations. Nevertheless they have to perform adaptations. To allow these persons to achieve a satisfying result they need support. In the following it is described, how patterns can be used to document best practices as a basis for such a support.

4.1 Collecting Knowledge with Adaptation Patterns

Patterns are a well accepted way of documenting best practices. As they are written in natural language they are easy to understand. No special training is needed to read a pattern, in contrast to many modeling formalisms used during analysis and design phase in software design. Many of the experts working with E-Learning material adaptations have no knowledge of software design. Patterns offer them a comfortable way to provide their knowledge to other persons.

Patterns are not invented but found. They document proven solutions to existing and recurring problems. Therefore the knowledge provided by a pattern first has to be detected, before it can be written down. We used an iterative process to write the patterns documenting the knowledge of experts of adaptation processes [Fig. 2]:

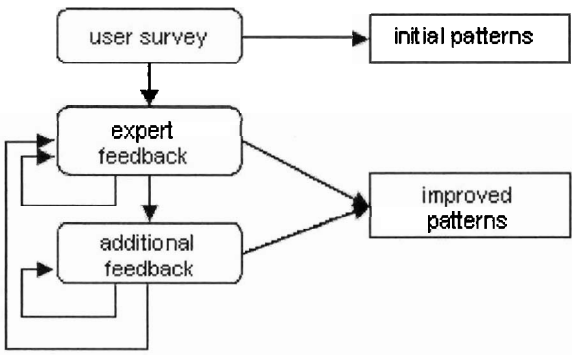

Figure 2: Pattern creation process

We started our work with a user survey [Zimmermann, 06a]. In this survey we asked persons working in the area of content creation how they perform certain adaptations. We analyzed the descriptions we got from those persons. Then we formulated a first rough version of initial patterns that represent a basic idea for each adaptation.

In a second step for each pattern we talked to experts of executing the adaptation described in the pattern. By this we refined our initial patterns and came to improved patterns. For patterns it is very important that they cover proven solutions. Therefore we determined for each pattern in which situations the solution described in the pattern has been applied successfully. Depending on the adaptation some of the

patterns went through several iterations during the second step. This means that we talked to several persons and refined the patterns again and again.

In a third step we presented some of the results at a pattern conference [Zimmermann, 06c], where we got additional feedback. This again is an iterative process: Publishing a paper at a pattern conference starts with the so called "shepherding process". Shepherding is a one-to-one review. The reviewer (the so called *shepherd*) has to be an experienced pattern writer. The shepherd helps the authors of the patterns to improve their work and to assure that the work really represents patterns. When the patterns are in a good shape they are prepared for the *Writer's Workshop*. The writer's workshop offers a structured process for additional feedback on the patterns. When a pattern has gone through the shepherding process and the writer's workshop, it has improved again and is ready to be published.

By now a reader can be sure that the patterns do not reflect the personal opinion of the authors. They are based on expert knowledge and are proven by a lot of experienced pattern writers.

The strong emphasizing of collecting knowledge from experts in the first two steps of our procedure reminds of the Delphi method [Linstone, 02]. This method can be used for example in the creation process of ontologies. The Delphi method is a structured process to collect and distill expert knowledge. It is based on written expert surveys. In contrast to the traditional proceeding of the Delphi method we decided to perform both the initial interview in the first phase as well as the feedback in the second phase not as a written survey. The answers we expected from the experts would have been too long to be written down in a bearable amount of time. Therefore we did the initial survey in the form of a structured telephone interview that has been recorded and then written down. Based on the results of this survey the initial patterns were created. They were taken as a basis for the feedback round with experts during the second phase.

Shepherding and writer's workshops, the elements of the third phase in our approach, are the traditional process to publish patterns in the proceedings of a pattern conference. They are not taken into account in the Delphi method. But nevertheless they are very valuable as they bring the feedback of experts in pattern writing into the patterns.

The patterns that are outcome of this proceeding are a valuable source of knowledge to experts as well as to novices or laymen.

4.2 Elements of an Adaptation Pattern

There exist a lot of different pattern formats. Some pattern authors even decided to take no fixed format at all, like Martin Fowler for his analysis patterns [Fowler, 96]. As a fixed format increases readability and understandability we decided to take a fixed format for the adaptation patterns. The format is based on the GoF format [Gamma, 95] as well as on the POSA format [Buschmann, 96]. It consists of the elements shown in table 1.

4.3 Providing Knowledge Based on Adaptation Patterns

The purpose of our work is to support non-experts in performing E-Learning material adaptations. The adaptation patterns themselves are a valuable source of knowledge.

Someone who has to perform an adaptation can look up what has to be done in the patterns.

As explained before some of the adaptations can be (at least partly) automated whereas for other adaptations it is not reasonably possible to automate the adaptation. To offer a more comfortable support for both kinds of adaptations we decided to create a wizard. Based on the knowledge collected with the patterns this wizard guides users through the adaptations and offers automated support where this is reasonably possible. If no automated support is available the wizard guides users step by step through the adaptation by providing information what has to be done in each adaptation. (This information is available in the adaptation patterns.) In case of an unstructured adaptation tips and tricks and hints on how to proceed are offered. In addition it is always possible to view the whole pattern for each adaptation and to take this as a guideline.

The patterns are provided in an XML-notation. They are rendered to HTML and displayed in a browser window. Thus it is possible to render the patterns differently for an expert or a novice. This is useful as an expert often needs less information than a novice: Whereas experts use the patterns to remember what they have forgotten, e.g. after a long holiday, novices need detailed information. They have never or only seldom performed the task they want to get information about. Figure 3 shows an example for this: a part of the design pattern rendered for a novice user.

When novices are more experienced they have the possibility to change the options of the wizard and to declare themselves as experts. This does not only impact the rendering of the patterns but also the whole wizard: For novices many explanations to all steps of an adaptation are provided. In contrast experts do not need as much information. They like a fast support that allows them to do their job more shortly. This is taken into account in the wizard.

Name	Unique identification of the pattern.
Classification	An asterisk to identify the degree of confidence of the authors into the pattern (no asterisk = lowest degree of confidence).
Intent	A short overview what the pattern is about.
Context	The situation in which the pattern can occur.
Problem	The problem that has to be solved.
Example	Helps the user to understand the pattern.
Forces	The trade-offs that have to be considered.
Solution	Tells the reader how to solve the problem.
Known Uses	Situations where the pattern has proven to be successful.
Consequences	The positive and negative consequences of performing the solution.
Related Patterns	Patterns of other pattern authors that deal with the same or a similar problem.
Connected Patterns	After performing the solution of this pattern it might become necessary to execute the connected patterns.
Used Patterns	Other patterns that are used when performing the solution.

Table 1: Elements of an adaptation pattern

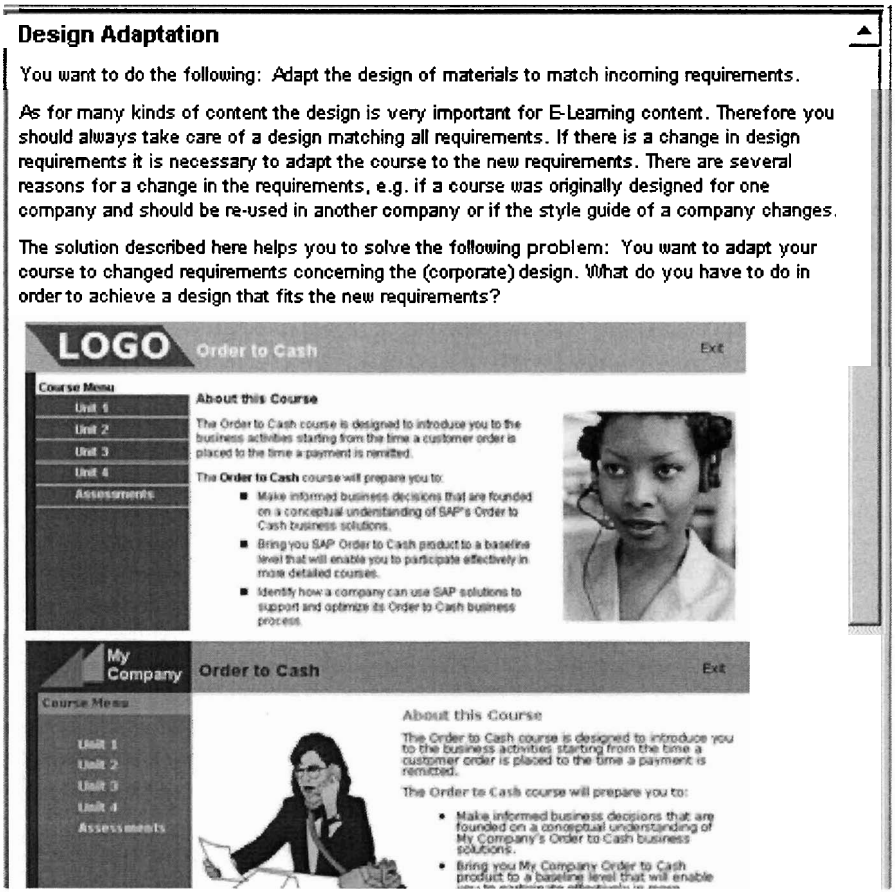

Figure 3: The design pattern

5 Summary and Outlook

The adaptation of existing E-Learning material to make it suited for changed requirements is an important prerequisite for the re-use of existing material. As this is a complex task it is desirable to provide the needed knowledge to non-experts who have to perform the task. In this paper an approach has been presented for collecting expert knowledge of adaptations with patterns. It has been shown how this knowledge has been collected and how it can help other persons in performing an adaptation.

With the approach presented here it is also possible to collect knowledge of other processes and to make it available to other persons, e.g. to all employees within a company. This offers an easy to use enhancement to existing knowledge management practices.

By now we are working on collecting knowledge on additional adaptations as well as knowledge of additional processes and making it available via patterns.

Furthermore we plan to improve the wizard guiding users through the processes by a component helping users to identify the adaptation suited for their requirements.

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References

[Alexander, 77] C. Alexander, et al.: A Pattern Language: Towns, Buildings, Construction. Oxford University Press, 1977.

[Buschmann, 96] F. Buschmann, et al.: Pattern-Oriented Software Architecture – A System of Patterns. Wiley and Sons, 1996.

[Meszaros, 96] G. Meszaros, J. Doble: A Pattern Language for Pattern Writing, 1996. http://www.hillside.net/patterns/writing/patterns.htm

[Duval, 03] E. Duval, W. Hodgins, A LOM research agenda. Published in Proceedings of the twelfth international conference on world wide web, 2003.

[Fowler, 96] M. Fowler: Analysis Patterns: Reusable Object Models. Addison-Wesley, 1996.

[Gamma, 95] E. Gamma, et al: Design Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley, 1995.

[Linstone, 02] H. Linstone, M. Turoff: The Delphi Method: Techniques and Applications, 2002. http://www.is.njit.edu/pubs/delphibook/

[Hörmann, 05] S. Hörmann et al.: ResourceCenter - A Digital Learning Object Repository with an Integrated Authoring Tool Set. In: Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2005, Montreal 2005; pp. 3453-3460.

[Obrenovic, 04] Z. Obrenovic, D. Starcevic, B. Selic: A Model-Driven Approach to Content Repurposing. IEEE MultiMedia, 11 (1), 2004; pp. 62-71.

[Schumacher, 05] M. Schumacher: Security Patterns - Integrating Security and Systems Engineering. John Wiley & Sons, 2005.

[Stash, 06] N. Stash, A. Cristea, P. De Bra: Adaptation to Learning Styles in E-Learning: Approach Evaluation. In Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2006; Chesapeake 2006; pp. 284-291.

[Zimmermann, 06a] B. Zimmermann, et al.: A Requirements Analysis of Adaptations of Re-Usable (ELearning) Content. In Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2006; Orlando 2006. S. 2096 – 2103.

[Zimmermann, 06b] B. Zimmermann, C. Rensing, R. Steinmetz: Formatübergreifende Anpassungen von elektronischen Lerninhalten. In Proceedings of DeLFI 2006: 4. e-Learning Fachtagung Informatik, 2006; Darmstadt 2006. pp. 15 – 26.

[Zimmermann, 06c] B. Zimmermann, C. Rensing, R. Steinmetz: Patterns for Tailoring E-Learning Materials to Make them Suited for Changed Requirements. In Proceedings of VikingPLoP 2006; Helsinore 2006.