Patterns for Tailoring E-Learning Materials to Make them Suited for Changed Requirements

Birgit Zimmermann, Christoph Rensing, Ralf Steinmetz

0   Introduction

Creating appropriate E-Learning material is a costly task. Re-use would help to lower those costs. But if you want to re-use existing material you need access to high quality material that can be re-used. By establishing a marketplace for high quality E-Learning materials the project Content Sharing (http://www.contentsharing.com) aims to solve the problem that often smaller companies have no access to such materials. This marketplace will make E-Learning materials available to all kinds of companies for use and re-use. But often the re-used materials do not completely fit to the new usage scenario. In those cases the materials have to be adapted to the changed requirements.

There exist lots of different kinds of such adaptations (e.g. adaptations to a changed corporate design, terminological adaptations, or content translation). This means that several aspects must be considered (layout, didactics, linguistics, technology). In addition various different formats are used (such as HTML, PPT or Flash), often within one course. Unfortunately, many authors do not have the knowledge to perform all the adaptations needed. Therefore a tool offering support to authors in performing E-Learning material adaptations would be useful.

To design such a tool, we analyzed which and how adaptations are done by experts [4]. We found that there are common ways how to do the adaptations. Some times adaptations can be done in an automated way (e.g. changing the design of a course). Some times it is hardly possible to offer a good automated support, as the adaptations are done based on human cognition and experiences (e.g. adaptation to a changed learning objective). But in all cases we found that there exist guidelines and best practices how those adaptations can be done. Therefore we decided to write a pattern language for the adaptation of E-Learning material.

In this paper we present a first version of solutions we have mined. We present them as five patterns that form a pattern language for E-Learning material adaptation. The aim of this language is to collect expert knowledge in performing single adaptation processes and to make it available to people who have to perform several adaptation processes. Those people have a certain basic knowledge that is needed to perform the adaptation processes. For example they may know how to change the size of an image. But they may not be experts in all the adaptation processes they have to execute.

Talking to experts we got a list of 15 adaptations (listed in table 1) performed by those experts. We also asked the experts to describe how they proceed in performing the adaptations. When analyzing the answers we got from the experts we found that adaptations cover three areas of changes:

- Changes in the *layout*,
- Changes in the *content*, and
- Changes with a more *technical background or purpose*

Each of the 15 adaptations belongs at least to one area. Adapting material to a changed design for example changes the layout of the material, changing the terminology changes the content. But some adaptations belong to several areas. For example the transformation into another format is mainly an adaptation with a technical background. But it also changes the layout, e.g. by resizing images that are not suited for the new format. With our pattern language we want to cover all areas of changes as all of them might be needed to make re-used material perfectly suited to changed requirements. The following table shows all adaptations and their assignment to the area of change they mainly belong to. The adaptations covered by the patterns in this paper are written in a bold font.

Layout	Content	Technical background or purpose
• **design** • **printability** • screen resolutions • accessibility	• **translation** • learning objective • terminology • degree of interaction • semantic density (see explanation below) • learning strategy • difficulty of the course • duration of the course	• transformation into several formats • end devices • bandwidths

Table 1: Areas of adaptations.

Explanation to semantic density: "The degree of conciseness of a learning object. The semantic density of a learning object may be estimated in terms of its size, span, or --in the case of self-timed resources such as audio or video- -duration." [IEEE Learning Technology Standards Committee: IEEE Standard for Learning Object Metadata 1484.12.1., 2002]

In addition we found that there exist certain connections between adaptations: Two adaptations *are connected* if the execution of the first adaptation probably leads to the execution of the second adaptation.

Example: If you change the semantic density of a course you should also check if you have to change the difficulty of this course. The connection can be very close or looser. E.g. the connection between semantic density and difficulty is close as a course with a high semantic density is normally more difficult then a course with a low semantic density. So changing one of those two items probably leads to a need for a change in the other one as well. Between design adaptation and terminology adaptation there is a loose connection. Design adaptations are often needed if one company decides to re-use the course of another company with a different corporate design. The companies might also have specific terminologies which results in a need to adapt the terminology.

The following figure shows the connections between the three adaptations that are described by the patterns in this paper. Each adaptation is described by one pattern which is named according to the adaptation. The arrows between two adaptations mean that if the first adaptation process is performed this probably leads to a need to perform the second process as well. The patterns describe how to perform the adaptations.
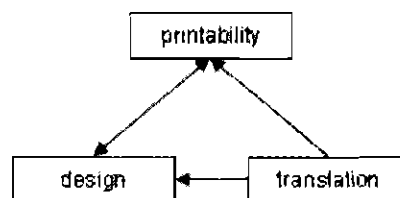

Figure 1: Connections between adaptations.

Our pattern language shows how to adapt E-Learning material to make it suitable for a new scenario of usage. There may be other pattern languages related to our language. like Ian Graham's "WU pattern language" [1] or Vogel and Zdun's pattern language for "Content Conversion and Generation on the Web" [3]. But up to now no pattern language for adapting existing E-Learning material to changed requirements exists.

There exist two kinds of patterns:

1. First we formulate 15 *adaptation patterns*, one pattern for each adaptation. Those patterns describe how to perform an adaptation. Whenever someone wants to adapt E-Learning material to make it suited for changed requirements he / she finds the description what to do in those patterns. (This paper contains three adaptation patterns: "Design Adaptations", "Printability" and "Translation".)

2. Second we formulate what we call *supporting patterns*. During the execution of an adaptation process there are typical problems you might run into. Those problems are described by supporting patterns. Several of those problems occur in more than one adaptation. For example there are many adaptations that replace parts of a text. The new text parts can have a different size than the old ones. If it is important that the new text parts keep the length it is necessary to correct the text parts that differ in their length. A description of how to solve this problem can be found in the supporting pattern "Correct length of text blocks". Therefore supporting patterns describe how to solve problems that typically occur during performing adaptations. ("Correct Length of Text Blocks" and "Correct Arrangement of Elements" are the supporting patterns described in this paper.)

Problems can also occur during the execution of a solution described in a supporting pattern. To solve the problems that come up here again supporting patterns are used. If a supporting pattern does not need any other patterns to support its execution we call this a final supporting pattern.

As stated before our target group is not the group of people being experts in performing one special adaptation (like a translator is expert in performing translations or a designer is expert in changing the design). We aim at those people who have to work with adaptations but are not experts in performing them. To understand our pattern language, only a basic knowledge in adapting E-Learning material is needed. But to adapt existing material in a useful way, persons who do adaptations should have knowledge in the topic the course covers.

1 Re-Using existing E-Learning Material *

Intent: Change existing E-Learning material to meet new requirements.

Context: Creating appropriate E-Learning material is a costly and time consuming task. One possibility to make the production of E-Learning material less expensive is to re-use existing material. This is particularly relevant for smaller companies that cannot afford to create custom material tailored to their particular needs. Re-using material can either mean that you take parts of an existing course, e.g. a good example, and add them to a new course. Or it also can mean that you re-use a whole course. However, re-using existing material is not enough since often the existing material does not completely fit the new usage scenario. As a result of this, the material has to be adapted to this new scenario.

Problem: You want to adapt existing E-Learning material to changed requirements. What do you have to do in order to achieve material that fits the new requirements?

Forces:
- You have to create new E-Learning material.
- You re-use a whole course or only parts of it, as they (at least partially) fit to your needs.
- The re-used course or the re-used parts do not completely match to the new scenario of usage. But it is cheaper to adapt them then to build them from scratch.

Solution: You start by defining your requirements. Then you decide which existing material best fits your needs. To achieve a 100% match between your requirements and the re-used material it might be necessary to adapt the existing resources to these requirements. How costly an adaptation is depends on the tools you have supporting you in performing the adaptation, and on the knowledge you have for this adaptation. You have to consider 15 possible adaptations:
- design: the (corporate) design of the material has to be changed
- printability: you need a version optimized for printing it
- screen resolutions: you need versions optimized for several screen resolutions
- accessibility: the material has to me made available to disabled persons
- translation: the material has to be translated into another language
- learning objective: the learning objective has slightly changed (if major changes should be done to the learning objective, you have to create new material)
- terminology: the terminology used in the material has changed
- degree of interaction: you want to change the degree of interaction
- semantic density: you have to adapt the material to a changed semantic density
- learning strategy: the material has to be adapted to a changed learning strategy
- difficulty of the course: The degree of difficulty of the material has to be changed
- duration of the course: the material should change its duration
- transformation into several formats: you need several file formats (e.g. PDF and HTML)

- end devices: users will access the material using different devices (PDA, note book,...)
- bandwidths: users download the material via different bandwidths. The material should be optimized to achieve the best possible download rates for several bandwidths

Known uses: This pattern is based on the experience of several people working in the area of E-Learning material production.

Consequences:
Positive:
- You save time and money.
- You get E-Learning material that completely fits your needs.

Negative:
- You have to do the adaptations.
- You have to take care not to forget an adaptation. Otherwise you would get material that is not really suited for your needs.

Related patterns: Not known

Connected Patterns:
- None

Used Patterns:
- You adapt E-Learning materials to changed requirements with adaptation patterns such as TRANSLATION (for different languages), DESIGN ADAPTATION (for different designs) and PRINTABILITY (to get a printable version).

2   Design Adaptation *

Intent: Adapt the design of materials to match incoming requirements.

Context: As for many kinds of content the design is very important for E-Learning content. Therefore you should always take care of a design matching all requirements. If there is a change in design requirements it is necessary to adapt the course to the new requirements. There are several reasons for a change in the requirements, e.g. if a course was originally designed for one company and should be re-used in another company or if the style guide of a company changes.

Problem: You want to adapt your course to changed requirements concerning the (corporate) design. What do you have to do in order to achieve a design that fits the new requirements?
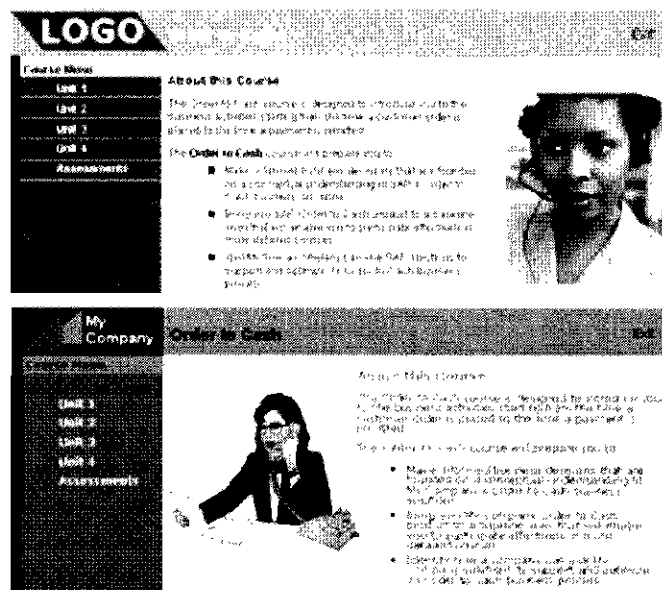

Figure 2: Example for a design adaptation.

Fig. 2 shows a course: First the original version, and then after adapting it to a changed corporate design.

Forces:
- E-Learning courses are normally designed by following a style guide. If this style guide changes for some reason the design of the course has to be adapted to the new guideline.
- The design normally consists of many items, like logos, background images and colors, fonts etc. To adapt the design all elements have to be considered.
- If a style template is used you can change this template (e.g. CSS for HTML or slide master for PPT).

- If no style template is used you have to change the design by changing element by element, page by page and file by file.

Solution: A design adaptation starts by replacing graphical elements that do not meet the requirements (e.g. logos). Therefore you decide for each graphical element if it is conform to your requirements. If it is not you replace it by a conform element. If the new graphical elements have a different size compared to the original ones it might be necessary to resize them. Depending on the file format of the materials the way how you replace the elements is different. E.g. in HTML you replace the target of the element's tag, whereas in DOC you delete the old element and insert a new one.

There might be some graphical elements that occur in places where no elements at all are allowed to occur. You should check for those elements and if you detect some you must delete them.

If you need additional graphical elements in places where no element is provided you have to add those elements. Keep in mind that this has effects on the arrangement of all elements. In the last step you rearrange all elements that are not placed correctly.

Style guides normally define rules how to design the whole layout. If the style guide changes you have to adapt the design accordingly.

If you want to use the course in another company it might be also necessary to change the company name. Be careful if the new name has a different length then the old one. This might has a negative effect on the look of the text blocks, where the name has been changed.

There is no strict order in executing the steps mentioned so far. However the order proposed here seems to be useful. The step "Rearranging text parts and images" should always be executed as the last step. When executing this step you should check that all elements are positioned correctly. All other steps might influence the arrangement of elements. E.g. if a logo is deleted instead of replacing it, this leads to a change in the arrangement of the other elements as well.

Steps needed to execute the solution:
1. Replacing graphical elements
2. Deleting graphical elements
3. Add additional graphical elements
4. Performing changes according to style guides
5. Changing company naming
6. Rearranging text parts and images

Known uses: This pattern is based on the experience of experts in branding and corporate design from several companies, e.g. SAP, as well as on our experiences in changing the design of E-Learning content.

Consequences:
Positive:
- The course is adapted to the required (corporate) design. This generates the required look and feel for this course.

Negative:
- In the rare cases where no style guide is available the adaptation is hard to execute and might be incomplete.

- If you have done adaptations that provide an additional version of the course for parallel use (like translation or printability) you should perform the design changes for these versions as well.

Related patterns: Not known

Connected Patterns:
- Terminology (Often the target group has changed if a layout change has to be executed. A change in the target group might also require an adaptation to a changed terminology.)
- Printability (If you have changed a version that is optimized for printing, you should check that none of your changes conflicts with printability.)

Used Patterns:
- "Correct arrangement of elements" used by "Rearranging text parts and images"
- "Correct length of text blocks" used by "Changing company naming"

3   Printability *

Intent: Printing E-Learning materials appropriately.

Context: Most E-Learning materials are designed to access them via a browser. Often materials are without any provision for printing them in a suitable way. For example, a course may allow a student to exercise an online test, but not to print the results. But often users want a printable version of the materials. As Ian Graham says: "Navigability and aesthetics conflict with printability..." [1]. Therefore you should provide two versions: the original one optimized for output on a screen, and a second, separate version that is optimized for printing. The user can then print the material if he / she wants to do so.

Problem: You want to provide a separate version of the material that is optimized for printing. How do you optimize the new version for printing?
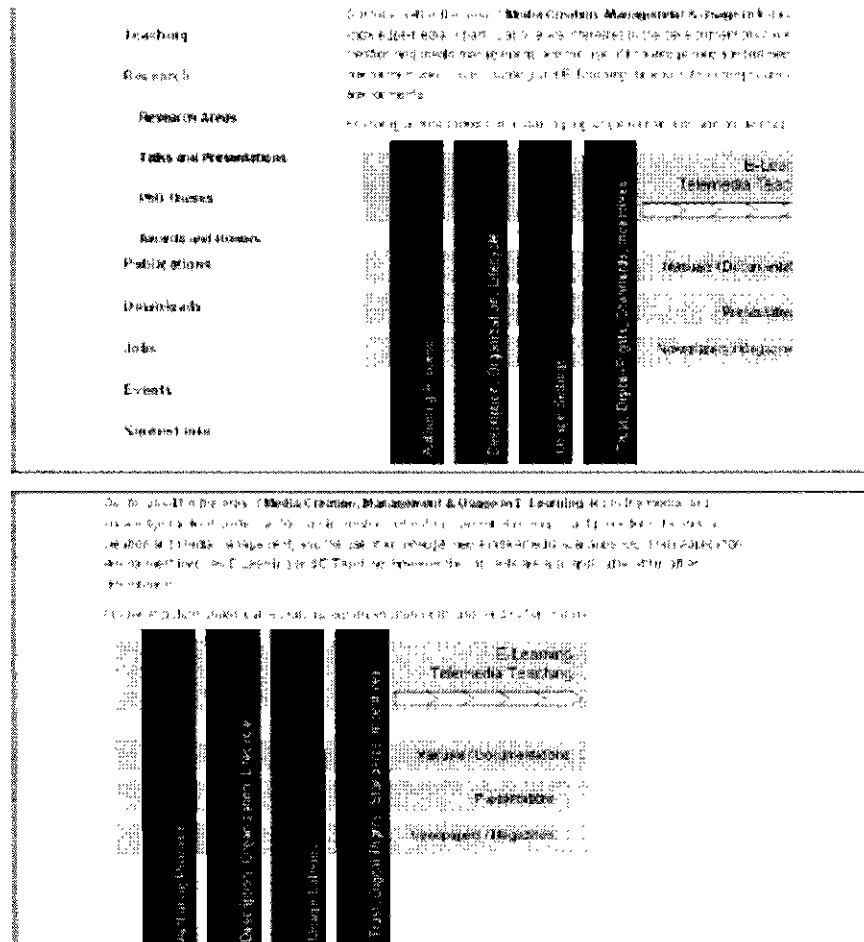

Figure 3: Example for a printability adaptation.

Fig. 3 shows how the research department KOM solved the printing problem. The first part of the image shows a small section of the print preview of a part of KOM's homepage. You can see that some elements on the right hand side are cut off. To overcome this problem KOM offers a second version of their website that is optimized for printing. This is demonstrated in the lower part of the figure. You can find the same problem and the nearly same solution in the area of E-Learning material.

Forces:

- Adaptation to achieve a good printability is not needed for all formats. Page based formats like PDF or DOC that have been created to be printed later on, do not need to be adapted.
- Your material is not optimized for printing, but for access e.g. via a web browser or a special player for E-Learning courses.
- When printing the material some elements might be cut off.
- Sometimes formatting data like CSS is available and can be used for optimization, sometimes this is not the case. But often it is not enough to "only" change this CSS file, you also have to take care for images if they are used.
- When printing some elements might be separated in a way that downgrades readability and understandability.
- You need a version optimized for printing in addition to the version optimized for viewing it on a computer screen.

Solution: In general you should create a new printer friendly version of your material. This means you have to create a second version of your material that is provided in addition to the original material. To achieve a good printability for this new version you have to resize all elements that cannot be separated in a way that they match with a printed page (e.g. images that are too big). You have to do the same for all elements that can be separated (e.g. text boxes or tables). You should remove all colors that cause negative effects when being printed (e.g. yellow font color, or white font on a black background). You should check for elements that contain important information but are not printed. Those elements should be added in a printable version as well. And you should correct all page breaks that reduce readability. The order of the steps is partly fixed (the first two steps and the next two steps belong together). It is useful to follow the order proposed here to achieve a good result.

Steps needed to execute the solution:
1. Detecting non separable elements (like images) not fitting to targeted page size
2. Matching non separable elements to targeted page size
3. Detecting separable elements (like tables) not fitting to targeted page size
4. Matching separable elements to targeted page size
5. Checking colors not suited for printing
6. Checking for elements that are not printed (like backgrounds)
7. Correcting page breaks

Known Uses: You find lots of examples where a separate version of a resource optimized for printing is provided, e.g. company homepages like the one of the company SAP mentioned above.

The problem of printer friendly versions is considered often in the hypermedia area. In this area other patterns were developed to solve this problem. E.g. Lyardet and Rossi [2] have written a pattern called "Printer Friendly" and Graham [1] wrote another pattern "Separate print pages". This pattern uses ideas from their work.

Consequences:
Positive:
- You have a version that is optimized for printing.
Negative:
- Having two versions, one optimized for viewing on a screen and one optimized for printing, causes more effort in keeping both versions current.
- If you have done adaptations that provide for additional versions of the course for parallel use (like translation) you should create a printable version of those versions as well.
- This adaptation provides a print version for each page, if you need a print version for the whole course you should additionally convert the course to a format suited for printer output (e.g. PDF).

Related patterns: "Printer Friendly", "Separate print pages"

Connected Patterns:
- Design Adaptation (If you match several elements to the targeted page size or correct page breaks, this might influence the arrangement of the elements in a way that is not conform to the design guide requirements.)

Used Patterns:
- "Correct arrangement of elements" used by "Matching non separable elements to targeted page size", "Matching separable elements to targeted page size ", and "Correcting page breaks"

4 Translation *

Also known as: Multilingual Content Production

Intent: Provide content in a different language.

Context: Normally E-Learning material is first designed in one language. If versions in another language are needed the original version has to be translated.

Problem: You want to translate E-Learning content from one language to another language. Which process has to be performed to achieve a translated version?
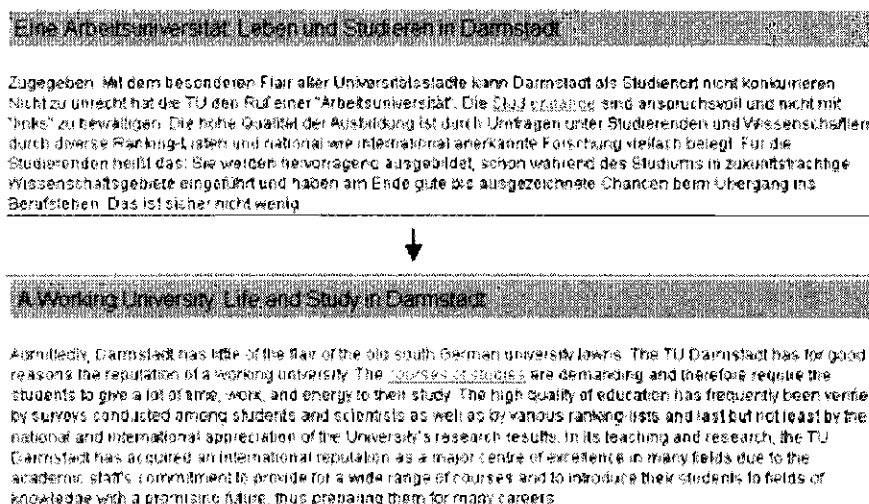

Figure 4: Example for multilingual content.

Fig. 4 shows the first paragraph of an introduction to the University of Darmstadt. The upper part shows the German version; the lower part shows the translated English version.

Forces:
- Your content is provided in a language that is not understood by your target group.
- To provide a version understandable to your target group you need to translate the material.
- You know in which source languages the content is written and to which target language it should be translated.
- You need to know whether only parts of the course or the whole course has to be translated.

Solution: To create a translated version you have to provide the content to the translator. Caution: You should always provide as much information to the translating person as possible. This allows for a better quality of the translation. (If for example the translator has only a few sentences to translate but not the whole text he or she probably may have difficulties to understand the correct meaning of the sentences depending on the context.) In addition you should make available domain specific information to the translator. In most domains a specific terminology is used that has to be regarded during translating the content.

The translator translates the content. If the length of the text is important it has to be checked during translation that the translated text stays within the allowed length. This means that you have to provide the information if the text size matters to the translator. If the text size is of importance the translator also needs information about the allowed text size and possibilities how to correct the size, e.g. if certain abbreviations have to be used. Based on this information the translator then has to check and if necessary correct the length of the text. If only parts of the material have been translated you or the translator have / has to add or to replace those parts. (Adding might be necessary if you want to keep the original part, e.g. a definition, and want to add the translation.) After adding or replacing the translated elements you or the translator should check if the arrangement of the elements is still according to your requirements. (This is not necessary if you replaced text parts by new texts with the same length.) The order of the steps needed for translation is fixed. This means that you should execute the process in the order as it is described here to achieve an optimal result.

Steps needed to execute the solution:
1. Making elements that need to be translated available for translation
2. Translating content
3. Checking for correct length of text
4. Resizing texts with a wrong length
5. Adding translated elements
6. Replacing translated elements
7. Re-arranging elements that do not fit the requirements

Known uses: We talked to people in several companies, e.g. SAP, providing E-Learning materials in several languages. In addition we talked to several translators. We found that the solution described above is accepted as best practice.

Consequences:
Positive:
- The translated text elements are now available in the desired language.
- If you decide that the length of the text in both versions is not important you have no problems with texts being too long or too short.

Negative:
- If the length of the text is not important you have two different versions with respect to the layout of the course.

- If the length of the text is important the translator has to take care of formulations that match the length of the original text. This might cause many abbreviations or formulations that have slightly different meaning then the original text. In addition the readability might be decreased by many abbreviations.
- Providing a translated version of your course causes a higher maintenance effort as later changes in the original course also have to be translated.
- You have to translate each parallel version of your course (e.g. a print optimized version) as well.

Related patterns: Not known

Connected Patterns:
- Printability (After translation of material that has been optimized for printing a further optimization for printing may be necessary.)

Used Patterns:
- "Correct length of text blocks" used by "Resizing texts with a wrong length"
- "Correct arrangement of elements" used by "Re-arranging elements that do not fit the requirements"

Remark: At the moment only a few supporting patterns are available, but translation needs lots of supporting patterns as it is a complicated task. This will be taken into account in future versions of this pattern language

5   Correct Arrangement of Elements

Intent: Get a correct arrangement of the elements contained in your course.

Context: There are several adaptations that change the arrangement of course elements, like text blocks or images. In some cases you need to re-arrange the elements.

Problem: You have to change the arrangement of some elements in order that it fits to your requirements. How can you execute the re-arrangement?
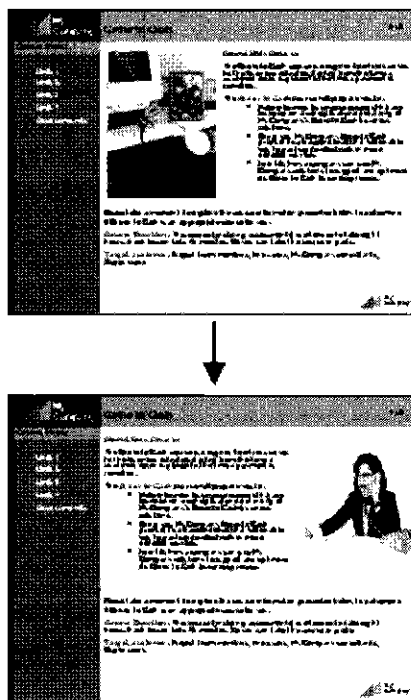

Figure 5: Example for re-arranging elements.

Fig. 5 shows a course page where a photograph has been replaced by an image. In addition the image had to be placed on the right hand side of the page. This made a re-arrangement necessary.

Forces:
- The arrangement of some elements in your material has changed for some reason (e.g. deletion or insertion of graphical or textual elements or replacement by other elements with a different size).
- The new arrangement does not comply with your requirements, e.g. given by a company style guide.

- The guidelines concerning the arrangement of course elements have changed and you have to adapt the material to the new requirements.
- Or the requirements how to arrange elements have changed.
- You must re-arrange the elements to achieve an arrangement compliant with the requirements.

Solution: You have to re-arrange the elements in a way that they comply with the requirements, e.g. given in a company style guide. There are several reasons why the arrangement of the elements is not correct (see forces).

If the arrangement has changed because you have replaced an element you can try to change the size of the new element. If for some reason (e.g. loss of quality) this is not possible or if you have added or deleted an element you can try to resize the surrounding elements. If you resize elements you should always take care not to decrease the quality.

If you cannot resize the elements or if the requirements on the arrangement of elements have changed you have to rearrange the elements. This means that you have to check how the elements can be arranged to achieve a result that supports a good readability and understandability and that complies with the requirements.

Known uses: This pattern is based on our own experiences with changing the arrangement of elements in E-Learning courses and on company guidelines describing the arrangement of elements in different formats.

Consequences:
Positive:
- The elements are arranged correctly.
Negative:
- Depending on a potential resizing of elements their quality might have decreased.
- The new arrangement might be not as good as the original one, but at least it should be better than before the re-arrangement.

Related patterns: Not known

Used Patterns: None

6 Correct Length of Text Blocks *

Intent: Get a correct length of the text parts contained in your course.

Context: There are several adaptations where you replace text parts by new text parts, e.g. changing a companies name, changing the terminology or translating content. If the new text element has to keep the length of the original element you have to change the new text element in a way that it gets the correct length.

Problem: You have to correct the length of text parts. How can you execute the correction?

When you remove a favorite from your favorites list, you are not actually deleting the respective file, program, or transaction; you are merely removing a link to that particular item.

↓

Wenn Sie einen Eintrag aus Ihrer Favoritenliste löschen, löschen Sie nicht die entsprechende Datei, das entsprechende Programm oder die entsprechende Transaktion; Sie entfernen lediglich den Verweis auf das jeweilige Element.

↓

Wenn Sie einen Eintrag aus Ihrer Favoritenliste löschen, löschen Sie nicht die entsprechende Datei oder Transaktion bzw. das entsprechende Programm, sondern nur den Verweis darauf.

Figure 6: Example for a corrected text length.

Fig. 6 is split into three parts. The first part shows a piece of the original text from an English manual. The second part shows the direct translation to German. The third part is the corrected version of the German text. (In this case the length of the corrected version is very similar but not completely identical with the length of the English version.)

Forces:
- Your material contains text boxes that changed their length for some reason, e.g. because of changing a companies name, changing the terminology or translating content.
- The new length of the text boxes does not comply with the length required for those text boxes, e.g. if the text has to fit into a speech bubble.
- To change the size of the text box it is not enough to resize it e.g. by changing the font size. You must change its length.

Solution: If you want to correct the length of a text box you have to change the content. There are two possibilities regarding the length: Your new text is too long or too short. Texts, that are too long, have to be shortened and texts, that are too short, have to be lengthened.

To shorten a text you can try to find abbreviations. (Caution: Do not use too many abbreviations. This has a negative impact on readability and understandability.) In addition you can try to find synonyms that are shorter (e.g. "to make longer" – "lengthen"). If you use synonyms you must be careful that you do not change the meaning. You can also try to find phrasings that are shorter (see Fig. 6).

To lengthen a text you have the same possibilities: You can write out all abbreviations, you can try to find longer synonyms and you can try to find longer phrasings.

Known uses: This pattern is based on our own experiences as well as on the experiences of several other people working with text, like translators.

Consequences:
   Positive:
   - The changed text now has the correct length.
   Negative:
   - Depending on how you changed the length the quality of the text might have decreased.
   - The text might have a slightly different meaning.
   - If you use many abbreviations the readability of the corrected text might be not as good as it was before.

Related patterns: Not known

Used Patterns: None

7 Acknowledgements

Contact Information:

Birgit Zimmermann[1,2], Christoph Rensing[2], Ralf Steinmetz[2]

[1] SAP AG
SAP Research CEC Darmstadt
Bleichstr. 8, 64283 Darmstadt, Germany
birgit.zimmermann@sap.com

[2] KOM Multimedia Communications Lab
Technische Universität Darmstadt
Merckstr. 25, 64283 Darmstadt, Germany
{birgit.zimmermann, christoph.rensing, ralf.steinmetz}@kom.tu-darmstadt.de

For further questions and remarks please contact Birgit Zimmermann.

References

[1] Graham, I.: A Pattern Language for Web Usability. Addison Wesley, 2003

[2] Lyardet, F., Rossi, G.: Web Usability Patterns. In: Proceeding of EuroPLoP 2001

[3] Vogel, O., Zdun, U: Content Conversion and Generation on the Web: A Pattern Language, Published on EuroPLoP 2002

[4] Zimmermann, B., Bergsträßer, S., Rensing, C., Steinmetz, R.: A Requirements Analysis of Adaptations of Re-Usable (E-Learning) Content. Published in: Proceedings of EdMedia 2006

E-Learning Content Adaptation Patterns

Birgit Zimmermann[1,2], Christoph Rensing[2]. Ralf Steinmetz[2]

[1] SAP AG
SAP Research CEC Darmstadt
Bleichstr. 8, 64283 Darmstadt, Germany
birgit.zimmermann@sap.com

[2] KOM Multimedia Communications Lab
Technische Universität Darmstadt
Merckstr. 25, 64283 Darmstadt, Germany
{birgit.zimmcrmann, christoph.rensing, ralf.steinmetz} @kom.tu-darmstadt.de

Abstract: Creating appropriate E-Learning content is difficult and expensive. Therefore, a re-use of this content would be desirable. However, this is non-trivial, as content is usually context specific. When content is re-used in a new context, it often does not fit the needs of the new usage scenario. Hence, an adaptation to the new scenario of usage is needed.
In this paper we present a fragment of a pattern language for E-Learning content adaptation. These patterns focus on how the adaptation process to E-Learning content can be executed. We first give an overview on E-Learning content adaptations. Then we introduce our patterns.

1   Introduction

Creating appropriate E-Learning content is a costly and time consuming task. One possibility to make the production of E-Learning content less expensive is to improve the re-use of existing content. This is particularly relevant for smaller companies that cannot afford to create custom content tailored to their particular needs. In addition, they often have no access to high quality E-Learning content.

The project Content Sharing [Co06] aims to solve this problem by establishing a marketplace for high quality E-Learning content. This marketplace will make content available to all kinds of companies. Customers could then download the content provided on the marketplace and use it for their purposes. However, this is not enough since often the content does not completely fit the new scenario of usage. As a result of this, the content has to be adapted to this new scenario.

There exist lots of different kinds of adaptations (e.g. adaptations to a changed corporate design, terminological adaptations, or content translation). This means that several aspects have to be considered (layout, didactics, linguistics, technology). In addition various different formats are used (such as HTML, PPT or Flash), often within one course. Unfortunately, many authors do not have the knowledge to perform all the adaptations needed. Therefore a tool offering support to authors in performing E-Learning content adaptations would be useful.

In order to design such a tool, we analyzed which and how adaptations are done by experts [Zi06]. We found that there are common ways how to do the adaptations. Some times adaptations can be done in an automated way (e.g. changing the design of a course). Some times it is not possible to offer a good automated support, as the adaptations are done based on human cognition and experiences (e.g. adaptation to a changed learning objective). But in all cases we found that there exist guidelines and best practices how those adaptations can be done. Therefore we decided to write a pattern language for the adaptation of E-Learning content.

In this paper we present five patterns that are part of a first version of a pattern language for E-Learning content adaptation describing the existing solutions we are mining. Our pattern language documents successful solutions in the area of E-Learning content adaptation. Aim of this language is to collect the knowledge of experts in performing single adaptation processes and to make it available to people who have to perform several adaptation processes. Those people have a certain basic knowledge that is needed to perform the adaptation processes. For example they know how to change the size of an image. But they are not experts in all the adaptation processes they have to execute.

2   E-Learning Content Adaptations

As stated before, we have carried out a user survey [Zi06] to find out which adaptations are done by the experts of different companies. As a result of this survey, we got the following list of 15 adaptations:

Adaptation to...
1) translation
2) (corporate) design
3) learning objective
4) transformation into several formats (HTML, PDF, ...)
5) printability
6) terminology
7) degree of interaction (of the course participants)
8) semantic density
9) learning strategy of the course participants
10) difficulty of the course
11) screen resolutions
12) duration of the course
13) accessibility
14) end devices (PC, PDA, mobile...)
15) bandwidths (modem, ISDN, DSL ...)

We also asked the experts to describe how they proceed in performing the adaptations. The analysis of the descriptions given by the experts showed that there are three major groups of adaptations:

- Changes in the *layout*,
- Changes in the *content*, and
- Changes with a more *technical background or purpose*

Each adaptation belongs to at least one of those groups. But some adaptations partly belong to other groups as well. For example the transformation into another format is mainly an adaptation with a technical background. But it also contains parts of a layout adaptation, like resizing images that are not suited for the new format. The following table shows all adaptations and their assignment to the group they mainly belong to.

Layout	Content	Technical background or purpose
• (corporate) 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

Table I: Groups of adaptations

In addition we found that there exist certain connections between adaptations: Two adaptations *are connected* if the execution of the first adaptation probably leads to the execution of the second adaptation.

Example: If you change the semantic density of a course you should also check if you have to change the difficulty of this course. The connection can be very close or more loose, e.g. the connection between semantic density and difficulty is close as a course with a high semantic density is always more difficult then a course with a low semantic density. So changing one of those two items probably leads to a need for a change in the other one as well. Between (corporate) design and terminology adaptation there is a loose connection. Design adaptations are often needed if one company decides to re-use the course of another company with a different corporate design. This company might also have a specific terminology which results in a need to adapt the terminology.

The following figure shows the connections between three adaptations described by the patterns in this paper. The arrows between two adaptations mean that if the first adaptation process is performed this probably leads to a need to perform the second process as well.
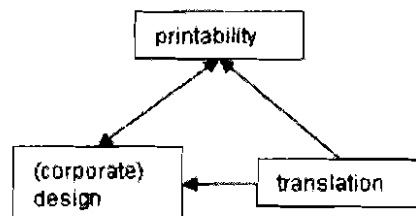

Figure 1: Connections between adaptations

2.1 A Pattern Language for E-Learning Content Adaptation

Our pattern language shows how to adapt E-Learning content to make it suitable for a new scenario of usage. We decided to split our pattern language into two levels of patterns:

1. On the first level we formulate 15 *adaptation patterns*, one pattern for each adaptation. Those patterns describe how to perform an adaptation.

2. On the second level we formulate what we call *supporting patterns*. Each adaptation is a kind of a process that consists of several steps that can or have to be done to execute the adaptation. We call these steps *process fragments*. Supporting patterns describe how to solve problems that often occur when the process fragments are executed. Those problems normally occur in more then one process fragment. For example there are many process fragments that replace parts of a text. The new text parts can have a different size than the old ones. If it is important that the new text parts keep the length it is necessary to correct the text parts that differ in their length. A description of how to solve this problem can be found in the supporting pattern "Correct length of text blocks".

Problems can also occur during the execution of a solution described in a supporting pattern. To solve the problems that come up here again supporting patterns are used. If a supporting pattern does not need any other patterns to support its execution we call this a final supporting pattern.

As stated before our target group is not the group of people being experts in performing one special adaptation (like a translator is expert in performing translations or a designer is expert in changing the design). We aim at those people who have to work with adaptations but are not experts in performing them. To understand our pattern language, only a basic knowledge in working with (E-Learning) content is needed.

In chapter 3 we present three adaptation patterns, in chapter 4 we present two supporting patterns.

2.2 How to Use this Language?

As described in the previous chapter our pattern language consist of two parts: Adaptation patterns and supporting patterns. If you want to perform an adaptation you first search for the pattern describing the adaptation you have to perform.

During performing an adaptation process it might occur that you run into additional problems. Then you have a look into the supporting patterns. Here you find solutions to problems that can occur during performing an adaptation process.

2.3 Notation Formalism

In contrast to Fowler's analysis patterns [Fo97] we decided to use a fixed format of notation for our patterns. A fixed format allows for better readability and makes the patterns easier to understand. Our format is based on the GOF pattern format [Ga95] as well as on the POSA format [Bu96].

Each pattern is addressed by its name. The name is followed by a **classification** indicating the degree of confidence of the pattern. This classification is based on Alexander's pattern format [Al77]. It uses asterisks to indicate the confidence. Three asterisks stand for the highest degree of confidence. This means that the pattern has been used successfully in several situations. No asterisk means the lowest degree of confidence. These patterns are first ideas based on talks to experts and own experiences but still have to be evaluated in practical use. Our patterns are a first approach to a pattern language for the adaptation of E-Learning content. Therefore the patterns are classified with zero or one asterisks. We want these patterns as a basis for further discussion and improvement.

In addition to the section "Related patterns", which address related patterns from other authors, we added two new sections: **Connected patterns** and **used patterns**. Connected patterns name all adaptation patterns that are connected to the actual adaptation pattern. Used patterns enumerate the supporting patterns that are used during the execution of the solution. (As not all supporting patterns exist up to now, we only name the supporting patterns described in this paper.)

The number in front of a pattern is only for a better readability in this paper. It has no meaning to the pattern itself.

3 Adaptation Patterns

3.1 Design Adaptation *

Intent: Adapt content design to match incoming requirements.

Context: As for many kinds of content the design is very important for E-Learning content. Therefore you should always take care of a design matching all requirements. If there is a change in design requirements it is necessary to adapt the course to the new requirements. There are several reasons for a change in the requirements, e.g. if a course was originally designed for one company and should be re-used in another company or if the style guide of a company changes.

Problem: You want to adapt your course to changed requirements concerning the (corporate) design. What do you have to do in order to achieve a design that fits the new requirements?
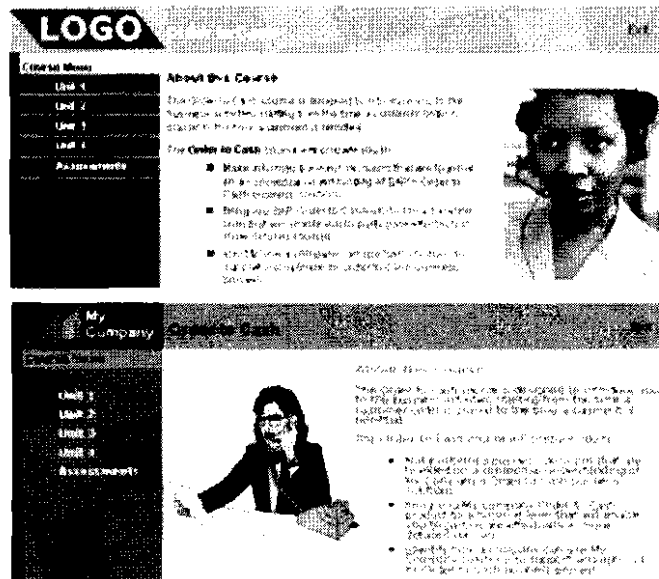
Figure 2: Example for a design adaptation

Fig. 2 shows a course: First with its original design, then after adapting it to a changed corporate design.

Forces:

- E-Learning courses are normally designed by following a certain style guide. If this style guide changes for some reason the design of the course has to be adapted to the new guideline.
- The design normally consists of many items, like logos, background images and colors, fonts etc. To adapt the design all elements have to be considered.
- If a style template is used you can change this template (e.g. CSS for HTML or slide master for PPT).
- If no style template is used you have to change the design by changing element by element, page by page and file by file.

Solution: A design adaptation starts by replacing graphical elements that do not meet the requirements (e.g. logos). If the new graphical elements have a different size compared to the original ones it might be necessary to resize them. Some graphical elements might occur in places where no elements at all are allowed to occur. Those elements have to be deleted. Style guides normally define rules how to design the whole layout. If the style guide changes you have to adapt the content accordingly. If you want to use the course in another company it might be necessary to change the company name. There is no strict order in executing the steps mentioned so far. However the order proposed here seems to be useful. The step "Rearranging text parts and images" should always be executed as the last step. When executing this step you should check that all elements are positioned correctly. All other steps might influence the arrangement of elements. E.g. if a logo is deleted instead of replacing it, this leads to a change in the arrangement of the other elements as well.

Steps needed to execute the solution:
1. Replacing graphical elements
2. Deleting graphical elements

3. Performing changes according to style guides
4. Changing company naming
5. Rearranging text parts and images

Known uses: This pattern is based on the experience of experts in branding and corporate design from several companies, e.g. SAP, as well as on our experiences in changing the design of E-Learning content.

Consequences:
Positive:
- The course is adapted to the required (corporate) design. This generates the required look and feel for this course.

Negative:
- If no style guide is available the adaptation is hard to execute and might be incomplete.
- If you have done adaptations that provide an additional version of the course for parallel use (like translation or printability) you should perform the design changes for these versions as well.

Related patterns: Not known

Connected Patterns:
- Terminology (Often the target group has changed if a layout change has to be executed. A change in the target group might also require an adaptation to a changed terminology.)
- Printability (If you have changed a version that is optimized for printing, you should check that none of your changes conflicts with printability.)

Used Patterns:
- "Correct arrangement of elements" used by "Rearranging text parts and images"
- "Correct length of text blocks" used by "Changing company naming"

3.2 Printability *

Intent: Printing E-Learning content materials appropriately.

Context: Mostly E-Learning content is designed multimedia-based, e.g. to allow online tests but not for printing it. But often users want a printable version of the content. As Ian Graham says: "Navigability and aesthetics conflict with printability..." [Gr03]. Therefore you have to create a separate version that is optimized for printing.

Problem: You want to provide a separate version of the content that is optimized for printing. How do you optimize the new version for printing?
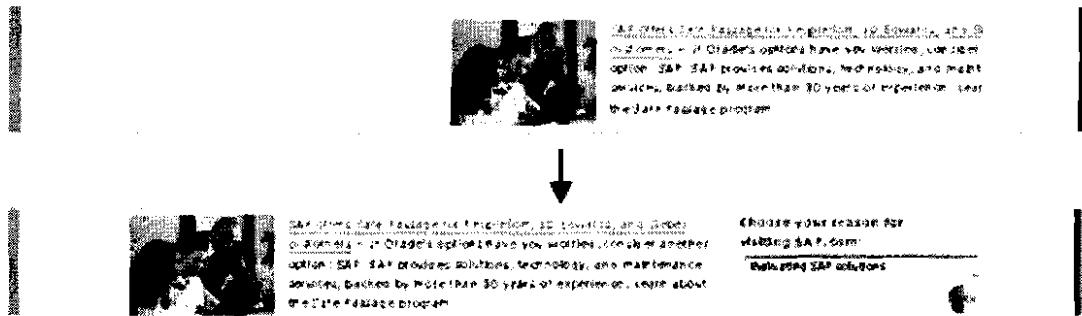
Figure 3: Example for a printability adaptation

Fig. 3 shows how SAP solved a printing problem. The first part of the image shows a small section of the print preview of SAP's homepage. You can see that some elements on the right hand side are cut off. To overcome this problem SAP offers a second version of their website that is optimized for printing. This is demonstrated in the lower part of the figure. You can find the same problem and the same solution in the area of E-Learning content.

Forces:
- Adaptation to achieve a good printability is not needed for all formats. Page based formats like PDF or DOC that have been created to be printed later on, do not need to be adapted.
- Your content is not optimized for printing, but for access e.g. via a web browser or a special player like a SCORM player.
- When printing the content some elements might be cut off.
- When printing some elements might be separated in a way that downgrades readability und understandability.
- You need a version optimized for printing.

Solution: In general you should create a new printer friendly version of your content. This means you have to create a second version of your content. To achieve a good printability for this new version you have to resize all elements that cannot be separated in a way that they match with a printed page (e.g. images that are too big). You have to do the same for all elements that can be separated (e.g. text boxes or tables). You should remove all colors that cause negative effects when being printed (e.g. yellow font color, or white font on a black background). You should check for elements that contain important information but are not printed. Those elements should be added in a printable version as well. And you should correct all page breaks that reduce readability. The order of the steps is partly fixed (the first two steps and the next two steps belong together). It is useful to follow the order proposed here to achieve a good result.

Steps needed to execute the solution:
1. Detecting non separable elements not fitting to targeted page size
2. Matching non separable elements to targeted page size
3. Detecting separable elements not fitting to targeted page size
4. Matching separable elements to targeted page size
5. Checking colors
6. Checking for elements that are not printed
7. Correcting page breaks

Known Uses: You find lots of examples where content is provided in a separate version for printing, e.g. company homepages like the one of the company SAP mentioned above.

The problem of printer friendly versions of content is considered often in the hypermedia area. In this area other patterns were developed to solve this problem. E.g. Lyardet and Rossi [LR01] have written a pattern called "Printer Friendly" and Graham [Gr03] wrote another pattern "Separate print pages". This pattern uses some ideas from their work.

Consequences:
Positive:
- You have a version that is optimized for printing.

Negative:
- Having two versions, one optimized for viewing on a screen and one optimized for printing, causes more effort in keeping both versions actual.
- If you have done adaptations that provide for additional versions of the course for parallel use (like translation) you should create a printable version of those versions as well.

Related patterns: "Printer Friendly" [LR01], "Separate print pages" [Gr03]

Connected Patterns:
- Design Adaptation (If you match several elements to the targeted page size or correct page breaks, this might influence the arrangement of the elements in a way that is not conform to the design guide requirements.)

Used Patterns:
- "Correct arrangement of elements" used by "Matching non separable elements to targeted page size", "Matching separable elements to targeted page size ", and "Correcting page breaks"

3.3 Translation *

Also known as: Multilingual Content Production

Intent: Provide content in a different language.

Context: Normally E-Learning content is first designed in one language. If versions in another language are needed the original version has to be translated.

Problem: You want to translate E-Learning content from one language to another language. How do you proceed?
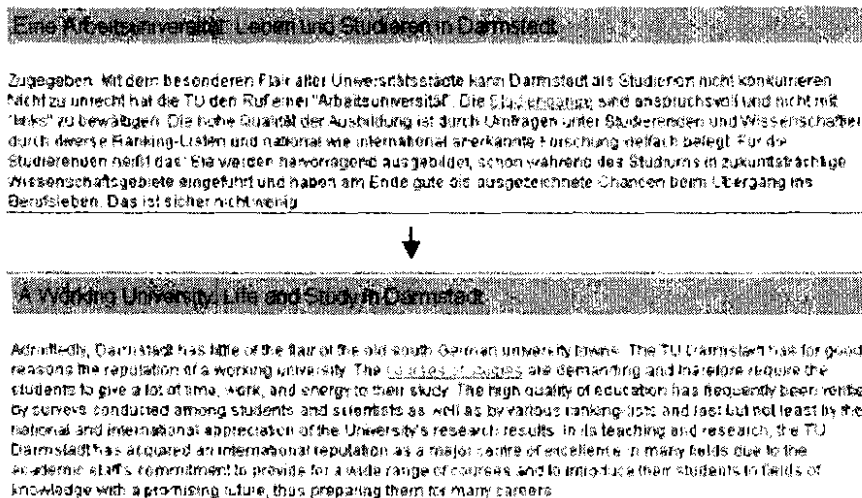
Figure 4: Example for multilingual content

Fig. 4 shows the first paragraph of an introduction to the University of Darmstadt. The upper part shows the German version; the lower part shows the translated English version.

Forces:

- Your content is provided in a language that is not understood by your target group.
- To provide a version understandable to your target group you need to translate the content.
- You know the source and the target language.
- You need to know whether only parts of the course or the whole course has to be translated.

Solution: To create a translated version you have to provide the content to the translator. Caution: You should always provide as much information to the translating person as possible. This allows for a better quality of the translation. (If for example the translator has only a few sentences to translate but not the whole text he or she probably may have difficulties to understand the correct meaning of the sentences depending on the context.) If the length of the text is important it has to be checked during translation that the translated text stays within the allowed length. If only parts have been translated you have to add or to replace those parts. After adding or replacing the translated elements you should check if the arrangement of the elements is still according to your requirements. (This is not necessary if you replaced text parts by new texts with the same length.) The order of the steps needed for translation is fixed.

Steps needed to execute the solution:
1. Making elements that need to be translated available for translation
2. Translating content
3. Checking for correct length of text
4. Resizing texts with a wrong length
5. Adding translated elements
6. Replacing translated elements
7. Re-arranging elements that do not fit the requirements

Known uses: We talked to people in several companies, e.g. SAP, providing E-Learning content in several languages. In addition we talked to several translators. We found that the solution described above is accepted as best practice.

Consequences:

Positive:

- The translated text elements are now available in the desired language.
- If you decide that the length of the text in both versions is not important you have no problems with texts being too long or too short.

Negative:

- If the length of the text is not important you have two different versions with respect to the layout of the course.
- If the length of the text is important the translator has to take care of formulations that match the length of the original text. This might cause many abbreviations or formulations that have slightly different meaning then the original text.
- Providing a translated version of your content causes a higher maintenance effort as later changes in the original content also have to be translated.
- You have to translate each parallel version of your course (e.g. a print optimized version) as well.

Related patterns: Not known

Connected Patterns:

- Printability (After translation of content that has been optimized for printing a further optimization for printing may be necessary.)

Used Patterns:

- "Correct length of text blocks" used by "Resizing texts with a wrong length"
- "Correct Arrangement of Elements" used by "Re-arranging elements that do not fit the requirements"

4   Supporting Patterns

4.1   Correct Arrangement of Elements

Intent: Get a correct arrangement of the elements contained in your course.

Context: When you execute an adaptation process it might be necessary that you change or delete some elements (graphical or textual). For example you change the company name or you delete occurrences of an old logo or replace them by a new logo. Deleting an element or replacing it by an element with a different size can cause a changed arrangement of the elements. If this new arrangement does not fit your requirements you have to re-arrange the elements. Or your requirements concerning the arrangement of elements have changed. This also leads to a need of a re-arrangement.

Problem: You have to change the arrangement of some elements in order that it fits to your requirements. How can you execute the re-arrangement?
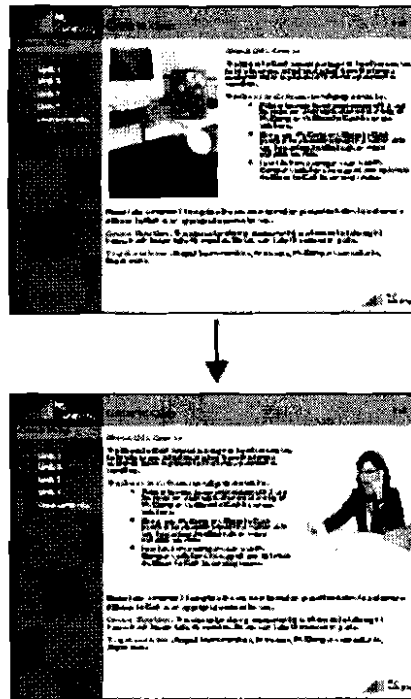
Figure 5: Example for re-arranging elements

Fig.5 shows a course page where a photograph has been replaced by an image. In addition the image had to be placed on the right hand side of the page. This made a re-arrangement necessary.

Forces:

- The arrangement of some elements in your content has changed for some reason (e.g. deletion or insertion of an element or replacement by an element with a different size).
- The new arrangement does not comply with the requirements.
- Or the requirements how to arrange elements have changed.
- You must rearrange the elements to achieve an arrangement compliant with the requirements.

Solution: You have to re-arrange the elements in a way that they comply with the requirements. There are several reasons why the arrangement of the elements is not correct (see forces).

If the arrangement has changed because you have replaced an element you can try to change the size of the new element. If for some reason (e.g. loss of quality) this is not possible or if you have added or deleted an element you can try to resize the surrounding elements. If you resize elements you should always take care not to decrease the quality.

If you cannot resize the elements or if the requirements on the arrangement of elements have changed you have to rearrange the elements. This means that you have to check how the elements can be arranged to achieve a result that supports a good readability and understandability and that complies with the requirements.

Known uses: This pattern is based on our own experiences with changing the arrangement of elements in E-Learning courses.

Consequences:
    Positive:
- The elements are arranged correctly.

    Negative:
- Depending on a potential resizing of elements their quality might have decreased.
- The new arrangement might be not as good as the original one, but at least it should be better than before the re-arrangement.

Related patterns: Not known

Used Patterns: None

4.2 Correct Length of Text Blocks *

Intent: Get a correct length of the text parts contained in your course.

Context: There are several adaptations where you replace text parts by new text parts, e.g. changing a companies name, changing the terminology or translating content. In all these cases it might occur that the new text parts have a length different from then the original ones. If it is important that the text parts do not change their length you have to correct the text parts in a way that the new length is equal to the original length.

Problem: You have to correct the length of text parts. How can you execute the correction?

When you remove a favorite from your favorites list, you are not actually deleting the respective file, program, or transaction; you are merely removing a link to that particular item.

↓

Wenn Sie einen Eintrag aus Ihrer Favoritenliste löschen, löschen Sie nicht die entsprechende Datei, das entsprechende Programm oder die entsprechende Transaktion; Sie entfernen lediglich den Verweis auf das jeweilige Element.

↓

Wenn Sie einen Eintrag aus Ihrer Favoritenliste löschen, löschen Sie nicht die entsprechende Datei oder Transaktion bzw. das entsprechende Programm, sondern nur den Verweis darauf.

Figure 6: Example for a corrected text length

Fig.6 is split into three parts. The first part shows a piece of the original text from an English manual. The second part shows the direct translation to German. The third part is the corrected version of the German text. (In this case the length of the corrected version is very similar but not completely identical with the length of the English version.)

Forces:
- Your content contains text boxes that changed their length for some reason.
- The new length of the text boxes does not comply with the length required for those text boxes.
- To change the size of the text box it is not enough to resize it e.g. by changing the font size. You must change its length.

Solution: If you want to correct the length of a text box you have to change the content. There are two possibilities regarding the length: Your new text is too long or too short. Texts, that are too long, have to be shortened and texts, that are too short, have to be lengthened.

To shorten a text you can try to find abbreviations. (Caution: Do not use too many abbreviations. This has a negative impact on readability and understandability.) In addition you can try to find synonyms that are shorter (e.g. "to make longer" - "lengthen"). If you use synonyms you must be careful that you do not change the meaning. You can also try to find phrasings that are shorter (see Fig. 6).

To lengthen a text you have the same possibilities: You can write out all abbreviations, you can try to find longer synonyms and you can try to find longer phrasings.

Known uses: This pattern is based on our own experiences as well as on the experiences of several other people working with content, like translators.

Consequences:
Positive:
- The changed text now has the correct length.
Negative:
- Depending on how you changed the length the quality of the text might have decreased.
- The text might have a slightly different meaning.
- If you use many abbreviations the readability of the corrected text might be not as good as it was before.

Related patterns: Not known

Used Patterns: None

5 Conclusion and Future Work

Creating appropriate E-Learning content is often not affordable to companies that would like to use E-Learning content. To those companies re-using existing content would be a cheaper solution. However often this fails as content has to be adapted to the specific usage scenario of the company before they can use it. It would be desirable if one person could perform all the adaptations without needing experts for each single adaptation. But this means that the adaptations are performed by persons with a basic but not an expert knowledge in executing all the adaptations.

To support those people we started developing a pattern language, which provides expert knowledge on the different kind of adaptations and helps people to execute the adaptation processes.

The language is divided into two parts: Adaptation patterns and supporting patterns. The former describe how an adaptation process as a whole should be executed. The latter help to solve problems that often occur during executing the adaptations processes.

In the future we plan to enhance the amount of patterns for the adaptation of E-Learning content. In addition we started building a tool to support users in doing adaptations. Furthermore we plan to use our patterns in the adaptation tool as a basis for guidelines offered to users that have to perform adaptations manually.

6 Acknowledgements

7 Literature

[Al77] Alexander, C., Ishikawa, S., Silverstein, M.: A Pattern Language: Towns, Buildings, Construction. Oxford University Press, 1977

[Co06] Content Sharing: http://www.contentsharing.com. (Last accessed on 05/06)

[Fo97] Fowler, M.: Analysis Patterns: Reusable Object Models. Addison Wesley, 1997

[Ga95] Gamma, E., Helm, R., Johnson, R., Vlissides, J.: Design Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley, 1995

[Gr03] Graham, I.: A Pattern Language for Web Usability. Addison Wesley, 2003

[LR01] Lyardet, F., Rossi, G.: Web Usability Patterns. In: Proceeding of EuroPLoP 2001

[Bu96] Buschmann, F., Meunier, R., Rohnert, H., Sommerlad, P., Stal, M.: Pattern-Oriented Software Architecture, Volume 1: A System of Patterns. John Wiley & Sons Ltd, 1996

[Zi06] Zimmermann, B., Bergsträßer, S., Rensing, C., Steinmetz, R.: A Requirements Analysis of Adaptations of Re-Usable (E-Learning) Content. To be published in: Proceedings of EdMedia 2006