The VLEG based production and maintenance process for Web-based learning applications

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ABSTRACT

For the realization and maintenance of high quality and complex Web-based applications there is a need to use sound Web-engineering principles. This paper presents an application for the realization, management and maintenance of Web-based learning applications. Web-based learning applications are very important for the area of E-Learning, which is a field of increasing importance for E-Commerce.

1. INTRODUCTION

In many cases there is a lack of systematic approaches to the development of Web-based systems [MuDe99]. Due to the increasing complexity of Web-based applications there will be an increasing demand for methods and tools, that support the efficient development of Web-based applications. By using adequate methods and tools the costs and time to develop and maintain a Web-based application can be decreased enormously. Furthermore the quality of the resulting Web-based applications will be much higher. [ChZh99]

This paper introduces an architecture of a special kind of Web-based application, a Web-based learning application, the production process of the Web-based application, the architecture of a tool that plays an important part in the production process and the overall process model. The product model of the Web-based learning application is modelled with the well known OOHDM method. The process model can be applied to different kinds of Web-based applications. The importance to differentiate between a product model and a process model is stressed in [Gini98] and [LoHa99]. The tool that plays a very important part in the production process is called the *Virtual Learning Environment Generator* (VLEG). It is a tool for the realization, management and maintenance of Web-based learning applications. Examples of products produced by the VLEG are Web-based learning applications of the project WINFOLine. WINFOLine is a well known german teaching cooperation of the universities of Göttingen, Leipzig, Kassel and Saarbrücken. The following figure 1 shows the situation at the beginning of the WINFOLine project, after the requirements of the Web-based applications had been defined. Figure 2 shows briefly the development method chosen to produce and maintain the Web-based applications.
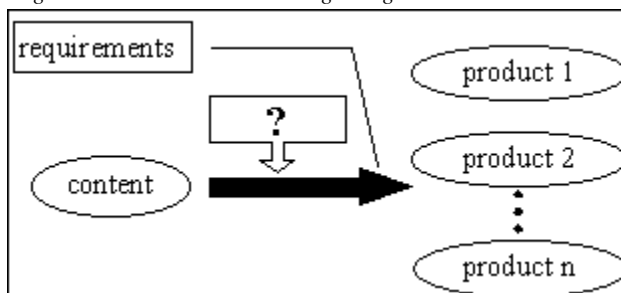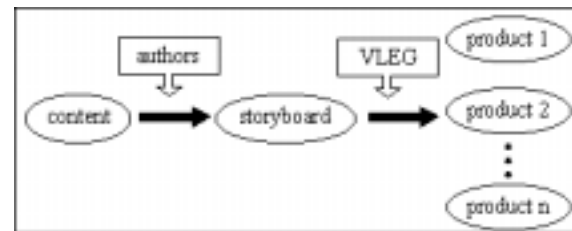
Figure 1: The situation at the beginning

Figure 2: The chosen development method

2. ARCHITECTURE OF THE WEB-BASED LEARNING APPLICATIONS

This chapter presents the architecture and some typical features of Web-based learning applications that are produced by the VLEG.

2.1 Features of the Web-based learning applications

The Web-based learning applications contain the content, communication services and numerous features to support the learning process. Students are able to configure the Web-based learning application according to their learning styles. One of the most important possibilities to configure the Web-based learning application is that students can choose between several output alternatives, e.g. slides, slides and audio, slide and text or slides, text and audio. The following figure shows a sample configuration with slide and text.

Figure 3: Screenshot of a VLEG product (http://winfoline.wirtschaft.uni-kassel.de/intranet.htm)
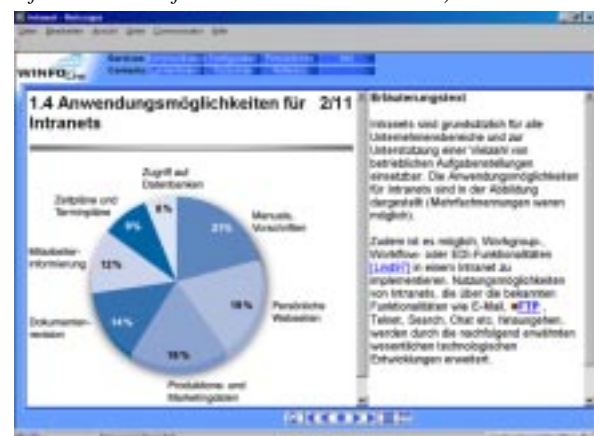
The learning process is supported in different ways. Due to the fact that in many hypertexts users tend to become disoriented, the Web-based learning application offers a wide variety of instruments that help avoiding the problem of disorientation. The Web-based learning application consists of several chapters, every chapter consists of several sections, and every section consists of several units. Depending on the user configuration a unit can be just a slide, a slide and a separate text that explains the slide, a slide with an audio file or a slide with an audio file and a text that explains the slide. To the student it is always transparent to which section and chapter the current slide belongs. Every slide has got a heading and a number. Students can get a list of learning goals and important keywords for every section.

There are up to 18 different types of hyperlinks. Every type of hyperlink is characterized by a small icon in front of the hyperlink or by brackets. Most internal and external hyperlinks offer a kind of textual and graphical preview. While the students are following referential hyperlinks they are working in a special mode. In order to continue a linear learning process, they can terminate the special mode whenever they want to. Additional information is provided by several types of pop-ups.

The communication is supported by a number of means. Every slide offers the possibility to send a contextual email to the tutor, which indicates where the question of the student occurred. In addition there exists a Web-based forum with a kind of list-server functionality. Furthermore it is possible to make public and private annotations. There are several types of self-learning exercises, such as multiple-choice questions, crossword puzzles, one-word responses and long text answers.

2.2 Product model of the Web-based learning applications

This section shows the conceptual model and the context schema of the VLEG products and gives an abstract description of the used product model.

The essential conceptual objects of the VLEG products are chapters, sections, units, tests, glossaries, bibliographies, bookmarks, printouts and index pages. Specializations of printouts are printouts for slides, printouts for text and printouts for slides and text. Specializations of units are units with slides containing keywords, units just containing the learning material and units with exercises. The following figure shows the **conceptual model** of the VLEG products in OOHDM notation.

Figure 4: Conceptual model of the VLEG products
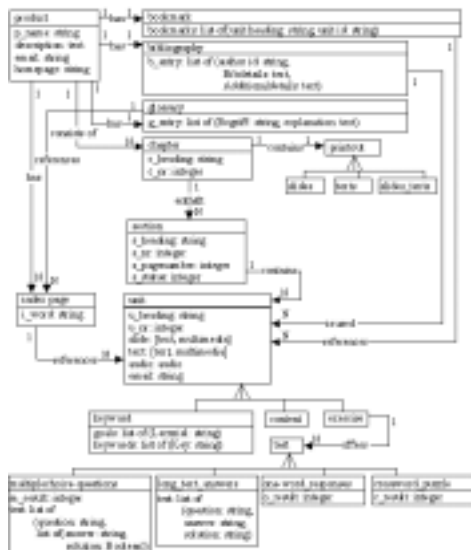
All classes of the conceptual schema, except for the class chapter, belong to the **navigation class schema** as well. Every navigation class corresponds to a certain type of web page of the VLEG products. The navigation class section contains some additional attributes of other conceptual classes.

The numerous access structures, which allow to access the content of the VLEG products from different perspectives, are shown in the following **context schema** in OOHDM notation.

Figure 5: Context Schema for the Web-based learning application
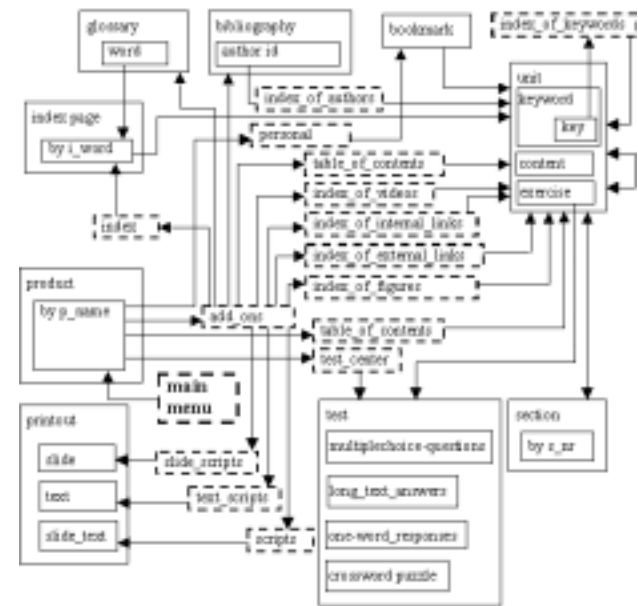
3. THE PRODUCTION PROCESS AND ARCHITECTURE OF THE VLEG

The basis for the production of the VLEG products are storyboards and multimedia assets. The storyboards are written by means of WYSIWYG HTML editors like Netscape Composer. The development and production process of the VLEG products were designed with the following main goals in mind:
- Separation of the production of content and the production of the final products.
- Authors should concentrate on the production of the content.
- The production of the final products should be automated.

The automation of the production process has many advantages: faster production of the final products; separation of content, layout and technical realization; easier reuse of content; easier production of different variants and versions; high quality of the final products; a common look and feel.

3.1 The structure of the storyboards

For a VLEG product several storyboards can exist. In a kind of meta storyboard several storyboards can be combined. For the structuring of the storyboards VLEG specific tags are used. These tags are used to mark headers, slides, texts, pop-ups and many other semantic units. The following figure shows a typical part of a storyboard illustrating the separation of a slide from the explaining text.

Figure 6: A unit of a storyboard

Figure 8: Development process for the VLEG products

3.2 The production process

Authors of VLEG products write, modify and manage storyboards. In the meta storyboard the authors decide which storyboards to combine in order to produce a VLEG product. The following figure shows the input and output relation of the VLEG:

*Figure 7: Input and output relation of the VLEG*
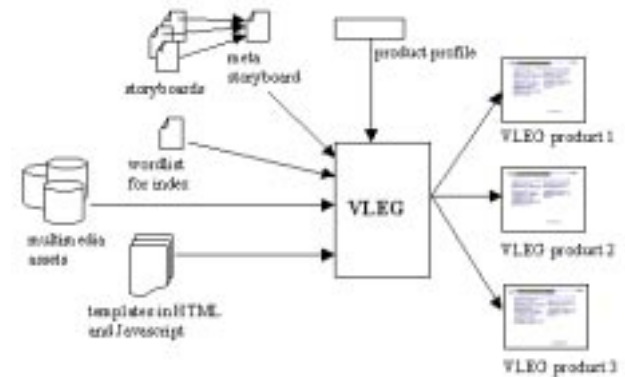
The product profiles are used for the setting up and the management of product configurations. A given product configuration determines the production process of a certain VLEG product. Template files and resource files can be changed by the authors. Therefore it is possible to change the look and feel as well as the functionality of the resulting VLEG products. The VLEG can handle several different sets of template files and resource files. Authors can develop special sets of template files and resource files for Web-based documentations, catalogues and other types of Web-based applications.

The VLEG is able to manage different variants of products. These variants can share resource intensive objects like multimedia assets. The VLEG product for the university course intranet for instance corresponds to a manuscript of 200 pages. The product intranet contains about 50 internal and 50 external hyperlinks that were manually inserted in the corresponding storyboards. By producing the VLEG product intranet, the VLEG created a hypertext with about 800 notes and 5000 hyperlinks. All internal hyperlinks were validated and all the hyperlinks within the slides and texts were semantically enriched by the VLEG during the production phase.

4. THE PROCESS MODEL

The process model shown in the following figure contains the authoring process for VLEG products as well as the development process for the VLEG tool and the template files.
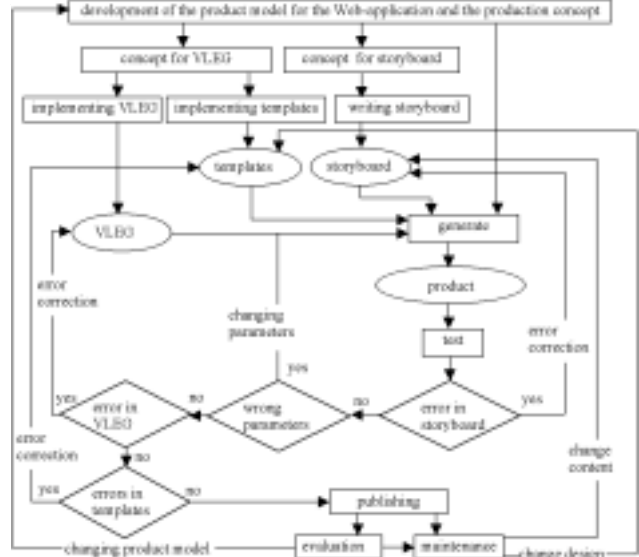
After implementing the VLEG, programming the template files and writing storyboards, it was possible to produce the described type of Web-based applications. Every Web-based application that is produced by the VLEG should be tested, before it is published. The following types of errors could occur:

1. error in storyboard (author)
2. wrong parameters in the product profile (author)
3. error in template files (author or programmer)
4. error in the VLEG tool (programmer)

Errors of type 3 will only occur if new template files are tested. Errors of type 4 could occur if the programmer tests new features for the VLEG tool. If errors of type 3 or 4 occur in other situations as well, this means that either the new template files or the VLEG tool have not been tested properly. After the final tests have been made, the VLEG product can be published. The VLEG products function on web servers and CD-ROMs. There is no need to do any web server specific or operating specific tests. The VLEG products are maintained by changing the storyboard and in rare cases by changing the template files.

The following figure shows the **authoring process**. The main task of an author is to write the storyboard. For the realization of the final Web-based learning application the author executes the VLEG tool, selects the appropriate product profile and activates the production process. If the author notices any mistakes in the storyboard he has to correct them, afterwards he has to restart the production process.

Figure 9: Authoring process for the VLEG products
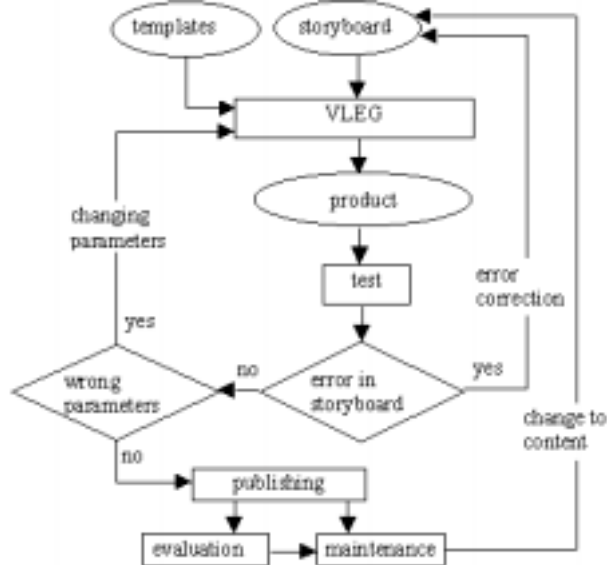
5. CONCLUSION

For the realization and the management of highly complex and sophisticated Web-based applications the utilization of adequate software tools is necessary. The presented tool VLEG can be used to produce flexible, configurable Web-based learning ap-

plications as well as some other types of Web-based E-Commerce applications. The VLEG helps to reduce the development expense for Web-based learning applications significantly. In addition, the maintenance process is simplified. The VLEG products automatically have many sophisticated features and are especially well suited for Web-based learning. Two years of experience with the VLEG products and product evaluations show that they are highly accepted by different kinds of users.

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