COMPUTER AIDED INSTRUCTION MODELING

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ABSTRACT
Courseware systems are software systems that support intended instructional processes. In order to build a courseware system of high quality, teachers need an easy to use courseware engineering tool. Whereas there exist a lot of tools for the implementation phase (authoring tools, learning management platforms) the design phase of courseware system development is neither supported by methodologies nor by tools. This paper shows an approach to conceptual courseware system modeling and presents eduWeaver as a tool for computer aided instructional modeling.

KEYWORDS
Courseware design, instructional modeling, IMS content package, learning object reusability, e-content repository

1. Motivation

Courseware systems are a special form of software systems with a high degree of multimedia components and special requirements on didactical standards. They are aimed to support learners and teachers during the distance learning process in form of virtual courses. There exists a variety of different types of courseware systems like monolitic CBT (Computer Based Training) courses, individual web pages built for resource download or online courses accessible via learning management systems (LMS). Although there are a lot of web based LMS on the market using these tools to engineer and organize courseware systems still stays a very difficult task for most teachers.

During the last years it has been recognized that in analogy to software system engineering, process models are also needed for courseware engineering to guarantee high quality and reusability of the results. Although LMS provide the courseware system engineer with a variety of predefined basic functionalities like file uploads, structuring of files to course structures, student administration, chattools, forums or assessment tools they support only parts of the implementation process and the performing process of a courseware system. Neither courseware system analysis nor design is supported by LMS. In most cases also content authoring has to be done using other tools.

During typical software system engineering, professional software engineers are analyzing, designing, implementing and testing the system. However teachers, who normally are not engineering experts, do most of the courseware design. Their work focuses rather education within their field (languages, history, business administration, etc.) than courseware system development.

So teachers often have problems

- to design their courses according to the intended instruction process,
- to structure the courseware system with high quality and reusable components,
- to author multimedia materials because of the complexity of the tools and lack of time,
- to find existing learning objects that fit into their course context,
- to switch with their courseware from one LMS to another because of interoperability problems.

A lot of teachers fail or capitulate after the first trials. A clear courseware system design framework, a graphical instruction process modeling approach supported by a tool and the access to an e-content repository would help them to do their work more motivated and efficiently.

Section 2 of this paper deals with current approaches to courseware system engineering and highlights the gaps that have to be bridged during the courseware design phase. Section 3 regards courseware systems as a mean for teachers to support instruction process design. Hence

during the design phase of a courseware system instruction processes have to be modelled similarly to business processes. Like in traditional software engineering also in courseware engineering tools are necessary to support this design process. Section 4 introduces eduWeaver as an easy to use tool for courseware design and shows how to move from an instruction process model to the courseware system. Section 5 closes with a summary and an outlook on future developments.

2. Engineering of Courseware Systems

During the last decades a lot of software system engineering process models with different goals have been developed to optimize analysis, design, implementation and maintenance processes. The spectrum stretches from linear and iterative process models like the waterfall model in different forms of modification, prototyping [1], concurrent engineering, evolutionary process models, the spiral model of Boehm to object oriented process models. Requirements regarding didactical standards demand reusable and specialized courseware system components of high quality. For this purpose courseware engineering process models have been developed extending existing process models in respect to knowledge regarding learning theories (see also [2]). Examples of courseware engineering process models are the CBT process model [3], models for hypertext system engineering like OOHDM [4], WebML [5], UML WAE [6] or E-BPMS [7], the courseware engineering process model of Stucky and Klein [8] or the 3-Space Design-Strategy of Moon [9].

All of these courseware system engineering models cover the phases analysis, design, implementation, use and maintenance in different ways. However the focus of this paper is the courseware system design phase, which has to be done before implementation within an LMS. Existing courseware engineering models describe mostly in an informal way the design rules using natural language. As main ideas they describe how to modularize courseware systems, how learning objects should look like, the importance of reusability within the courseware design and the planning of navigation paths.

In traditional software system design, process modeling languages like UML are used to describe system structure and behaviour, and the functionalities on a conceptual level. Different CASE tools are available to support the development process from modeling to code generation.

Learning objects represent system components with special characteristics within the courseware system design context. They are e-content in form of multimedia learning materials (dynamic html pages, animations) or communication processes (e.g. a chat to discuss a problem, a forum to post opinions). These learning objects are put together to courseware systems via user navigation structures. Code generation based on a courseware system model could produce e.g. an IMS package ready to be imported into a compliant LMS .

General purpose modeling languages and CASE tools are too general and hence too heavy to use for a teacher to design the courseware system. Non professional courseware system engineers where not provided until now with tool support for simple courseware design.. Tools can only be found in the area of courseware system design during the implementation phase in form of

- LMS
- authoring tools
- learning object metadata indexing tools enabling the administration and retrieval of reusable e-content.

The tools mentioned above are offered on the market for professional course design, but in reality only the implementation phase is supported. The process of courseware system design meaning

- the structuring the courseware system into educational units (module, lessons, learning objects),
- the graphical modeling of intended instruction paths,
- the reuse of single learning objects and of instruction patterns,
- the generation of courseware systems based on this design

is currently not supported. Hence the application of these implementation tools often overburden a non professional user, like a teacher trying to build a courseware system for his own purposes. Professional courseware system development is too expensive in most cases. Figure 1 shows the use cases a teacher has to handle building his own courseware system.

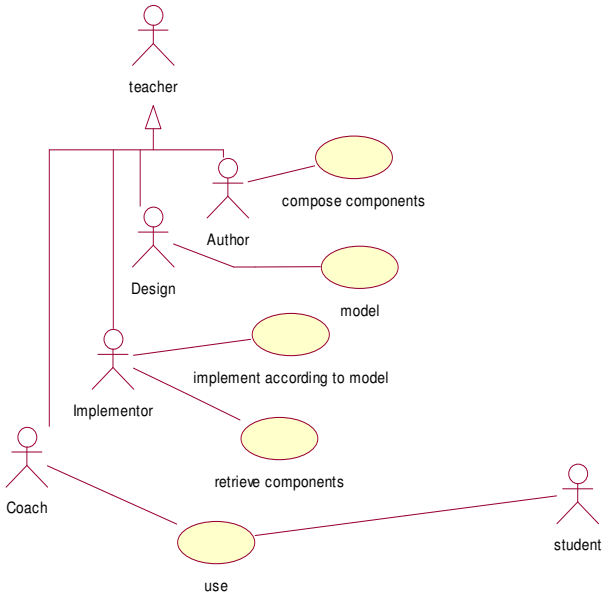

Figure 1. Roles of a Teacher in the Courseware System Engineering Process

3. Instruction Process Modelling

Courseware systems support instruction processes. These can be seen as business processes of the education industry focusing contents and didactical standards. Davenport & Short [10] define business process as "a set of logically related tasks performed to achieve a defined business outcome" and "a structured, measured set of activities designed to produce a specified output for a particular customer or market. It implies a strong emphasis on how work is done within an organization".

Instruction processes have the task from the instructor's point of view to achieve the course goal by communicating information. This can be done within courses, modules, lessons and through learning objects which cover the smallest unit in an instruction process (see figure 2).

Instruction design mostly happens by using the top-down approach, which means that teachers start to define their courses by splitting them into modules which are including lessons that use learning objects in order to transfer knowledge. Learning objects vary accordingly to their goal being a content item, a practice item or an assessment item.

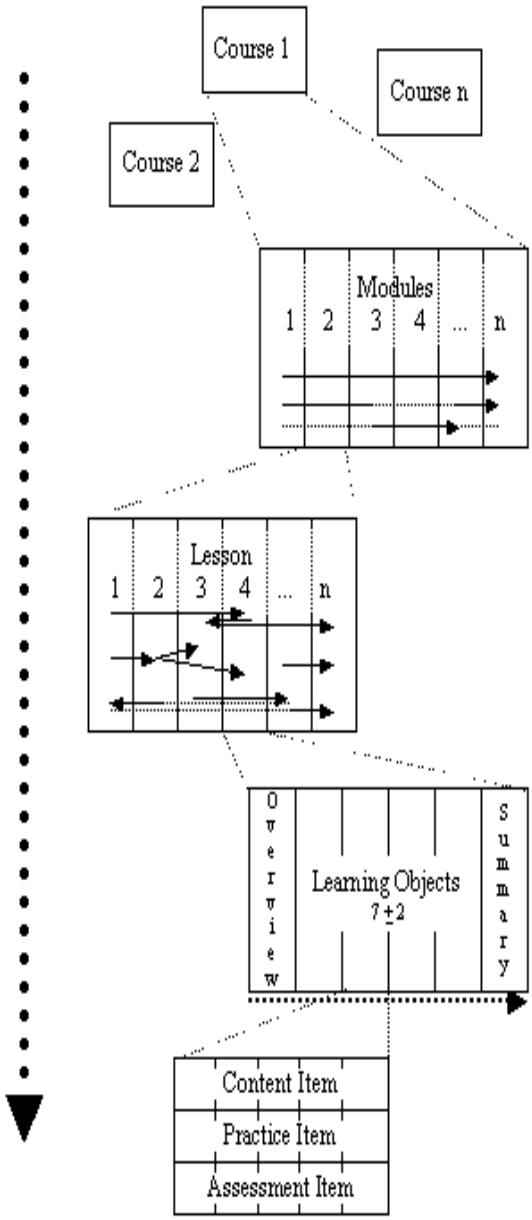

Figure 2. Instruction Process from Courses to Learning Objects

The learner can be seen in the role of the customer, the organisation covers the whole learner group. To design a course from a teachers view means to design the instruction processes and to support these processes via courseware system later on. Best practice instruction processes for special instruction purposes (instruct how to learn a language, instruct how to train soccer, instruct how to build a webpage) can support the development process of new courseware systems especially for inexperienced courseware system engineers (teachers).

4. From Education Process to Courseware

The development of a tool called eduWeaver is the main challenge of an e-learning project at the Universities of Vienna and Klagenfurt. The main goal is to develop a tool that supports teachers during the design process by providing a graphical modeling especially for instructional design.

EduWeaver is based on the metamodeling platform ADVISOR® [11]. ADVISOR® is a process modeling platform for the educational industy that allows the usage of common or newly defined modeling methods [12]. Within this metamodeling platform the e-learning specific courseware design tool eduWeaver was implemented.

EduWeaver consists of four modeling levels. Each level contains learning construct instances that correspond to the model type Course, Module, Lesson or Learning Object Use. These model types are hierarchically linked to each other by internal references. Within each modeling level sequences of instruction can be graphically modeled by using according object and relation classes representing different granularities of the process level.

Figure 3 shows an example for the modeling level 4, the Learning Object Use. Here the object classes start, learning object, decision and end are instanced, connected with the relation class "follows". Further this figure also gives an impression of the user interface of eduWeaver providing different menus on the top, the modeling classes on the left and the modeling canvas in the middle.

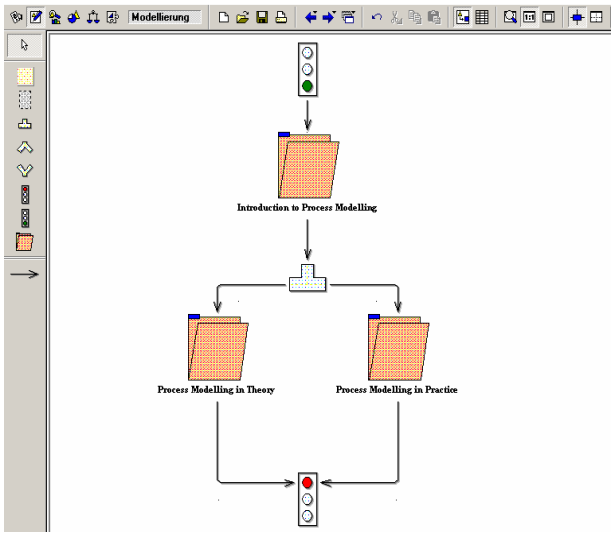

Figure 3. Simple example of modeling level 4 in eduWeaver

From this fourth level of Learning Object Use teachers can directly access the Learning Object Pool, the common repository also provided by eduWeaver. Within this repository reusable multimedia materials are stored.

Learning Objects reference to documents of any format since eduWeaver has no restrictions of possible document kinds, allowing teachers to use and design their contents without any restrictions. The only necessity to be done by the authors is the meta-indexing of Learning Objects when publishing them within the pool. These metadata correspond to selected parts of the IMS standard that allows the content packaging of lessons, modules or even whole courses through the export functionality of eduWeaver.

4. Summary and future developments

Today's most challenging task is to support teachers by providing their contents through the means of e-learning. Since the market is overfilled with highly sophisticated authoring tools on the one side and also offering high quality learning management systems on the other side, the gap to be bridged is the difficulty of courseware and instructional design (Figure 4).

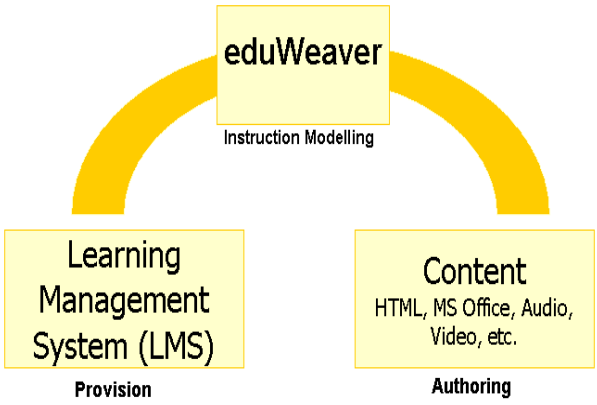

Figure 4. eduWeaver bridging the gap between content authoring and content provision

EduWeaver aims to become an instruction modeling tool not only in terms of supporting teachers at the design their e-learning courses but to allow personalized, individual learning on demand so that life long learning can become part of every day's life. By offering an easy to use modeling tool that allows the reuse of multimedia learning objects, it supports teachers and even learners at the design of individual courseware. On click provides IMS content packages ready to be imported into any LMS. This brings us one step nearer to the realization of high quality e-learning anywhere, any time and for everybody.

References

[1] Raasch, J.: Systementwicklung mit strukturierten Methoden: ein Leitfaden für Praxis und Studium. 3. Aufl., Hanser, München, Wien 1993.

[2] Pawlowski, J.: das Essener Lernmodell, PhD. Work, 2001.

[3] Steppi, H.: CBT- Computer Based Training: Planung, Design und Entwicklung interaktiver Lernprogramme. Klett, Stuttgart 1997.

[4] Schwabe,D., Rossi D., Barbosa S.: Systematic Hypermedia Application Design with OOHDM in: Proceedings of the Conferend´ce Hypertext'96, 1996, p 116-128;

[5] Ceri, S., Fraternali, A. Bongio,A.: Web Modelling Language (WebML): A modelling language for designing Web sides in: Proceedings of the WWW conference, 200, p137-157.

[6] Conallen, J.: Building Web Applications with UML, Addison Wellsey, Longman Inc 2000.

[7] Kuehn, H.: Modellierungssprachen für Web Applikationen in: [13], p379-390.

[8] Stucky W., Klein M.: A process model for developing virtual education contents in WI February 2001.

[9] Moonen, J.: A three-space design strategy for digital learning material. In: Educational Technology 40 (2000)

[10] Davenport, T.H. (1993). Process Innovation, Harvard Business School Press, Boston, MA.

[11] BOC Information Technologies Ltd.
www.boc-eu.com

[12] Bajnai, Judit; Karagiannis, Dimitris: ADVISOR® – Meta-Modeling Tool for Individual Instructional Design, Proceedings of ICL2004, September 2004, Villach, Austria

[13] Horster, P.: Elektronische Geschäftsprozesse, IT Verlag, 2001.