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Developing and Deploying an XML-based Learning Content Management System at the FernUniversität Hagen

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Abstract

This paper is a report about the FuXML project carried out at the FernUniversität Hagen. FuXML is a Learning Content Management System (LCMS) aimed at providing a practical and efficient solution for the issues attributed to authoring, maintenance, production and distribution of online and offline distance learning material. The paper presents the environment for which the system was conceived and describes the technical realisation. We discuss the reasons for specific implementation decisions and also address the integration of the system within the organisational and technical infrastructure of the university.

Keywords: e-learning, learning content management system (LCMS), cross-media publishing, XML, authoring.

Introduction

The University of Hagen (FernUniversität Hagen) is in a unique position in Germany, since it is the only distance teaching university in the German-speaking countries and regions. The university is an integral part of the standard public higher education structure and offers German degrees in the fields of economics, law, human science, computer science, mathematics and electrical and information engineering. The students receive the printed course material in a two-week rhythm and have to pass assignments before being admitted to final examinations. The university has built an infrastructure of study centres throughout Germany, Austria, Switzerland and Eastern Europe, where students can meet their tutors and have access to small libraries, computers and video conferencing equipment. Apart from the distance part of their courses, the students have to spend several days in Hagen attending seminars, laboratories and oral examinations.

The FernUniversität is determined to make best use of the vast possibilities which are offered by information technology and the new media. Diverse projects are underway at the university to evaluate the route from the traditional university for distance teaching towards a new media university. During the recent years, the university has integrated its faculties and central institutions into a concept called *Education and Knowledge Space: Virtual University*. This concept aims at completely representing the university and its services in the virtual space provided by the Internet. To achieve this goal several internally funded projects have been carried out which target aspects of e-learning content, services and infrastructure.

The learning content management system FuXML [FuXML] described in this paper is one of these projects and was funded during 2002 and 2003. The project was conducted by the Department of Computer Science I, the Department of Communication Systems, and the university's media centre, the ZFE (Centre for the Development of Distance Teaching).

The FernUniversität Hagen has a long tradition of employing various kinds of media in addition to the printed course material. Media design is thus of high importance within the concept of the virtual learning space. Teachers who wish to make use of hypermedia content in their courses are supported by the ZFE. The assistance offered ranges from specific course design for visually impaired students to the production of TV programmes on specific academic topics.

The content creation process at the FernUniversität has not been standardised yet. Although guidelines and style guides were created by the ZFE in the past, their application is not mandatory and teachers are free to use any approach which suits them best. Most courses at the FernUniversität only exist as printed material created with standard word-processing and type-setting software such as Microsoft Word and LaTeX. There are also some courses which are not printed on paper but are published as CBT courses on CD ROM. Generally these are results from specially funded multimedia course development projects.

With the advent of the Internet in public life during the last decade, the advantages of the new Internet services for distance teaching and learning soon became undisputed. The possibilities offered by hypertext and hypermedia obviously have great potential with regard to new pedagogical models. The new electronic communication techniques such as videoconferencing, chat, email and newsgroups were expected to greatly enhance the contact between students and their teachers.

However, the expectation that e-learning would quickly revolutionise the way students learn has not been fulfilled to the extent predicted a few years ago. While it is possible to develop web-based hypermedia course material within individually financed projects, it is not realistic to expect similar developments for all university course material when the financial resources available are considered. The FernUniversität currently offers 1600 courses. It is not economically feasible to spend the amount of money usually required to create high quality hypermedia material for each of these courses. Teaching experience also shows that while students happily accept the provided hypermedia content as additional material, it does not provide a satisfactory replacement for the printed course. Currently there are no cross-media publishing systems in use and the maintenance of an online version and a print version which provide identical course content is the responsibility of the faculty staff. This situation is not satisfying and an economically reasonable solution has to be found.

This paper is a report on a specific approach taken by the FernUniversität to implement certain functionalities with regard to the creation and publication of contents within the scope of the university's learning material production process. These functionalities are commonly assigned to a learning management system. However FuXML is not an exhaustive learning management system, since many further functionalities are implemented in the university's infrastructure, which builds the complete learning space.

In rest of this paper we will describe the specific solution for cross-media publishing of e-learning contents taken by the FernUniversität. Other recent experiences with regard to design and production of online learning material can be found in [GGMS04] and [KM04].

Make or Buy ?

E-learning is the key-technology that enables what is considered to be one of the most important concepts in the modern information society, namely life-long learning. Therefore it is not only of major significance to the public academic sector but also to enterprises. The business interest in e-learning technologies and the associated investment capital has created a considerable market for e-learning solutions. There is a wealth of Learning Management Systems (LMS) and Learning Content Management Systems (LCMS) available on the market. Thus it would seem logical for a university, or any other company, to decide to buy one of the existing commercial solutions instead of developing it´s own . Nevertheless, what appears to be a good decision in theory may prove different in practice. The three main reasons are: firstly, academic institutions and enterprises have different requirements. Secondly, commercial e-learning solution providers do not adapt their products to these requirements, they do merely adapt their marketing strategies. Finally, in the long run, the licence costs for commercial solutions are too high. There are several examples of universities that bought commercial LMS at a time when the competition was strong and the licensing fees were low. Following the withdrawal of some of the weaker competitors from the market, licensing prices suddenly became much higher than at the time of purchase.

Goals and Requirements

Since the FernUniversität is a university for distance teaching, the requirements of a content creation and management system are different to those of conventional universities. The course material is provided in the form of an elaborated textbook which is divided into several course units including exercises and assignments. This stands in contrast to the rather ad hoc nature of lecture material used at conventional universities mostly comprised of sketchy Powerpoint slides and lecture notes. The content creation process must therefore support substantially more options than assembling course modules out of existing presentation slides and PDF documents.

The high level goals the system should meet are:

- Simplification and standardisation of the course material production process.
- Reduction of the technical overheads in the course creation process so that authors and faculty members can focus on content and didactics.
- Separation of contents and design which allows the authors and design experts to work independently.
- Provision of a cross-media publishing process that gives teachers the option to choose multiple output formats of the course without generating an additional workload.
- Utilisation of a standardised document format with a half-life cycle much greater than that of standard word processors.

At the time the FuXML project was started, the market did not offer a LCMS that met the university's requirements. Apart from basic editorial and multimedia features some other important requirements are:

- Cross-media publishing that delivers a print version very similar to the existing printed version of the course. The print version of an existing course represents an established standard and a deviation from its original structure and layout is often not accepted.
- A great degree of flexibility with regard to design and layout. University professors do not like to be forced to use a specific visual presentation. They want to establish their own style and are not always willing to compromise. On the other hand, the costs created by customisation have to be kept to a minimum and adaptation must not require special programming skills (e.g. XSLT programming).
- Correct academic implementation of numbering schemes, bibliographies, footnotes and marginal notes. The faculty of law, for example, places great importance on the realisation and implementation of these editorial tools.
- Extensive support of scientific mathematical notation in large volumes and adequate presentation on printed paper and screen. This is a requirement that many LCMS do not account for adequately.

Media Concept

In the traditional pedagogical concept of the FernUniversität, students use the course material as their textbook and working material. The course text is enriched with didactical elements such as learning objectives, summaries, prerequisites, examples, comments, etc. The text is based on basic principles regarding structure and format which have been established especially for distance learning materials. Typography and design are chosen to reflect certain pedagogical goals. Hence, although detailed mandatory style guides do not exist, all courses must abide to a minimal common quality standard.

This didactical methodical and design-oriented course profile has proven itself over many years. The basic principles of traditional course development are also applied to the courses in the Virtual University. Although completely new pedagogical models can be realized in modern e-learning environments, this was not the goal of the FuXML project. The project's emphasis was based more on establishing economical work processes rather than on introducing novel didactical concepts in the distance learning approach of the FernUniversität. Today, this rather conventional approach seems to have been the right choice. Slipping in new methods of teaching through the backdoor of technology without organisational incentive and support might not be the correct procedure. The adoption of new working methods based on the structured editing of XML course documents already presents a barrier to untrained academic staff that should not be underestimated. The target user group does not consist of euphoric media and computer experts who love to use fancy e-learning tools for daily enjoyment, but are pragmatic academic employees that are interested in software tools that deliver efficient solutions for their work. Acceptance of the system would have been very low, if extensive training towards new pedagogical methods had been necessary and existing didactically structured material could not have been directly imported into the new system.

As a result of this, FuXML was first applied to existing courses which employ the traditional didactical concepts of the FernUniversität and are imported into the system. Even a simple imported electronic course without any hypermedia features provides added value to students because of its online availability and digital versatility. Visually impaired students have always been a target group of the FernUniversität but require specially prepared material. The cross-media production process of FuXML can be extended to provide an electronic version of each course that can be processed by Braille screen readers in the future. The HTML screen version produced by FuXML conforms to the accessibility guidelines of the W3 consortium and the German directive to ensure accessibility without barriers (”Barrierefreiheit”). One of the advantages of online digital courses is the inexpensive supply of ”demo” material for prospective new students. Parts of regular courses can be made public to offer a first insight into typical university courses for those who are interested in studying but undecided on whether to enrol or not. An even more radical step would be to follow in the footsteps of the MIT, who made their complete course material freely available to the public in their OpenCourseWare project [OCW].

The digital online courses can be ”enhanced” in several steps to provide added value to the students. In the first step, the extensive application of hypertext mechanisms by linking the course material is an inexpensive way of introducing an extra quality into the course. This includes linking of contents and special directories like index, glossary, list of abbreviations, etc. Some of the linking can be automated by the system to relieve the author as much as possible from this tedious task. Many students will still use the printed version of a course for the first reading. A hypertext course can be used by a student in a later phase to recapitulate important concepts and find keywords, definitions, interesting figures quickly, indeed everything the author might consider worthy of indexing. Furthermore, learning objectives and summaries can be easily accessed for every course unit which helps students to get a quick overview of the course’s main goals and achievements. The didactical markup provided by the author helps to visually pronounce important concepts and improve the attractiveness of the course. Pleasant visual design may also lead students to preferring the screen version over the printed version, even if no further multimedia contents are available.

The integration of multimedia elements such as animations, videos and simulations into the course material is the second step that can be taken to improve the quality of the original course. However, the costs introduced with this step are considerably higher than those attributed to hypertext features. If high quality is demanded, professional support by media experts is required. Care must be taken with regard to the selected media formats. Open standardised formats are better suited than proprietary formats since the latter are often changed with the products they are created with and carry the risk that they cannot be accessed by modern versions of the authoring software even after only a few years. The annoying experience that expensive multimedia content, which is still appealing, cannot be reused due to technical inaccessibility has already been made with CDROM courses that were created in the early years of the last decade.

Technical Realisation

While technology should not be the main motivating factor for working on a new e-learning project, choosing a wrong technological approach will have severe impacts on the practical utility of the project's results.

For FuXML the following technological decisions were made in the inception phase of the project:

- The Extensible Markup Language (XML) was chosen as the document format for the textual contents of a course. A document type definition (DTD) was developed according to the special needs of course production at the FernUniversität. The supported media types consist of open standardised formats only. Specifically, Microsoft Office documents can only be included as external objects.
- The FuXML system is implemented as a client server solution and is divided into three main parts: authoring (client), data management and cross-media-publishing (server). Clients can connect to the system via the Internet from virtually everywhere.
- The software architecture is based on the Java J2EE enterprise platform, which is currently the leading software technology for developing distributed and scalable enterprise applications.
- Open-source solutions were selected where appropriate for the realisation of server components.
- For the client side, commercial solutions were chosen to provide good usability to the users of the system.

The following diagram presents an overview of the system architecture.

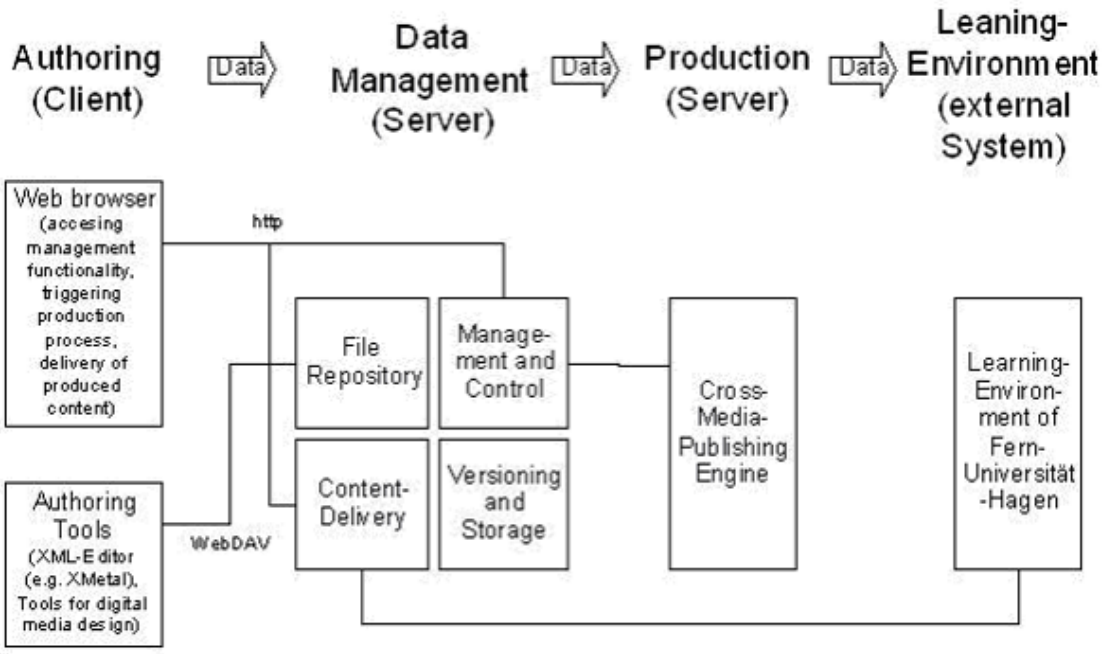

Figure 1 - System overview

The component architecture and the use of standard protocols facilitate development and maintenance. To support the heterogeneity of the IT-infrastructure at the FernUniversität Hagen, there is no commitment to use a specific tool or platform on the client side. This architectural choice improves sustainability. New trends and technologies not only on the client but also on the server can be integrated with ease.

Editing of the XML-documents is the most frequently performed authoring activity during course development. Hence, usability of the XML-Editor is a key issue. The project team chose the commercial XMetaL-Editor that was specially developed for XML-content creation by users who do not have previous knowledge of XML. It was extended by style sheets to provide a view that hides the XML markup and is similar in appearance to the resulting HTML-representation. Customised macros to facilitate course creation were also developed. Users are not constrained to use XMetaL and may use any other XML editor. However, special customisations for the FuXML DTD are currently only provided for XMetaL. It must be noted that the customisations provided for the editor are necessary to achieve optimal usability for the authors. Hence, before choosing a different or additional XML-Editor, the costs of customisation should be carefully examined.

The authoring of media files, such as graphics, animations and sounds, is carried out using tools appropriate for the application in question. The media files are linked to the XML documents by a file reference.

The files that constitute a course are managed in a central repository and can be accessed by the standardised WebDAV-Protocol [1] [WebDAV]. A WebDAV-Client provides directory based access to the files. In Windows such a client is part of the standard distribution (Web folder feature). In addition applications that directly support the WebDAV-protocol (e.g. the XMetaL-Editor) make use of its locking facility to avoid concurrent access to documents.

The repository is part of the data management server that manages all information related to the development and maintenance process of the courses. For tasks related to authoring, e.g. triggering the production process, viewing the result or generating consistency information, as well as for system and project management tasks, a Web GUI has been realised that can be accessed by a standard web browser.

The data management server implements a role system to facilitate fine grained access control to files and functionality. Course files can be versioned as single resources and complete courses. There are several functions for consistency control which are described below.

The production server implements the cross-media publishing process. At the moment a PDF and a HTML output can be produced for each course. A course can be published in the learning environment of the FernUniversität Hagen.

FuXML Documents

Since XML was chosen as a base technology for documents, a document type definition (DTD) that defines the structure of FuXML documents had to be developed. Existing DTDs were found to be unsuitable in the context of German distance learning material. The DocBook DTD [DocBook] has placed too strong an emphasis on computer science and does not provide visual and didactical markup. The Educational Modelling Language (EML) [EML] is targeted towards describing complex pedagogical models but does not consider the editorial and didactical elements required by the course authoring process of the FernUniversität.

So its was decided to develop a FuXML DTD that reflects the university's specific requirements. The FuXML DTD contains

- editorial elements such as section, paragraph, quotation, etc.,
- didactical elements such as course, course unit, learning objective, prerequisite, exercise, example, etc.,
- faculty-specific elements such as formula, theorem, proof, etc. for mathematicians and case, adjudication, etc. for the lawyers,
- multimedia elements such as graphic, animation, video, simulation, audio, text object.

The editorial compartment also provides elements for visual markup, such as bold, italic, underlined. In theory these elements could be replaced by semantic markup, in practise these elements are urgently required. The reasons for this are: firstly, the amount of semantic markup elements from six different scientific faculties would blow up the DTD and create considerable implementation overhead, secondly, most authors would demand visual markup anyway since they are used to using it, and finally, an exact prediction of all required semantic markup elements is not possible and visual markup can replace these missing elements. Similarly, different types of paragraphs are supported that differ in the space they create at the end of the paragraph. These visual variation can intuitively be utilised to create semantic cohesion within the course text that could otherwise hardly be expressed.

Multimedia elements can also be combined into compound multimedia objects. Such compound objects can be used to account for the different characteristics of the output media formats. For example, a compound object that contains an animation, a graphic and a text object can be transformed to an HTML page containing only the animation and a PDF page containing the graphic and the text object.

As already mentioned, for a LCMS deployed in the academic environment of a university the comprehensive support of mathematical expressions is of utmost importance. There are two problems in this area that have to be solved. The first problem is that of entering and displaying the formula in a user-friendly way in the XML-Editor. The second problem is that of displaying the mathematics in high quality in the output documents. Although the international standard MathML [MathML] has been created by the W3C to support mathematical notation in XML and XHTML documents, there are still some shortcomings which currently limit the applicability of MathML in practice. In 2002, when the FuXML project began, a satisfying solution based on MathML was not to be found. Therefore, the decision to use LaTeX notation instead of MathML was taken. The advantage of this is that existing mathematical and technical courses could be readily imported into the system. Recently however, the situation concerning MathML support in browsers and XML editors has improved, with standard browsers supporting MathML notation (current versions of Internet Explorer, Netscape, Mozilla) [WebMathML]. Also on the XML-editor side the availability of commercial MathML plugins (see e.g. [MathFlow]) for the most popular XML-editors like BlastRadius' XMetaL and Abortext's Epic is a major step towards the practicability of MathML. However, for documents containing a large number of mathematical expressions, the LaTeX notation is still superior to MathML, because it does not need a cumbersome equation editor for even the simplest of inline mathematical expressions.

FuXML allows the modular composition of courses from several independent XML documents. This is a first step towards the concept of learning objects. For example, this feature can be used to realize a master and a diploma course on the same topic. The common parts of the two courses can be provided by a single XML document. This can considerably reduce the maintenance overhead considering the work involved when identical changes have to be made in two different documents. However, the vision of independent sharable content objects (SCO) as defined by the SCORM standard [ADL] is outside the scope of our system. Although the content aggregation model (CAM) of SCORM could easily be implemented, there is no incentive on part of the university to implement SCORM now. There are neither plans to buy SCOs from other educational institutions and content providers nor plans to distribute the university's own learning materials via third party systems. Existing contents would have to be heavily edited to become self-contained SCOs that could be assembled with other SCOs to provide a new learning context. Furthermore, the demand for self-containment requires that cross-references within the course material are kept to a minimum, which is certainly not desirable from a didactic point of view [B04]. While, at the moment, SCOs are not projected to be incorporated within the regular courses of the university, the road to reusable modular learning contents will be investigated within the recently started research project "Campus Content", which is funded by the German Research Foundation (DFG) and is carried out by three academic institutions of the FernUniversität.

The process of course development

Course development is divided into several phases: initiation, authoring, publication and maintenance.

Initiation

At first the course to be developed is analysed with regard to its requirements. The design templates and configuration parameters are set to accommodate the wishes of the course provider. This consultation work is done by the ZFE. The course and a project manager are registered in the system. The project manager performs further administrative actions such as registering co-workers for specific activities or controlling publication deadlines.

If the course already exists as a Microsoft Word document the word import feature of the XMetaL-Editor can be used to generate an XML document master for the course. The master is of particularly good quality, if the standard word template provided by the ZFE is used.

An important issue to be addressed at the beginning of course development is the specification of the granularity of XML documents that capture the structural and textual contents of the course: Parts that are used in more than one course (e.g. bachelor and diploma course on the same subject) should be isolated in a separate document. To allow several authors to work simultaneously on the course, separation of course parts according to the individual responsibilities of the authors is necessary.

Authoring

When the design and the configuration parameters have been determined (initiation phase) the course developers can make arbitrary changes within the content and can simply produce an updated version of the course by the press of a button. This procedure is a great improvement in comparison to the complex traditional course development process which required the close interaction of media and design experts with the authors of the course during the whole authoring process.

The main authoring activity is the editing of the XML-documents and the generation of media files (pictures, animations, etc.). If a developer makes a mistake or different co-workers make interfering changes, the system reports on the consistency issue and provides hints for solving the problem.

Publishing

As the deadline for publication nears, the authoring activities change from content creation to proof reading. The finishing editorial touch has to be added: if the automatic page layout does not deliver a satisfying result, line and page breaks can be inserted manually where necessary.

Currently, the publication of the print version is carried out by sending the printed course unit to the technical production for print and postal delivery to the students. Publishing in FernUniversität Hagen's virtual learning environment is much easier: the course can be directly imported.

Maintenance

After the course is delivered to the students, it resides in the system for revision at a later date. If the course contains URLs and the URL-redirect option is activated (see below), URLs in published material can be replaced by a proper message or an alternative URL, if they are no longer valid or the referenced content underwent a major change.

If the course provider decides to offer a new revision, the authoring-publishing-maintenance cycle restarts.

Centralised data management and consistency control

As mentioned before, the files that make up a course are held in a central repository accessed by the WebDAV-protocol. For each course there is a shared workspace that can be accessed by all co-workers. If more than one course developer works on the course at the same time, managing concurrent access to resources becomes an issue.

Using WebDAV-protocol's locking facility a user can obtain an exclusive writing access to a resource. Neat integration of locking is provided by some authoring tools, e.g. the XMetaL-Editor: If a resource is opened a lock is acquired that prevents other users from opening the same resource for writing access. The lock is released when the resource is closed. This procedure can be regarded as an on-the-fly check-out and check-in coupled with the traditional open and close operations. Locking allows simultaneous work on different course parts provided they are captured in different documents, and consecutive work on the same part without the risk of interference.

If some of the co-workers are disconnected from the system either temporarily or for a longer period of time (offline editing) they work in a local workspace. Locking cannot be used here and the consolidation of changes made in the local workspace along with the changes made in the global shared workspace is performed afterwards by file based synchronisation. To avoid lost updates in this situation the repository performs checks and prompts conflict resolution.

For consistency control of the global shared workspace consistency reports are available on the level of single XML documents and the complete course. Issues such as a broken internal link, duplicated IDs, an invalid or changed URL, a syntactically incorrect LaTeX fragment representing a mathematical formula or an invalid XML-document are reported and rated by relevance. Hints are given for resolving an issue. For changed resources referenced by URLs, a difference view is provided for change tracking.

To retain control over changes of URLs in courses that are already published a redirect service exists: in the course the original URL is replaced by one to a redirect server. A request to a replaced URL is normally redirected to the original one but in case of changes it is possible to display a proper message and link to another page.

The centralised data management with access control and consistency features described above shows clear advantages over the rigid provident style of interaction that collaborating users are constrained to when using a standard word processor.

Cross-Media Publishing

The cross-media publishing process produces the desired output documents in various formats. Currently, two major formats are available:

1. A PDF format optimised for printing.
2. An HTML format targeted for viewing the course material on screen.

With these two formats the three major publication channels of the FernUniversität can be utilised (see Figure 2).

- The traditional offline paper version is realised by sending the printed manuscript or the electronic PDF file to the technical production facility of the FernUniversität. Here the course material is printed, packaged, and sent to the students by conventional mail.
- An offline electronic version can be published on CDROM. As already mentioned the production process can replace the URLs contained in the course text with URLs linking to a redirect web service.
- An online electronic version can be published via the university's LMS. The production component produces a ZIP file which can be imported by the LMS.

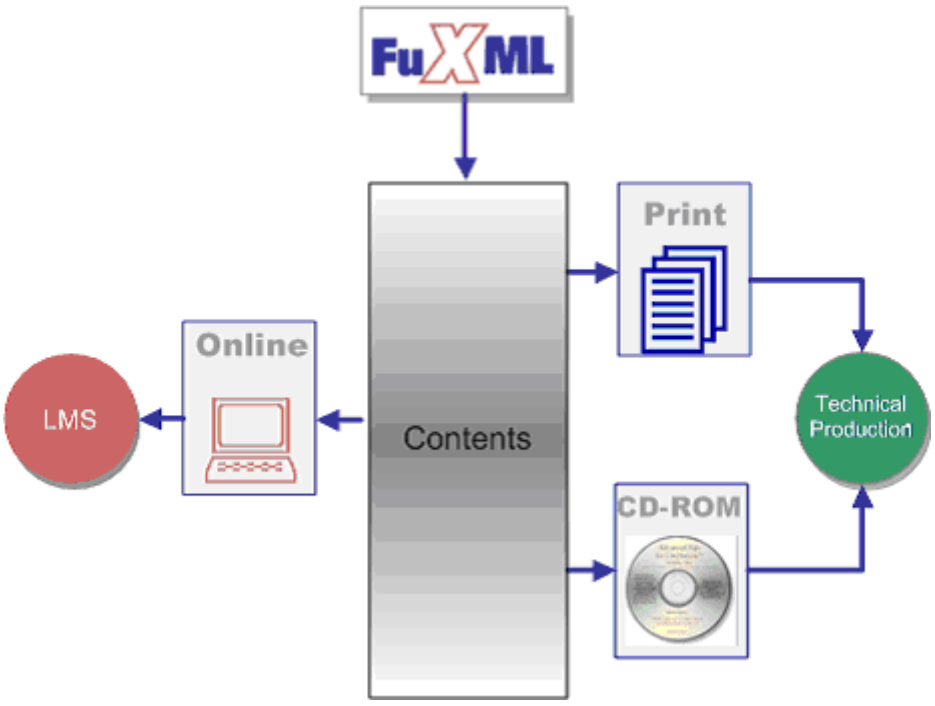

Figure 2 - Primary production channels

An important requirement regarding the production system was, that it should support different design and layout variants for each course. Additionally, the cost of the solution should be moderate. This demand for an efficient solution excluded time-consuming programming of individual transformation for each course. The chosen approach is depicted in Figure 3. It consists of a rule-based production engine and a design interface which is realised in the form of various configuration files.

These configuration files are edited by the configuration managers and designers of a course, not the authors themselves. The design interface provides a way to customise all relevant attributes of a course. Some examples of these are

- the labelling and numbering scheme for sections and other elements such as figures, tables and examples
- the layout and structure of the different XML elements such as animation, paragraph, definition, axiom, quotation and exercise
- appearance and layout of table of contents, index and table of figures.

Furthermore, the output documents to be produced can be configured individually for each XML document. For example, a single XML document containing the text of a course unit may be transformed into three different output documents: the course unit text for the students, the assignments for the student and the assignments with solutions for the teacher.

The production engine for the PDF format is based on the LaTeX typesetting system, thus the required high quality print version can be achieved. Multimedia elements which cannot be displayed on paper can be represented by textual content, e.g. a note to the students that additional multimedia material is available in the HTML version of the course.

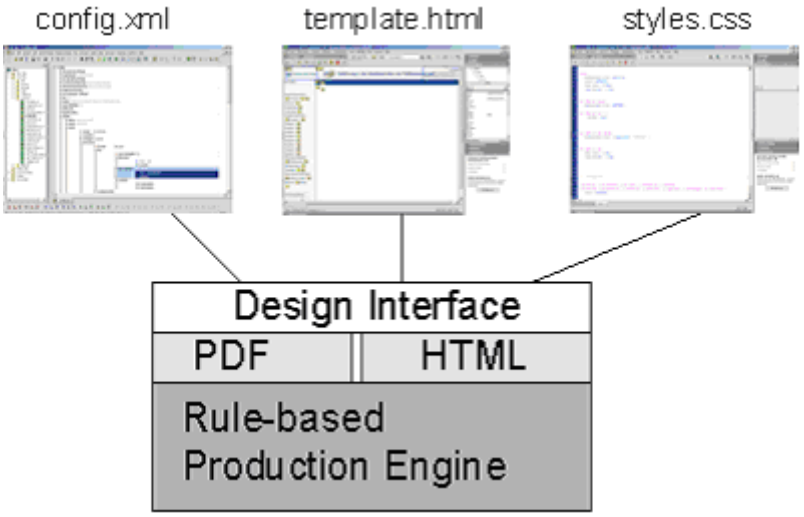

Figure 3 - The production system

Integration of the System within the Organisational and Technical Infrastructure of the University

The realisation of sustainability and longevity in e-learning projects at universities has always been a big problem. Many projects do not survive a couple of months after the official end of the project. The biggest problem is that of finding adequate personal that is able to operate and maintain the system and provide user support over a longer period of time. The members of the project teams are often not available and are assigned to new tasks or leave the university after finishing their academic work. The central institutions of a university like the computer centre or media centre normally do not have the required resources to take over every completed e-learning project.

In the case of the FuXML project the following issues had to be solved:

1. Adequate user support has to be offered. Furthermore, since the employed authoring technology is new, at least rudimentary training and tutorials for university staff have to be provided.
2. Availability and stability of the system have to be guaranteed.
3. Knowledge transfer from the project team to the organisational units has to take place to share the experiences made in the project.
4. Software maintenance and further developments have to be assured after the end of the project.

For the first two issues solutions have been found which required commitments from the media centre and the computer centre. Due to the fact that the ZFE was part of the project from the very beginning, the third issue has also been addressed adequately. Although some knowledge will inevitably be lost when the project team splits up, the major insights and achievements will be saved for the university.

For the fourth issue a satisfactory solution still has to be found. A solution proposed by the CampusSource [CS] initiative is to make the code open source and let the software support be provided by small and medium-sized businesses. This approach has already shown to be successful for other e-learning projects.

FuXML has been introduced to university personal of several departments. The departments with no technical background have, in particular, shown great interest in the system. A major issue for the success of the system will be the usability of the XML editor. Experience so far has shown, that the acceptance of the XML editor is less a matter of technical knowledge than a matter of willingness and openness to work with a new tool and to adopt novel authoring mechanisms. Authors that are used to direct formatting of contents in a word processor like MS Word must get used to semantic markup of contents. In fact, the demand for semantic markup is what causes most problems, not the introduction of a new authoring tool.

Summary and Conclusions

In this paper we described the approach taken by the FernUniversität Hagen to establish a novel organisational and technical procedure for developing course material in the field of distance learning. The university decided to build its own LCMS within the internally funded FuXML project. The requirements placed on a content management system of the university were discussed and the essential parts of the developed system were described. Practical considerations and experiences as well as the integration of the system within the organisational and technical infrastructure of the university were presented.

In conclusion it can be stated, that the technical feasibility of the new approach was successfully demonstrated. The future acceptance of the system within the university will largely depend on the political and financial decisions taken by the university's administration with regard to further supporting actions.

Acknowledgements

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References

[ADL] Advanced Distributed Learning (ADL) Initiative, http://www.adlnet.org/ (last visit: 22.01.2005)

[B04] Peter Baumgartner: ROI: Reusable Object and Instruction Paradox, keynote at the 9th European Conference on Media in Higher Education GMW, Graz, Austria, September 2004

[CC] Campus Content project, http://www.campuscontent.de/index_en.html (last visit: 22.01.2005)

[CS] The CampusSource initiative, http://www.campussource.de/org/ (last visit: 22.01.2005)

[DocBook]The DocBook DTD, http://www.docbook.org/ (last visit: 22.01.2005)

[EML] Educational Modelling Language (EML), http://eml.ou.nl/ (last visit: 22.01.2005)

[FuXML] Home page of the FuXML project, http://www.fuxml.de/ (last visit: 22.01.2005)

[GGMS04] Görlitz, Gudrun; Grimm, Oliver; Müller, Stefan; Schrade, Eva: "Design and Production of Online-Learning-Material". In: Proceedings of the ISAS CITSA 2004, Volume II, Communications, Information and Control Systems, Technologies and Applications. Orlando Fl. 2004. ISBN: 980-6560-19-1, S. 387-389

[KM04] Kania, J. P.; Müller, S.: Vom Skript zum multimedialen Online-Studienmodul. In: Stübig, J.; Peitz, B. (Hrsg.): Internet- und multimedial gestützte Lehre an Hochschulen: Beispiele und Transfer. Aus den BMBF-Leitprojekten "Vernetztes Studium - Chemie" und "Virtuelle Fachhochschule". Schriftenreihe des Bundesinstituts für Berufsbildung BIBB, Bonn, 2004. ISBN 3-7639-1023-9. S. 154-165

[MathFlow] MathFlow MathML Editor, http://www.dessci.com/en/products/mathflow/ (last visit: 22.01.2005)

[MathML] Mathematial Markup Language, http://www.w3.org/Math/ (last visit: 22.01.2005)

[OCW] MIT's OpenCourseWare project, http://ocw.mit.edu/ (last visit: 22.01.2005)

[WebDAV] Web-based Distributed Authoring and Versioning, http://www.webdav.org/ (last visit: 22.01.2005)

[WebMathML] Putting mathematics on the Web with MathML, http://www.w3.org/Math/XSL/ (last visit: 22.01.2005)

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[1] WebDAV stands for "Web-based Distributed Authoring and Versioning". It is a set of extensions to the HTTP protocol which allows users to collaboratively edit and manage files on remote web servers.