collaborative European Virtual University

# Digital platforms

**(Work Group 1)**

| | |
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# DOCUMENT HISTORY

Chapters were distributed among members of the group to be created and reviewed.

April 20, 2003 all chapters were collected into on single document, which is this report.

May 2, 2003 the report was sent to parallel review among members of the group.

May 20, 2003 circulation of signing page.

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# 1. About this Document

## 1.1. Global objectives

In line with the European Union's e-learning action plan, and with its priority on (a) virtual university concept(s) in general and the creation of (a) European Virtual University/Universities in particular, the cEVU project (collaborative European Virtual University) started with the assumption that it is unrealistic to launch a European Virtual University as in independent/dedicated institution. In the perspective of cEVU's promoters, the only realistic approach to a European Virtual University is a collaborative structure in which existing universities (both conventional and open universities) and university networks are involved.

The cEVU project has been initiated with the following objectives:

- Study the various aspects that may constitute and/or influence the concept of a cEVU: (Work package 1 - design of a cEVU)

- Development of services that are needed to run a cEVU (concretely oriented towards a portal site, a virtual campus, databases for exchange of courses and learning/teaching materials, training of staff) (Work package 2)

- Some pilots that may validate the taken options (Work package 3).

Outcomes of the project are threefold:

- Reports of working groups and activities

- A "Manual for a Collective European Virtual University

* Part1. Policies, models and joint working practices

* Part 2. Requirements, recommendations and guidelines for participating institutions and for the transition from small-scale experimentation to full deployment

* Part 3. Elements for a business plan"

- A final dissemination conference

The intention of the cEVU - Working Groups, of which the Digital Platform working group is a part, is to:

- gather information that may be considered as state-of-the-art with respect to the topic of the Working Group;
- identify (eventually) examples of good practice;
- indicate eventually where expertise/experts are to be found;
- translate this information into guidelines and recommendations for good practice in the framework of a cEVU; to be put into the "Manual"
- indicate which elements are lacking in the knowledge, procedures, methods... about the topic of the Working Group, but identified as necessary for the proper working of a cEVU.

## 1.2. Objectives of task

The original objectives as expressed in the project application scheduled the following activities on the basis of the partners' incoming responses on a questionnaire:

1. Provision of an overview of the bandwidth status between partner universities and students' connectivity.
2. Description of local technical and pedagogical support services and policies of the participating partners.
3. Synthesis of the opportunities and problems to be solved in collaboration between universities with respect to digital platforms.
4. Development of a proposal for "interfaces" that support interconnectivity and exchange of learning and teaching materials.
5. Collection of known free tools
6. Evaluation of existing interoperability solutions and tools
7. Formulation of recommendations

During the first meeting of the working group, it was however discussed that collecting information about the first and second element would only draft a very temporary view, which might even be outdated before the publication of the report. Consequently the focus should be on specifications of the universities' needs with respect to technical

platforms and the characteristics and requirements that can be derived from them. This is in line with the items 3 and 4, whereas items 5 and 6 can be considered as validation of the items 3 and 4.

## 1.3. Acronyms

| | |
|---|---|
| ADL | Advanced Distributed Learning |
| AICC | Aviation Industry CBT Consortium |
| API | Application Program Interface |
| ARIADNE | http://ariadne.unil.ch/ |
| CoTTCoL | Cooperative Theme and Tool Competence for Learning |
| DND | Canada's Department of National Defence |
| DTD | Document Type Definition |
| EML | Educational Model Language |
| GUI | Graphical User Interface |
| HRM | Human Resource Management |
| HTML | Hypertext Markup Language |
| IEEE | Institute of Electrical and Electronics Engineers |
| IP | Internet Protocol |
| ISO | International Organization for Standardization |
| JPEG | Joint Photographic Experts Group |
| LCMS | Learning Content Management System |
| LMS | Learning Management System |
| LOM | Learning Object Metadata |
| MCQ | Multiple Choice Questionnaire |
| MIME | Multimedia Internet Message Extensions |
| MPEG | Moving Picture Experts Group |
| PBL | Problem Based Learning |
| PDF | Portable Document Format |
| PHP | Personal Hypertext Preprocessor |
| R&D | Research and Development |
| SCENARI | Système de Conception d'Enseignements Numériques Adaptables |
| SCORM | Réutilisables et Interactifs |
| URL | Uniform Resource Location |
| WG 1 | This workgroup number 1 under cEVU |
| XML | eXtensible Markup Language |
| XSL | eXtensible Style sheet Language |

## 1.4. References

### 1.4.1. Publications

**Ref 1 Borch Ole. et al: UniFlex:A WWW-environment for project-based collaborative learning**

**4th International Conference on Information Technology Based Higher Education and Training ITHET03 July 7-9, 2003, Marrakech, MOROCCO**

**Ref 2 Outils auteurs : approche industrielle versus approche artisanale, Bruno Bachimont, Isabelle Cailleau, Stéphane Crozat, Manuel Majada, Sylvain Spinelli, ARIADNE'2002, Lyon, France, November 2002**

**Ref 3 Le procédé SCENARI : Une chaîne éditoriale pour la production de supports numériques de formation (The SCENARI solution: a publishing chain to produce educational digital media) *Bruno***

*Bachimont, Isabelle Cailleau, Stéphane Crozat, Manuel Majada, Sylvain Spinelli* TICE'2002, Lyon, France, Novembre 2002.

Ref 4 Web site: wwwspul.utc.fr / example of publication: Bruno BACHIMONT, Isabelle CAILLEAU, Stéphane CROZAT, Manuel MAJADA, Sylvain SPINELLI, "Le procédé SCENARI: Une chaîne éditoriale pour la production de supports numériques de formation", TICE'2002, France, 2002.

Ref 5 Bruno Bachimont, Jean Charlet, "PolyTex : un environnement pour l'édition structurée de polycopiés électroniques multisupports", EuroTex'98, France, 1998.

Ref 6 Georges Van der Perre, H. Roos endaal and J. Van den Branden, „The distributed virtual university", Armando Rocha Trindade (ed), New Learning, Lisbon 2000, pp. 419-436

Ref 7 Knudsen M. et al: Project-Based Collaborative Learning - Transferring twenty-eight years of experience with the Aalborg Model to distance education (To appear in an anthology published 2003 by The Faculty of Humanities, Aalborg University).

Ref 8 Marc Ketels: Digital Learning Platform & Digital Campus, Final report Task force 1 EUNITE, December, 2000

Ref 9 Eléments pour la conception industrialisée des supports pédagogiques numériques (Elements for industrial design of instructional digital medias) *Stéphane Crozat* Mémoire de Thèse, soutenu à l'UTC le 22 mars 2002.

Ref 10 Développer un Campus Numérique : le problème de la production des supports. *Stéphane Crozat, Manuel Majada* IPM'2002, Lille, France, Novembre 2002.

Ref 11 Structuration et scénarisation de documents pédagogiques numériques dans une logique de massification *Stéphane Crozat, Philippe Trigano* STE (Sciences et Techniques Educatives), vol.9, N°3, Ed° Hermès, 2002.

### 1.4.2. Web references

Ref 12 ARIADNE http://ariadne.unil.ch/

Ref 13 AFNOR, www.afnor.fr

Ref 14 ADL, adlnet.org

Ref 15 AICC, aicc.org

Ref 16 Brandon Hall, www.brandonhall.com

Ref 17 CEN, www.cenorm.be

Ref 18 DUBLIN CORE, www.dublincore.org

Ref 19 HRM, www.hrm.net

Ref 20 IMS, imsproject.org

Ref 21 ISO JTC1 SC36, jtc1sc36.org

Ref 22 LOM, grouper.ieee.org/groups/ltsc/index.html

Ref 23 Le Préau, www.preau.asso.fr

Ref 24 PROMETEUS, prometeus.org

Ref 25 SCENARI, wwwspul.utc.fr

Ref 26 SCORM, adlnet.org

Ref 27 Uniflex prospect http://www.mii.auc.dk/uniflex/common_info/uniflex_update_03.pdf and login example (visitor/guest) http://uniflex-proactt.itorg.auc.dk/

## 1.5. Contractual Aspects

The European Commission provides part of the funding of the cEVU project, but is not responsible for its outcomes. The content of this document is a collaborative effort of various authors who consequently own the intellectual property rights. The Commission however preserves the right to use the results of the project, particularly for demonstration or dissemination activities.

# 2. Main report

## 2.1. Background

The cEVU project studies the possibilities and obstacles that accompany the creation of a European *collaborative* virtual university. In order to understand what is implied precisely with the word "collaborative", we should distinguish different types of virtual universities.

The idea of a « virtual university » as such is not new, but it is not standing for a unique concept. It varies from a fully internet based "digital university" [1] (e.g. the Universitat Oberta de Catalunya in Spain) to the mere brokerage of programs and courses for education (e.g. the Western Governors University in the US)

Most of the so-called "virtual universities" may be categorized as variants of the "digital university": an environment for primarily internet-based courses or even complete internet-based degree programs, often connected to a traditional university. The "digital university" creates classes in which teachers and students are not physically present. They "attend" class from a remote site (home, a study or training centre) at an individually convenient time. With the exception of a sometimes available "chat mode" and in advanced systems also videoconferencing through Internet protocol, by which people can virtually "meet" online, the complete process, is asynchronous. This kind of "digital university" is clearly becoming the successor of the traditional "open university", in that it exchanges the basic model of correspondence teaching (with emphasis on the teacher as locus of control for the learning process) with a model of real autonomous learning (wherein the learner largely is responsible for the own learning process), using the potential of information and communication technologies to realize this shift.

The model of the "digital university" is mostly established in either dedicated open universities or in dual and mixed mode ones. Dual mode universities offer the same courses and programmes both on campus and as distance teaching, whereas mixed mode universities deliver part of their education on campus in a traditional way and another part as distance education.
This model however expects that enough (usually also large) financial resources be available at the university to cover at least the initial investments for such "digital university"; that the number of learners that can be attracted is sufficient to cover its costs, and that the necessary expertise for programme and course development as well as for learner support be present. That is where a second model within the concept of "virtual university" comes in, namely the "distributed or *collaborative* virtual university".

[1] This paragraph has been almost entirely taken from: Ref 6

In this model, information and communication technologies for learning and instruction are not only used to deliver education to the learner, but also to establish networking between the participating universities, that jointly set up virtual university activities. The full range of university activities can be mirrored in these virtual institutions, not only the development and delivery of courses and programs, but also joint research as well as research and education services to society at large.

It is clear that working in such a networking environment imposes some pedagogical and technical restrictions. Learning materials, even while working within one single digital platform, have to be developed and structured in such a way that regular maintenance is possible and that the reusability of these materials is optimized. In a collaborative virtual university, different digital platforms will be used, which enhances the need for contents that are made and even designed in a standardized way.
From a technical point of view the collaboration between these different platforms, already in use at the different universities has to be assured. These aspects of technical standardization and interoperability will be studied here.

In the cEVU project we also want to take into account the evolutions that have taken place in this field and more precisely the new (pedagogical and other) insights that have been developed and that are influencing the technology profoundly. Over the years, quite some progress has been made regarding the quality of digital platforms in general. Where the first products were rather rigid, imposing the content provider's strict templates that had to be followed, modern digital platforms focus more on openness and flexibility and this at various levels. The more advanced platforms are not only open to all kinds of subject domains and levels of studies, but also offer the possibility to customize the interface of the platform.
The widespread open source philosophy stretches these ideas of openness and flexibility possibly to its limits, as users can modify even the code of a particular product on the condition that it is communicated in the larger community.

Since the first digital platforms were developed, an important shift has taken place from "technicality" to "functionality". Whereas the first digital platforms were developed on the basis of the technical logic of programmers, who defined the possibilities of the platform from what was technically possible, the focus is now more on the functionalities of the platform. The idea is that in the development of a learning platform, the needs of the user of the platform have to be translated into technology and not the other way around.

As a consequence of the constructivist view on education, one of these needs that is of increasing importance, is the need of collaboration between all those involved in the learning process (student-student, student-teacher, teacher-teacher, etc..). The conviction has grown that learning is more effective when you learn in collaborative environments. The constructivist approach implies a different view on the learning process as a whole.

Learning was traditionally associated mostly with knowledge building, and the learning process was mainly seen as the transfer of information (teacher centered). Now, in the constructivist approach, it is the process of learning itself that is more in focus (student centered) and importance is also given to attitudes and skills that have to be acquired

(competence building).

Another insight that is taken up in this report is the idea that an ideal learning platform should combine both LMS (a Learning Management System) and LCMS (a Learning Content Management System). This point of view contradicts the more traditional way of thinking where a LCMS is seen as a next step in the evolution of a LMS, with a higher degree of complexity.

## 2.2. Introduction

As a starting document for this working group, the following model, developed by the EUNITE taskforce on Digital Learning Platforms and Digital campus has been used (Ref 8).

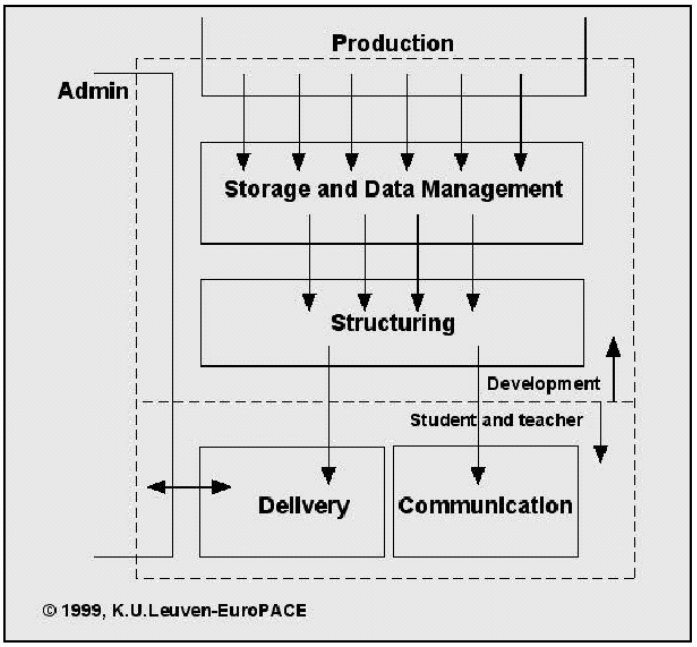



**Figure 1**

In this figure one possible concept is given that is used to structure the technical functionalities of a digital learning platform.

When taking a closer look at the conceptual architecture of a digital learning platform, one can distinguish between five functional layers:

- Layer 1: Production and development of learning material
- Layer 2: Storage, labelling and retrieval of this (reusable) learning material
- Layer 3: Structuring learning material into courses
- Layer 4: Making the courses available and supporting the communication
- Layer 5: The administrative framework

In a collaborative European Virtual University however, aimed at exchange and sharing of learning materials, courses, packages and even full programs between the participating

universities, and at the joint development of teaching and learning materials by network members, this model is not sufficient. In such an environment, it is the interoperability between digital platforms that will prove to be crucial.

This aspect of interoperability is better represented in the following figure. This model[2] shows a more complete approach as it includes not only the interoperability aspect, but also assessment and competence management.

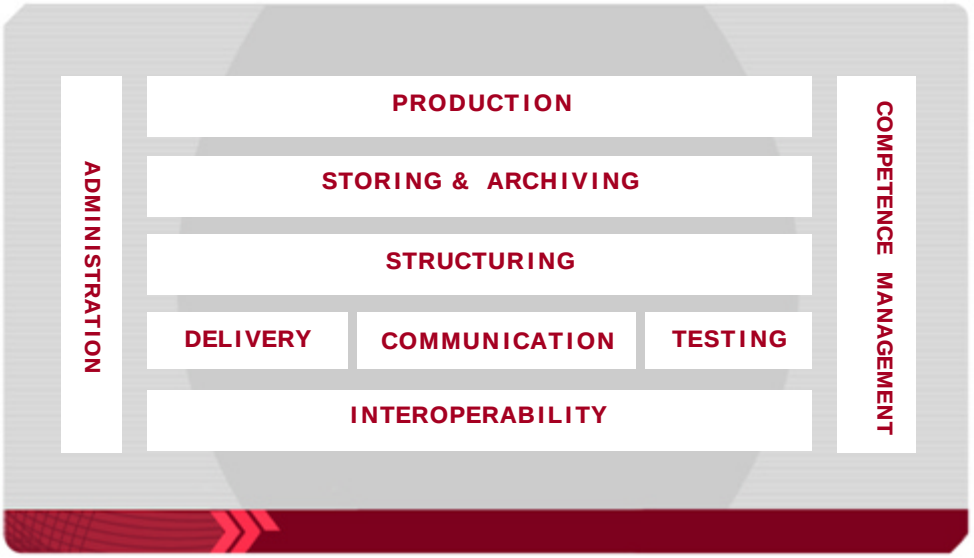



**Figure 2** ©EPYC, 2002

To tackle the interoperability issue, it might be less important to have an in depth description of the different tools used in all the universities (knowing that the products are constantly changing). It seems more interesting and efficient to focus on the functional approach, specifying the aspects, the characteristics to which a digital platform in a collaborative environment should respond.

To describe these functional characteristics, the following model was used (see next page). The model tries to specify all the different actors involved in the educational process and the interactions between them.

After analysis of the different functionalities and a discussion on the purpose of this working group it was decided to identify some clusters of issues, and to take those clusters as starting point for further description:

- The digital environment (2.3)
- Course activities (2.4)
- Project work activities (2.5)

For each of these topics functionalities will be described, demands will be listed on the basis of which recommendations can be formulated.

[2] Pita Vandevelde (EPYC), *Actual trends in LCMS* , a EuroPACE seminar, November 14, 2002

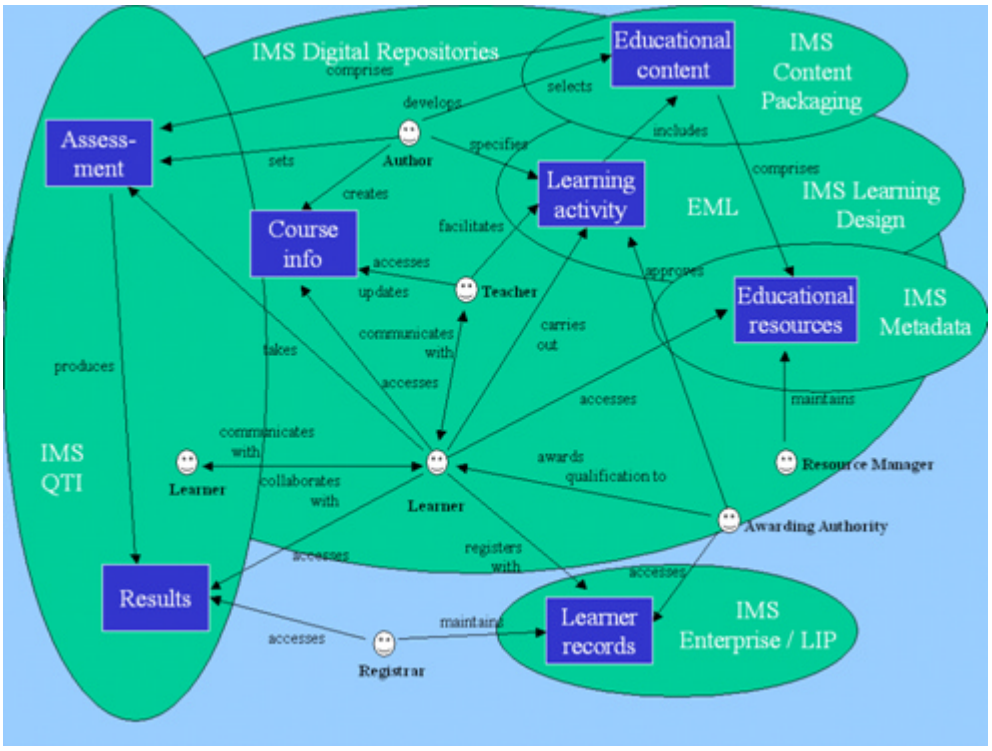



**Figure 3 ©Niall Sclater**

### 2.2.1. Focus of this report

In the introduction and background, the scope that was taken referred to the state of the art of digital platforms today. However, as many things can be said about digital platforms, the working group limited itself to the aspects of functionality, transparency and interoperability. Other aspects were considered to be either too temporal for reporting (e.g. overview of characteristics) or not decisive for collaboration in a cEVU (e.g. interfaces).

## 2.3. The digital platform environment

### 2.3.1. General architecture

#### 2.3.1.1. What is an e-learning digital platform?

Whereas till recently an e-learning platform was understood as only an LMS platform, we propose that in fact two kinds of platform are needed, an LMS and an LCMS:

- The LMS is in charge of managing the training, and especially the learners and teachers, the material and digital means they need, the planning and communication tools, and the follow up of the training.
- The LCMS is in charge of managing the contents, and especially their specification, production, publication, maintenance and reuse.

An e-learning device's objective is to allow massive distance learning using digital technologies. The distance learning is "massive" in the sense that it deals with large

amounts of students, and large amounts of training offers, i.e. contents. LMS are in charge of managing the volumes in terms of students and the LCMS are in charge of managing the volumes in terms of contents.

Let us add that LMS have been considered as more important at the beginning of e-learning development, since they were needed to initiate training. But now that LMS have been dispatched everywhere, LCMS are as important, since they are the condition to develop contents in a realistic way and so, to propose meaningful training programs.

| **e-Learning digital platform** | |
|---|---|
| **LCMS : content management**<br>*Documentary level* | **LMS : training management**<br>*Organisation level* |
| • Production<br>• Maintenance<br>• Compatibility<br>• Publication<br>• etc. | • Persons<br>• Means<br>• Planning<br>• Communication<br>• etc. |

**Figure 4: e-Learning platform composed with LMS and LCMS**

#### 2.3.1.2. Why two different platforms?

There are two main reasons why LMS and LCMS do not need to be the same platform, i.e. a global digital platform that would assume both training and content aspects.

First of all because they assume different functions:

- LMS are expected to manage activities during the training
- LCMS are expected to manage content production before the training

Since these functions have few common points, it is obvious that they could be different systems, and it not obvious that a single system could be efficient on both aspects.

Secondly, because they need different technological frameworks:

- The actors of the systems are different (learners and teachers for LMS and authors and multimedia producers for LCMS). The number of actors is also very different (few actors for LCMS, a dozen for instance, and a large set for LMS, till several thousands of learners)
- The cycles of use are different (the time of the lecture for LMS, few weeks, and the time of the institution for LCMS, several years).
- The technological format and constraints are different (durable and modifiable content for LCMS, executable and interactive content for LMS, high quality communication tools for LMS, high quality versioning and storage for LCMS, etc.).

Mainly other differences could be pointed out. The conclusion, with a computer science

engineering point of view, is that the technical system has to be different in order to be adapted to their technical constraints. As a matter of example, a platform that is in charge of managing hundreds of simultaneous users would have to optimise its web architecture, whereas a platform that is in charge of managing thousands of durable units of contents would have to optimise its database architecture.

The ultimate argument is that the LCMS interests are not the LMS interests, commercially speaking. The LMS has an objective to keep its customers. As a consequence, its policy in terms of independence and opening is most of the time quite low. In the other hand, LCMS have to be easily interfaced with the greatest possible number of LMS. As a consequence, they need to be interoperable and open to develop. In other words, the more the LMS is open, the weaker it is, the more the LCMS is open, the stronger it is.

#### 2.3.1.3. Nobody's perfect!

As we just said, it seems more realistic to have different digital platforms to manage the training and to manage contents. Moreover, we can add that there is no perfect system, neither LMS nor LCMS, but there are some systems more adapted to some contexts. One consequence is that systems need to be interchangeable, since contexts evolve. The second consequence is that systems need to be chosen depending on the context.

In order to evaluate the needs in one context, we need to realise pedagogical specifications, i.e. training need analysis. With these parameters it is possible to choose one or more LMS and one or more LCMS able to feed these LMS with contents.

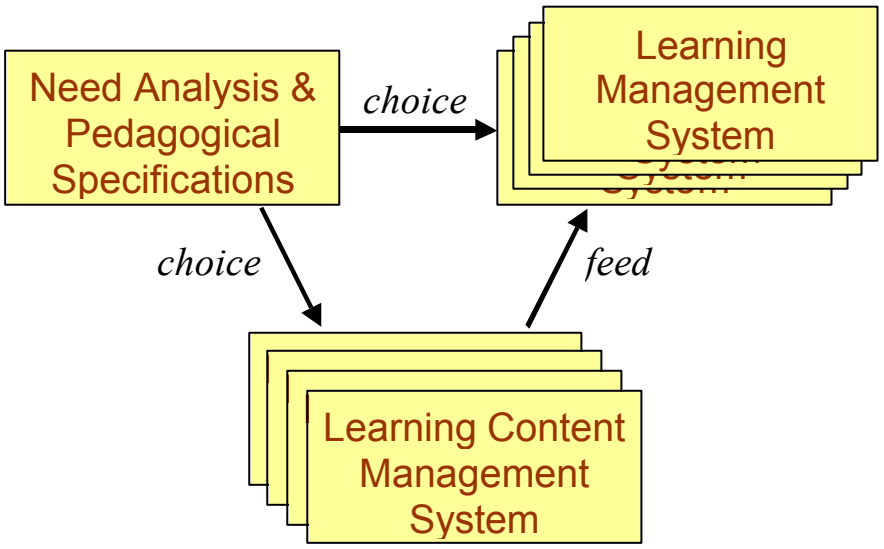



**Figure 5: LMS and LCMS choices depending on Need Analysis**

#### 2.3.1.4. Need for communication between LMS and LCMS

Since we proposed to dissociate content and training management, it is required that LCMS and LMS communicate, so that LCMS can effectively and easily "feed" LMS with executable contents.

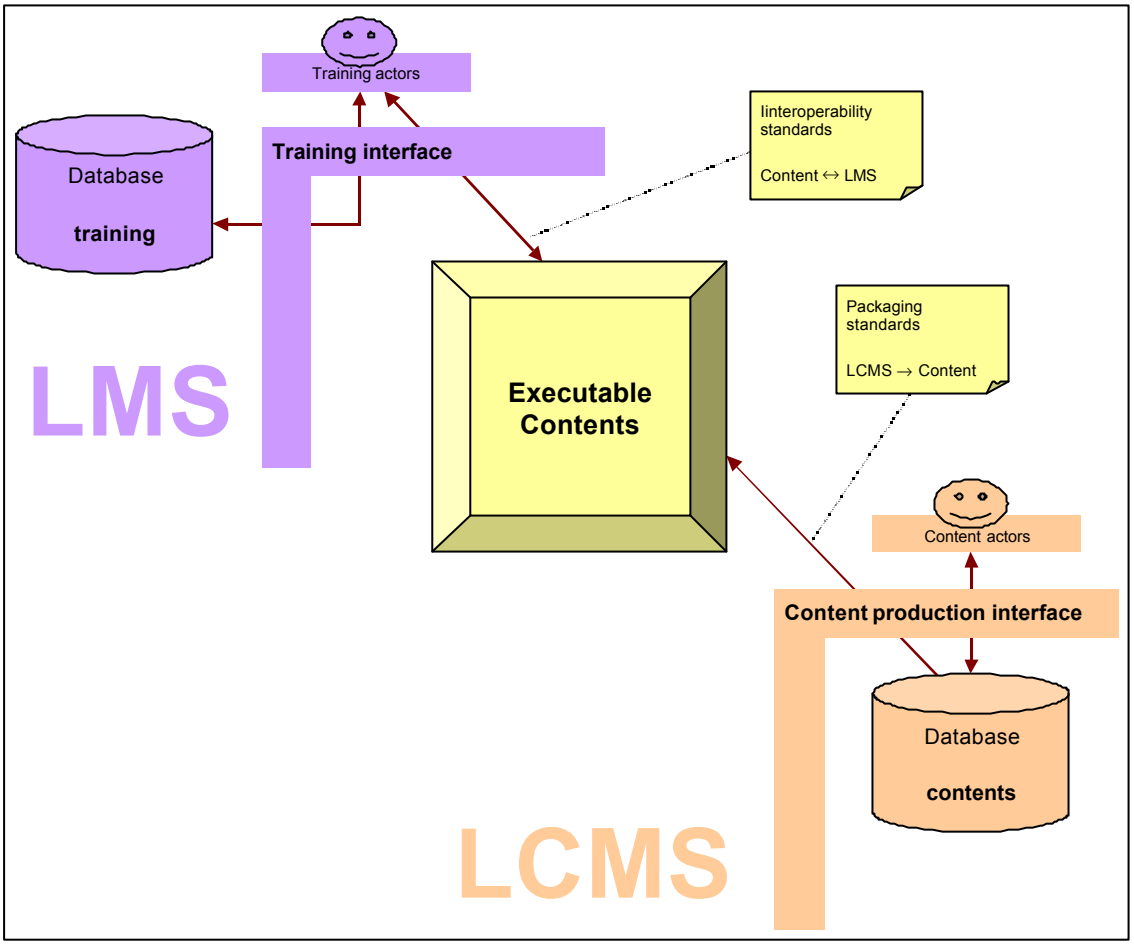
The communication between LMS and LCMS is not direct, but mediated by the content.

Three main communication "channels" have to be opened so that LMS and LCMS communicate exchanging content:

- LCMS has to package executable content so that it is automatically integrated and launched by the LMS.
- Content (provided by the LCMS) has to be able to communicate to the LMS the results of its interaction with the learners, so that the LMS is able to store and manage this information. For instance if the content allows exercise, the answers given by the student have to be sent to the LMS. Then the LMS is in charge of storing these answers, and moreover of managing them, such as sending them to a teacher for evaluation, allowing cross comparison with others students answers, etc.

In order that LMS and LCMS could communicate, following these three channels and whatever considered LMS or LCMS, the communication protocols need to be standardized. A set of e-learning standards is being developed within several related project (AICC, ADL SCORM, IMS, IEEE LOM, EML, etc.). These standards, that are at the moment integrating by a ISO group (technical comity JTC1, sub-group SC36), are for most of them operational at the moment, and so can be used to allow LMS and LCMS communication.

#### 2.3.1.5. Architecture proposal




### 2.3.2. Interoperability and standardization aspects

#### 2.3.2.1. Global overview

Standardization process has been initiated by US aviation industry, within the AICC(Ref 15) organisation, in order to allow reuse of learning software. Two main other projects have raised to enlarge AICC work, IMS (Ref 20)in order to deal with questionnaire and content packaging specific aspects and LOM (Ref 22) (supported by IEEE) to reinforce indexation aspects. The SCORM (Ref 26) project (supported by ADL(Ref 14), from US defence department) appears in order to unify all the initiatives in one single and global standard. The ISO normalisation process has also started, mainly on the basis of SCORM works, to institute the standards.

The positive aspects of these standards is that they exist and begin to be used, and so, allows a first level of interoperability. The main negative aspect is that their historical development (American, aviation, defence) drove to quite specific pedagogical principles that are no very compliant with the major practices (for instance European pedagogical models, non technical industrial contexts, etc.).

Some other initiatives have been taken to provide more generally adapted standards. We

can quote for instance proposals for SCORM evolution by the Canadian DND or EML proposal as an input for IMS by the Open University of the Netherlands.

The conclusion is that in one hand standards are not yet finalized, and in the other hand some principles are already widely adopted. In order to propose solutions that are able to run at the moment, we propose to focus on SCORM 1.2 standard, which:

- Is quite widely adopted
- Gathers most of AICC, IMS and LOM aspects.
- Is enough to provide a first level of interoperability

In other words, SCORM is clearly not a perfect solution, but if it would be applied, it would be already a first step, and a good base for further enhancement. Waiting for the perfect standard will lead to use no standard, whereas using existing ones will lead to the raising of new expression of needs that will allow the standards improving. And SCORM is the more consensual candidate, which is the best quality for a standard. And 1.2 version is a good compromise between poorness of 1.1 and not yet complete applicability of 1.3.

#### 2.3.2.2. LCMS ® LMS (packaging)

The first need for standardisation, having admitted that LCMS and LMS should, or at least could, be different systems, is a standard way of packaging contents so that a LCMS could transfer contents to a LMS.

Reusing IMS works and adding its proper organisation proposal, SCORM proposes:

- A standardized structure for content aggregation. This insures that LMS will be able to propose synthetic presentation and direct navigation within the content. In other words, without these standards description, LMS could only present the content as a "black box", whereas with it, it is able to present it as a hierarchical and navigational tree structure. Let us note that SCORM 1.2 provide also standardized way of representing sequencing condition, such as "access to piece of content X depends of result obtained for piece of content Y".
- A standardized way of packaging contents. This insures that when multiple files contents (which is the general case with multimedia and interactive contents, such as HTML) are transmitted to the LMS, it will be able to correctly import the contents, whatever is its format and internal physical file organisation. The standard also provides a technological solution, based on XML description, in order to implement the packaging.
- A standardized way of indexing contents. This insures that the LMS will be able to provide information about the content to the teacher or the learner before the training begins, for instance the pedagogical objectives, the duration of the training, the expected mark, etc. The index list is based on LOM works.

#### 2.3.2.3. Content « LMS (communication API)

Training applications suppose interactive contents. We can define interactive contents as contents that expect the user (the learner) not only to read information, but to produce

information within the contents, while reading. The applications of these principles are very wide, from simple MCQ quoting, to answers giving to open questions or free annotation. Such interactivity supposes that the produced information has to be stored somewhere, and our architectural principles suggest that it is the LMS role.

And the LMS has not only the role to store, but also to manage this information, in order to provide, typically, inter-students and inter-contents comparisons for teachers or students analysis. To be able to do so, the LMS has to be able to analyse the information produced by the learner, and so, to "understand" it.

In the other hand, the content will need to have information from the LMS to run properly. For instance, it could need to know who is using the contents, and what are his preferences in terms of pedagogical approach (theoretical or practical, oral or textual, etc.), technical limitation (network bandwidth, ability to listen speech, etc.)

The second need for standardization is so, having admitted that content has to be, or at least could be, interactive, is a standard way for LMS and content to dynamically communicate.

Basing on AICC first works, SCORM proposes an API, i.e. a normalized way of communicating, between content and a LMS. This API allows:

- Content launching by the LMS. It insures that whatever kind of contents it is, the LMS will be able to ask him to initiate in a single common way. In the same way, content terminating is also standardised.
- Data transfer. It insures a single common mechanism for a content to send or to ask for information to the LMS. A proposal language describes all kind of information that could be asked or sent (student information, lesson status, scores, objectives, etc.), but it could be easily extended.

#### 2.3.2.4. Proposal

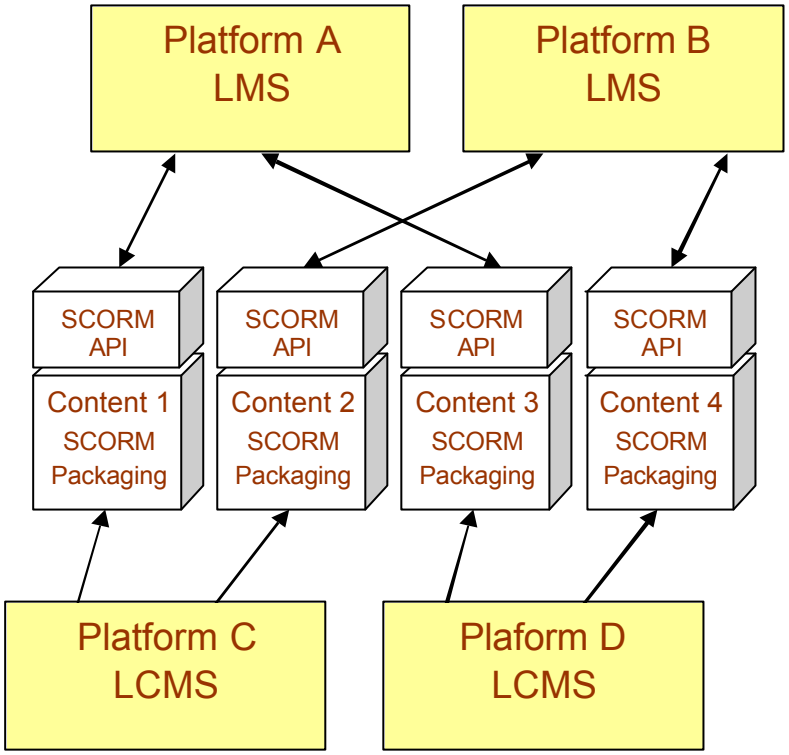



**Figure 6: Application of SCORM standards for LMS and LCMS communication**

### 2.3.3. Format aspects

#### 2.3.3.1. Dealing with heterogeneity

Dealing with contents implies to deal with format, in the sense of technological format and in the sense of pedagogical format. The basic hypothesis is the heterogeneity of these formats:

- Heterogeneity of technological format means that some are used to use HTML (some for Internet Explorer, some for Netscape), others are used to use PDF, others Macromedia Flash, others Microsoft Word or PowerPoint, etc.
- Heterogeneity of pedagogical format means that some are used to provide expositive courses, others are uses to provide more active or constructivist pedagogy, some full distance learning, other mixed distance and on attendance courses, etc.

It is undesirable, and moreover undoable, to make everyone conforming in a standardized framework of use. The remaining solution is so to assist in dealing with this heterogeneity.

#### 2.3.3.2. Technological format

Storage and publishing format

Nearly every format has a sense in a given context of use (because with the format comes the condition of use, and so of learning). That implies that every LMS has to be able to

deal with (nearly) every format.

In the other hand, allowing every format to be produced and stored in a LCMS considerably reduces the chances of reuse and adaptation of the content. As a matter of example, it is quite impossible to modify a PDF, very difficult to modify an interactive HTML, hard to assembly a Word with a PowerPoint document… and totally non realistic to will to assembly a piece of PDF, with a piece of HTML, a piece of Flash, etc.

The problem is that in a very heterogeneous context, managing natively the contents in any formats leads to anarchy, and choosing one of them leads to reduce possibilities of use. The first element of solution, well known in the field of documentary engineering, consists of dissociating the *storage format* from the *publishing formats*, and to set up software tools that automatically transform content from their storage format to one or more publishing format. Let us note that a storage format has very different properties (generic, logical, richly indexed, very structured, etc.), from the publishing one (readable, executable, specific, etc.). The second element of solution is then to find a "pivot format" that is able to be the storage format for all the publishing formats.

Such a format has to advantage "logical" representation of the information, describing not how the information has to be presented on a support, but what are the inbuilt characteristics of the information. It is the main requirement to remain neutral toward publishing formats.

```
<FONT color="red" font="Impact" size="24pt">
   Definition: Digital
</FONT>
<BR/>
<FONT color="black" font="Times" size="12pt">
   Related to numbers.
</FONT>
```

A publishing format is dedicated to a support, and gives information about how to present the content.
It is hard to switch from one publishing format to another.

```
<definition>
   <notion>Digital</notion>
   <explication>Related to numbers</explication>
</definition>
```

A logical storage format is independent from a support, and gives information about how the content is represented.
It is easy to generate any publishing format from a storage one.

**Figure 7: Storage versus publishing format**

### XML technologies

Research about content technologies has been providing powerful solutions for five last years, with the arrival of XML. XML provides structuring and powerful solutions to represent contents in a logical and neutral format. It is the best candidate for being a (nearly) universal storage format. It can only be "nearly" universal, since it is not adapted to represent binary contents (images, videos, etc.). But even in this case it remains the best candidate to index these binary contents (and standard solution already exists to

encode theses binary contents, such as JPEG, MPEG, etc.).

Moreover XML comes with powerful and generic software solutions for publishing contents in any public format (which means any format which encoding is known, such as HTML, RTF, PDF, etc.) from XML structured contents.

Proposal

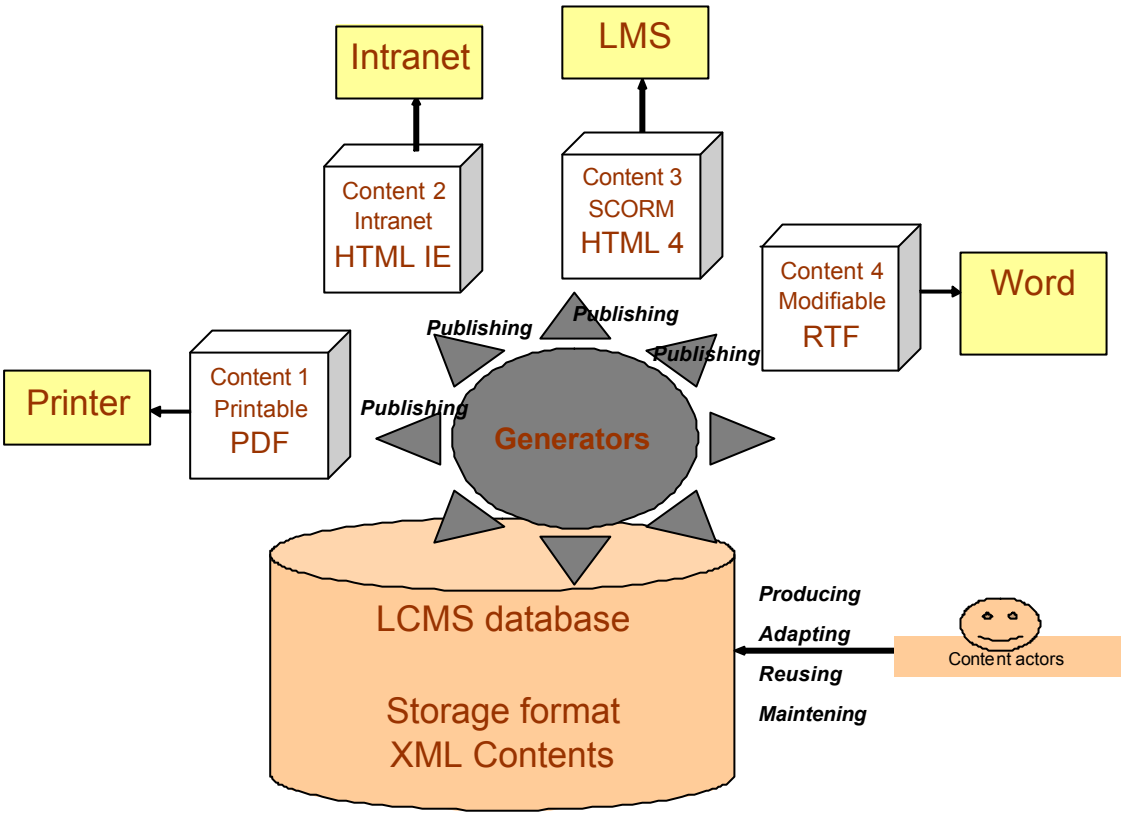



**Figure 8: XML storage and multi-format publishing generators. For the content actors it is important to access the generated output formats easily for the purpose of checking.**

Economical aspects

The adoption of XML as a storage format in a LCMS leads to a more rational way of dealing with contents. It does not reduce the possibilities of use of publishing format within the LMS side.

Moreover this adoption leads to:

- A real independence between contents and platforms, whether LMS or LCMS. If the desired LMS respect the SCORM standard, it can just be interchanged without changing anything. If the LMS does not, the contents can nevertheless be adapted to it, only by modifying the generators, in order to fit the expected publishing format, and without authoring the contents again. To interchange LCMS, either the contents will directly be transfer in its native XML format (and no work is needed) or the XML need to be adapted to the LCMS requirements, and it is managed like a special kind of publication (toward a new XML format)

- An important reduction of production costs, since it is much easier to produce using XML than using most of publishing language. And moreover since the technological developments are "factorised" in the generators and remains independent of the volume of contents produced.
- A huge reduction of maintenance costs, since the process of production is controlled and well managed in an industrial way, and no more dependent of the technological evolution of the publishing format.

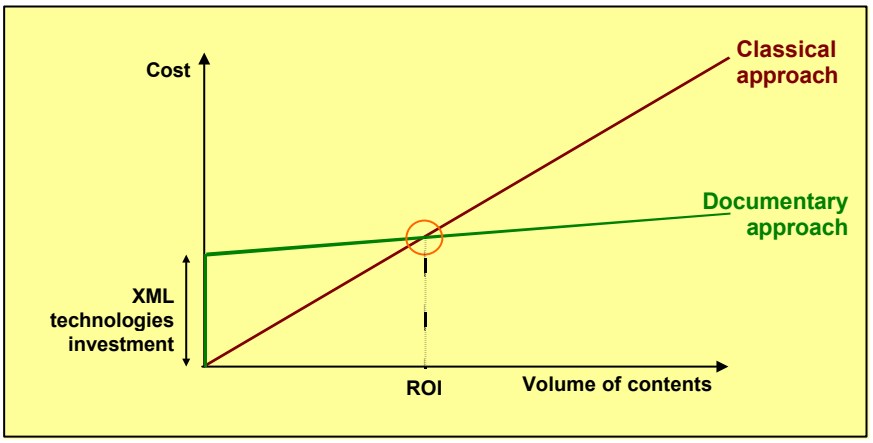
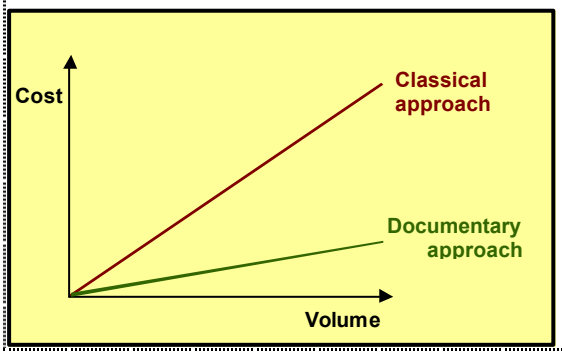
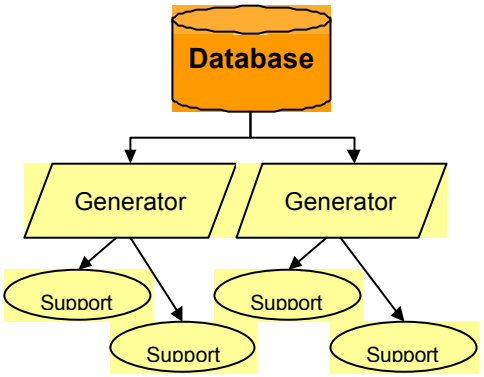



**Figure 9: Production cost saving**

The content modification is directly done in the stored contents in XML, and all the associates publishing supports are generated




The generation does not need any kind of technical expertise

**Figure 10: Maintenance cost saving (content changes)**

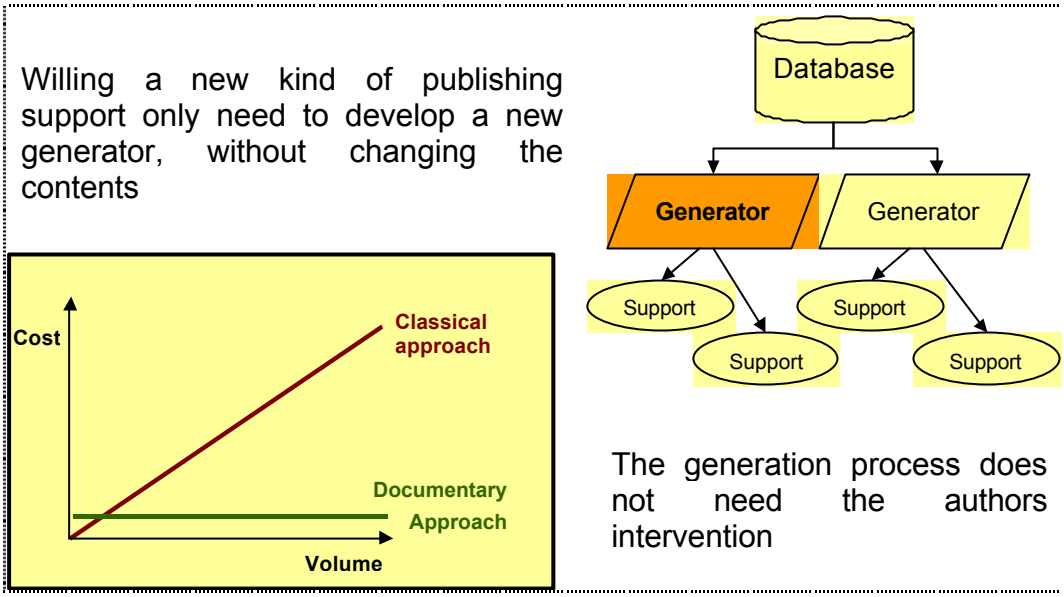



**Figure 11: Maintenance cost saving (publishing changes)**

### 2.3.3.3. Pedagogical format

What is a pedagogical format?

Whereas a technological format is easily identifiable, since it refers to a technical way of organising information, the pedagogical format is less classifiable. As an analogy, we can say that it refers to the methodological way the information is organised. And more precisely we can define a pedagogical format as:

- The information in itself (the pedagogical resources)
- The way the information can be read and navigated (the pedagogical scenarios)
- The graphical style of the published supports (the pedagogical composing)
- The pedagogical actions expected from the learner (the pedagogical activities).

Content is designed following a pedagogical format adequate to the context and objectives it aims to answer. The problem of pedagogical format is similar to the problem of technological format: How to easily represent pedagogical information without depending too much on the format, so that the content could be shared and reused in several contexts?

What needs to be managed?

The problem of pedagogical format can be summarized in two main functions:

Easily reorganise content in order to add and remove resources, and to switch for one pedagogical scenario to another.

Easily republish the content in order to fit new requirements in terms of composing and pedagogical activities.

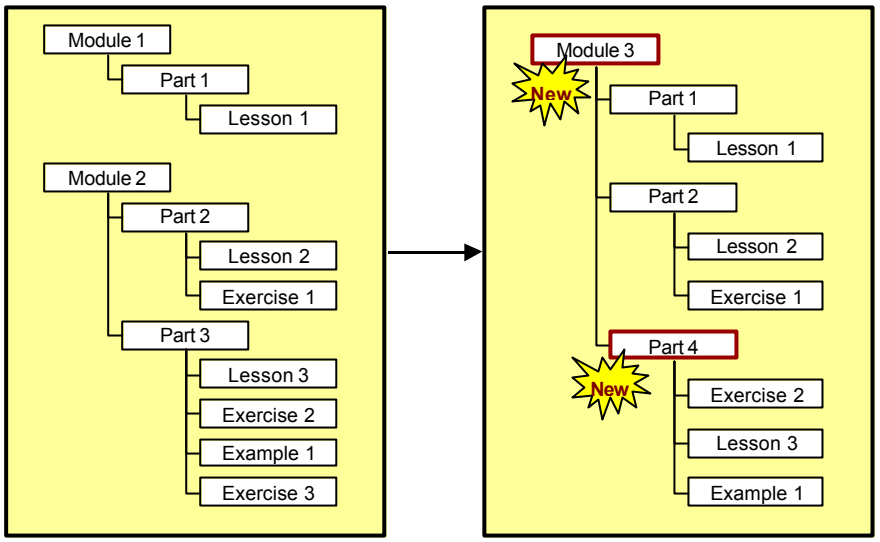



**Figure 12: Content reorganisation depending on the context**

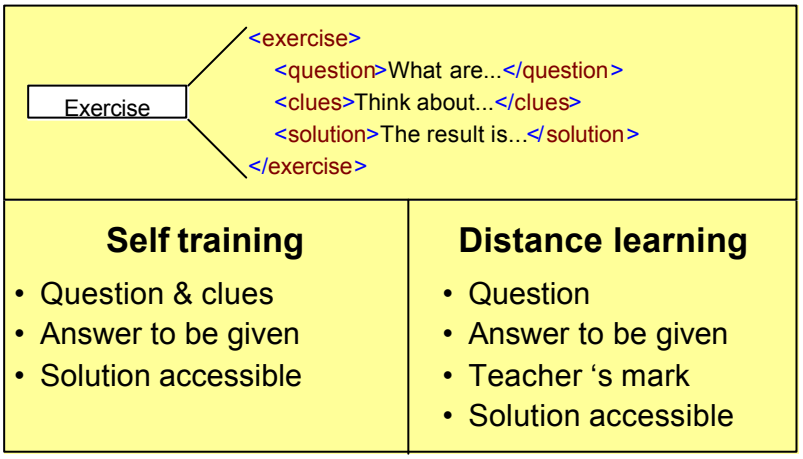



**Figure 13: Content various publishing depending on the context**

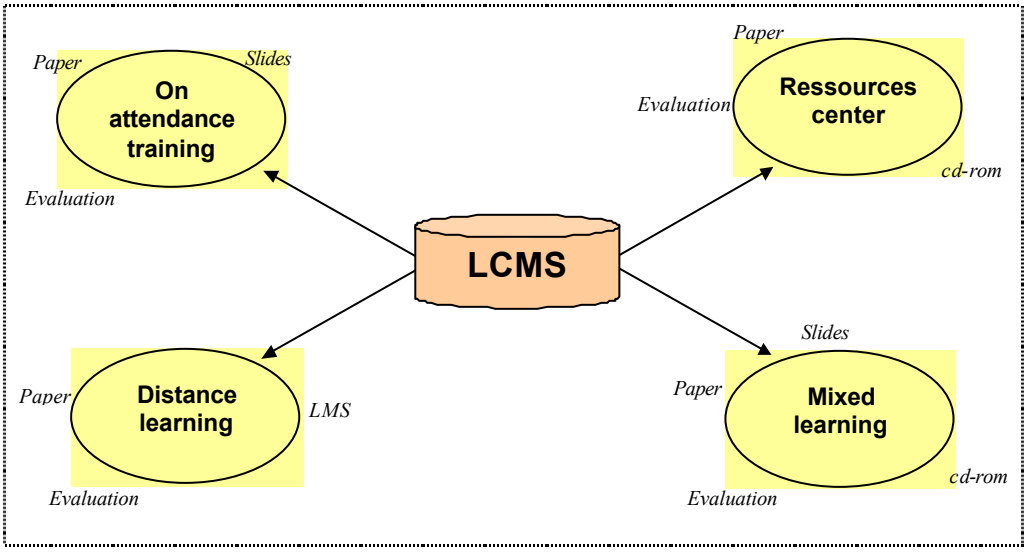


**Figure 14: Multi-publishing for multi-uses contexts**

How to manage it?

To achieve the needs of flexibility required for pedagogical format, it is first of all necessary to base on a flexible technical format. It is then necessary to base on a technological framework that allows multi-support publishing. The previous choice of a logical storage format and of XML technologies, complies these two first requirements.

The last needed condition is an adapted way of representing contents, basing on two basic principles:

- The content modularity: the more granular the content is, the easier it is reusable
- The separation between resources and their pedagogical scenarios: if this separation is complied, then is becomes easier to fit the resources on a new scenario, different from the one it has been designed for

Several solutions exist to fulfil these principles, such as:

- Content Aggregation Model from SCORM
- EML from Open University of the Netherlands
- PS/LU model[3] from University of Technology of Compiègne (France)

Let us remark that all these models base on XML representation of the contents.

### 2.3.4. Focus on LMS

#### 2.3.4.1. Recommending functions

Many studies have tried to define the main functions expected from a LMS, we just recall the main ones below:

- **To organise the courses** within several pedagogical contexts (distance learning, on attendance teaching, self-training, etc.)
  - Specifying the activities to be follow-up
  - *Providing time management tools* (planning, calendar, diary, etc.) related to contents (linking date to concerned contents for instance)
  - *Alerting* users of the steps of the training (informing about new contents since last visit, about deadline to be reached, etc.)
  - *Preparing collaborative activities*, so that each user knows and respects its tasks
  - *Making easier assessment*, whereas it is on-line or out-of-the-LMS assessment, providing marks and corrections, etc.
- **To manage actors** (learners and teachers typically)

[3] For "Pedagogical Schema & Logical Unit", developed in "Eléments pour la conception industrialisée des supports pédagogiques numériques, Stéphane Crozat, PhD thesis, Université de Technologie de Compiègne, France, 2002.", and used in SCENARI LCMS (wwwspul.utc.fr).

- *Insuring security*, by users identification and accesses management
- *Insuring robustness* and scalability, even for thousands of actors
- *Connecting to local directories*, generally existing in the existing information system
- *Clarifying the roles* of the actors (learner, tutor, supervisor, etc.)

– **To deliver contents**, in the framework of the courses

- *Referencing* the contents in adapted catalogues, allowing navigation between large number of courses
- *Helping to find* and choose the courses for a specific need (search engines, pre-evaluation and positioning tools, etc.)
- *Connecting to external tools for content production* and management (LCMS, but also authoring tools, etc.)
- *Insuring quality* and quality of service (i.e. quality and rapidity of delivery), even when dealing with hundreds of courses for thousands of learners

– **To enhance communication** between students, and between students and teachers

- *Providing communication tools*, for synchronous and asynchronous communication, by textual, audio and/or video channel
- *Organizing threaded discussion lists*, for question and answers capitalisation
- Connecting to external communication systems (such as mail servers for instance)
- *Allowing individual and group working areas*, to manage personal documents and productions of students and teachers in the framework of the training

#### 2.3.4.2. State of the art

A very large set of studies have been realising for last four years in Europe and USA in order to submit comparison between existing LMS. We can quote as a matter of examples:

- Préau (preau.ccip.fr) / Aska (aska.fr)
- Algora (algora.org)
- Thot (thot.cursus.edu)
- Canal Eife-l (eife-l.org)

Since these studies exists and are usually updated, we mainly based on them, along with the own experience and expertise of UTC, to analyse the state of the art.

As a conclusion we can establish that three main solutions exists in order to set up a LMS

solution, commercial platforms, free and open-source platforms and specifically develop platform.

| | Description | Examples | Positive aspects | Negative aspects |
|---|---|---|---|---|
| **Commercial LMS** | Ready to use, and generally adaptable, solutions sold by editors. | Docent<br>Learning Space<br>WebCT<br>Top Class<br>VirtualU<br>BlackBoard<br>Luvit<br>Saba<br>Aspen<br>etc. | Many offers<br>Reliable solutions | Licences costs<br>High costs for specific adaptation<br>Technical infrastructure needed<br>Dependency<br>Low respect of the e-learning standards |
| **Free and open source LMS** | Generally issued from universities, these solutions can be used without paying an editor. | Ganesha<br>Claroline<br>Phèdre<br>etc. | Free<br>Source code adaptation possible<br>Future evolution expected | Few offers<br>Open source communities not yet constituted for e-learning platforms<br>Product still young and functionally and technologically poor<br>Still important costs for adaptation since the application cores are not very advanced<br>Non respect of the e-learning standards |
| **Specific solutions** | Directly developed for the needs of one organisation, such as web portals or web applications. | Universities and firms portals for distance learning management | Functions and technologies totally adapted to the needs<br>Possibility to respect any interoperability needs | Costs generally high for one organization<br>Redoing what already exists |

**Figure 15: Comparison between three large families of LMS solutions**

### 2.3.5. Focus on LCMS

#### 2.3.5.1. Recommending functions

As a synthesis of our studies on the subject[4], we propose the non-exhaustive set of

[4] For instance :Ref 2

functions that can be expected from a LCMS:

- **To model** pedagogical contents within formal documentary language (a DTD[5] and a set of XSL[6] for instance)
  - *Adapting to the previous existing contents*, without imposing a predefined structure and being able to evolve with the evolution of the needs
  - *Profiling to various contexts* to fit the conditions for reproducibility and generalization
  - *Being reliable* to ensure correct description and exploitation of the contents
  - *Admitting deep reengineering*, to be able to move from an old model to a new one
- **To produce** logically structured contents (XML for instance)
  - *Providing authoring tools and methods*, to guide authors in their content production
  - *Resisting to technological evolutions* (typical problem of format)
  - *Being easily maintainable*, directly by the authors themselves and without the need of any technical expert mediation
  - *Weakly depending on any supports*, to allow automatic publishing
  - *Weakly depending on the contexts of use*, to allow enlarged exploitation
  - *Being controllable and automatically validated*, to ensure quality certification, in terms of structure and drafting
- **To publish** readable supports from structured contents (HTML for instance)
  - *Managing interactivity*, since the user in a pedagogical context, the learner, needs not only to consume information, but also to produce his own information (answers to exercises, annotations, etc.)
  - *Managing multimedia*, since the digital support offers the possibility of simultaneous use of several different kinds of media (text, scientific formulas, speech, image, video, etc.)
  - *Managing multi-support*, in order to be able to generate automatically (i.e. calculate) several composing of the information, for several publishing supports, on the basis of one single content (paper and slights for on attendance learning, Internet web site for distance training, cd-rom for self-training, etc.)
  - *Managing multi-LMS*, as an extension to multi-support, to allow generated contents (typically HTML plus JavaScript) to be used within any LMS with a similar functional range
  - *Ensuring quality control* and homogeneity (in terms of information, composing and interaction) of a large scale production within one or more

[5] A formal model for a set of XML documents
[6] XML, i.e. programming language to manage XML documents manipulation and publication

line of business

- **To manage** and maintain previously produced contents (in their XML format typically)
  - *Enhancing reuse and sharing,* in particular in a multi-authors context (security, access rights, etc.)
  - *Enhancing continuous improving* of the content, with access to flexible and reliable functions (versioning, historic and undo, etc.)
  - *Enhancing contents recombining,* allowing multiples scenarios to be set on the same contents
  - *Enhancing context adaptation,* meaning being able to adapt generic contents to each specific pedagogical context of use

#### 2.3.5.2. State of the art

The LCMS domain has been developing for one or two years. Some reports on the subject begin to appear (for instance "HRM report n°2" (Ref 19) or "LCMS Report: Comparative Analysis of Enterprise Learning Content Management Systems"(Ref 16)). This domain is one of the main specialities of UTC, involved since 1997 in research around the use of documentary technologies within the field of education (Ref 5). These former researches have been developed through out a thesis and gave birth to a first system called SCENARI (Ref 4). This system has been developed in order to become a LCMS with in the framework of a French ministry of industry R&D program (program name: RIAM, project name: CHAPERON, global budget: 1.2 M€).

An overview of SCENARI LCMS functions is given in **Appendix 1**.

Since the domain is still emerging and since e-learning actors are not all aware of this subject, we observe that five main types of systems are used to manage contents, real commercial LCMS, R&D LCMS from universities, LMS providing content management functions used as LCMS, authoring tools used to produce content, and specific systems developed to fulfil the content management functions:

| | Description | Examples | Positive aspects | Negative aspects |
|---|---|---|---|---|
| **Commercial LCMS** | Real systems able to manage contents within a documentary approach. | LearnXact from Giunti Publishing Group, Italy<br>(Till today we have not been able to identify another commercial LCMS system) | Reliable solution<br>Respect of e-learning standards | Very few offers<br>License cost |

| | Description | Examples | Positive aspects | Negative aspects |
|---|---|---|---|---|
| **University LCMS** | R&D systems still developing by universities and not yet in a commercial phase. | SCENARI from UTC (Till today we have not been able to identify another university LCMS system) | Evolving solution<br>Functionally and technologically rich solution<br>Reliable solution | Not yet commercially available<br>Still developing solution |
| **LMS used as LCMS** | Since most of LMS provide content management solution, the are often used as LCMS. | Aspen<br>Docent<br>ARIADNE (Ref 12)<br>Archimed<br>Learning Space<br>Saba<br>Etc. | Available when already have a LMS | Not really oriented toward management of content<br>Non documentary oriented solution<br>Difficulties to reuse contents outside the LMS<br>Poor respect of the standards |
| **Authoring tools** | Many tools exist to help authors in content production activity. | Toolbook<br>Frontpage<br>Dreamweaver<br>Director<br>Flash<br>Etc. | Quite simple of use<br>Large freedom of production for the authors | Proprietary format solutions<br>Non documentary approach<br>Only oriented toward content production and not toward content management<br>Technical competencies needed (more or less depending on the systems) |
| **Specific solutions** | Directly developed for the needs of one organisation, such as database, workflow or EDM application. | Universities and firms application either based on light solutions (PHP, MySQL, etc.) or harder solutions (Oracle, | Functions and technologies totally adapted to the needs<br>Possibility to respect any interoperability needs | Very high costs for a complete solution<br>Difficulties to specify a good system in such an emerging domain (few functional expertise available) |

| | Description | Examples | Positive aspects | Negative aspects |
|---|---|---|---|---|
| | | Documentum, etc.) | | |

**Figure 16: Comparison between four large families of LCMS solutions**

## 2.4. Course activities

### 2.4.1. Introductory Remark

Under the header "Platform Support for Collaborative e-Learning", basic functions for a variety of net-based learning platforms will be described, taking into account the specific requirements of course activities. In this chapter, we will be listing the objectives of and requirements for a common platform. While a common platform may not even be realistic (given the wide range of learning systems and purposes) we consider this it as a kind of template for platforms tailored to particular learning purposes.

### 2.4.2. Course Activities

In traditional classroom teaching the speaker (a lecturer, at times a student in a seminar setting) lectures while the students are acting in a mostly receptive way. Feedback from students, or discussions, is unlikely to occur in case of large classes.

By using net-based or net-supported, services several new learning methods could be integrated into class presentations, or they could constitute novel forms of net-based teaching:

Self-Learn Activities

Comprehensive class material, even a complete video-taped lecture, can be offered via a web-based learning platform. The material could be utilized as support for the actual presentation, e.g. replay of passages that had not been thoroughly understood, or as a substitute of a class presentation (distance teaching). In the latter case, students may use built-in assessment tools for testing their understanding of presented topics; in particular tests and exams (mid-term, final) could be done via the Internet.

Cooperative / Collaborative e-Learning

While a large class size is prohibitive for oral communication or more elaborate forms of direct cooperation, net-based communication and collaboration tools open new doors for a dialogue between all participants (lecturer and students). News, Chat, or video conferencing have been used frequently. However, this is barely the tip of the iceberg. Organizing a substantial form of brainstorming in a class of 600 students (a frequent size for undergraduate CS classes in Dortmund) is an "elementary" example which makes the need of even fundamental research evident. Voting as a way to streamline the process is e.g. inadequate since ingenious ideas would typically be ruled out. In a different direction novel CSCL procedures for e-learning could be developed where the educational structures are in congruence with the objects and operational structures in the topic area. This is the theme of the CoTTCoL project which is done in

Dortmund in order to create both intensifying and compacting collaborative processes in large classes. This has implications for shaping platform services. We anticipate that also other group members or universities have come up with a number of innovative e-learning concepts. Such contributions should in the near future be discussed in terms of support services and tools required from platforms.

*Student mobility* also poses several problems for providing adequate platform services. Not only should students in a virtual university be encouraged to move between different campuses while finding the same quality, structure, and format of services. At the same time collaboration between students at different campuses should ideally be organized in transparent manner.

### 2.4.3. Functionality

| Topics | Functions | Constraints | Comments |
|---|---|---|---|
| **Development and production** | | | |
| Author/ production tools | There are 2 ways for production tools to work:<br>• Tools are integrated into the platform<br>• Standard tools<br>A teacher should be able to easily switch between a student's and a tutor's view. In this way LCMS and LMS functions are tied conveniently. | Since there are hardly tools that work across platforms a simple, integrated input tool to be used by a browser should be available at least. | A platform should provide for both integrated and standard tools. For simple design tasks an integrated solution with a few options is sufficient. Extensive tasks should be better performed by utilizing standard tools. |
| Templates | The initial design frame for a course helps the author to create a course. It documents the pedagogical approach concerning the contents, structures and operational issues. | | Didactical planning is to be reflected in the templates. Despite their recommending character they initiate a discussion about the topics, and they facilitate uniform action. This is a strong motivation for templates. |
| Instructional Design Tools | These tools enable a lecturer to combine different learning modules which are stored in a database related to a course. | This function needs modules to be categorized based on common standards. However, this may cause an extra effort on behalf of the authors. | cEVU will certainly provide a data base for learning modules to form the basis for export offers, or to be decentrally composed and used by participants in different universities. |

| | | | |
|---|---|---|---|
| **Delivery** | | | |
| Online | The contents are available on-line. Communicative and collaborative facilities can be used interactively. This is specifically useful if not indispensable for collaborative elearning yet it relies on dedicated channels. | Switching between on-line and offline mode should not change the topology or communication structures between the sites involved. | For web-based contents, services etc. the data transfer rate can be kept to a minimum as long as a local copy is used, and consistency is maintained between the distributed copies. Depending on the application mutual or weak consistency could be the adequate choice, respectively.<br><br>The same technique could e.g. be utilized for tracking of pages used, or when test/ exam results entail a modification of the course contents or its presentation. |
| Up-/download | These functions can be realized through internal functions or through standard tools such as FTP clients. They could be performed locally or remotely. | Data security is a central issue. Integrated components may potentially have restricted functionality yet they are normally more secure. | Sine user-friendliness is a dominant objective preference should be given to integrated solutions. |
| Offline | Through a specific function the complete content of a course or learning module should be offered to be downloaded for off-line work. | This function requires that courses as well as learning modules are offered as autonomous units. A linking of modules may be adversary to this service. Through integrated packing programs the data volume could be kept to a reasonable size.<br>Besides downloading courses or course modules, even files should be available for downloading. | Since dedicated communication lines and flat rates become ever more accepted, since connection costs grow no longer excessively this service is decreasingly relevant. Of course, this might change once W-LAN connections are used heavily. |
| Import / Export | Contents, network structures but also user profiles etc. should be exchangeable between different platforms through specific functions. | Exchanging complex data structures involving communication platforms with non-open standards is rather difficult if not prohibitive. This implies that open standards are the adequate choice. | Since many universities already operate their own platforms import/ export functions are of particular importance. It is suggested to design requirements for learning modules with respect to cooperation across platforms. |
| | | | |
| **Collaboration** | | | |

| | | | |
|---|---|---|---|
| E-Mail | Sending and reading mail by<br>• a standard E-mail client (e.g. Outlook)<br>• a web-interface (It may include searchable address-books)<br>Providing mailing lists of course members | Replying by broadcast is feasible within small groups only while this is inappropriate for large groups. The service should be configurable to the needs. | Web mailers become increasingly accepted for a variety of reasons. This trend could be further supported by an integrated web mailer. |
| News / Forum | Threaded discussion forums to organize the exchange of, and the response to, messages.<br>Each course has its own discussion forum | Discussion forums may be equipped with additional functionality such as:<br>• marking new entries<br>• communicating new entries through other communication channels (mail, SMS)<br>• labeling contributions after reading them<br>• Certain forums with restricted access. | In order to avoid a messy picture additional functions should be carefully selected. As an example, alerting a user about a reply to a previously sent message has been proven helpful, even more so if offered as an option. |
| Chat | It enables conversations between class participants synchronously<br>Each class has its own chat room. | A wide-spread characteristic of chat users is their use of synonyms. In the teaching context this should not be permitted. Identification should be performed through logging into class pages. | Although this instrument is rarely used it should be available nevertheless. It is helpful that chat appears in a separate window if material under shared inspection should be discussed on-line. |
| White Board / Application Sharing | A White Board is an electronic version of a classic blackboard. All participants of a course can write / paint on it, and everyone can see it. Application Sharing extends this functionality. A software program can be viewed by all, and will be controlled by the owner (a student or lecturer). Beyond this: While for a single application (white board) a control passing is a reasonable option more complex structures of distributed control for sharing multiple resources have still to be explored. | Besides technical discussions also licensing and legal problems limit the range of sharing. Since technical evolution is fast regarding channel bandwidth, communication protocol, and hardware components this is a permanent issue of intensive research. In the future ASP (Application Services Providing) will be a major R&D domain. | Technically, application sharing is still in its beginning phase, its utilization in a teaching/ learning context has not been substantial. Since in this direction new forms and qualities of learning could originate basic functions for application, sharing should be provided. |

| | | | |
|---|---|---|---|
| Audio / Video – Conferences | Video Services enable real-time voice and picture (video) interaction as part of the course.<br>Video Services include tools for broadcasting video to those without a video input device. Some video services provide for two-way or multi-way video conferencing which may be point-to-point connections or mediated through a central server. | Currently many technical deficiencies have to be overcome. While point-to-point video connections are essentially steady and of good quality multi-point connections frequently experience technical problems resulting from small bandwidth or through conflicts with firewalls and incompatible video communication protocols. At this time a safe connection can be achieved only through the ISDN pay service. | In e-learning and teaching video conferences, in particular multi-point connections are of secondary relevance only. They make teaching more attractive; however its effect on learning success is marginal. |
| Brainstorming | This is a well-known collaborative technique for generating *innovative* ideas. | The problem in large classes (100 students and more) is that the communicating and building a cooperative awareness for really new ideas yet a dynamic structuring concept for groups working on closely related theme contributions is indispensable. | Open R&D issues. Easy solutions like voting while streamlining the solution process are not appropriate since they typically rule out the really ingenious ideas. |
| Negotiation | Distributed agent / broker systems | Available techniques would have to be adapted for developing specific fact-finding methods or for preparing/ interpreting experimental results or set-ups, respectively | Open R&D issues |
| Tool-based online services | Search for executable (simulation) tools;<br>Topic-specific DBS search procedures for explaining, discussing, verifying properties in a practical context (where an analytical approach does not apply). | Research here would need both pedagogical and topic-related competence, so far quite a rare combination. | Open R&D issues; example: experimental verification of conjectured system properties |
| | | | |

| **Productivity** | | | |
|---|---|---|---|
| Instructional Standards Compliance | For the interoperability of applications and services it is necessary to use standards e.g. developed by the IMS global Learning Consortium.<br>As long as student data are maintained in the system This is a complicated issue (data security). | As commercial products (typically proprietary standards) are not meant to have their data integrated into other systems without loss (e.g. data anonymity) there seems to be no natural way of standard compliance. On the contrary, data management and transfer across platforms have to rely on open standards and transparent data structures, for best results. | The compliance requirements could be more easily realized through Open source products. Once these are widely spread and both contents and services are widely available commercial suppliers will probably offer import filters at the least in order to participate (partially) in the business. |
| Connection to administrative (student, faculty) data | Utilization of existing data bases | In each administrative university data base the student data should be linked to the user administration of learning platforms. This allows the learning platform service to verify student access to class material and at the same time assign credit points after passing a course. While this could be handled conveniently in one university data security and integrity are so far problem areas that still need major research if credit point transfer between universities is to be established. | The connection between platform services and administrative systems is certainly indispensable for international credit point transfer. |
| | | | |

| **Assessment** | | | |
|---|---|---|---|
| Self tests | • Generation of self tests<br>• Access by the students<br>• Automatic corrections / hints | Development of assessment tools is time consuming. A high rate on labor investment could be achieved once standardization and joint development/use are feasible. This is an area that needs further exploration and research. (In addition: one could consider buying in and adapting. At this moment, Strathclyde University leads a consortium of UK universities that have their self assessment tools development outsourced to an Indian software company.) | In traditional learning situations feedback between students and teacher might be easy enough to achieve, like in homework discussion groups (student/tutor communication). Where a direct feedback cannot be realized self assessment tools (both for students and the teacher) gain importance. Thus it is at least advisable to include a standard e-learning tool package into the platform services. |
| Homework assignments | • Generation of assignments<br>• Access by students<br>• Access to student solutions by the lecturer<br>• Automatic pre-correction / hints<br>• Access to results by the students | It would be a foregone benefit if the web would only be used in this learning context as a high speed data exchange medium.<br>We get the most of the new opportunities that the web offers us if a full-swing re-engineering of learning environments results in creating or adopting new interaction forms in interactions between students and lecturers. Also a maximum use of new interaction and collaboration services is to be achieved.<br>Once more, further exploration and research should have priority here. | Convincing first steps should be the implementation of tools that enhance efficiency for actors in the teaching/ learning process and widen their scope of (asynchronous) access. Once this has been achieved and actors get engaged the implementation of novel services and forms of interaction should be the next step. |
| Exams | • Registration<br>• Automatic check for prerequisites<br>• Access to results by the students | For traditional forms of written exams it appears impossible to control unpermitted access to sources or help from third parties if a student may take the exam e.g. at home. | While the authentication and authorization problems will probably remain unsolved new scenarios of student evaluation will be a major research issue. |
| | | | |

| **Administration Tools** | | | |
|---|---|---|---|
| User Management | For a student:<br>• Registration at the platform<br>• Registration for a course<br>For a teacher:<br>• Registration of a lecture<br>• Giving registered students access to his own lectures<br>For an administrator:<br>• Assigning roles (evaluator, grader, moderator, external expert,...)<br>• Access to the platform<br>• Processing of new lectures | User specific services have to be offered. Specific procedures (registration of user name and email address) should be conducted by the user using data bases.<br>A complex problem is the overall management and the control of decentralized databases between co-operating universities. Not only functional software problems will have to be solved, the main problem will be protection and security between decentralized databases. | User-friendliness is a crucial factor for swift acceptance of a learning platform. Easy use is therefore the predominant requirement. In particular during registration to a course formats, contents, and prerequisites etc. should be available for convenient browsing. |
| Curriculum Management | These services support the students in making use of the curriculum offered in the following ways:<br>• Highlighting the learning materials that have been recently updated or are new offers<br>• Allowing for restricted access to class material like test results.<br>• Blending in special assignments to improve the understanding of homework assignments. | The issue of user adaptive learning environments still requires much research. At stake are intelligent systems that adapt to learning strategies and selection of material/ methods to student strength and preferences. The main challenge seems to be how to deal with interoperability of these complex systems. | Basic services for curriculum management should be available in any learning environment. Often the availability of these services is the major quality issue platforms. |

## 2.4.4 Sub conclusions

The envisioned modern and future platform services for enabling **course activities will be *across platforms* and *collaborative*** as much as course development itself will be. Only in this way will the platform support have a fertilizing effect on course development as well as a flexibility of curricula and their development so far unforeseen will be spreading across borders.

To this end, a few more leading thoughts and observations regarding the successful future

use of services may conclude this section.

In the future instructors need to build their teaching and ***learning functions and tools in a modular way,*** and ***services for different course activity support have to be fully integrated.*** Without modularization or standardization collaboration across platforms will not be efficient, not even possible.

In addition to this, new communication facilities like WLANs create a special incentive for collaboration among instructors, developers, and researchers, and they certainly entail novel forms, and a novel potential, for ***instructor and student mobility.*** This has to be paid for by higher connections costs, reduced bandwidth, and increased security problems.

Currently classical forms of **collaboration** like through e-mail are widely distributed and used. Also Chat is still rather popular in tutoring or consulting scenarios. However, more advanced tools such as e-supported brainstorming, Whiteboard, or video/ audio conferencing are very infrequently used, or even need to be developed into a mature state: So far technical prerequisites are inadequate, e.g. the reduced bandwidth for video communication, or the lack of appropriate firewalls for secure collaboration during (on-line) course development.

Finally novel elaborated teaching/ learning concepts would create a strong impulse for collaborative course activity or development projects. As an example there is currently a real need for such novel concepts to handle large classroom settings in an adequate and efficient way, as remarked in the introduction of this section. This opens up a novel set of **open research issues** that should be approached very soon. Of course, collaborative platform facilities could help here considerably.

## 2.5. Project work activities

Collaborative project work should be viewed as a broad activity in many different applications: making a project report in computer science, writing an article, developing software, creation a music composition, making a multimedia document with images, audio and video etc. Basically it is a matter of handling all data formats and large files in a structured way.

Project work made as a remote activity needs 3 groups of facilities with more topics:

1. Negotiation
    a) Work distribution
    b) Time planning
    c) Competence development
    d) Tools
2. Interaction and collaboration
    a) Online communication tools (forum, chat, IP videoconference, audio conference)
    b) White board (concurrent use of the same contents by different users)
3. Document collaboration

a) Administration
b) Upload
c) Download
d) Development outlook
e) Development management
f) Product presentation

### 2.5.1. Negotiation

At the beginning of a project work, important commitments are going to be settled among group members. All kind of communication may be used, but in case of remote education, people may meet physically at the beginning of a semester to know each other and make the first agreement on future collaborations. The goals for the negotiations are:

a) Identifying the work and distribute the work among group members. Sub groups are recommended to strengthen the collaboration, the social factor and progress in work.

b) Making the first schedule including deadlines for activities until the next planned group meeting.

c) Making agreements for individual and parallel competence development. This is important since collaborative work is based on an equal level of knowledge in terms of theory, methods and practical experiences.

d) Selecting proper tools for the work. It is important to select tools with respect to computer power, network infrastructure and best praxis.

### 2.5.2. Interaction and collaboration

Two methods are used: asynchrony and synchrony. The first is free in time and is known from News, email, www and other posting facilities. The second is a real time method and is known from written and spoken chat and video conferencing.

The synchronous way to interact has a problem in network performance and capability, so until now, the written chat is mostly used. When it comes to 'free in space' audio and video chat using simple headset (also known from telephone meeting) and web-cam the latency time is often too high for interactive sessions and most IP networks do not yet allow forwarding of multicast. Video conferencing needs special facilities and is therefore not free in space; it is costly too. A point to point connection is much easier to establish, so collaboration between 2 persons is optimal. Firewalls must in all cases be taken into account.

Shared white board is not used very much either, since the use of writing pads is not common yet. It is however an area of interest since it does not necessarily require very fast network and can be seen as a kind of graphical chat facility.

### 2.5.3. Document collaboration

The content management for the collaborative project work need a lot of facilities to ease document exchange, (re)view and storage. Many online versioning systems are available with very different facilities and qualities of user interfaces.

The basic requirements are discussed here.

#### 2.5.3.1. Project work administration

Before a project group can work on a project, the environment must be established on the digital platform. This is done by the supervisor/coordinator for the group via a web interface and consists of:

- Creation of project on the server - deletion as well
- Assigning users on the digital platform to the project
- Providing necessary communication aliases

When created, all participants are assigned with reading/writing permission. The deadline for project termination is also defined as an attribute.

It should be taken into account that different projects can be carried out in the same time, which can complicate the administration of the project. Instead of one supervisor per group, there can be one general administrator and several supervisors for the different groups. All members of the groups and subgroups can have different rights (reading, writing deleting permission in a certain project) and can give access rights to each of the objects they create.

#### 2.5.3.2. Document upload

After a project work environment is created, restricted users may upload documents. The storage is in an open file structure on the server, which is backed up regularly. Reference to documents and document attributes (dates for upload and deadline, author, file name, mime type, size, etc.) are stored in a database.

When uploading for overwriting, it is recommended to use an internal numbering system stored in a parallel document and to provide a backup service in case of accidental overwrite.

Most file formats (MIME) must be accepted (textural, audio, video, images, etc). Documents relaying on references to objects outside the document must be handled in a special way. This is for instance the case for HTML documents which have associated and not embedded objects. In that case, a packed (ex. zip) file might be used for upload and unpacked at the server side for presentation. It is recommended to use document formats and tools easy to annotate and review in the collaborative process. (Ex. MS word)

The user interface for upload is a simple graphical user interface (GUI) containing:

1. Button for browsing the source document
2. Menu for browsing the destination in the project tree like:
    a. a new version in a chapter
    b. a new review to a version
3. Fields to insert attributes such as:
    a. expire date or deadline
    b. change of responsible person
    c. change of document name

### 2.5.3.3. Document download

Download of documents – for view and processing - should be made directly from the visible project tree relying on precise naming and position.

#### Development outlook

The visible project tree should present the project structure and an associated frame or pull-down menu should be used to access document itself and view and modify document attributes. Sections (or chapters) in the tree should be collapsible to increase overview and expandable to focus on details.

An example of a project tree is shown in Figure 17 where chapter 22 has 3 documents in the beginning and the first has a review associated.

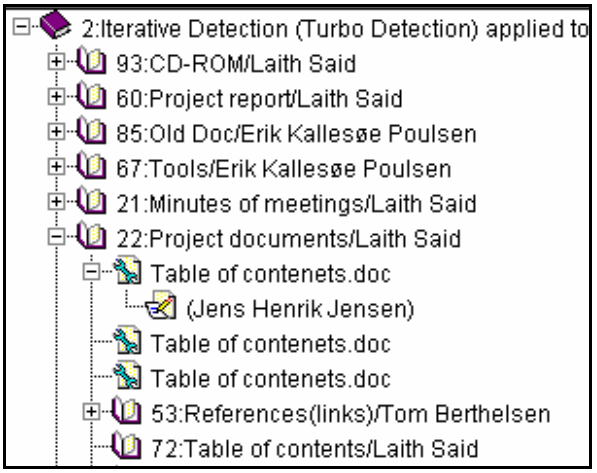



**Figure 17 Example of a project tree. A closed book icon denotes the project name. An open book icon is a chapter and the rest are documents. The person responsible for a chapter and the review author are also shown. The 3 document with the same document name are 3 consecutive versions (A naming may be used to display the version number). Version 2 is a result of processing parallel review(s) to version 1. When a document is new, a 'star' is shown on the document icon, and will disappear when touched. A 'tool' icon denotes a locked document blocking for further review upload.**

#### Development management

Time management of deadlines should also be included in the document handling and not just timestamps of creation of a document, consultation, downloading, etc...

Example on project management is shown in Figure 18. The frame is displayed when activating the closed book icon on top of the project tree in Figure 17. Facility for creating chapters in the tree is available. A complete history (dates, author) for groups of documents (chapters, sub chapters, project) is useful both for the project members and statistics.

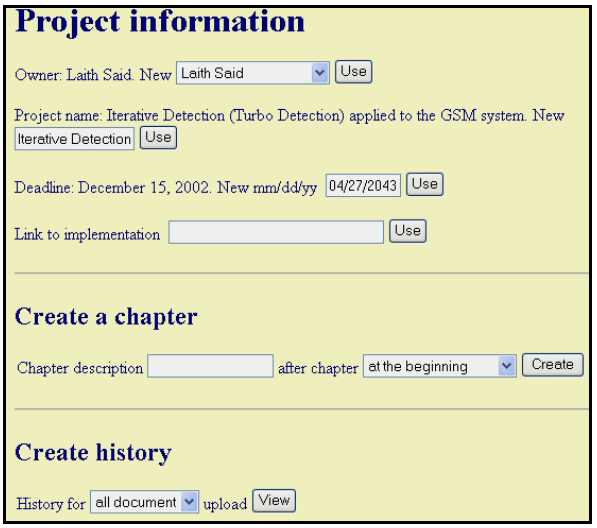



**Figure 18 Information frame showing project attributes and user facilities. The changeable author and project name as well as the project deadline. The URL for final project is loaded in the implementation field.**

Example on chapter management is shown in Figure 19. Subchapters may be created in the tree and moving chapters including subchapters and documents is also possible. User interface for upload of a document to the chapter is partly visible in the figure and results in a new automatically numbered version in the tree.

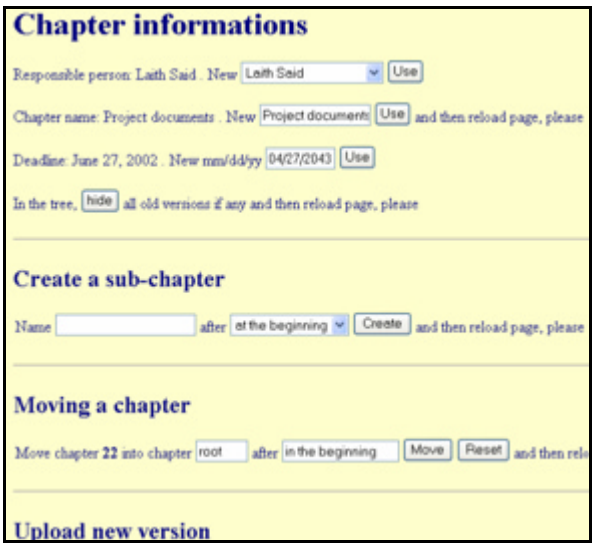



**Figure 19 Information frame showing chapter attributes and user facilities. Pressing the 'hide' button, all old documents are hidden in the project tree view. When a hidden document exists, a 'show' button is presented instead of the 'hide' button.**

Example on version management is shown in Figure 20.

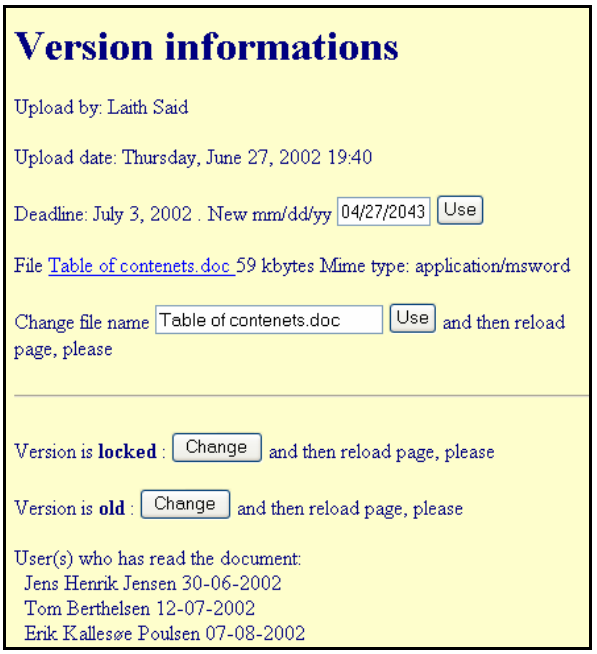



**Figure 20 Information frame showing version attributes and user facilities. The document is locked for further review upload and made 'old' and eventually to be hidden in the project tree (see Figure 19). Three persons have opened the document at the specified time.**

Reviews to a document version are also auto versioning.

To have the possibility to hide a document in the tree, it can be marked 'old' by using a toggle button.

Other nice facilities are document lock to prevent further review to be uploaded. Also a document attr ibute showing who has consulted the document is very useful.

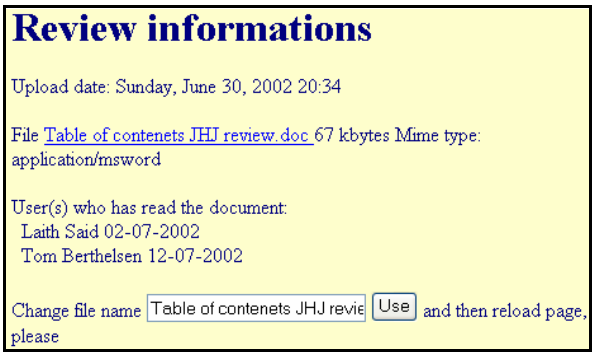



**Figure 21 Example of review document information's. Date for upload, link for download, size, mime type, who has touched the document and a possibility to rename the document. Delete of review is not shown.**

Deletion of documents is restricted to members of the project group.

#### 2.5.3.4. Product presentation

The final product is stored on the digital platform and the URL is inserted automatically into the user interface.

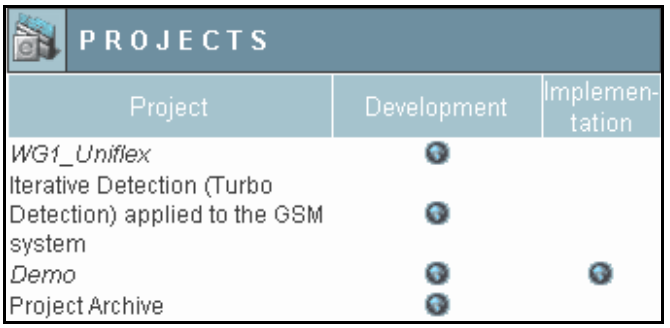



**Figure 22 User interface for project activity in a selected digital platform (UniFlex/AAU (Ref 27)). By pressing the 'Development' dot, the project tree structure is opened as shown in Figure 17. The 'Demo' project has an implementation URL stored via the input field in Figure 18 and is behind the 'Implementation' dot for access.**

### 2.5.3.5. Constraints consideration

If the server side does not support a database for on-line project work this is a problem since only very few rules for access and manipulations are then available. If web based interfaces are not used, there might be problems in access via firewalls. Concurrent work must be taken into account by locking opened document.

### 2.5.3.6. Recommendations

Client interactions should be web-based and the server should include a database for managing all documents. A reliable backup system must be used at the server side. The project tree must present the document structure showing document status too. Responsibilities and deadlines are important attributes. Auto versioning must be used and the type of review must be chosen (parallel or sequential). Concurrent work is recommended and the system should handle large files and numerous MIME types.

### 2.5.3.7. Research considerations

To minimize network load and delays, multicast is the best to use, but multicast is not commonly routed, so another method must be used if ex. audio chat among more persons is wanted. An audio reflector using point to point communication could be developed and used, reflect packets coming in to all users assigned. The same reflector may be used for video too, so synchronization between audio and video is possible and even blocking for video if the network bandwidth is limited.

### 2.5.3.8. Pedagogical considerations

In the frame of PBL, the courses and project work are interacting. The problem to be solved is performed in project groups as project organized work leading to a product solving the problem. In an educational situation, the students are focusing on the project and the courses are taken to increase competences in terms of theory and methods. Group members can only work on equal base if they develop competences in parallel, thus to emphasize that a calendar for synchronizing courses with project work is needed. Of course all courses may be given first in a semester followed by the project (Ref 7), but motivation is highly increased if courses are given following up the problems that need to be solved in the project.. The method to be used is to set up milestones in the calendar

marking reached learning goals. If the courses are to be taken as self learning, advanced pedagogical methods must be used to motivate and guide the student through the learning process.

The project is offered as a project description, and the working activities are made by the project group members.

Recommended Project description

- **Title:**
- **Proposal:** description of the problem to be solved.
- **Learning goals:** a list of general methods to be adapted

Recommended working activities

1. Initiating the problem
    a. "Why this problem and why are we going to solve it?"
2. Pre-analysis
    a. Context investigations, tool collection, reading experiments, course taken
3. Problem description
    a. The problem
    b. The hypotheses
        i. Statement arguing why the group believe the problem can be solved
    c. Goal
    d. Sub goals
        i. Split goal into sub activities useful for distributed collaborative work
4. Limitations
    a. Assumptions and simplifications.
5. Strategy for the project development
    a. A detailed plan for solving the problem based on the problem description and limitations. Workload, time manager, milestones, distribution of work and responsibilities.
6. Analysis - "**What** is it all about?"
    a. Deep context investigations, user interface, prototypes, demands, model, etc.- like to find out what a building are going to be used for, look like, etc
7. Design – "**How** are we going to make it?"
    a. Organizing things, relating tings, parts used where and when – like drawings, list of materials and planning for building a house
8. Implementation
    a. Make it! – based on the design – like actually building the house
9. Verification, validation
    a. Test the product to see if it fulfills the demands (verification)
    b. Test to see if the user is satisfied with the product he or she requested.( validation)

10. Results
    a. "What are the results of the project work?"
11. Conclusions
12. References
    a. Books, links, helpers…
13. The learning process
    a. Reflections
        i. List of methods used, "where did we use the specialties and where did we find the generalities such as methods".
    b. Describe the process and compare to the learning goals

The working activities could (and typically) be the contents list of the project report.

### 2.5.4. Sub conclusion

A digital platform offering collaborative on-line project work must be simple and user-friendly with a minimum of facilities to support progress in the working process. Management of documents and the document structure is needed, as well as document versioning.

# 3. Conclusion

As it has been argued in the introduction the original objectives of the Working Group on Digital Platforms has been concentrating on specifications of the universities' needs with respect to technical platforms and the characteristics and requirements that can be derived from them. Within the context of a collaborative European Virtual University, these can be summarized into three topics: (1) exchangeability of contents, (2) interoperability, and (3) interconnectivity of platforms. These topics on their turn are closely connected to openness and flexibility of the digital platforms that are in use at the partners' side. Therefore, the Working Group took as its main focus "functionality" (and from a users view point also transparency), rather than "technicality".

Functionality is in a technical perspective dependent from the nature of the LCMS and the LMS (as well as connected printer, browser, application programs, etc) that the partner institutions use, either as two faces of an integrated digital platform or as two collaborating elements of the platform. In the latter case, the LCMS part is responsible for storage of content uploaded from authors, the other part (LMS and connected equipment and programs) is to be considered as the service provider to actors, who are requesting the services. Finally, a generator extracting raw material from the storage media and composing the right format for the user is accessed on request from the actor.

Courses should be developed in the philosophy of modularization and standardization across platforms to optimize flexibility in time, exchangeability and reusability of content. Standardization implies a standardized structure, packaging and indexing of contents, as well as standardizing the way of communication between content and LMS

functions. Flexibility in place should be foreseen to incorporate wireless systems as well as to support instructor and student mobility.

In practice, with the variety of existing systems and investments made in every participating institution, full standardization at all levels is however not feasible nor maybe even desirable. Part of the solution of the occurring interoperability problems can be the use of open source software (especially if a active community supports the open source) and by dissociating storage format form publishing format. Storage should use XML technologies to enable generators to publish in various formats and layouts the same content, and to reduce their maintenance costs.

From a pedagogical perspective, the constructivist view on education increased the need of flexibility of pedagogical scenarios and pedagogical activities, interactivity between users and contents, communication between the actors (students, teachers, tutors), as well as collaboration between all those involved in the learning process. Necessary functionalities for the digital platform affect development and production (with the necessity of authoring and production tools as well as instructional design tools), delivery (both online and offline, with connected functionalities for up- and downloading, import and export), collaboration (from conventional communication to sharing of applications, conferencing and typical collaboration functionalities such as brainstorming, negotiation and shared simulation), productivity (especially the connection to administrative databases), assessment and administration (both of students, staff and curriculum).

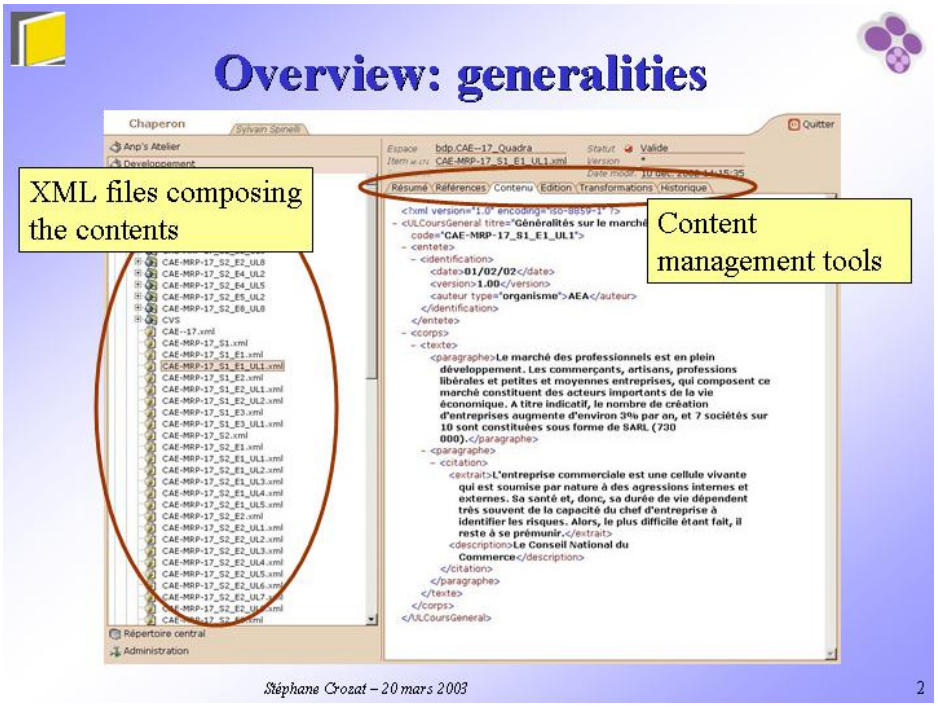
The collaborative environment (synchrony, asynchrony; written, spoken) proves to be difficult to establish, but is strongly recommended for reflections among course participants and across course and project work boundaries. Collaborative project work must include facilities for planning and distribution of work as well as document versioning system and display of project progress.

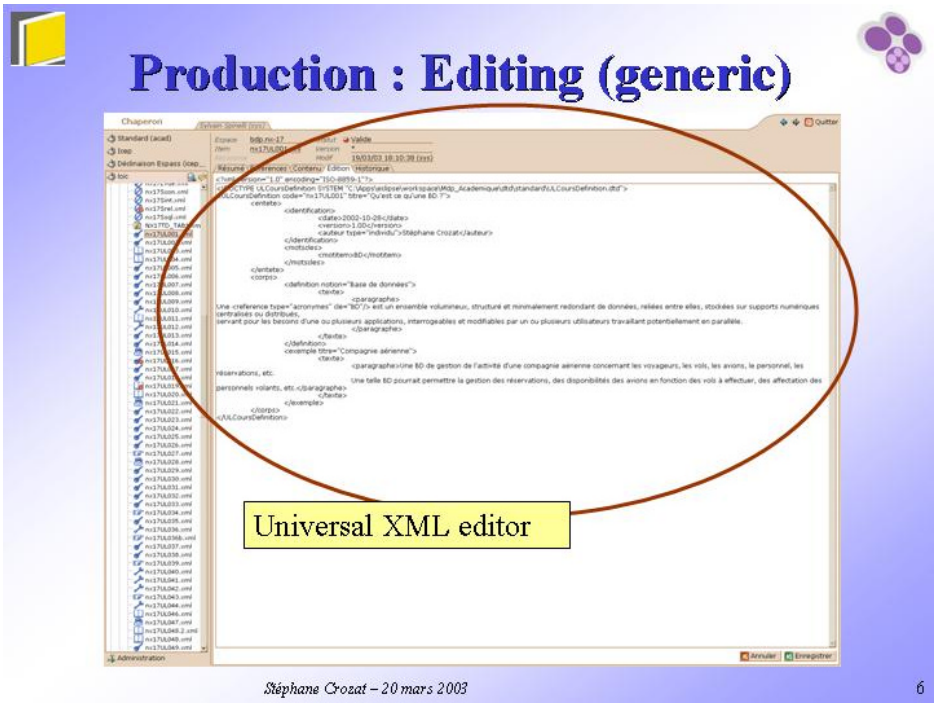
Although the functionalities are manifold, the digital platform itself should be (relatively) simple, user-friendly, and while working across platforms in the collaborative environment of a European virtual university, transparent to the user. Web based solutions are therefore preferred.

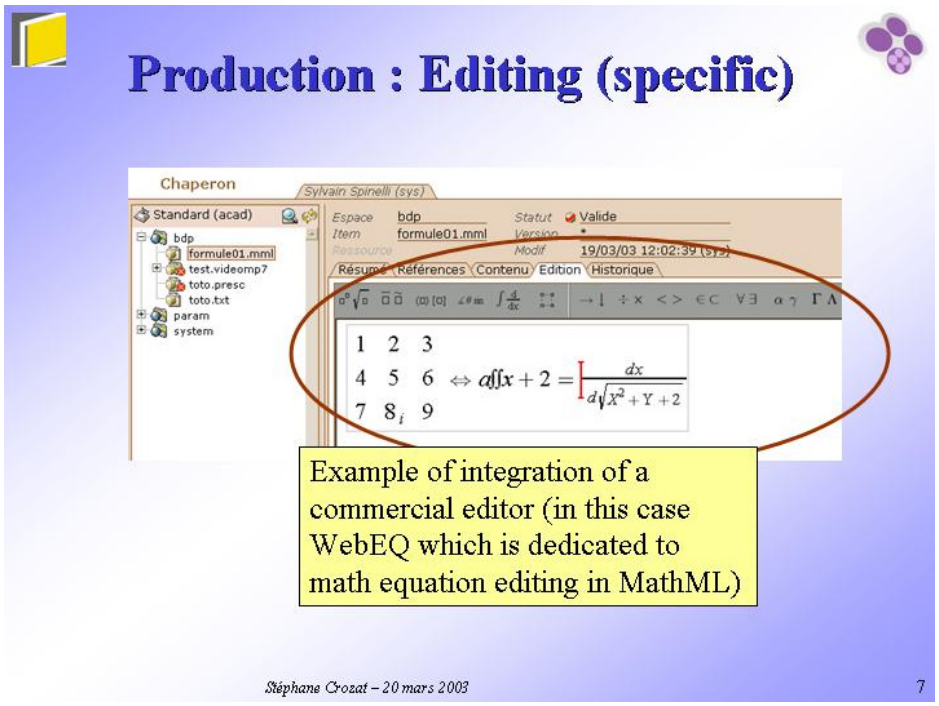
Much of the technological evolutions in digital platforms have been so far the result of economical considerations of commercial companies. Throughout the work of the group, need for further research and development was regularly identified, not only with respect to technological functionalities, but also and maybe even especially with respect to pedagogical functionalities. For educational applications, the latter should come first, but must be carried out in close connection and collaboration with the technological one.

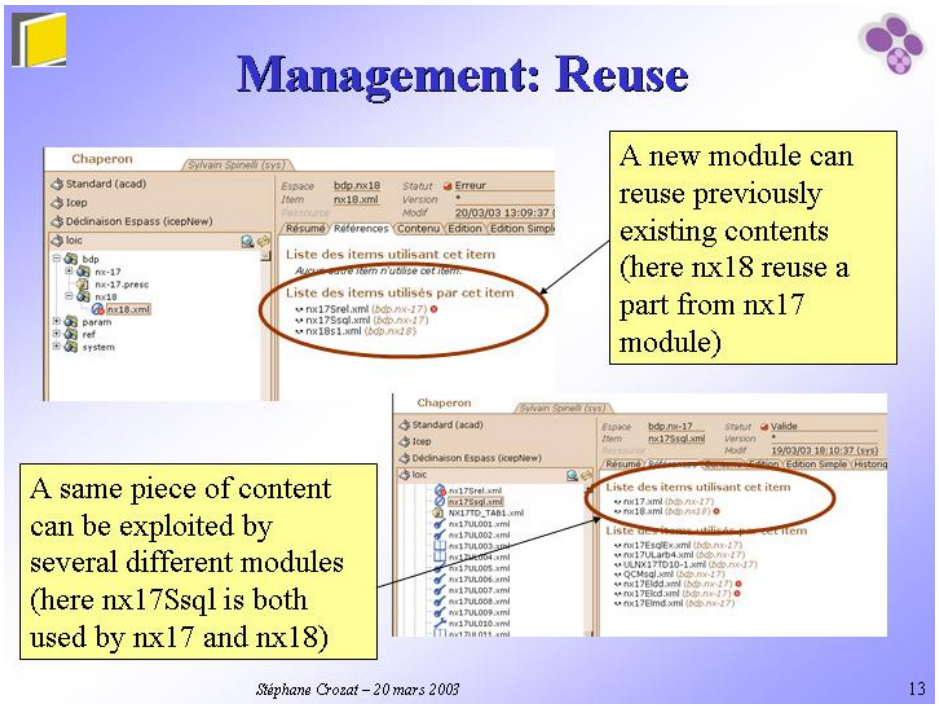
# 4. Appendix 1

SCENARILCMS slides are in the right sequence despite the slide numbers.




Production : Editing (specific)
Chaperon
Example of integration of a commercial editor (in this case WebEQ which is dedicated to math equation editing in MathML)
Stéphane Crozat – 20 mars 2003
7


Management: Reuse
Chaperon
A new module can reuse previously existing contents (here nx18 reuse a part from nx17 module)
A same piece of content can be exploited by several different modules (here nx17Ssql is both used by nx17 and nx18)
Stéphane Crozat – 20 mars 2003
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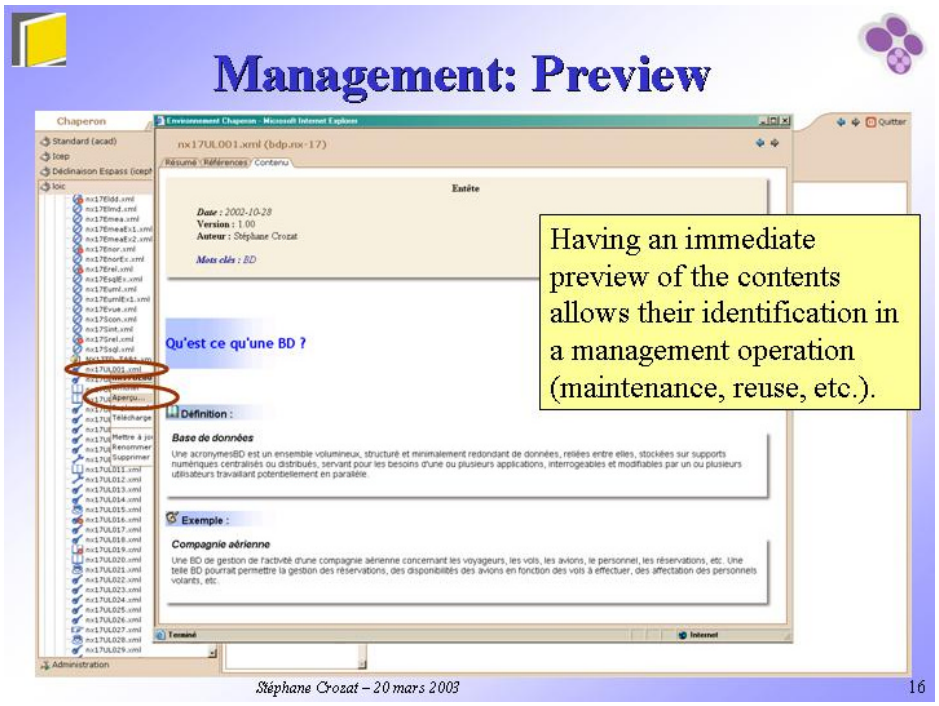
Management: Preview
Having an immediate preview of the contents allows their identification in a management operation (maintenance, reuse, etc.).
Qu'est ce qu'une BD ?
Définition :
Exemple :
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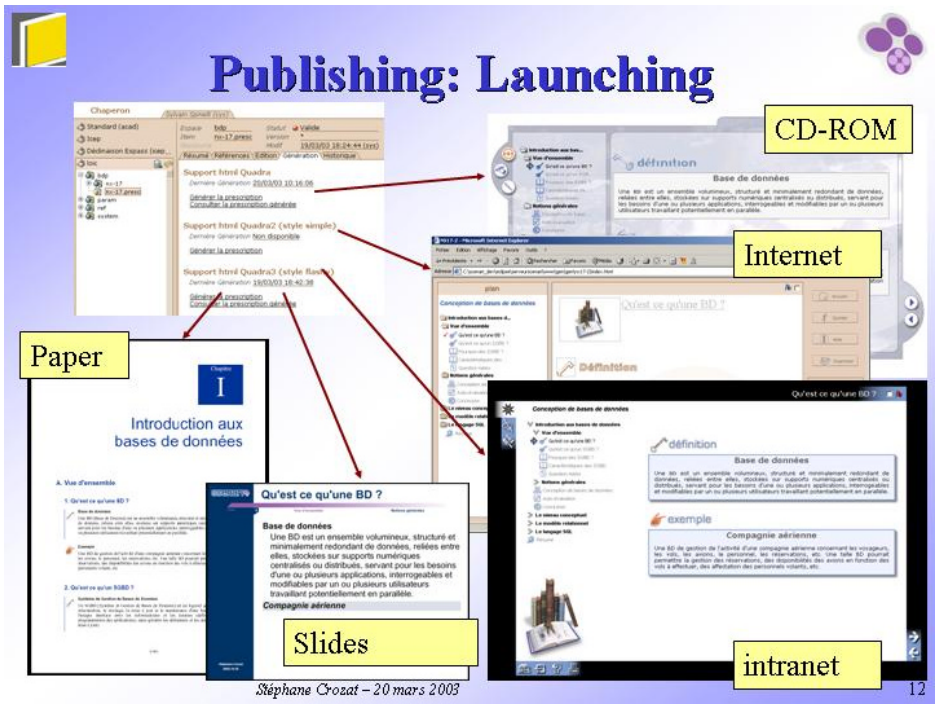
Publishing: Launching
CD-ROM
Internet
Paper
Slides
intranet
Introduction aux bases de données
Qu'est ce qu'une BD ?
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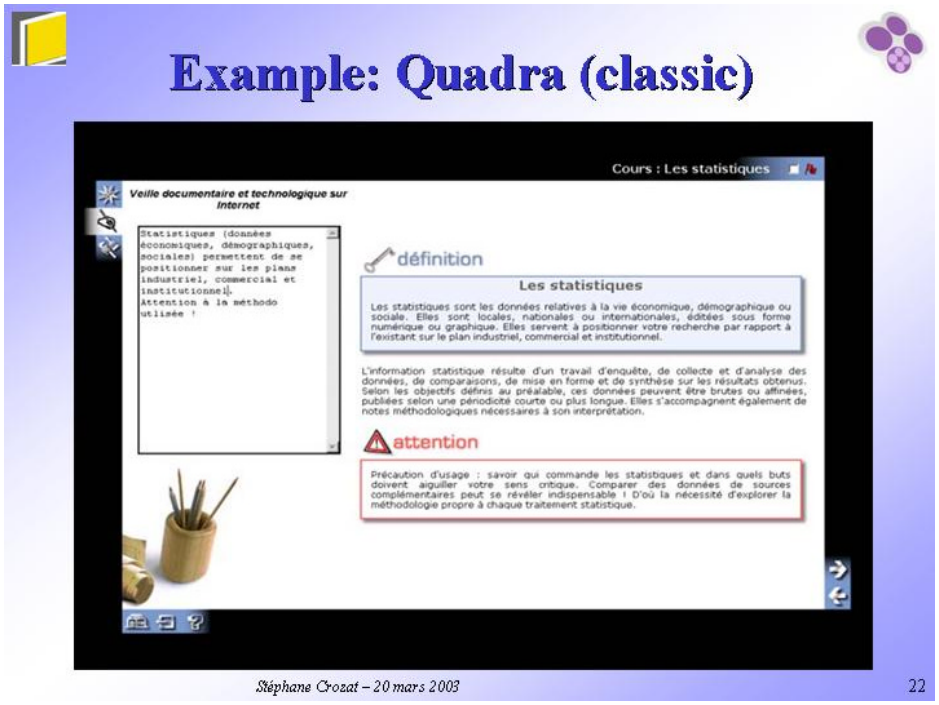
Example: Quadra (classic)
Cours : Les statistiques
Veille documentaire et technologique sur Internet
Statistiques (données économiques, démographiques, sociales) permettent de se positionner sur les plans industriel, commercial et institutionnel. Attention à la méthodo utilisée !
définition
Les statistiques
Les statistiques sont les données relatives à la vie économique, démographique ou sociale. Elles sont locales, nationales ou internationales, éditées sous forme numérique ou graphique. Elles servent à positionner votre recherche par rapport à l'existant sur le plan industriel, commercial et institutionnel.
L'information statistique résulte d'un travail d'enquête, de collecte et d'analyse des données, de comparaisons, de mise en forme et de synthèse sur les résultats obtenus. Selon les objectifs définis au préalable, ces données peuvent être brutes ou affinées, publiées selon une périodicité courte ou plus longue. Elles s'accompagnent également de notes méthodologiques nécessaires à son interprétation.
attention
Précaution d'usage : savoir qui commande les statistiques et dans quels buts doivent aiguiller votre sens critique. Comparer des données de sources complémentaires peut se révéler indispensable ! D'où la nécessité d'explorer la méthodologie propre à chaque traitement statistique.
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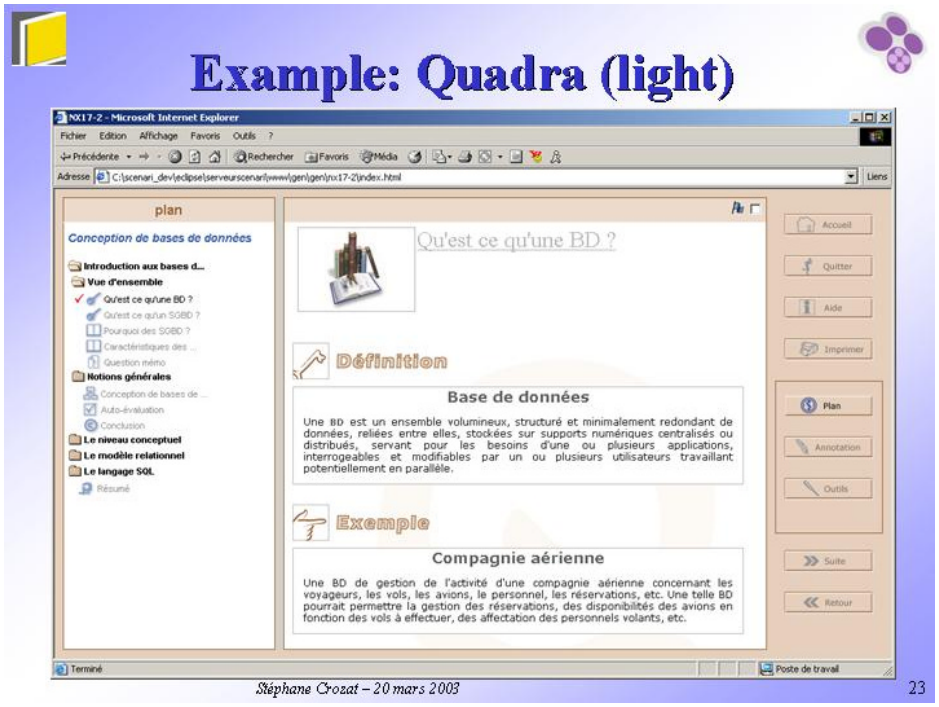
Example: Quadra (light)
NX17-2 - Microsoft Internet Explorer
plan
Conception de bases de données
Introduction aux bases d...
Vue d'ensemble
Qu'est ce qu'une BD ?
Qu'est ce qu'un SGBD ?
Pourquoi des SGBD ?
Caractéristiques des ...
Question mémo
Notions générales
Conception de bases de ...
Auto-évaluation
Conclusion
Le niveau conceptuel
Le modèle relationnel
Le langage SQL
Résumé
Qu'est ce qu'une BD ?
Définition
Base de données
Une BD est un ensemble volumineux, structuré et minimalement redondant de données, reliées entre elles, stockées sur supports numériques centralisés ou distribués, servant pour les besoins d'une ou plusieurs applications, interrogeables et modifiables par un ou plusieurs utilisateurs travaillant potentiellement en parallèle.
Exemple
Compagnie aérienne
Une BD de gestion de l'activité d'une compagnie aérienne concernant les voyageurs, les vols, les avions, le personnel, les réservations, etc. Une telle BD pourrait permettre la gestion des réservations, des disponibilités des avions en fonction des vols à effectuer, des affectation des personnels volants, etc.
Accueil
Quitter
Aide
Imprimer
Plan
Annotation
Outils
Suite
Retour
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Example: Quadra (player)
Qu'est ce qu'une BD ?
Introduction aux bas...
Vue d'ensemble
Qu'est ce qu'une BD ?
Qu'est ce qu'un SGB...
Pourquoi des SGBD ?
Caractéristiques de...
Question mémo
Notions générales
Conception de bases ...
Auto-évaluation
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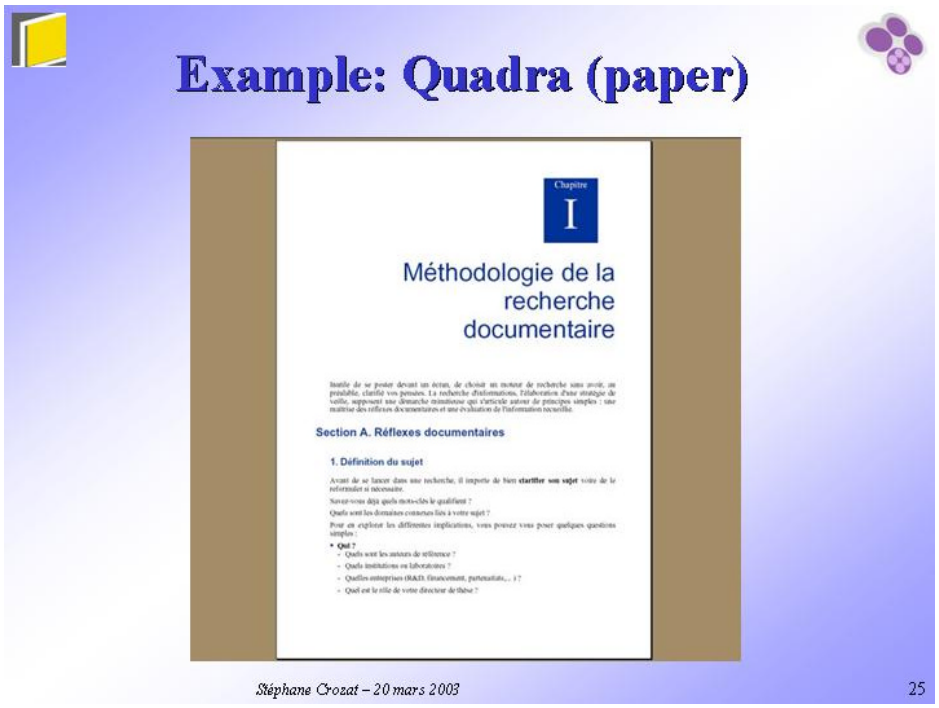
Example: Quadra (paper)
Chapitre
I
Méthodologie de la recherche documentaire
Section A. Réflexes documentaires
1. Définition du sujet
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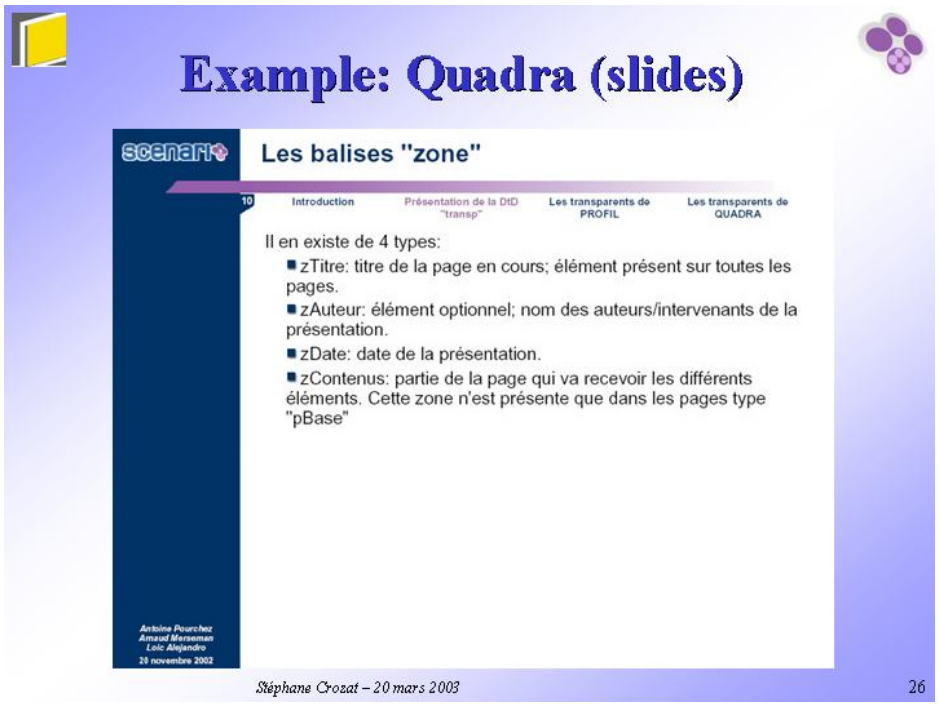
Example: Quadra (slides)
scenari
Les balises "zone"
10
Introduction
Présentation de la DtD "transp"
Les transparents de PROFIL
Les transparents de QUADRA
Il en existe de 4 types:
zTitre: titre de la page en cours; élément présent sur toutes les pages.
zAuteur: élément optionnel; nom des auteurs/intervenants de la présentation.
zDate: date de la présentation.
zContenus: partie de la page qui va recevoir les différents éléments. Cette zone n'est présente que dans les pages type "pBase"
Antoine Pourchez
Arnaud Merseman
Loic Alejandro
20 novembre 2002
Stéphane Crozat – 20 mars 2003
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