Educational Multimedia Databases: Past and Present

Gerrit Hiddink
Centre for Telematics and Information Technology
University of Twente

September 14th, 1998

Contents

Chapter 1

Introduction

The Idylle subproject "Educational multimedia databases: design, production and application" focuses on labeling so-called *Units of Learning Material* (Hiddink, 1998b) for the purpose of retrieval by teachers, thus increasing the reuse of (possibly expensive) learning material (Hiddink, 1998a). In the past, several projects have focused on (multimedia) databases of learning material. This document reports on a World Wide Web and literature research to documents and articles on the subject of storage of reusable (multimedia) learning material, with the purpose of gaining insight into people and organizations working on educational databases, and the methods and principles they have developed.

Special attention has been payed to labelling technique, search technique and evaluation of the system, if any. First, educational multimedia database systems and projects are presented in Section 2. After that, Chapter 3 presents the groups that are working on standardization of labeling systems. Then, Chapter 4 relates these groups and projects to eachother. Finally, some concluding remarks are given in Chapter 5.

Chapter 2

Educational multimedia systems and projects

Please note that most of the information below is cited or adapted from the referenced WWW sites and/or the referenced literature. Cited information is placed between double quotes. Also note that due to the volatile nature of web pages, URLs may have become invalid. It is suggested to use a search engine to retrieve (recent versions of) relevant pages.

2.1 CSTC

CSTC (Computer Science Teaching Centre) is a recently initiated project, funded by the American National Science Foundation (NSF). There does not seem to be much information concerning participants, funding, or intermediate results.

Purpose "The CSTC is an internet-based repository of peer reviewed reusable teaching resources for computer science educators. It will be implemented as a compelling web site with intuitive navigation and powerful search capabilities. Outcomes will include a framework for developing and distributing peer reviewed reusable teaching resources."

Institutions The Association for Computing Machinery (ACM).

People Deborah Knox, Scott Grissom and Edward Fox.

WWW references

- `http://ei.cs.vt.edu/~cstc`
- `http://ei.cs.vt.edu/~docs/summary.html`

2.2 DISCourse

DISCourse (Design and Interactive Specification of Courseware) is a Delta 2 project (D2008). It bases its expertise on three former DELTA projects: AAT (Advanced Authoring Tools), TOSKA (Tools and Methods for a sophisticated Knowledgebased Authoring Facility, see Mispelkamp (1990)) and ESM-BASE (see Section 2.5). The ULMs are used by an adaptive learning system, ECAL (Elsom-Cook, 1990).

Project goal To develop and pilot test a modular multimedia authoring environment that comprises tools to support courseware authors in the design as well as the production phase of the courseware life-cycle.

Labeling technique Instruction is decomposed into a tree structure of tasks and methods.

Participants CNR-ITD (Sarti and Persico), London University (Jacques Le Fevre), Knowledge Technologies (van Marcke), University of Lancaster, Leeds University, Siemens AG (Germany), University of Leeds, Dornier GmbH (Mispelkamp and Windmüller) and others.

Literature references Sarti and Van Marcke (1995), Mispelkamp and Sarti (1994)

WWW references

- `http://www.irpeacs.fr/papers/rc/discrome.htm`
- `http://www.irpeacs.fr/projects/en/discours.htm`
- `http://archiginnasio.dsnet.it/vivi/research/disc.htm`

remarks ViVi Software is currently selling a product called Visual Object Manager which is a visual browser for the commercial Object Oriented Object Store. It is an evolution of the Construction Tool, the user interface of the OSCAR and DISCourse database of learning material. The key persons of ViVi Software are Vittorio Viarengo, Carlo Innocenti, Ivan Pedruzzi and Alberto Massari.

2.3 ELECTRA

The ELECTRA (Electronic Learning Environment for Continual Training and research in the ALMA universities) project started in 1996 and is partly funded by the European Commission.

Project goal Design and implementation a sophisticated electronic learning environment

Subprojects The learning environment will use a multimedia database developed in the IMM-DB subproject (see Section 2.9).

Institutions Universities of Aaken, Luik, Maastricht, and Diepenbeek-Hasselt (ALMA)

Coordination board Prof. Dr. J. van de Herik (Maastricht), Prof. Dr. O. Spaniol (Aachen), Prof. Dr. L. Hornke (Aachen), Prof. Dr. D. Leclercq (Liège), Prof. Dr. E. Flerackers (Limburgs Universitair Centrum), Prof. Dr. F. van Reeth (idem), Drs. G. Kockelkorn (Maastricht).

WWW references

- `http://www.unimaas.nl/~electra`

2.4 ELM-ART

ELM-ART (ELM Adaptive Remote Tutoring) is a text-only tutoring environment that is based on ELM (Episodic Learner Model). The follow-up on this project is called ELM-ART II, an intelligent interactive textbook to support learning programming in LISP.

Labeling technique concept-based indexing; educational purpose (introduction, presentation, summarization) and inter-concept relations: prerequisites.

Search techniques keyword-based with one boolean operator (and, or, not); kept very simple as the project aims at developing an intelligent tutor (see prototype).

Institution The ELM project is part of the cognition and communication group of the departement of psychology at the University of Trier, Germany. The group is headed by Dr. Gerhard Weber and Prof. Dr. K. F. Wender; Dr. Peter Brusilovsky has been a visiting researcher at the group. The group can be contacted at `elm@cogpsy.uni-trier.de` .

Literature references Brusilovsky, Schwarz, and Weber (1996)

WWW references

- Prototype: `http://www.psychologie.uni-trier.de:8000/elmart`
- ELM-ART: `http://www.psychologie.uni-trier.de:8000/projects/ELM/elmart.html`
- ELM: `http://www.psychologie.uni-trier.de:8000/projects/ELM`

2.5 ESM-BASE

The ESM-BASE (Educational Systems based on Multimedia Databases) is a project that ran in 1990 and 1991, and that laid the basis for databases of learning material. It was funded by the European Commission as Delta D1012.

Project goal addressing the problem of courseware reusability by developing a database structure suitable for organising multimedia learning material in a given content domain (Persico, Sarti, & Viarengo, 1992).

Labeling technique description of content, description of context and description of the relation with the context. From Persico et al. (1992): learning-obj-type, pedag-qual-level, completeness, educational-function, difficulty-level, knowledge-type. ulm-id, ulm-source, ulm-quality-level, comments, ulm-approach. approach-type, school-level, context-id, context-source.

Search techniques Browsing the content descriptions and navigating freely using the relations between the units of learning material.

Institution Instituto per le Tecnologie Didattiche del CNR (ITD), Italy; ViVi Software and others.

Evaluation "The process of construction of the database has provided tremendous feedback on the architecture of the database. A better definition of the architecture of ULMs, improved structures to allow for multilingual ULM design, a clarification of the role of contexts and of the relation of ULMs are some of the most important results of this experimental phase" (Olimpo, Chioccariello, Tavella, & Trentin, 1990).

WWW references

- `http://archiginnasio.dsnet.it/vivi/research/esm.htm`

remarks In the project, the term *Unit of Learning Material* was defined as(Olimpo et al., 1990, page 537): "basic blocks of multimedia learning material used by authors to develop new educational applications. (...) A ULM is an abstraction which collects content segments of various media and type, hides their differences and offers a common and consistent interface in order to accopmlish fruition and/or authoring activities." A prototype has been built about plate tectonics.

2.6 GEM

GEM (Gateway to Educational Materials) is a consortium of the National Library of Education (NLE) and the U.S. Department of Education.

Purpose To "provide easy access to the substantial collections of educational materials found on federal, state, university, non-profit and commercial Internet sites."

Labeling technique Modified Dublin Core

Search technique keyword browse, subject browse (linear), educational level (K-range and vocational, higher and adult/continuing education).

Institute ERIC Clearinghouse on Information and Technology, Syracuse University (principal investigators: Nancy Morgan, Stuart Sutton, Ruth Small, Michael Eisenberg).

WWW references

- `http://geminfo.org`
- `http://www.geminfo.org/Consortium/Press_kit/pr980520.html`
- search form: `http://www.thegateway.org/simple1.html`

2.7 HBLE

HBLE (Hypermedia-Based Learning Environment) is a product being developed at the Tampere University of Technology at the department of Mathematics.

Labeling technique "Cells are indexed and labeled according to the information they refer to. Each cell is assigned a topic knowledge measure, a scalar representing the measured knowledge state of the student of the topic."

"Cells in HBLE comprise five types of material: theory, exercises, theoretical and practical examples as well as tests. These are divided into difficulty levels by the author."

WWW references

- `http://www.tut.fi/ onykane/papers/hci-et/hble.html`
- `http://www.tut.fi/ onykane/papers/sar2.html`

remarks The quality of the articles is poor.

2.8 ILCE

ILCE (Interactive Learning and Course Development Environment) is a project of the OTEC (Onderwijstechnologisch Expertisecentrum) at the Vrije Universiteit in The Netherlands.

Project goal The design and development of a two-component computer system: design and production of learning materials, and a delivery system.

Structuring technique Content model (semantic net) to be defined by course designers (Brok, 1997). Each network node represents a certain subject. Also each node has an internal substructure of chapters on the subject.

Evaluation Results from three interviews with authors, plenary meetings and a survey: "the system forced them to think systematically about course content and structure. "

- `http://www.usq.edu.au/dec/decjourn/v18n197/valcke.htm`
- `http://www.usq.edu.au/dec/decjourn/v18n197/limbach.htm`

remarks A commercial version is available as "Mercator". The group visited the University of Twente in 1997 to demonstrate the product to the faculty of Educational Technology.

2.9 IMM-DB

IMM-DB (Interactive Multimedia Multimedia-Database) is a subproject of ELECTRA (see Section 2.3).

Project goal To realise generic access structures for networked multimedia databases.

Evaluation The first version of the multimedia database was used by the LDBT-project (Long-distance Bedside Training, another ELECTRA subproject) to implement a diversity of interactive multimedia learning resources in the medical domain.

WWW references

- (down) `http://antigoon.luc.ac.be/immdb`
- `http://www.ecotec.com/telematics/education/en/news/new273b.html`

2.10 IMS

IMS (Instructional Management System) is an initiative of EDUCOM, a company that conducts educational research and consultancy.

Labeling technique A modified Dublin Core and the Warwick Framework (Lagoze, Lynch, & Daniel, 1996; Hakala, Husby, & Koch, 1996).

Institution EDUCOM and a wide range of industry and academic partners; a.o. Apple Computer, Asymetrix, AT&T Learning Network, IBM Education, University of Michigan, and the University of California. Some remarkable members of the developers' network are: Lotus Learning Space, WBT Systems (see Section 2.20), and WebCT Educational Technologies Corporation.

Evaluation The testbed participants are generating a lot of feedback; no (integrating) evaluation paper has been produced yet.

WWW references

- Homepage: `http://www.imsproject.org`
- Metadata forum: `http://www.collegis.org/partners/IMS/public.nsf`
- List of partners: `http://www.imsproject.org/dn.html`

remarks The departement of Instrumentation of the faculty of Educational Technology is participating in the testbed, giving the faculty access to the testbed forums. One of these is a forum about the metadata used in the IMS project; the comments of the testbed users can be used to gather anecdotal evidence about labeling (see the online metadata forum).

2.11 Indios

Indios concerns the integration of DISCourse (see Section 2.2) and Oscar (see Section 2.15). It runs from 1994 until 1995, involving most of the same institutions and companies as the two projects it is based on.

Institutions The Centre for Studies in Advanced Learning Technology (CSALT) at Lancaster University (Karen Valley), ViVi Software (Innocenti, Viarengo), Knowledge Technologies (a.o. Kris van Marcke) and other companies.

Coordination Harald Mispelkamp and Wilfrid Windmüller

WWW references

- `http://www.lancs.ac.uk/users/edres/people/staff/evaldel.htm`
- `http://archiginnasio.dsnet.it/vivi/research/indios.htm`

2.12 MUCH

MUCH (Many Using and Creating Hypermedia) is a research project led by Roy Rada at the University of Liverpool into a collaborative multimedia authoring system. The project focusses on reusing multimedia learning material by multiple authors.

Evaluation Recent evaluations of

Literature references

- Rada (1995, Chapter 6)
- Roy Rada et.al., "Many Using and Creating Hypermedia (MUCH) system", *Computers and Education* 20(3), 1993, 225-233
- Min Zheng; Rada, R. "A Model for Computer Supported Collaborative Work and Document Re-use." *Intelligent Tutoring Media* 4/1 (February 1993) 3-14;

- Zheng, Min and Roy Rada. "MUCH Electronic Publishing Environment: Principles and Practices", *Journal of the American Society for Information Science* 45(5) (June 1994):300-309.

WWW references

- Roy's publications: `http://www.eecs.wsu.edu/~rada/cv/pubs/`
- About MUCH: `http://www.eecs.wsu.edu/~rada/research/papers/classroom/talk.htm`
- Roy at WSU: `http://www.eecs.wsu.edu/~rada`
- MUCH with Andrew: `http://hpftp.cict.fr/hppd/hpux/X11/Toolkits/mucha-1.0/readme.html`

remarks The system supports linking learning objects. A variant, the Many Using and Creating Hypermedia with Andrew (a distributed file system), is freely available on the Internet (HP-UX Porting and Archive Center, see WWW references).

2.13 Mercator

See ILCE (Section 2.8).

2.14 NEEDS

NEEDS (National Engineering Education Delivery System) is a courseware and development system which will provide access to a large number of diverse instructional modules.

Labeling technique The basic building blocks of courseware (clips, photos, interviews, sound bites, images) are provided with indices. Furthermore, there exists "curricular paths" through the elements in the database.

Search technique The user can search at three different levels, being:

- course elements: keywords, mime-type and size;
- courseware: title, author, subject heading, keywords;

- platform.

Literature references Agogino et al. (1993)

WWW references

- NEEDS database: `http://needs.org`
- NEEDS project homepage: `http://needs.iastate.edu`
- Search: `http://www.needs.org/database/index.html`
- Article: `http://www1.needs.org/Presentations/FIE93/FIE.html`
- Bibliography: `http://needs3.me.berkeley.edu/needsinfo/papers/`

remarks developed by (partners of) the Synthesis Coalition (see Section 3.6).

The database contains *educational elements*, which are basic building blocks of courseware such as short video clips, photos, interviews, sound bites, or scanned images. Furthermore, the database contains *courseware elements*, which are collections of educational elements that address a single engineering concept.

2.15 OSCAR

OSCAR (Open Systems for Collaborative Authoring and Reuse) is a large DELTA project, running from 1992 until 1994, involving many european research institutes and companies,

Purpose Develop and pilot test a system for supporting collaborative and distributed authoring of multimedia training materials, facilitating the cooperation between actors involved in courseware projects and the reuse of existing materials or half-products.

Labeling technique Learning material was classified using a pedagogical classification schema.

Institutions ViVi Software, Knowledge Technologies (van Marke), CNR-ITD (Chioccarello, Persico, Sarti), University of Lancaster (Goodyear), University of Liverpool (Rada) and several Italian companies.

Literature references Rada (1995, Section 7.2 to 7.5), Persico et al. (1992), Sarti and Van Marcke (1995)

WWW references

- `http://archiginnasio.dsnet.it/vivi/research/oscar.htm`

remarks The project was funded by European Union. It consists of a database of Instructional Components and Presentational Components. These Presentational Components consist of a Multimedia Unit (MMU) which consists of several monomedia units (MUs).

2.16 ODB

The ODB (Optical Database) project ran at the Faculty of Educational Technology of the University of Twente. During the project, many prototypes were developed to test ideas. The prototype of main interest was a configuration tool that allowed to edit standard instruction routes.

Labeling technique C/BB method: a way to structure multimedia units of learning material which incorporated elements of concept mapping and schemata.

People Plon Verhagen, René Bestebreurtje and Willem-Jaap Zwart.

Evaluation The teachers that used the prototype found that the structuring method limited the application area to teaching procedural knowledge. Bestebreurtje and Verhagen (1992), Bestebreurtje, Verhagen, and Zwart (1995), Bestebreurtje (1989).

2.17 OLA

OLA (Oracle Learning Architecture) is an initiative of Oracle to provide an online educational system for delivering interative, multimedia education over networks.

Labeling technique Reusable Content Objects; the press release (see WWW references) suggests that input was used from the IEEE working group (see Section 3.4) and the ADL group (see Section 3.1).

Search technique text search in subject, role, vendor, language, "solution type" (certification path, course, subject library, training path), delivery format (download, web playable), training method (knowledge tutorial, performance support, simulation, skill tutorial)

WWW references

- `http://ola.oracle.com`
- `http://www.prweb.com/releases/1998/prweb3175.htm`

2.18 PHOENIX

A commercial product of Pathlore which uses a database of "course elements" in a Learning Objects Repository. The system seems to produce instructional material.

WWW references

- `http://www.pathlore.com/products/phoenix.html`

remarks Pathlore is a development member of the IMS project (see Section 2.10).

2.19 Rosetta

Rosetta is a modification of the UNITE explorer (see chapter 2.21) for the purpose of archiving information and materials for English language teaching.

Labeling technique A hierarchically structured curriculum taxonomy, extension of the Dublin Core: *target language, educational level, media type* and *curriculum type*. Certain elements, such as *coverage* and *relation*, have been redefined to fit the purposes of the project. The *resource type* element has been extended.

Search techniques In addition to free text searching, a boolean search engine is part of the Unite system, and therefore also of the Rosetta system. The curriculum hierarchy can be graphically browsed.

Institution The Japanese Center for Language Research, University of Aizu at Aizu-Wakamatsu.

Research leader Steven D. Tripp

Literature references Tripp (1997)

2.20 Topclass

Topclass, formerly known as WEST (Web Educational Support Tools) is a tool that allows teachers to create courses that are delivered via WWW. It is marketed by WBT systems.

Labeling technique "Courses are composed of Units of Learning Material (ULM). These ULMs can consist of pages, exercises and other ULMs. In this manner course material in TopClass is created in a hierarchy that is managed by the server. The ULM represents the small unit of learning, effectively chunking or breaking the material up into modules or manageable units."

Search techniques ULMs can be searched by title, body of the ULM, or both. Most characteristics (learning objectives etc.) are denoted using "free text".

Evaluation Most evaluation reports deal with the learners' experiences. No useful evaluation remarks about the instructors' experiences, and especially about searching the database of learning material, were found.

WWW references

- sample course: http://www.wbtsystems.com/solutions/course1.htm and http://www.online.ddce.cqu.edu.au/topclass/bigfamine/default.html
- White paper: http://www.wbtsystems.com/products/whitepa6.htm
- Press release: http://www.wbtsystems.com/company/press4.htm
- Evaluation: http://serc.gws.uky.edu/www/ukat/TopClass/tc.html and http://www.chem.uky.edu/misc/topclasssurvey.html

remarks "TopClass Server provides a powerful virtual classroom environment to manage all aspects of content and class management and to deliver a flexible learning environment built entirely on the open, non-proprietary standards of the Web."

The white paper referenced above deals (a.o.) with reusability. In practice, however, TopClass content seems to be designed for one course only.

Topclass has been chosen in the July 1997 issue of PC week as the best web-based training solution, judged by eighteen corporate and educational representatives (see Press release).

2.21 Unite

Unite stands for Unified Network InformaTics for Education.

Labeling technique taxonomical indexed resources (learning objects).

Search technique graphical, hierarchical search through the subject tree, and boolean queries.

Institution University of Aizu, Great Lakes collaborative

Evaluation "Earlier research and development efforts in designing network information services for educators indicated that teachers initially found hierarchical curricular browsing structures to be an easy way to locate information. (...) With this familiarity of the information domain also came a desire to more precisely focus their queries. (...) Instead, they began to

focus their queries more precisely with questions such as, "I need ecology lab activities for grade 4 students that help to develop observation and analytical skills". These kinds of questions require more advanced document indexing and query mechanisms than the parent-child hierarchy needed for a curricular browsing structure" (Deniau et al., 1995).

WWW references

- Deniau: `http://ftp.isoc.org/HMP/PAPER/248/html/paper.html`

remarks The project used extended and modified HTTP servers and clients due to certain (early) limitations of WWW delivery, such as statelessness, limited interaction, and the need for CGI scripts.

Chapter 3

Research groups

3.1 ADL

The Department of Defense and the White House Office of Science and Technology Policy (OSTP) launched the Advanced Distributed Learning (ADL) initiative in November 1997.

Project goal Amongst others: create reusable content and lower cost with object-based tools; develop next generation learning technologies.

Labeling technique As the ADL project uses the IMS specifications, its labeling technique will also be based on the Dublin Core.

WWW references

- Homepage: `http://www.adlnet.org`
- What's hot: `http://www.adlnet.org/whatshot/whatshot.cfm`

remarks In the ADL project, the American Departement of Defence will apply the IMS (see Section 2.10) specifications in a number of prototype efforts to produce a common framework that enables the development, delivery and management of reusable learning content (see "what's hot" WWW reference).

3.2 ARIADNE

ARIADNE (Alliance of Remote Instructional Authoring & Development) is a project that is sponsored by the European Union. It runs from 1996 until 2000.

Labeling technique based on the Dublin Core.

Project goal development of tools and methodologies for producing, managing and reusing computer-based pedagogical elements and telematics supported training curricula.

Institutions labeling: EPFL (Lausanne, Switzerland) and KUL (Leuven, Belgium)

WWW references

- `http://ariadne.unil.ch/main.htm`
- metadata: `http://ariadne.unil.ch/metadata.html`

3.3 Dublin Core

"The Dublin Core is a 15-element metadata element set intended to facilitate discovery of electronic resources. Originally conceived for author-generated description of Web resources, it has also attracted the attention of formal resource description communities such as museums and libraries."

The Metadata Workshop of the Online Computer Library Center in March 1995 resulted in the first version of the Dublin Core. This workshop was attended by 52 researchers from the library world, the networking and digital library research communities, and content specialists.

Literature references Hakala et al. (1996), IMS project (1997a)

WWW references

- Homepage: `http://purl.oclc.org/metadata/dublin_core`
- User guide: `http://128.253.70.110/DC5/UserGuide5.html`

- Introduction: http://ahds.ac.uk/public/metadata/disc_03.html
- Workshop report: http://www.oclc.org:5046/oclc/research/conferences/metadata/dublin_core_report.html

purpose The purpose of the Dublin Core is to achieve international consensus around a core element set for describing Web resources, making them more visible to search engines and retrieval systems. It is intended to be used by non-cataloguers.

remarks The Dublin Core workshop series still continues:

- First workshop: Dublin, UK, march 1 – 3, 1995[1];
- Second workshop: Warwick, UK, april 1 – 3, 1996[2];
- Third workshop: Dublin, Ihio, USA at September 24 – 25, 1996[3];
- Fourth workshop: Canberra, Australia, March 3 – 5, 1997[4];
- Fifth workshop: Helsinki, Finland at October 6-8, 1997[5].

3.4 IEEE P1484.12

Full name Learning Objects and Metadata Working Group, part of the IEEE Learning Technology Standards Committee

Labeling technique comparable to Dublin Core; the group's documents include a mapping to the Dublin Core.

Purpose amongst others:

- To enable learners or instructors to search, evaluate, acquire, and utilize Learning Objects.

[1] http://www.oclc.org:5046/oclc/research/conferences/metadata/
[2] http://www.oclc.org:5046/oclc/research/conferences/metadata2
[3] http://www.oclc.org:5046/conferences/imagemeta/
[4] http://www.dstc.edu.au/DC4/
[5] http://linnea.helsinki.fi/meta/DC5.html

- To enable the sharing and exchange of Learning Objects across any technology supported learning systems.

- To enable the development of learning objects in units that can be combined and decomposed in meaningful ways.

Institution IEEE, Learning Technologies Standards Committee

People involved (a.o.) Wayne Hodgins (chair), Erik Duval, Tom Wason, Steve Griffin, Peter Brusilovsky and Steve White.

WWW references

- `http://www.manta.ieee.org/P1484/sg-lo.htm`

remarks Members of the IMS and Ariadne projects are participating in the working group. Logs of past discussions (since May 1997) are online at the IEEE website.

3.5 LOMG

Full name Learning Objects Metadata Group

Goal To develop specifications in the area of metadata for learning objects

Organizations NIST (the American National Institute of Standards and Technology) and Apple and over 40 industry, government, higher education and K12 organizations.

WWW references

- Homepage:

- about IMS: `http://sdct-sunsrv1.ncsl.nist.gov/~boland/ims.html`

Remarks The group collaborated with IMS. Apparently, however, NIST decided to terminate the group and instead to cooperate with IMS. Currently, the Information Technology Laboratory of NIST is providing technical guidance and consultation to the IMS project (see Section 2.10) in developing specifications, prototype testing, and in developing methods for compliance testing and certification.

3.6 Synthesis coalition

The Synthesis Engineering Education Coalition is a group of eight universities funded by the National Science Foundation (from 1996 until 2000). The coalition runs innovative educational projects.

Project goal Design, implement and assess new approaches to undergraduate engineering education: developing, experimenting with and evaluating the effectiveness of a variety of innovative curricula, delivery systems, settings and pedagogies.

Projects NEEDS: National Engineering Education Delivery System, a courseware database (see Section 2.14).

WWW references

- `http://synthesis.stanford.edu`

3.7 NCITSL8

NCITSL8 was formerly known as "X3L8" and is a technical committee of the National Committee on Information Technology Standards (NCITS), accredited by Ansi (American National Standards Institute).

Purpose To establish standards for specifying and standardizing data to facilitate human use and to enable intelligent computer processing. Issues are naming, identification, definitions, classification and registration. The target standards document is ISO/IEC 11179.

WWW references

- `http://www.lbl.gov/ olken/X3L8/`
- `http://www.lbl.gov/ olken/X3L8/related.html`

remarks Documents (both approved and draft) are protected by passwords; access is only granted to members of the committee. The documents of X3L8 are still available (see second WWW reference).

3.8 Warwick Framework

The Warwick Framework is the result of the April 1996 Metadata II workshop in Warwick U. K. This framework: "builds on the Dublin results and provides a more concrete and operationally useable formulation of the Dublin Core, in order to promote greater interoperability among content providers, content catalogers and indexers, and automated resource discovery and description systems." The workshop was attended by some fifty representatives of libraries, Internet standards, text markup and digital library projects.

literature references Hakala et al. (1996)

WWW references

- Articles: `http://www.dlib.org/dlib/july96/lagoze/07lagoze.html` and `http://www.dlib.org/dlib/july96/07weibel.html`
- Workshop report: `http://www.ub2.lu.se/tk/warwick.html`

purpose The purpose of the framework is to provide means for describing competing, overlapping and complementary metadata models, as it was acknowledged that several metadata schemes might co-exist within one catalogueing system. The framework is purposed to be modular, extensible, distributed and recursive.

Chapter 4

Overview

In this chapter, an overview will be given of the projects and research groups described in the previous chapters, and the principles they used.

4.1 Delta projects

In Figure 4.1 the Delta projects that are related to eachother are depicted. These projects are interresting because they show a stepwise development of principles and software for storing multimedia learning material in databases. The concept of a Unit of Learning Material was developed during the ESM-BASE project, and in the OSCAR project a conceptual database schema for a database of learning material was reported. The Indios project was supposed to integrate all results of the various projects; however up to now no reports were found on this project. The projects GTE (Generic Tutoring Environment) and ECAL (a modular multimedia authoring environment) used results of former DELTA projects, but are not mentioned in this document as their emphasis was on other topics.

4.2 From theory to industry

Figure 4.2 shows how different theoretical approaches have, through research and application projects, have led to standardization and finally industrial exploitation of principles and methods. It also shows that some industrial systems do not build upon scientific research, which does not mean that they cannot be succesful (e.g. TopClass).

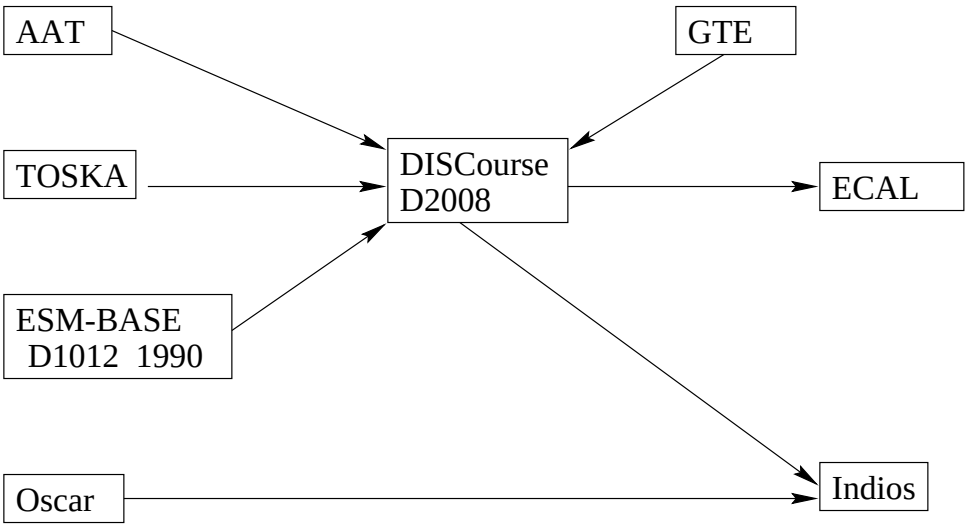

Figure 4.1: Family tree of (DELTA) projects

The figure also shows that todays' standardizing efforts find their roots in the Dublin Core metadata framework.

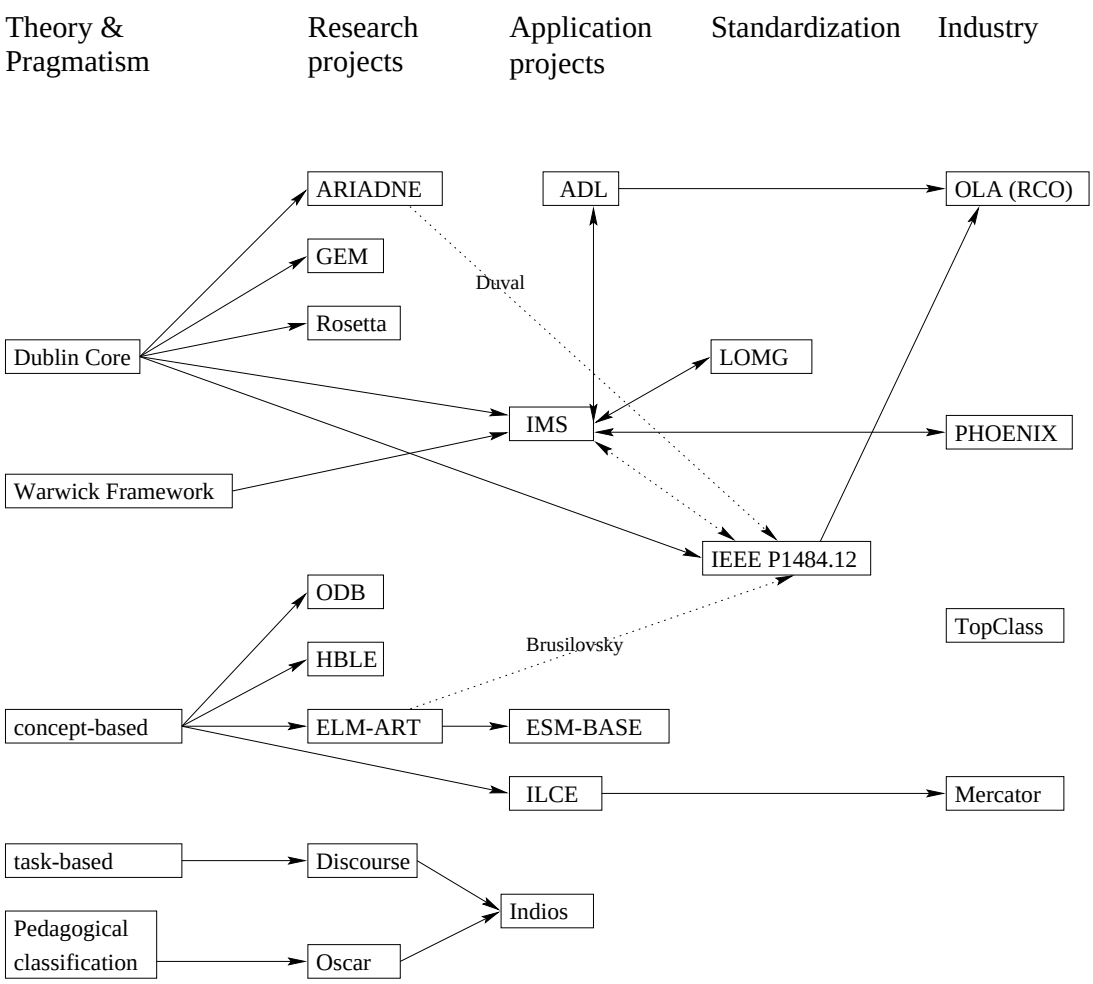

Figure 4.2: The labeling techniques and their derivatives

Chapter 5

Conclusion

The overall conclusion of this report is that a lot of work has already been done on the subject of databases of learning material and labeling (defining metadata) for units of learning material. The fact that the software industry (eg. Oracle, see Section 2.17) has recently started to develop software tools based on research results, indicates that sufficient knowledge has been acquired to build these kind of tools with an (in the opinion of the industry) reasonable chance of survival on the market. Also, the fact that metadata standardization groups have been installed indicates that the standards organizations consider the research to metadata being (nearly) completed.

No project attempted to gain insight into the effectiveness of the labeling system from the viewpoint of reusability of learning material. Many projects attempted to achieve reuse, hoewever only few of them evaluated the project results, let alone verify wether reuse had indeed been occured. Research into multimedia learning materials (hypermedia courseware, learning on the web, interactive learning environments) mostly focuses on the learners' perspective. OSCAR seems to be the only project that focused on the authors' perspective, and especially the problems encountered when collaboratively designing multimedia courseware.

Looking at the various projects, we can say that multimedia databases of learning material can be built for different purposes, each having its own requirements for the labeling system. The purposes we can identify are:

- authoring, collaboratively or individually, of courseware by an educational designer (possibly accompanied by multimedia technicians, programmers, subject matter experts etcetera);
- learning in a hypermedia environment, where the database serves as a

learning resource for the learners;

- teaching: the database is used as a resource for teachers, who can quickly compose course material by combining units of learning material found in the database.

The most common practice, as can be derived from the list of projects in this report, is to extend the Dublin Core with labels that are specific to the application area (in this case education) and for the purpose of the software. Note, however, that the Dublin Core was not specifically designed for education, and in most projects the extension labels are defined by the "trial and error" method: modify the labels according to the users' feedback so that eventually the labels are as much to the satisfaction of the users as possible. This may lead to appropriate labels; however it does not lead to generic insight into labeling systems, so that no theory is built and so that similar projects under different circumstances have to redo all trials and errors.

We also see a shift in delivery and presentation systems: the first prototypes used a proprietary (multimedia) delivery subsystem. These are very laborious to write, although many chose the Hypercards program of the Macintosh platform or a derivative. None of these systems, however, used a database; data was stored in directories and files. As soon as the World Wide Web became popular, many projects began using HTTP[1] as information delivery system. The complexity then moved from writing the presentation interface to getting the database system, middleware applications, the web server and (if present) applets running on the students' browsers to work together.

Summarizing, we can state that already a lot of methods and techniques have been developed for building multimedia databases for educational purposes. Starting at the basics of the database, the Entity-Relationship scheme (Persico et al., 1992; Olimpo et al., 1990), incorporating various concepts of units of learning material as a new type of Entity (Hiddink, 1998b). Several ways of modeling learning material have been tested (Broeke, Zwart, & Verhagen, 1994; Hendley, Whittington, & Jurascheck, 1993; Brok, 1997). A lot of various labeling techniques have been proposed to enhance retrievability (Weibel, Godby, & Miller, 1995; Hakala et al., 1996; IMS project, 1997b; Bestebreurtje, 1989; Held, 1994). Digitally storing information en-

[1]Hypertext Transfer Protocol, the hypertext document retrieval protocol used by the World Wide Web

ables reuse (Sarti & Van Marcke, 1995; Lemone, 1996; Rada, 1995; Hiddink, 1998a) and collaborative authoring, and large databases are currently being built (Agogino et al., 1993; Deniau et al., 1995). Finally, the user interface for searching and presenting multimedia information has also been researched (Tripp, 1997).

Appendix A

People

Person	Projects
Agogino, A. M.	NEEDS
Aust, R.	UNITE
Bestebreurtje, René	ODB
Brok	ILCE
Brusilovsky, Peter	ELM-ART, IEEE LTSC
Chioccariello	ESM-BASE, Oscar
Eisenberg, Michael	GEM
Elsom-Cook	ECAL
Evans, J. B.	UNITE
Deniau, C. C.	UNITE
Duval, Erik	ARIADNE, IEEE LTSC
Fevre, Jacques le	DISCourse
Flerackers, E.	ELECTRA
Fox, Edward	CSTC
Gauch, S.	Unite
Genalo, L.	NEEDS
Goodyear	Oscar
Griffin, Steve	IEEE LTSC
Grissom, Scott	CSTC
Harris, J.	NEEDS
Herik, J. van de	ELECTRA
Hodgins, Wayne	IEEE LTSC
Hornke, L.	ELECTRA
Innocenti, Carlo	ViVi Software, Indios

Person	Projects
Krisnagopalan, J.	NEEDS
Knox, Deborah	CSTC
Kockelkorn, G.	ELECTRA
Leclercq, D.	ELECTRA
Marcke, Kris van	DISCourse, Indios, Oscar
Martin, D.	NEEDS
Massari, Alberto	ViVi Software
Miller, J.	UNITE
Mink, K.	NEEDS
Mispelkamp, Harald	TOSKA, DISCourse, Indios
Morgan, Nancy	GEM
Niehaus, D.	UNITE
Olimpo	ESM-BASE
Pedruzzi, Ivan	ViVi Software
Persico	DISCourse, ESM-BASE, Oscar
Rada, Roy	MUCH, Oscar
Reeth, F. van	ELECTRA
Sarti	DISCourse, ESM-BASE, Oscar
Saylor, J.	NEEDS
Sheppard, S.	NEEDS
Small, Ruth	GEM
Spaniol, O.	ELECTRA
Sutton, Stuart	GEM
Swink, M. T.	UNITE
Travella	ESM-BASE
Trentin	ESM-BASE
Tripp, Steven D.	Rosetta
Valley, Karen	Indios
Verhagen, P.	ODB
Viarengo, Vittorio	ViVi Software, ESM-BASE
Wason, Tom	IEEE LTSC
Weber, Gerhard	ELM-ART
Wender, K. F.	ELM-ART
White, Steve	Microsoft, IEEE LTSC
Windmüller	DISCourse, Indios
Zheng, Min	MUCH
Zwart, Willem-Jaap	ODB

Appendix B

Web resources

B.1 Metadata

- registry: http://metadata.net
- resources: http://www.ukoln.ac.uk/metadata/resources/
- more resources: http://inf2.pira.co.uk/top037.htm

B.2 Workshops on metadata

- Workshop of the EC: http://hosted.ukoln.ac.uk/ec/metadata-1997/
- DELOS workshop: http://www.iei.cnr.it/DELOS/ErcimDL/second-DELOS-workshop/hall.html

B.3 Collaborative Learning

- CSCL projects: http://www.cpsc.ucalgary.ca/projects/grouplab/projects/cscl/projects.html

B.4 About reuse

- http://cs-www.bu.edu/techreports/95-001/beer.html

B.5 Misc resources

- Tom's Metadata web resources: http://www.imsproject.org/technical/Metadata/webstuff.html
- Hypermedia in Education: http://igw.tuwien.ac.at/igw/Personen/margit/yorkzwo.html

Bibliography

Agogino, A. M., Sheppard, S., Harris, J., Genalo, L., Mink, K., Krishnagopalan, J., Martin, D., & Saylor, J. (1993). National engineering education delivery system (needs). In L. P. Grayson (Ed.), *Proceedings of the frontiers in education '93* (pp. 592 – 600). Washington, DC.

Bestebreurtje, R. (1989). *Didactische vormgeving van interactieve video als audiovisuele databank: samenvatting van de literatuurstudie naar classificatie van inhoudselementen* (Tech. Rep. Nos. ODB 5, versie 1.0). Enschede: University of Twente.

Bestebreurtje, R., & Verhagen, P. W. (1992). *ODB project: developing the concept of an instructional multimedia database for multiple targetgroups.* Presented at AECT '92.

Bestebreurtje, R., Verhagen, P. W., & Zwart, W. J. (1995). *C/BB approach: a way to organise multimedia databases.* Presented at the 1995 AECT national convention "information technology: expanding frontiers", Anaheim, CA, February 8 – 12, 1995.

Broeke, B. A. ten, Zwart, W. J., & Verhagen, P. W. (1994). *De ordening en structurering van teksten (the organization and structuring of texts)* (Tech. Rep.). Enschede: University of Twente.

Brok, E. C. T. (1997). *Hypertext and semantic nets: experiences with modular authoring.* Presented at ed-media '97, Calgary, Canada.

Brusilovsky, P., Schwarz, E., & Weber, G. (1996). ELM-ART: An intelligent tutoring system on world wide web. In G. Goos, J. Hartmanis, & J. van Leeuwen (Eds.), *Lecture notes in computer science volume 1086: Third international conference, its '96.* Montréal, Canada: Berlin: Springer.

Deniau, C. C., Swink, M. T., Aust, R., Evans, J. B., Gauch, S., Miller, J., & Niehaus, D. (1995, june). *The UNITE system: distributed delivery and the contribution of multimedia objects over the internet.* presented at inet '95, Honolulu, Hawaii.

Elsom-Cook, M. T. (1990). The ECAL teaching engine: pragmatic AI for education. In *Learning technology in the european communities: proceedings of the delta conference on research and development* (pp. 329 – 340). The Hague.

Hakala, J., Husby, O., & Koch, T. (1996). *Warwick framework and dublin core set provide a comprehensive infrastructure for network resource description* (Tech. Rep.). Warwick, UK.

Held, P. (1994). *Het karakteriseren en representeren van informatie in een interactieve leeromgeving.* afstudeerverslag, University of Twente.

Hendley, R. J., Whittington, C. D., & Jurascheck, N. (1993). Hypermedia generation from domain representations. *Computers and Education*, *20*(1), 127 – 132.

Hiddink, G. W. (1998a). *Factors of reuse of units of learning material* (Tech. Rep. No. CTIT/IDYLLE/B/N40). Enschede: University of Twente.

Hiddink, G. W. (1998b). *The concept of a unit of learning material in multimedia databases* (Tech. Rep. No. CTIT/IDYLLE/B/N36). Enschede: University of Twente.

IMS project. (1997a). *using IMS metadata.* online document, URL: `http://www.imsproject.org/metadata/MDusing.html`.

IMS project. (1997b). *IMS metadata dictionary.* online document, URL: `http://www.imsproject.org/metadata/MDdictionary.html`.

Lagoze, C., Lynch, C. A., & Daniel, R. (1996). *The warwick framework, a container architecture for aggregating sets of metadata* (Tech. Rep. No. 96-1593). Departement of Computer Science, Cornell University.

Lemone, K. (1996). *Retargetable course generation - a methodology for reusability in distance education.* Presented at the workshop on architectures for intelligent tutoring systems, ITS'96, Montreal, Canada.

Mispelkamp, H. (1990). Generic tools for courseware authoring. In *Learning technology in the european communities: proceedings of the delta conference on research and development* (pp. 585 – 593). The Hague.

Mispelkamp, H., & Sarti, L. (1994). DISCourse: Tools for the design of learning material. In *Design and production of multimedia and simulation-based learning material* (pp. 45 – 60). Dordrecht: Kluwer Academic Publishers.

Olimpo, G., Chioccariello, A., Tavella, M., & Trentin, G. (1990). On the concept of reusability in educational design. In *Learning technology in the european communities: proceedings of the delta conference on research and development.* The Hague.

Persico, D., Sarti, L., & Viarengo, V. (1992). Browsing a database of multimedia learning material. *Interactive Learning International*, *8*, 213 – 235.

Rada, R. (1995). *Developing educational hypermedia: coordination and reuse.* Norwood, New Jersey: Ablex Publishing Corporation.

Sarti, L., & Van Marcke, K. (1995). *Reuse in intelligent courseware authoring.* Presented at AI&ED'95, Washington, USA.

Tripp, S. D. (1997, july). *Rosetta: the design and development of a web-based ESL database.* Presented at the third australian world wide web conference, Southern Cross, Australia.

Weibel, S., Godby, J., & Miller, E. (1995). *OCLC/NCSA metadata workshop report* (Tech. Rep.). Online Computer Library Center, Inc.