# Learning Objects Metadata and Tools in the Area of Operations Research

Stephan Kassanke
University of Paderborn
WarburgerStr. 100
33098 Paderborn, Germany
kass@upb.de

Abed El-Saddik
Darmstadt University of Technology
Merckstr.25
64283 Darmstadt, Germany
abed@kom.tu-darmstadt.del

Achim Steinacker
Darmstadt University of Technology
Merckstr. 25
64283 Darmstadt, Germany
stein@kom.tu-darmstadt.de

**Abstract:** Information technology and the Internet are making inroads into almost all areas of our society. The requirements of students and professionals are fast changing, the information society requires lifelong learning in practically all areas, especially those related to information technologies. The educational sector can profit in particular from the benefits IT adds to the ways of learning. The core techniques exists, still the integration into the curricula and the integration of learning environments and traditional knowledge management systems and libraries cannot keep up with the pace of technology development. This article focuses on the use of so called "learning objects" in the field of Operations Research and Management Science (OR/MS). Learning objects refer to pieces of information of different granularity which can be combined, linked and reused. We will demonstrate some of the concepts mentioned above by the LOM editor of the Technical University of Darmstadt and prototype systems developed in the project OR-World of the University of Paderborn and give an outlook on the future development.

## Introduction

The idea of learning objects follows a constructivistic view of learning where students actively construct knowledge rather than are being taught by a teacher. Web environments can be considered as an ideal platform for persons holding this frame of mind. Though a traditional web based approach (HTML) is a first step into the right direction, it is not optimal in terms of structure, consistency and manageability. If we consider large scale systems with a very large amount of documents, authors need tools to assist them while creating and maintaining educational material. On the other hand readers often get lost when retrieving documents, the amount of hits often turns out to be irrelevant. The flat description model which HTML offers is not precise enough to allow an efficient search and retrieval process. Due to the lack of support for efficient structuring, retrieval, and linking among very large amounts of documents by standard Web technologies, namely HTML, new technologies which allow a more sophisticated retrieval method, such as a structured Metadata approach, are emerging. In the context of learning objects the Learning Object Metadata standard (LOM) is widely accepted and becomes more and more important (see section 3 for further details, other examples for Metadata classifications are Dublin Core or IMS).

HTML is not consequently separating content, structure and representation of a document. Furthermore HTML is not extensible by additional tags. If we think of learning objects, other tags than <heading> or <bold> for example are desirable. The tagging of learning objects with specialized tags is simply not possible in HTML. Links among documents can only be defined as untyped, unidirectional links. In order to minimize maintenance efforts and costs it would be desirable to use single source documents (e.g. in the form of XML documents) published on demand in a format of one's choice (e.g. HTML, paper, e-book, WAP, etc.). A dedicated markup language stores structured document information besides the content and enables the rendering of different representations of the source document. This way the maintenance costs for material can be decreased and the material can be made available to different people with adaptive views. Open technologies standards such as XML and dedicated markup languages for documents offer the chance of constructing content which can be (re)used by people independent of their location. The standardization of metadata descriptions has the effect that tools dealing with metadata descriptions become universally applicable. LOM and IMS are excellent examples that a widely used specification which is accepted as a standard can promote immensely to the exchange of data.

## 2 OR-World

After being developed since about 40 years, contents of OR/MS have reached a high level of maturity. The basic algorithmic and modeling techniques form a stable core of the discipline, whereas implementation issues develop rapidly with new perspectives offered by information technology. This justifies the high amount of developing effort necessary to create such systems. The core contents are well-suited for hypermedia learning because they essentially consist of processes and algorithms, thus implying a dynamic nature. While the dynamics cannot be fully represented in paper-based books, it can very well be illustrated interactively by animations on a computer screen.

The knowledge domain OR/MS is highly interrelated, basic algorithms and methods can be applied to practical problems in varying contexts. Thus, in a graphical representation of the knowledge domain, a graph instead of a strict hierarchy would be drawn. A previous structuring of a content area is helpful for building the links among objects in a hypermedia network. Because OR/MS is already well-structured, it is very suitable for the representation within OR-World.

OR-World is funded within the Fifth Framework Programme of the European Community. The goal of the project is to develop a hypermedia network of learning objects where:

- Each object is well described by a Metadata description.
- Object granularity from media elements to thematic metastructures can be stored.
- Objects can be reused in the sense of combining objects of lower granularity to objects of higher complexity.
- Dedicated Document Type Definitions for different types of objects are available.
- Renderings in varying target formats can be generated by the system (see [OR-World2000] )

LOM is highly accepted and will be used for the Metadata description of our learning objects. In the project. The advantage of a data centered, standardized approach is obvious: An externally developed editor such as the LOM editor of TU Darmstadt can be integrated in OR-World without many hassles. The interfaces to the files/databases where the descriptions are stored may have to be adjusted but the basic data structure is fixed. This way the efforts in software development can be focused on building stable software components which can be reused just like the documents created in the standardized format.

Core technologies such as XML and XSL lay the foundations on which applications can be built. Metadata description is not the only application which can be imagined. One of the main drawbacks of HTML is that one kind of general document template serves to represent the whole variety of imaginable documents from small fragments to articles, books, etc. On a micro level, documents differ significantly in their structure. Within the project dedicated document type definitions for the varying granularities of learning objects will be developed. Currently document type definitions for large documents such as books or technical documentations are available. One example is the docbook DTD which stems from SGML but is also available for XML [Docbook 2000]. Media elements differ significantly in their structure from case studies, tests etc. and for optimal use this has to be reflected in the applied document structure. XML and XSL in this sense are just a means to specify he desired behavior. The structure of documents in the learning context still has to be defined. When a set of document type definitions will be available, the documents built consistently on these definitions can be rendered in different visual representations. Most obvious examples are renderings in the HTML or Acrobat PDF format. We use standard technologies from the XML Apache project [Apache XML 2000], see Figure  for a visualization of the process.

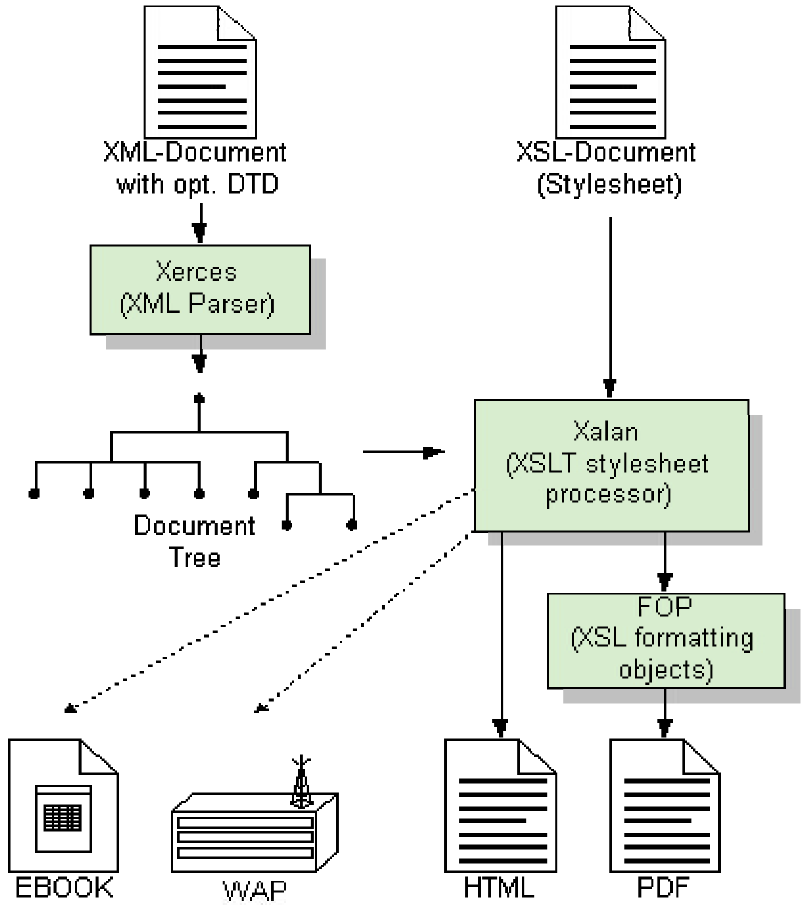


Figure 1: Process of generating varying renderings for XML source documents

The output format can also be varied in terms of extent. A case study for example can reveal more and more details or hints of the case. This allows students to approach a case gradually and helps them to solve the case finally.
Besides the rendering an interesting point is that information to be stored in the metadata description according to LOM is already existing in a structured document. E.g. the title or author are often stored in the source document. Since the metadata description is physically another entity mechanism to derive metadata information from the document to be described would be very useful. Most authors in our experience find it annoying to complete the task of setting up the Metadata appropriately. This is correlating to the experiences the TU Darmstadt made and since he appropriateness of the Metadata information determines its value the ease of use is a crucial issue.

## 3 LOM-Editor

In the following we describe the tool that we use to create the metadata. As the resources are only described it is neither necessary to change the resource nor needs the author of the metadata description physical access to the resource Therefore it is possible to publish metadata records for various resources, e.g. documents, images, audio clips, videos, animations, virtual reality worlds, or multimedia exercises. A metadata record consists of a set of elements, describing a multimedia resource. Examples of these elements are date of creation or publication, type, author, format, or title of a resource.
To access and discover multimedia information resources in a comfortable way, we developed a user-friendly tool, the LOM editor (Figure 2), based on the IEEE-LOM scheme version 5. IEEE's specification of Learning Object's Metadata (LOM). LOM extends the well known Metadata approach for general documents Dublin Core (DC) with elements to describe additional educational properties of multimedia resources. The elements are grouped in categories which are listed below.:

General: General metadata, such as the title, language, structure, or description of a resource
Life Cycle: Status, version, and role of a learning objet
Meta MetaData: Information about the metadata used to describe the learning object.
Technical: All technical information about a resource, such as the format, the length, browser requirements, which are necessary to use the resource.
Educational: Information about the educational objective of a resource, such as interactivity, difficulty, end-user type, etc
Rights: Commercial use and ownership of a LO
Relation: Links between Learning Objects, to express dependencies, or semantic connections
Annotation: Used to provide additional, eventually more detailed information about a resource
Classification: Elements to classify a resource according to existing classification schemes

Based on the LOM 5.0 draft and a DTD developed by the IMS, we have specified a XML DTD according to the actual LOM scheme. It is therefore possible to save an LOM description as an XML file and also to import existing descriptions . With the use of a free middleware broker implementation called CASTOR [Castor 2000] the Metadata descriptions can also be stored in a relational database like Oracle or IBMs DB2. The editor is implemented in Java, so it can be used on all platforms.
The time effort to describe all properties of a resource is considered as a hindrance to a wide distribution and usage of a metadata scheme. To offer users a faster way to describe the learning resources, the editor is using a template mechanism. If one author is describing similar resources many elements like the name of the author, the target audience or the access right stay the same and don't have to be changed. Using templates with common values, can avoid the necessity to fill a lot of fields again and again.
Another property of the LOM scheme which can be used for building a user friendly editor is the use of the vocabulary elements of a LOM description. For many elements the LOM scheme suggests to use an integer value, which can be mapped to different descriptions in different languages. With the use of Vocabularies it is possible to guarantee a fixed set of values for specific elements to avoid ambigious descriptions when searching for resources. Figure 2, shows a screenshot of the current implementation of the editor. One can also see the use of the Vocabulary element for the structure element of the General category. Depending on the selected language to describe a resource, the editor can offer the set of values to the user as a list. It is then easy for the author of the metadata description to select the appropriate value. Changing the language of the user interface, will also change the language of the possible values. As the mapping between the integer value and the language descriptions, is stored in an external text-oriented file. additional language mappings can be added very easy.

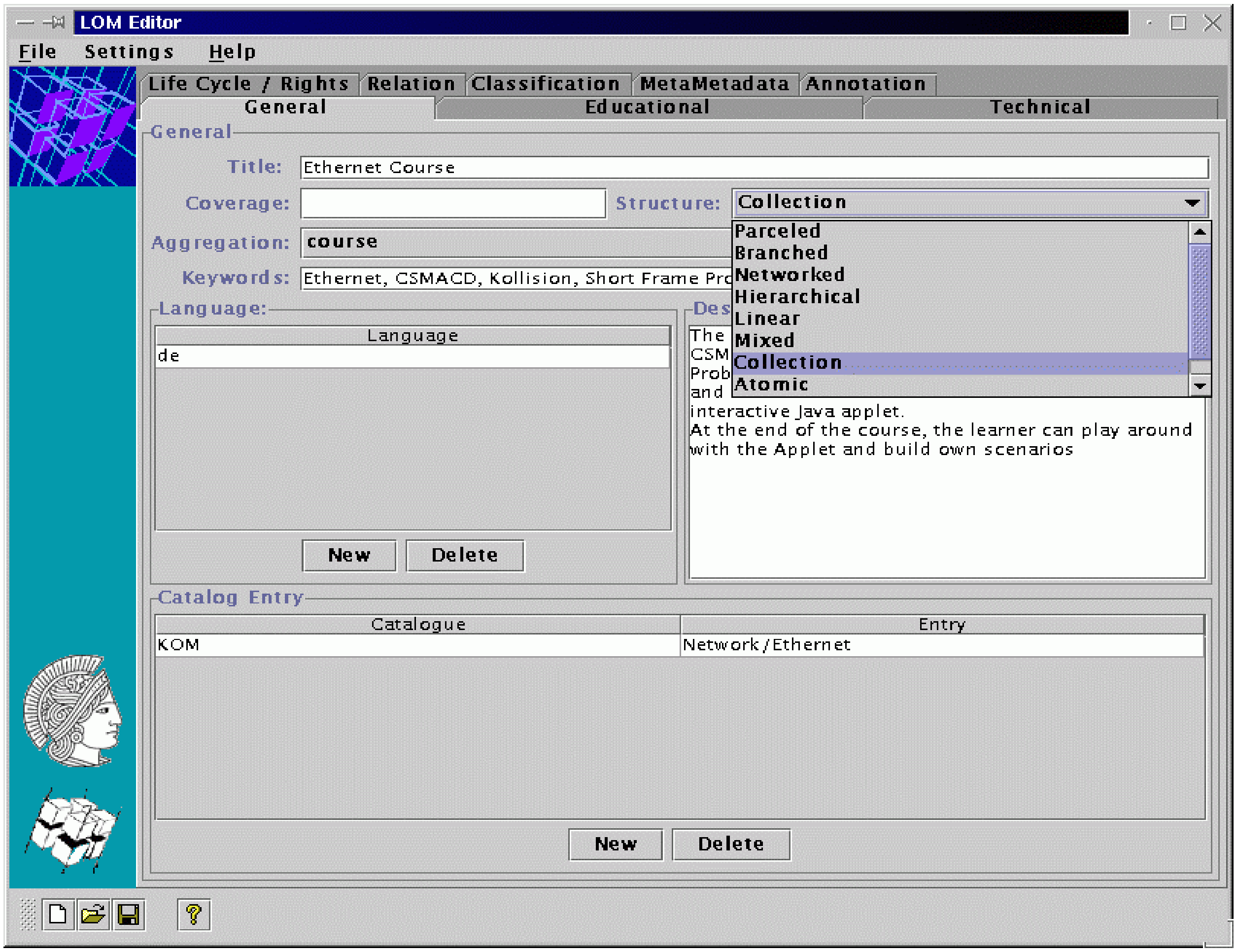


Figure2: Screenshot of LOM-Editor

## Conclusion

As more and more descriptions in a standardized form will become available, it will become increasingly attractively for software developers to invest in developing these tools. The critical mass of learning objects has to be reached if they should be successful. Especially in today's
information society the ability to find quickly the right information is a crucial factor. The whole band width of educational activities would benefit from one consistent description model and LOM could be the key to transport the structuredness of databases to the World Wide Web,
nothing more and nothing less.

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