Papers

Developing a metadata strategy: A road map

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Abstract This paper discusses the issues and decisions involved in developing a metadata strategy, particularly in terms of selecting and implementing a metadata standard. Different metadata standards and metadata development communities illustrate the various strategies an organization can take.

INTRODUCTION

In an earlier time, metadata creation was simply called cataloging. Cataloging rules were both rigid and complex, and a lot of energy was expended in understanding and applying them in a consistent manner. Other information organizations — museums, archives, etc — followed the leadership of the library community in creating lengthy, authoritative records that would presumably guide a user to the right published resource to meet an information need.

The advent of the web brought an explosion of information. Suddenly, anyone could be a publisher and share information with a large, even

unknown, audience. Cataloging experienced a similar explosion, aided by technologies that made it easy to publish database records on the web. Dublin Core,¹ the first “metadata for the web” simplified the description of web-based resources. As online communities of interest developed familiarity both with web publishing and with web technologies, they began to develop metadata standards specific to types of organizations (eg museums), types of materials (eg digital images) and subject areas (eg geographic information)

In no time at all, catalogers were faced with a bewildering array of options for creating metadata to describe and share

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information resources. An organization developing a metadata strategy currently has many options: select an existing metadata standard, create a new standard, or blend multiple metadata formats into a hybrid standard.

Unfortunately, although the options for creating metadata have expanded, the effort and cost involved in creating metadata have also increased. There is no longer an information community clustered around a single standard, as the library community organized itself around the Anglo American Cataloguing Rules² and Machine Readable Cataloging (MARC).³ While the wealth of standards gives organizations much freedom, it also means that collaboration, particularly sharing catalog records, is much more difficult. Metadata has become a risky and somewhat lonely business.

An organization developing a metadata strategy can create an empowering tool for its staff and its users, or make a very costly mistake that may require years for recovery. How can you plan a metadata strategy for your organization that provides the necessary flexibility to grow with your digital initiative, in a cost-effective and safe manner? This paper will not answer your every question but should provide the road map that puts you on the right path to resource description and discovery.

THE NATURE OF INFORMATION

Before designing a metadata strategy, it is useful to think first about the nature of information itself. The library and museum communities have each developed models to explain the nature and lifecycle of information.

The International Federation of Library Associations and Institutions (IFLA) issued detailed specifications for metadata, the Functional Requirements for Bibliographic Records (FRBR), which include a conceptual information model with entities in three areas, or groups.⁴ Group 1 entities reflect the information resource itself, beginning with the *work*, a highly abstract concept representing the creative content of the information resource. The work is realized through an *expression* of the work. Without expression, the work could not exist in the physical space, where it can be experienced and understood by users. The expression is embodied by the *manifestation*, a concrete physical format that is then exemplified by single or multiple *items*, such as the print run of a book. The item is a single physical entity occupying a point in space and time. The IFLA FRBR model (Figure 1) is an extensible model that can accommodate a traditional library, where many items are representatives of mass-produced manifestations, or a digital collection, where each item is uniquely produced but may exist in many different digital manifestations (eg TIFF, JPEG, etc).

The FRBR information model is

Figure 1: Example of the FRBR Information Model for Group 1 entities

particularly useful within the framework of archival information management, where the focus is on the long-term preservation of information sources. An archive will tend to conserve original source objects by creating a preservation master object, an access copy master object, which is used to create copies for users, and the access copies, which may be retrieved and displayed. Each copy represents a manifestation of the source object, where the manifestation is created to technical specifications the archive has established for each type of copy. A preservation master, for example, will have reproduction specifications that produce an object that is highly faithful to the source. An archive will often produce more than one copy (or item) for each manifestation.

Le Comité international pour la documentation (International Committee for Documentation of the International Council of Museums — CIDOC) Conceptual Reference Model (CIDOC CRM)⁵ emerged from the museum community through

Figure 2: CIDOC CRM

collaboration among members of the International Council of Museums. It is an event-based model with a focus on the lifecycle of cultural or artistic works. CIDOC CRM (Figures 2 and 3) is expressed in an ontology of 81 classes and 132 properties. It is intended to encompass individual metadata schemas to ensure conceptual comparability across descriptions and to enable mapping across metadata schemas at both the conceptual and semantic levels.

The CIDOC CRM is particularly useful when the provenance and lifecycle of objects predominate, such as objects

Figure 3: CIDOC CRM example

in a museum setting that may change ownership and custody across museums, or objects that may be frequently modified or repurposed by others, such as a repository of educational objects.

Before exploring the information model for your organization, it is useful to consider the two predominant information reference models and to determine whether either model more closely approximates the nature of information at your organization. This will help you evaluate metadata standards by mapping the core entities within schemas to an information model to validate the conceptual integrity of the metadata standard you select.

A final model to consider before beginning the evaluation of metadata standards is for the repository that will house both your objects and your metadata. A digital repository provides secure, robust, centralized storage and access to metadata and resources. A digital repository houses objects and applications to enable users to discover and use the resources it contains. The

architecture of the repository, which may be a commercial or open source digital asset management system (DAM), will integrate storage and creation utilities with web-based applications for presenting the metadata and objects in the repository to users.

A well-designed repository will maintain the information it contains in an understandable and useful manner for many future generations of users. In addition, given the volatile nature of the web, the repository must be the authoritative source for the information it contains — providing an authentic surrogate that is faithful to the original information and that identifies and supports the intellectual property rights of the information rights holder(s).

The Consultative Committee for Space Data Standards developed a reference model for an open archival information system (OAIS) (Figure 4) that provides a framework for ingest, archiving, management, preservation and access to information contained within a digital repository.⁶ Metadata

Figure 4: OAIS reference model high level diagram

provide both the intelligence and the “glue” that integrates the activities that maintain information about the resource throughout its lifecycle within the repository, including the information needed to provide access for users. The OAIS model identifies types of metadata important for managing and preserving information, including provenance, technical, rights and fixity information.

To ensure that information objects persist over space and time, it is critical that the different types of metadata that describe and manage the information object are durably linked to the object. The Metadata Encoding and Transmission Standard (METS)⁷ emerged to provide administrative, technical, descriptive and source metadata to describe and manage digital information, as well as a structure map and links between the object and its manifestations, and the object and its metadata. The types of metadata included in METS are:

- descriptive information for discovery and access;
- digital provenance that provides a digital audit trail documenting the digital creation and modification of the resource over its lifecycle;
- technical metadata describing the hardware, software and technical settings used to create and display the digital resource;
- source metadata describing the characteristics, provenance and context of the “source” or first-generation information object;
- rights metadata describing ownership, permissions and conditions for access and use; and
- a structure map enabling navigation through the component parts of an

information object (eg chapters and pages in a book).

An important consideration in developing a metadata strategy is determining which types of metadata to include and then selecting or developing a metadata schema for each metadata type.

THE NATURE OF INFORMATION USE

The organization’s data model should address the digital information object and also the information user. The IFLA FRBR identified four core user needs for information:⁸

- *Find*: find information relevant to the user’s query;
- *Identify*: correctly interpret the metadata record to understand what you have found;
- *Select*: select the most responsive resource among competing resources; and
- *Obtain*: obtain access to the resource.

The metadata standard you select must enable users to meet their core information needs. In addition, it is helpful to think about users according to the roles they play — creators (the creators of information and metadata), viewers (those that view the information), evaluators (those that evaluate or critique the information) and repurposers (those who will modify the information to create a derivative or revised information object).

UNDERSTANDING THE ORGANIZATION’S INFORMATION USE

While it is important and useful to understand the nature of information

and its use, it is most critical to understand how your intended audience wants to find, evaluate and use the information you are describing. It is also critical to understand the needs of those who will create and manage both the information and the metadata, as metadata do not exist in a vacuum but are part of an overall strategy to manage the organization's information, generally within a repository or other information management system.

Begin by answering some basic questions:

- *Who* are your primary users? What are their information needs? How do they discover, share and use information? What other information resources are they most likely to use?
- *Who* will create and manage the information and the metadata? What are their workflow needs?
- *What* is the nature of the information to be described? What formats does it include? What subjects or professional domains are included? For what purpose(s) was the information created?
- *When* will users most often need the information? How often must the information be updated?
- *How* will the information be used by the primary users, the information managers and any other users, including other organizations?

The first strategy to explore the answers to these questions is to study the organization itself — its mission and goals, the information it produces, and the information it needs, based on studying the organization's mission statement, website(s) and promotional materials; conducting user surveys; and talking to users in focus groups and

interviews. The collections that prompted the need for a metadata strategy should also be surveyed, including any existing metadata. In fact, it is quite useful to survey users about their use of the current metadata or other discovery tools, which may be a formal or informal discovery system. What works for them in the current discovery system? What doesn't work? Once they obtain the information, how do they use it? How does their information use support the organization's mission? It is important to understand the role that information plays in the organization's work to fulfill its mission, both to support that mission and to develop an assessment strategy for the metadata that evaluates the impact of metadata on user satisfaction and on the organization's work generally.

Next, expand the exploration to evaluate the information strategies used by organizations with a similar mission and purpose to yours. In your discussions with users, ask what other sources of information they predominantly use. What is the metadata strategy employed for those other sources of information? What organizations organize and make available these ancillary sources of information? It is important to co-locate your metadata within the larger information landscape for two reasons: to integrate your metadata collaboratively with other organizations for a "one stop shop" for information and to participate in a larger community so that the expense and expertise required to develop and maintain a metadata schema do not fall exclusively to your organization. An example of a very effective community collaboration

is the PBCore metadata standard developed by members of the public broadcasting community, under the sponsorship of the Corporation for Public Broadcasting.⁹

Now that you have identified the information and users specific to your organization, you can create a basic model that demonstrates the nature of the information you are managing and the user needs that it serves. This data model can be a simple diagram showing the relationship between different entities, including creators, managers and users of data. This completes a critical first step in developing a metadata strategy. Understanding your information, your users and how they interrelate is a critical but often neglected first step. The next step involves selecting among the many metadata standards available to meet the requirements of your data model.

UNDERSTANDING METADATA

Metadata can be simply described as “data about data.” Metadata only have relevance and meaning with respect to the source data that they describe. Metadata must be consistent and understandable to be useful. It is critical that metadata are consistently applied so that users can find relevant results in response to a query and interpret those results to select the best resources responding to an information need.

Metadata may be created and expressed in many ways, for example as data values within database tables, as comma delimited values in a spreadsheet, as HTML or as eXtensible Markup Language (XML). For a number of reasons XML¹⁰ has emerged as the semantic structure of choice for documenting, creating and displaying

metadata. To begin with, XML metadata can be validated against an XML schema to ensure that metadata are expressed consistently. XML tags can also be mnemonic and expressive, so that metadata data elements can be read and understood by anyone, and not just by computer programs. Finally, XML schemas document relationships and requirements for each data element to produce consistent metadata records that are faithful to the overarching information model, for each digital resource in a collection.

The standard components of metadata are:

- *Data element*: atomic unit of meaning (as defined by the user community);
- *Attribute*: refines, extends and interprets the data element;
- *Value*: information unique to each data element instance;
- *Constraint*: order imposed on data element expression for consistency and semantic viability; and
- *Label*: contextual instance of data element name. “How the data element displays on the web for the end user.”

Metadata standards (Figure 5) are generally documented in two ways: as an XML schema, to provide rules for applying and constructing data elements; and as a metadata registry, to document the metadata standard and to share information about each data element in an unambiguous way.

A metadata registry provides standardized information about the metadata standard at the data element level. The registry standard, ISO 11179, emerged to enable metadata and database creators to register their data for sharing in the wider digital

Rules:

- **Data element** (e.g. controlled vocabulary; formatting; prescribed value list or formatting rule)
- **Record structure: data element constraints:** (mandatory, recommended, optional) (repeatable) (order of elements)

Figure 5: Metadata components

environment. Section 3 (ISO 11179-3), the registry metamodel and basic attributes,¹¹ is the most important part of the standard for metadata development. It provides specifications for documenting data elements within a schema to enable these metadata building blocks to be understandable and reusable by both human users and machine applications. Requirements for documenting data elements include providing a name and a label for each data element; documenting whether use of the data element is mandatory, recommended or optional; documenting any required vocabulary or formatting rule for each data element and describing the value domain (or domain of use) which the data element is intended to support. Value domain is a particularly useful category of description for a data element, as the context of use really drives both data element value creation and meaning. For example, a database of US addresses for mailing list creation would include the data element “zip code” and require values that are formatted with the four-

digit extension. A database of movie theaters intended to respond to a query, such as finding the nearest theater to my home, would probably require that the data element “zip code” contain values that are formatted with only the five-digit base zip code, as the four-digit extension would be too granular to find many movie theaters for a user to visit.

SELECTING A METADATA STANDARD

Since the advent of Dublin Core, metadata have become a rapidly proliferating web information tool. Information communities have developed metadata standards to address a wide range of description needs, including metadata intended to support specific information communities, such as libraries and museums; metadata to support specific needs, such as the rights expression language, Open Digital Rights Language (ODRL)¹² and metadata specific to disciplines, subjects, metadata types (eg technical, administrative) or formats.

The proceeding sections covered the prerequisite knowledge for selecting a metadata standard: understanding of the data that you need to describe and manage, understanding the information use requirements of your target audience and an ability to read and understand metadata documentation. Now you are ready to evaluate metadata standards against the emerging data model for your organization. The following will describe important criteria for evaluating and selecting a metadata standard.

Information needs of the user

It is important to understand the information needs and practices of your target audience. What legacy metadata systems or standards do they currently use? At what point in their average workflow are they seeking the kind of information that you will be describing? What data elements will work with their workflow context and frame of reference? How can you meet their needs to find, identify, select and obtain in an efficient and understandable manner? While you want to meet the urgent and immediate needs of your target users, you also want to be aware that these needs will change over time and also that digital information inevitably attracts a wider audience than initially envisioned. You want to be sure that your information model is “context-independent” — that it can accommodate the needs of your current audience but also support additional users with different needs. You want to incorporate the current needs of the user but be extensible and flexible beyond those current needs. My recommended approach is to be context- or use-independent in the underlying metadata and the information model and then to

add user context in the creation, search, retrieval and display tools.

Unfortunately, many metadata standards are highly context-dependent. It will be interesting to see if they can survive the rapid evolution of user needs and interests.

Standard domain and purpose

It is important to evaluate metadata standards in the context of their development and use. Which community developed the standard and what needs did they intend to address through the standard? MPEG-7, the “Multimedia Content Description Interface,”¹³ emerged predominantly from the commercial media market. Its data model, structure and design focus on the delivery of digital media assets to end users. While it can be used for other purposes, such as the archiving and management of digital assets, there are limitations in the design that must be worked around to support different uses.

A good way to identify potential metadata standards to employ is to look at the metadata standards used by complementary organizations, by communities that produce information that is also heavily used by your target audience, and by organizations with which you might want to collaborate. Did they develop a metadata standard or an application profile for an existing standard? What metadata standard(s) did they choose, and why? In addition, as noted above, a flexible, context-independent metadata standard may offer the best opportunities for meeting current and future information needs. I generally like the strategy of selecting or developing a rich but context-independent “core” schema and then

mapping to context-dependent schema to support specific user needs. This is moving image collections (MIC) strategy, as described further, below.

The existing information environment

The metadata standard selected needs to integrate smoothly with the organization's existing information environment. Can the metadata be integrated with the organization's existing or planned DAM system, for example? Can it interoperate smoothly and transparently with the indexing for other information sources that are critical to the organization? A library may have an online catalog with MARC records numbering into the millions. To allow transparent access across both databases, libraries need to consider a metadata schema that maps readily to MARC, such as Dublin Core or Metadata Object Description Schema (MODS).¹⁴

The existing information environment also consists of the staffing and technology available to implement the metadata. If your organization plans to utilize the services of student labor or volunteers, it will be important to consider a simpler, more streamlined metadata schema.

It is also critical to consider the controlled vocabularies available to populate the data elements within a metadata standard. Many standards specify the use of controlled vocabularies within data elements, such as the requirement to use internet MIME types within a "format" data element. The use of controlled vocabularies, which provide authoritative terms for catalogers to choose among, can increase ease of cataloging among the metadata

creators as well as increase searching precision for end users.

Flexibility and extensibility of the metadata standard

Metadata standards are generally designed either to respond to the needs of a specific community of users or to serve a broad range of communities and information needs. In either case, the metadata standard as written is unlikely to meet all of your requirements. Over time, your requirements will change as your users' information needs evolve, and as the information you are collecting and managing changes. It is therefore critical to evaluate a metadata standard for its ability to accommodate customization and evolution. Does the metadata standard provide flexibility in adding controlled vocabularies that represent the subject domain and information context of your users? Does the metadata standard provide a means to add community extensions? MODS, for example, allows you to extend the schema using an extension subschema that enables you to add additional metadata elements or schemas, to create a hybrid metadata schema tailored to your needs. XrML, the eXtensible Rights Management Language,¹⁵ provides an extension schema to develop community extensions to the core language.

Different metadata standards serve different purposes, and are employed by different communities. In the highly interoperable world of the web, it is important to enable your organization to collaborate with others. This collaboration often requires a shared information context, which is provided largely via metadata. For example, an organization that provides streaming

Figure 6: MIC mappings

video assets for broadcast use may diversify into the educational marketplace and may want to package its assets. The organization, which is using PBCore, may want to share data with an educational repository using the IEEE Learning Object Metadata standard.¹⁶ The MIC project¹⁷ (Figure 6) addresses the need for supporting many metadata standards by developing a core schema that supports a simplified FRBR data model to map readily to any standard. As a result, different metadata standards can be used in different contexts, to support many needs. MPEG-7, which supports non-textual audiovisual features indexing, such as movement, color, speech recognition, etc, can thus be used for digital video assets, while MARC can be used for importing moving image records from libraries. One final but critical test for your selected metadata standard is to ensure that it maps readily to other metadata standards, to support many

different contexts of use for your resources.

SHOULD YOU DEVELOP YOUR OWN STANDARD?

When you explore many different metadata standards and compare them against the needs of your users and the requirements of your collection, you will probably identify many gaps where the standards fail to address some of your organization's needs. The temptation to develop your own standard — it doesn't look that hard! — is great. A good metadata standard may look deceptively simple, but generally much thought, considerable effort and many revisions have resulted in the standard you see today. You may want to develop your own standard if the following conditions apply:

- Your need for context independence is very strong, and a general-purpose schema such as MODS or Dublin Core

will not suffice. This was the situation that moving image collections (MIC) faced. The MIC core metadata schema was developed to harmonize many existing metadata schemas to produce metadata that were intelligible to a wide range of users.

- Your need for context is very strong, and a general-purpose schema such as MODS or Dublin Core will not suffice. This is the situation that the public broadcasting community faced, when the need to share information assets between stations as well as to enable discovery by the general public led to the development of PBCore.
- You are willing to robustly describe the metadata in a registry form, establish a version and XML schema and robustly maintain the schema you have developed. Metadata should always lead to interoperability and integration with the wealth of similar or complementary resources that are also important to your users. Even if you are not promoting the schema for use by others, you need to enable mapping to your schema by others.
- Your information resources, or your primary context of use is unique and no metadata schema can meet your needs, even with extensions.

Generally, a well-constructed and extensible general purpose standard such as MODS can be customized to meet most information needs. It is recommended that you extend an existing standard to meet your organization's needs, so that the rigorous requirements for establishing and maintaining a standard do not fall solely to your organization. Many communities have established application profiles for existing standards, in which

a standard is tailored and extended to a specific user group or information format.

WHAT ABOUT THE OTHER KINDS OF METADATA?

Metadata are not only used to describe digital information but also to preserve and manage it, to ensure that as better digital formats emerge, the digital master is migrated appropriately and as technologies become obsolete, the objects they created or displayed are still usable. This overview has looked primarily at descriptive metadata. Metadata to document the technical characteristics of the object, to track its analog and digital lifecycles and to ensure appropriate usage to support intellectual property rights, are emerging for all types of information, however. There are a few metadata standards that encompass all types of metadata. PBCore and MPEG-7 are two examples. Generally, you can expect to use multiple metadata standards for each type of activity, such as discovery, access and management. One of the great values of METS is that it provides a standardized framework or envelope for durably linking all types of metadata and for transporting the metadata in an XML package between systems. The SMPTE DMS-1 metadata model within the MXF or media exchange framework¹⁸ and MPEG-21,¹⁹ the MPEG multimedia framework standard, are also standards-based frameworks encompassing all metadata suitable for describing and supporting the lifecycle and use of the information resource. Many DAM systems encompass all the tasks to create and manage digital objects and utilize XML metadata for enabling, documenting and auditing

Figure 7: End-to-end metadata implementation

those tasks. It would be desirable but not essential that the DAM system support an encoding and transport standard for all types of metadata but it is highly desirable and very possible for a DAM system to import one or more standardized transport frameworks. You should expect and demand this when purchasing such a system

As you have seen, the development of a metadata strategy is a complex and lengthy undertaking. The wealth of available metadata standards has only made the selection more complex and time-consuming, not less. Figure 7 illustrates the basic process once all the pieces are pulled together.

CONCLUSION

When you think about all the components of a metadata implementation that must be addressed, the understandable temptation is to cut corners, quickly select an all-purpose standard, and worry about all the other issues later. After many years of selecting and applying metadata standards, however, I can assure you that the work will have to be done either at the beginning, when the mistakes are less costly, or later, when your metadata implementation eventually and inevitably ceases to work effectively or to grow with your organization and

your users. Paying careful attention to all the issues, particularly understanding the role your information plays for your organization, will be repaid when your metadata implementation becomes a critical tool for realizing your organizational mission — today and far into the future.

References

1. Dublin Core Metadata Initiative (2004). *Dublin Core Metadata Element Set, Version 1.1: Reference Description*. Available at: <http://dublincore.org/documents/dces/>, last accessed 20th September, 2005.
2. Joint Steering Committee for Revision of Anglo American Cataloguing Rules, *Welcome to the Homepage of the Anglo-American Cataloguing Rules*. Available at: <http://www.aacr2.org/>, last accessed 20th September, 2005.
3. Library of Congress. Network Development and MARC Standards Office (2005). *MARC Standards*. Available at: <http://www.loc.gov/marc/>, last accessed 20th September, 2005.
4. International Federation of Library Associations and Institutions (1998). *Functional Requirements for Bibliographic Records: Final Report*. UBCIM Publications, K.G. Saur München. Also available at: <http://www.ifla.org/VII/s13/frbr/frbr.htm>, last accessed 20th September, 2005.

5. International Council of Museums, ICOM CIDOC Documentation Standards Group and the CIDOC CRM Special Interest Group (2004). *Definition of the CIDOC Conceptual Reference Model*. Version 4.0. Available at: http://cidoc.ics.forth.gr/docs/cidoc_crm_version_4.0.pdf, last accessed 20th September, 2005.
6. Consultative Committee for Space Data Systems (2002). *Reference Model for an Open Archival Information System (OAIS) CCSDS 650.0-B-1 Blue Book*. Washington, DC: CCSDS Secretariat, Program Integration Division (Code M-3), National Aeronautics and Space Administration, January. Available at: http://ssdoo.gsfc.nasa.gov/nost/wwwclassic/documents/pdf/CCSDS_650.0-B-1.pdf, last accessed 20th September, 2005.
7. Library of Congress (2005). *METS: Metadata Encoding & Transmission Standard Official Website*. Washington, DC: Library of Congress, 25 January. Available at <http://www.loc.gov/standards/mets/>, last accessed 20th September, 2005.
8. See ref. 4 above, "Section 6.1: Mapping attributes and relationships to user tasks."
9. Corporation for Public Broadcasting (2005). *Welcome to PBCore: the Public Broadcasting Metadata Dictionary: PBCore v 1.0*. Available at: <http://www.utah.edu/cpbmetadata/>, last accessed 20th September, 2005.
10. W3C Architecture Domain (2000). *XML Schema*. Available at: <http://www.w3.org/XML/Schema>, last accessed 20th September, 2005.
11. *Information Technology – Metadata Registries (MDR) — Part 3, Registry Metamodel and Basic Attributes* (2005). Available at: [http://metadata-standards.org/metadata-stds/Document-library/Meeting-reports/SC32WG2/2005-04-Berlin/WG2-N0803_WD-11179-3_3rd-edition_v0_\(E\).doc](http://metadata-standards.org/metadata-stds/Document-library/Meeting-reports/SC32WG2/2005-04-Berlin/WG2-N0803_WD-11179-3_3rd-edition_v0_(E).doc), last accessed 20th September, 2005.
12. Ianella, R. (2002) *Open Digital Rights Language*. Version 1.1. Available at: <http://odrl.net/1.1/ODRL-11.pdf>, last accessed 20th September, 2005.
13. International Organisation for Standardisation (2004). "ISO/IEC/JTC1/SC29/WG11, Coding of Moving Pictures and Audio". *MPEG-7 Overview*. Available at: <http://www.chiariglione.org/mpeg/standards/mpeg-7/mpeg-7.htm>, last accessed 20th September, 2005.
14. Library of Congress (2005). *MODS: Metadata Object Description Schema, Official Website*. Available at: <http://www.loc.gov/standards/mods/>, last accessed 20th September, 2005.
15. (c2000–2005) *XrML: The Digital Rights Language for Trusted Content and Services*. Available at: <http://www.xrml.org/>, last accessed 20th September, 2005.
16. IEEE. *WG12: Learning Object Metadata*. Available at: <http://ltsc.ieee.org/wg12/>, last accessed 20th September, 2005.
17. Library of Congress. *Moving Image Collections: Window to the World's Moving Images*. Available at: <http://mic.loc.gov>, last accessed 20th September, 2005.
18. MXF Implementers Working Group. *SMPTE W25.10*. Available at: <http://www.smpite-mxf.org/>, last accessed 20th September, 2005.
19. International Organisation for Standardisation, ISO/IEC/JTC1/SC29/WG11, Coding of Moving Pictures and Audio (2002). *MPEG-21 Overview v. 5*. Shanghai. Available at: <http://www.chiariglione.org/mpeg/standards/mpeg-21/mpeg-21.htm>, last accessed 20th September, 2005.