

---

# Meta-information about MARC: an XML framework for validation, explanation and help systems

---

*Joaquim Ramos de Carvalho*  
*Maria Inês Cordeiro*  
*António Lopes and*  
*Miguel Vieira*

---

## The authors

**Joaquim Ramos de Carvalho** is Professor, University of Coimbra, Quinta da Nara, Portugal, and a founder of BookMARC.

**Maria Inês Cordeiro** is Library Information Systems Manager, Art Library, Calouste Gulbenkian Foundation, Lisbon, Portugal.

**António Lopes** is Lead Developer and **Miguel Vieirais** is Developer, both of BookMARC, Instituto Pedro Nunes, Quinta da Nora, Portugal.

---

## Keywords

Online cataloguing, Extensible markup language

---

## Abstract

This article proposes a schema for meta-information about MARC that can express at a fairly comprehensive level the syntactic and semantic aspects of MARC formats in XML, including not only rules but also all texts and examples that are conveyed by MARC documentation. It can be thought of as an XML version of the MARC or UNIMARC manuals, for both machine and human usage. The article explains how such a schema can be the central piece of a more complete framework, to be used in conjunction with "slim" record formats, providing a rich environment for the automated processing of bibliographic data.

---

## Electronic access

The Emerald Research Register for this journal is available at [www.emeraldinsight.com/researchregister](http://www.emeraldinsight.com/researchregister)

The current issue and full text archive of this journal is available at [www.emeraldinsight.com/0737-8831.htm](http://www.emeraldinsight.com/0737-8831.htm)

Since 1998 there has been widespread interest in the potentials of XML on the part of the library community, regarding raising awareness, expectations and experiences for library services in various aspects (Hjørsgensen, 2001a, b; Tennant, 2002; Cordeiro and Carvalho, 2002; Carvalho and Cordeiro, 2003a, b) more than clear directions regarding the implications for bibliographic metadata standards (Gardner, n.d.; Exner and Turner, 1998; McCallum, 2000; Kim and Choi, 2000; Miller, 2000; 2002; Qin, 2000; Van Herwijnen, 2000). The relationship between MARC and XML has already been addressed in the literature (Lam, 1998; Medeiros, 1999; Granata, 2000; Johnson, 2001; Miller, 2000, 2002; Carvalho and Cordeiro, 2002) (although MARC generally refers to library data formats, which can include different subsets for bibliographic, authority, holdings, classification and community information, in this paper we refer to MARC meaning mainly bibliographic data formats).

The interest in XML has been fueled by a variety of needs that exist in the bibliographic data processing community: wider circulation and usage of bibliographic records requiring a mainstream data format, the demand for flexible representations of bibliographic data in a continuously growing range of display formats (html, pdf, text), and awareness about a certain archaism of ISO 2709 as a transport format *Information and Documentation – Format for Information Exchange* (ISO, 1996). ISO 2709 is the common format for exchange underlying all MARC formats; it consists of a record label, a directory and data fields, with standard characters for separators. The corresponding ANSI standard is the ANSI/NISO (1994) *Information Interchange Format*. The hope that XML would help to remove, or overcome, unnecessary complexity in the creation and processing of bibliographic records is cited in the literature and in the messages exchanged on the XML4Lib mailing list[1].

In this article, the XML representation of MARC meta-information is the focus, instead of the more common topic of the representation of individual records. By meta-information is meant the information about the standard itself, such as the actual content of MARC documentation, most of it included in MARC21 or UNIMARC manuals (available at: <http://lcweb.loc.gov/marc/> and [www.ifla.org/VI/3/p1996-1/sec-uni.htm](http://www.ifla.org/VI/3/p1996-1/sec-uni.htm)). Beyond the record structure and morphological level of content designation, an important part of such information describes semantic characteristics of valid MARC records: which

---

Received 1 September 2003

Revised 2 October 2003

Accepted 7 November 2003



fields are mandatory, which are repeatable, what are the legal values for indicators or certain sub fields, etc. These aspects are essential for the validation of bibliographic records.

The issue of validation is central in discussing the relationship between XML and MARC. This is due to the fact that validation is an aspect that was built into the design of XML. XML documents can be validated against a special document, called a schema[2], containing a description of the legal structures and data that are “legal” for a certain type of information. Widely-available tools can use schema documents to check the validity of XML documents[3].

Since validation is a very common data processing activity, one would expect that bibliographic records expressed in XML could be validated using the built-in mechanisms derived from schemata. It turns out that this goal cannot be achieved in a simple way, because the range of rules that may define what a valid MARC record is cannot easily be mapped to a schema. This is especially true if one wishes to maintain a simple XML representation of MARC, in order to allow for easy transportation of records between systems.

As a matter of fact, in a first stage of exploring the use of XML to express MARC records, most of the approaches assumed self-validation or self-explanation of MARC records as an essential feature, resulting in very long and complex DTDs (see for example Hough *et al.*, 2000) and confounding different goals and functions for how and why to use XML versions of MARC records. Examples of this approach are LoC MARC DTDs, BiblioML and Medlane XMLMARC experiment[4]. This situation soon revealed a tension between the simplicity required for the transportation and dissemination of records, and the complexity that is implied in expressing the full set of rules that make a record valid. The solution is to design an XML transport format that is simple and efficient for that purpose (hence “slim”), and to produce an alternative mechanism for validation.

This was the approach followed by the Library of Congress (LoC) with MARCXML (available at: [www.loc.gov/standards/marcxml/](http://www.loc.gov/standards/marcxml/)), and it was also proposed by the authors in Carvalho and Cordeiro (2002). Three areas were identified for the use of XML with bibliographic records:

- (1) record exchange (data transportation level);
- (2) record validation (data conformity level); and
- (3) sharing of services (application services level).

Separating record exchange from validation was the first step emphasized (Carvalho and Cordeiro, 2002). The potentials of XML applied to sharing services between systems, notably using Web services, was later explored in Cordeiro and Carvalho (2003b) and some practical

exemplifications were provided in Carvalho and Cordeiro (2003a). Altogether these considerations form what the authors called the *TVS – Transport, Validation and Services – Model*[5].

In this article, this route is taken a step further by proposing an XML representation of the information needed for the validation of MARC records. The novelty of this approach is that such representation assumes the form of an XML Schema targeted not at bibliographic records as such, but rather at the set of information that describes what a valid MARC record is. This proposal can be thought of as a sort of XML transcription of the MARC manual, aimed at both machine and human usages.

Before introducing the schema itself, it is worth elaborating on what is meant by “validation” of records. Validation is not a straightforward and uniquely-defined concept. It can be considered at different levels, expressed by different concepts, each having different implications from the point of view of the type of information needed to determine if a MARC record is valid or not.

### **“Readable,” “correct” and “adequate” records**

MARC records are formalized representations of bibliographic information. “Formal” means that they conform to a set of conventions, principles and rules about how a bibliographic item should be described and how this description should be coded into machine-readable form.

Like all formalisms, MARC represents reality by reducing (i.e. simplifying) the complexity and variations of real bibliographic entities in a way that is considered adequate for a set of purposes. MARC records abstract and simplify bibliographic reality by means of a set of conventions where some are generally present in all MARC formulations while others can be particular to specific materials, or derive from a given policy of application. That is to say, the level of rules and criteria that can be considered for MARC “validation” can vary according to the requirements of a given case and of a given purpose (i.e. like the map of a city that, beyond general conventions of a city map, conveys special features suited to a given purpose, e.g. that of providing guidance about public transport mobility).

There are several levels of rules and conventions in MARC that converge in the formal representation of bibliographic information. Some are very “low level” and have to do with the structure of the record, its atomic parts and how they are presented in an electronic file. Others are of a “higher level” and define what type of information should be present, if and when certain

data elements should or should not occur, or what elements of bibliographic information should be transcribed using pre-defined codes or vocabularies. Not all of the information included in MARC documentation is absolutely prescriptive and exclusive of alternatives; in the same way, not all the prescriptions relating the production and management of MARC records are included in official MARC documentation, because some derive from policies adopted by institutions or communities of systems.

In this context, the concept of a “valid” record can have different meanings and scope. It is therefore useful to categorize different levels of understanding “validity” before we proceed with the discussion of how different aspects of MARC validation can be handled. We suggest decomposing the concept of “a valid record” into three different levels: “readable”, “correct” and “adequate”. Like all terminologies, these levels are somewhat arbitrary and other terms could be used. The important thing is to distinguish clearly the meaning of each level:

- (1) A “readable” record is composed of a leader, a set of control fields and a set of data fields with the additional characteristics defined by the ISO 2709 standard. From a functional point of view, this is a record that can be read by a machine and further processed. Alternative designations of a “readable” record could be “structurally valid” or “syntactically valid”. Limitations of this level of analysis include the fact that a record may be “readable” but it may consist of a set of fields and content which make little sense as a MARC record.
- (2) A “correct” record is a “readable record” that contains the required set of fields prescribed by the MARC standard to model a given type of bibliographic item and the content of which follows the relevant coding rules and vocabulary types, wherever applicable. Functionally, this is a record that a MARC-aware automated system can extract information from, producing, for instance, indexes or ISBD displays of the contained information. An alternative designation of a “correct” record could be “semantically valid”. Limitations of this level of analysis include the possibility that a record can be “correct” in this sense but provide inappropriate description of the bibliographic item, either because it contains semantic errors (misreadings, incorrect recording of dates or names, etc.) or because it lacks information that is not mandatory by the standard but is relevant and needed for the case in question.
- (3) An “adequate” record is a “readable” and “correct” record that is fit for the purpose defined for that record in its context.

Functionally, this is a record which applies MARC following the relevant guidelines, good practice, consistency rules and policies of a given librarianship community. It is a record that correctly surrogates the original item and fulfills the role and features of the information system(s) where it was generated or in which it will “live”. An alternative designation for an “adequate” record could be “fit for purpose”. Limitations of this level of analysis derive from the issue that the “purpose” of records, in the sense explained above, is seldom clearly defined and even when such definitions exist they can change over time and circumstances.

From this categorization it is clear that when most people talk about “valid” records they usually mean “readable and correct” records. It is fairly obvious that labeling a record as “adequate” is not a task that can be fully automated, mainly because it relies in “real world” information that is not available as such to machines.

It is also clear that the main source of information for labeling records according to this typology is MARC documentation, such as MARC21 and UNIMARC manuals, just to mention the two major MARC formats. MARC manuals define the rules for “readability”, “correctness” and, although not covering all possible aspects of “adequacy”, they provide examples and directions related to generally accepted good practices and desirable outcomes in terms of modeling bibliographic surrogates.

### **The role of XML: from “readability” to “correctness”**

Where does XML fit into this “validation” landscape? Current MARC XML mappings are aimed at “readable” records. The LoC MARCXML Schema, having data transport as the main goal, defines exactly what a “readable” record is, not if it is correct. This task is currently being relegated to specialized software that in turn relies on stylesheets. Extensible Stylesheet Language Transformation (XSLT), is an XML specification with the status of a W3C Recommendation, for transforming XML documents into other XML documents using stylesheets[6].

At this point, it is worth pausing a moment to reflect on how the limited role of XML has been over-hyped. The introduction of an XML “slim” format is an example of how MARC records are “read” into machines. It provides no conceptual revolution and no change in the intellectual aspects of producing bibliographic records according to the

standard. It looks like a simplification because XML records are more easily read by humans than the original ISO 2709 records, but in fact nothing of what makes a MARC record what it is (a formalized mapping of a real world entity) is changed. What XML brings is a significantly greater simplification in the machine processing of records. This simplification can be further expanded if we extend XML usage from the “readability level” to the “correctness level”, achieving a fully XML-based validation framework.

To achieve such a framework, there is a need to express in a machine-readable format the knowledge behind the definition of a “correct record” and, beyond that, to provide as much as we can of “adequacy” information, mainly in the form of conditional rules, descriptive commentaries and examples. The functional horizon is to provide information that an “adequately informed” system can use in order to validate records and to provide enhanced assistance to human operators in producing “adequate” records.

As already mentioned, this apparently elaborated goal comes down to a very pragmatic task: to express the full (explicit and implicit) content of MARC manuals (e.g. of MARC21 or UNIMARC) in XML.

## Getting the MARC21 manual into XML: general concepts

Each field is described through a set of identifier attributes – a field has a tag and a name – and a set of occurrence attributes – a field may or may not be mandatory and repeatable. Description and examples elements hold information in (at least almost) human-readable form that can be used in help or documentation systems:

```
<FIELD tag="005" name="DATE AND TIME OF  
LATEST TRANSACTION" mandatory="y"  
repeatable="n">
```

Sixteen characters that indicate the date and time of the latest record transaction and serve as a version identifier for the record. They are recorded according to Representation of Dates and Times (ISO 8601). The date requires 8 numeric characters in the pattern *yyyymmdd*. The time requires 8 numeric characters in the in the pattern *hhmmss.f*, expressed in terms of the 24-hour (00-23) clock.</DESCRIPTION>

<EXAMPLES>

```
<EX n="1">005 19940223151047.0  
[February 23, 1994, 3:10:47 P.M.]</EX>
```

</EXAMPLES>

```
</FIELD>
```

Data fields also contain indicators and subfields elements:

```
<FIELD tag="500" name="GENERAL NOTE"  
mandatory="n" repeatable="y">  
<DESCRIPTION>General information for  
which a specialized 5XX note field has not  
been defined.</DESCRIPTION>  
<IND1 name="blank (not defined)" />  
<IND2 name="blank (not defined)" />  
<SUBFIELD tag="a" name="General note"  
mandatory="n" repeatable="n">  
<DESCRIPTION />  
</SUBFIELD>  
</FIELD>
```

The legal values of indicators can also be described as a set of options. Each member of this universe of values can be expressed as a singular value or as a range and can have an associated descriptive text:

```
<IND1 name="Sequence of publishing  
statements">  
<OPTION value=" " name="Not applicable/No  
information provided/Earliest available  
publisher" />  
<OPTION value="2" name="Intervening  
publisher" />  
<OPTION value="3" name="Current/latest  
publisher" />  
<IND2 name="Nonfiling characters">  
<OPTION value="0-9" name="Number of  
nonfiling characters" type="range">
```

A value that specifies the number of character positions associated with a definite or indefinite article (e.g., Le, An) at the beginning of a title that are disregarded in sorting and filing processes.</DESCRIPTION>

```
</OPTION>
```

```
</IND2>
```

Subfields are described by the same set of identifier and occurrence attributes used in fields description:

```
<SUBFIELD tag="a" name="Topical term or  
geographic name as entry element"  
mandatory="n" repeatable="n">  
<DESCRIPTION />  
</SUBFIELD>
```

Fixed-length data elements contained in subfields (or fields) are represented through an appropriate element type, subfield, that adds information about the start and end of the element. When these elements store only a discreet and finite set of values, an appropriate vocabulary of possible items is composed (provision is made to allow for external vocabularies located by means of an URL):

```
<PSUBFIELD n="17" name="Technique"
  start="34" mandatory="n" end="34">
  <DESCRIPTION>A one-character code that
  indicates the technique used in creating
  motion in the motion picture or
  videorecording.</DESCRIPTION>
  <VOCABULARY type="local"
  name="Technique">
  <ITEM code="a" name="Animation">
  <DESCRIPTION />
  </ITEM>
  <ITEM code="c" name="Animation and live
  action">
  <DESCRIPTION />
  </ITEM>
  <ITEM code="l" name="Live action">
  <DESCRIPTION />
  </ITEM>
  <ITEM code="n" name="Not applicable">
  <DESCRIPTION>Item is not a motion
  picture or a
  videorecording.</DESCRIPTION>
  </ITEM>
  <ITEM code="u" name="Unknown">
  <DESCRIPTION />
  </ITEM>
  <ITEM code="z" name="Other technique">
  <DESCRIPTION />
  <ITEM code="|" name="No attempt to code">
  <DESCRIPTION />
  </ITEM>
  </VOCABULARY>
</PSUBFIELD>
```

The structure of some data elements can be affected by the content of others. For instance, the type of material as set by the value of the first position of field 006 affects the composition of the rest of the field. This kind of adjustable structure is formalized by the `APPLYIF` element, that describes how the contained subfields and positional fixed-length data elements are interpreted in view of a particular condition. The condition expression must form a syntactically correct XSLT Boolean expression:

```
<APPLYIF condition="substring($content, 1,
  1) = 'a' or substring($content, 1, 1) = 't'"
  name="Books">
  ...
</APPLYIF>
```

## The framework and its deliverables

MARC and UNIMARC rules transcribed in this way can be processed in a number of useful ways.

The authors have produced a set of derived products from the XML version of a subset of the MARC21 manual, and have a more developed and extensive version of the UNIMARC manual. Here we present how the schema exemplified above can foster usage in the areas of validation, explanation of records and documentation of the standards.

While developing examples of the usefulness of the schema, the authors relied intensively on XML transformation stylesheets (XSLT). XSLT is a standard for transforming an XML document in another type of document, including another XML document or another stylesheet. The authors used this technology to show how an XML version of the MARC manual can be used to validate records, to “translate” MARC records into readable English descriptions, and to produce a Web-ready version of the manual. Since XSLT technology is freely available, the cost of implementation of the described usages was very low.

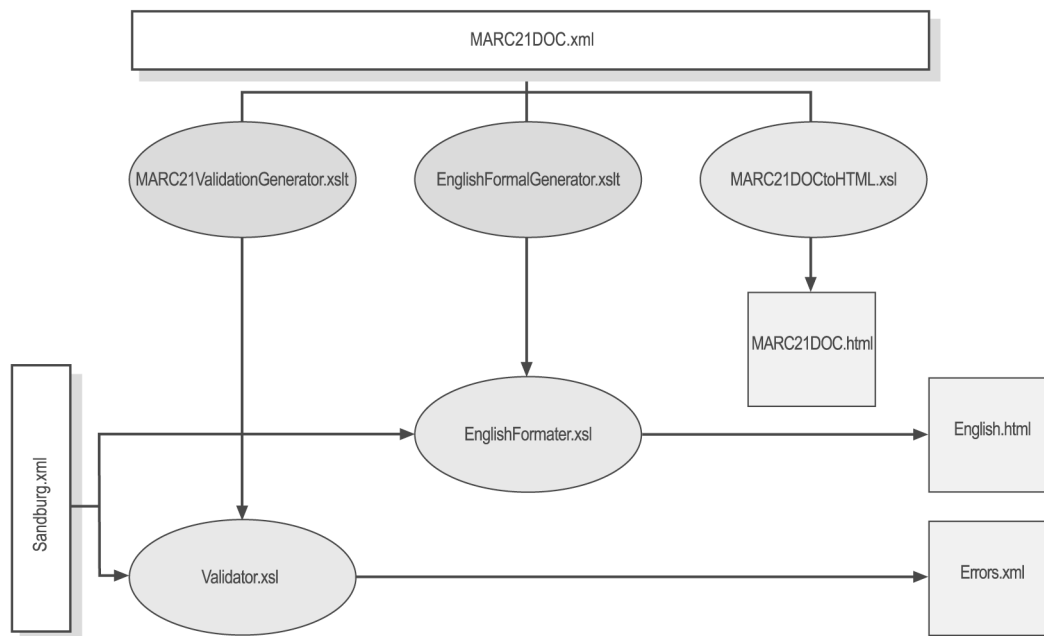
Figure 1 shows how the XML MARC manual (MARC21DOC.xml) can produce a set of related products through XSLT transformations.

The authors have produced the following stylesheets:

- MARC21ValidationGenerator.xslt is a stylesheet that produces another stylesheet (Validator.xsl) that, when applied to a MARCXML bibliographic record, validates the record against the rules specified in MARC21DOC.xml. Note that the current LoC MACXML toolkit includes a stylesheet similar to Validator.xsl. The new approach here consists in the automatic production of the validating stylesheet from the MARC manual. This insures that changes in the XML representation of the MARC manual can be immediately applied to validation of records.
- EnglishFormatGenerator.xslt is a stylesheet that also produces another stylesheet (EnglishFormater.xsl) that, when applied to a MARCXML bibliographic record, displays the record in an easy-to-read format, with tags decoded, indicator semantics explained, coded values translated into plain English. This mimics the behavior of a similar stylesheet included in the LoC kit, but it is generated from the MARC manual.
- MARC21DOctoHTML.xsl is a more conventional stylesheet that produces a HTML version of the MARC manual.

Examples on the usage of these stylesheets, along with a more detailed description of the XML schema, a sample of the subset of the MARC21 manual, and a toolkit for testing purposes is available at: [www.bookmarc.pt/tvs/marcdoc.html](http://www.bookmarc.pt/tvs/marcdoc.html)

Figure 1 XMLMARC through XSLT transformations



## Conclusions

The evolution of approaches to XML regarding MARC records representation has recently emphasized the separation of concerns between the transport and validation functions. In turn, alleviating XML transport from the validation rules raises the need to reappraise the validation function itself.

General-purpose MARC validation programs have been around for many years, and most bibliographic applications include validation facilities at the level of “correctness” of records, e.g. controlling cardinality and repeatability of fields, offering drop down menus of codes for editing coded data fields, etc. Many systems also include some level of help systems for human operators, in the form of texts transcribing explanation phrases for the content designators shown on MARC editor screens. In both aspects, these are constructs that usually make use of reduced information and limited functionality, very far from conveying all knowledge that is included in MARC analogue documentation. Moreover, these validation and help functionalities are built from scratch for each system or application, with no automated relationship with the authoritative source of the underlying MARC standards.

This paper has considered an XML framework for the validation of MARC records, having in mind a full-feature knowledge base to support both systems’ and users’ activities. The flexibility and neutrality of XML constructs allows for the

combination of these traditionally separated, or not completely integrated, purposes. The authors have proposed a MetaMARC Schema that, together with standard stylesheet techniques, can produce data-driven validation, documentation, help systems, and human-friendly transformation of records.

The authors believe that this approach will lower the cost of implementation and usage of MARC-based software; at the same time, it can facilitate the standard use of XML regarding bibliographic records. XML has introduced yet another level of crucially needed agreement in the library community, if it is to make the most of the standardization efforts previously achieved at all levels up to MARC. Finally, the proposed MetaMARC Schema can facilitate and extend the authoritative function and the reach of the documentation produced by the MARC standard agencies.

These are goals that can contribute decisively to the technological realignment of bibliographic systems, bringing together actual systems with legacy features with the newest technologies by taking full advantage of the major standards of both sides.

## Notes

- 1 Available at: <http://xmlmarc.stanford.edu/webliography.html> and <http://sunsite.berkeley.edu/XML4Lib/>
- 2 Available at: [www.w3.org/XML/Schema](http://www.w3.org/XML/Schema)

- 3 Available at: [www.w3.org/Style/XSL](http://www.w3.org/Style/XSL) and [http://dmoz.org/Computers/Data\\_Formats/Markup\\_Languages/XML/Style\\_Sheets/XSL/Implementations/](http://dmoz.org/Computers/Data_Formats/Markup_Languages/XML/Style_Sheets/XSL/Implementations/)
- 4 Available at: <http://lcweb.loc.gov/marc/marcdtd/marcdtdback.html>; [www.culture.fr/BiblioML](http://www.culture.fr/BiblioML); and <http://xmlmarc.stanford.edu>
- 5 Available at: [www.bookmarc.pt/tvs](http://www.bookmarc.pt/tvs)
- 6 Available at: [www.w3.org/TR/xslt](http://www.w3.org/TR/xslt)

## References

- ANSI/NISO (1996), *Information Interchange Format, Z39.2-1994* (2001), Washington, DC.
- Carvalho, J. and Cordeiro, M. (2002), "XML and bibliographic data: the TVS (transport, validation and services) model", paper presented to the 68th IFLA Council and General Conference, available at: [www.ifla.org/IV/ifla68/papers/075-095e.pdf](http://www.ifla.org/IV/ifla68/papers/075-095e.pdf) (accessed 31 August 2003).
- Carvalho, J. and Cordeiro, M. (2003), "Web services: next generation interoperability for libraries", in Nixon, C. (Comp.), *Internet Librarian International Conference, 25-25 March 2003, Birmingham UK, Collected Presentations*, Information Today, Medford, NJ, pp. 40-9.
- Cordeiro, M. and Carvalho, J. (2003), "Web services: what they are and its importance for libraries", *VINE*, Vol. 32 No. 4 Issue 129, pp. 46-62.
- Exner, N. and Turner, L. (1998), "Examining XML: new concepts and possibilities in Web authoring", *Computers in Libraries*, Vol. 18 No. 10, November/December, available at: [www.infotoday.com/cilmag/nov98/story2.htm](http://www.infotoday.com/cilmag/nov98/story2.htm) (accessed 31 August 2003).
- Gardner, J. (n.d.), "Exploring what's neXt: XML, information sciences and markup technology", available at: [http://vedavid.org/xml/docs/eXploring\\_xmlandlibraries.html](http://vedavid.org/xml/docs/eXploring_xmlandlibraries.html) (accessed 31 August 2003).
- Granata, G. (2000), "XML e formati bibliografici", *Bolletino AIB*, No. 2, pp. 181-91.
- Hjørsgensen, P.H. (2001a), "XML standards and library applications", paper presented at ELAG 2001, available at: [www.stk.cz/elag2001/Papers/Poul\\_HenrikJoergensen/Show.html](http://www.stk.cz/elag2001/Papers/Poul_HenrikJoergensen/Show.html) (accessed 31 August 2003).
- Hjørsgensen, P.H. (2001b), "VisualCat: cataloging with XML, RDF, FEBR and Z39.50", available at: [www.bokis.is/ioid2001/slides/Jorgensen\\_slides.ppt](http://www.bokis.is/ioid2001/slides/Jorgensen_slides.ppt) (accessed 31 August 2003).
- Hough, J., Bull, R. and Young, B. (2000), "Using XSLT for XML MARC record conversion", discussion paper, v. 0.2, 16 June, available at: [www.crxnet.com/one2/xslt\\_marc\\_report.pdf](http://www.crxnet.com/one2/xslt_marc_report.pdf) (accessed 31 August 2003).
- International Standards Organization (ISO) (1996), *Information and Documentation – Format for Information Exchange*, ISO 2709, ISO, Geneva.
- Kim, H. and Choi, C. (2000), "XML: how it will be applied to digital library systems", *The Electronic Library*, Vol. 18 No. 3, pp. 183, 189.
- Johnson, B.C. (2001), "XML and MARC: which is right?", *Cataloging and Classification Quarterly*, Vol. 32 No. 1, pp. 81-90, available at: <http://elane.stanford.edu/docs/johnson.pdf> (accessed 31 August 2003).
- Lam, K.T. (1998), "Moving from MARC to XML", available at: <http://ihome.ust.hk/~lblkt/xml/marc2xml.html> (accessed 31 August 2003).
- McCallum, S. (2000), "Extending MARC for bibliographic control in the Web environment: challenges and alternatives", paper presented at the Library of Congress Bicentennial Conference on Bibliographic Control for the New Millennium, available at: [http://lcweb.loc.gov/catdir/bibcontrol/mccallum\\_paper.html](http://lcweb.loc.gov/catdir/bibcontrol/mccallum_paper.html) (accessed 31 August 2003).
- Medeiros, N. (1999), "Making room for MARC in a Dublin Core World", *Online*, November, available at: [www.onlinemag.net/OL1999/medeiros11.html](http://www.onlinemag.net/OL1999/medeiros11.html) (accessed 31 August 2003).
- Miller, D. (2000), "XML and MARC: a choice or a replacement?", paper presented at ALA Annual Conference 2000, available at: <http://elane.stanford.edu/laneauth/ALACHicago2000.html> (accessed 31 August 2003).
- Miller, D. (2002), "Adding luster to librarianship: XML as an enabling technology", available at: <http://elane.stanford.edu/laneauth/Luster.html> (accessed 31 August 2003).
- Qin, J. (2000), "Representation and organization of information in the Web space: from MARC to XML", *Informing Science*, Vol. 3 No. 2, available at: <http://inform.nu/Articles/Vol3/v3n2p83-88.pdf> (accessed 31 August 2003).
- Tennant, R. (Ed.) (2002), *XML in Libraries*, Neal Schuman Publishers, New York, NY, and London.
- Van Herwijnen, E. (2000), "The impact of XML on library procedures and services", available at: <http://lhcb.web.cern.ch/lhcb/~evh/xmlandlibrary.htm> (accessed 31 August 2003).

## Further reading

- Gatenby, J. (2000), "Internet, interoperability and standards: filling the gaps", available at: [www.niso.org/press/whitepapers/Gatenby.html](http://www.niso.org/press/whitepapers/Gatenby.html) (accessed 31 August 2003).
- Hopkinson, A. (1998), "Traditional communication formats: MARC is far from dead", paper presented at the International Seminar, "The function of bibliographic control in the Global Information Infrastructure", available at: [www.lnb.lt/events/ifla/hopkinson.html](http://www.lnb.lt/events/ifla/hopkinson.html) (accessed 31 August 2003).
- Motta, S. and Ursino, G. (2000), "XML su tecnologia MOM: un nuovo approccio per i software delle biblioteche", *Bolletino AIB*, No. 2, pp. 195-203.