Resources Description in the Digital Age

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ABSTRACT

RESOURCE DESCRIPTION, KNOWN MORE familiarly within the library community as cataloging or indexing, is undergoing intense scrutiny with the rapid proliferation of, and access to, digital resources. There are many initiatives addressing a range of issues. The author references the following discussions and proposals: the need for, and definition of, a basic set of metadata elements; the examination of library cataloging objectives and record structures; persistent addresses for resources; and the proposal for a data registry to facilitate interoperability among metadata schemes. The importance of a framework for resource discovery created through formal resource description is reiterated.

INTRODUCTION

Library catalogs began centuries ago with handwritten entries of manuscripts housed in royal libraries, such as those in ancient Alexandria, and medieval monasteries. Individual entries were abbreviated in form and content, a function not only of lesser numbers of manuscripts but also of the fact that the catalog makers knew the collections intimately and were integral in their use. The situation today diverges on both dimensions. Accessible documents number well into the millions, many a result of the ease of electronic desktop publishing. End-users have assumed greater independence in their consultations of a wide range of library catalogs, citation indexes, as well as full text, numeric, and multimedia databases accessible through the national and international bib-

liographic infrastructure, relying for assistance on the organization and
structure provided by classification and cataloging.

The fundamental reasons for cataloging remain. Within the system
of information exchange, authors and creators want their documents to
be found while users want to find information relevant to their needs.
Toward that end, the organizers and describers who make possible re-
source discovery and retrieval are key players. The library community is
but one segment of the information system, but one distinguished by its
attention to all aspects of making information accessible including its
rigorous application of principles for organizing and describing retrieval.
In this rapidly changing world of resource discovery and retrieval, this
article describes evolving means of making documents and document-
like objects bibliographically accessible by the library cataloging commu-
nity and, without attempting to forecast the future, anticipates their fu-
ture use.

RESOURCE DISCOVERY AND RETRIEVAL IN THE DIGITAL AGE

Since 1990, the information world has been stunned by the dramatic
expansion in popularity and use of the Internet and, more recently, the
World Wide Web. Almost overnight, Web browsers burst upon the scene
enabling users to search thousands of Internet sites with no more key-
strokes than are needed for a typical online catalog search and through
software operating from the user's own workstation. Although the sig-
nificance, authoritativeness, and applicability of the discovered informa-
tion ranges widely, albeit perhaps no more widely than is true of printed
sources if the full range of publications were so readily available, the ease
of surfing the Web has made it a first choice of many whether for work or
entertainment.

Successive generations of citation databases and library online cata-
logs incorporated more capable search engines as well as remote access
any hour of the day, but the continuing evolution of Internet services has
changed forever the landscape of document discovery and retrieval. From
the initial offerings of telnet and gopher to the hypertext transfer proto-
col (HTTP) now known as "the Web," the capabilities for gathering, in-
dexing, storing, accessing, and delivering digital documents have grown
more powerful although they have not kept pace with the increase in the
numbers of documents. Robots search and index documents daily, mak-
ing thousands of resources available. Documents are retrievable with a
single keystroke activating the link from the bibliographic citation di-
rectly to the document. Users visit hundreds of databases in one session,
approaching the Internet as if it were a seamless coherent information
system. In this climate of rising expectations, there is a hope as well that
quantum leaps in information discovery and retrieval reminiscent of the

significance that "moveable classification" had on efficient storage and retrieval of books in libraries lie ahead in the not so distant future.

Recognizing that it requires more than the ability to move swiftly from source to source to endow a robust information system, players in the information community are exploring a host of issues. In setting an ambitious agenda for research and tool development, the *CNI White Paper on Networked Information Discovery and Retrieval* lists two major categories which are, broadly speaking, issues of architectures and technologies and second, of description and metadata (Coalition for Networked Information, 1996). Of primary interest here, description and metadata encompass new and familiar issues: document description by creators, HTML extraction (webcrawlers), library descriptive cataloging, MARC practices and multiple schemes, GILS and TOPNODE, authority files, the mixing of controlled and uncontrolled vocabularies, access to nontextual media, and the complexities of description for aggregate objects and information spaces such as databases and newsgroups.

The goal is a sustainable, distributed, and scalable approach to resource discovery and retrieval via the networks (Nicholson & Steele, 1996). Many players, including library consortia, libraries, government agencies, scholarly associations, software vendors, and groups, such as the Internet Engineering Task Force, the National Digital Library Federation, World Wide Web Consortium (W3C), to name only a few, are exploring the opportunities made possible by digital and network functionality. From the user perspective, this functionality highlights the interconnectedness of individual catalogs, databases, and search engines and, not surprisingly, many activities are directed toward creating a more coherent global system. The following initiatives, which are only a fraction of those underway, reference important directions and proposals. These include: (1) definition of a basic set of data elements known as the Dublin Core, (2) examinations of library cataloging objectives and record structures, (3) proposals for persistent addresses for resources, and (4) support for the idea of a data registry to facilitate interoperability among metadata schemes.

SURROGATES AND METADATA

Before turning to a discussion of the Dublin Core set of data elements, it is useful to start with the role of surrogates and metadata in resource discovery. A fundamental assumption underlying future bibliographic access to digital resources, some networked, some not, is that the demand for surrogates will increase rather than decrease in the information network of the future (Lynch, 1995). Surrogates are cataloging/ indexing records that describe the actual resources and inform the searcher of how to access them. Surrogates may be richly detailed in their identification of significant document attributes and relationships

or be so brief their primary function is to indicate the existence and loca-
tion of a document. Regardless of the amount of information included,
however, issues of system scalability, protected intellectual property not
available without purchase or contract agreement, and the limitations of
automatic indexing are sufficient to ensure ongoing reliance on surro-
gates at all levels. Certainly automatic data collectors (robots) will con-
tinue to gather and index some freely available information but, for these
and other reasons, the bibliographic access infrastructure underlying re-
source discovery will depend on surrogates.

Metadata are documentation about documents and objects. They
describe resources, indicate where the resources are located, and outline
what is required in order to use them successfully. These data elements
can be embedded in fields or tags within a target document or object or
they can be put into a surrogate record. Overall, the metadata can be
free form or prescribed by a set of rules of which there are literally hun-
dreds of schemes defining how to construct and encapsulate metadata.
Gradually, a working categorization of metadata types is emerging, with
one typology listing six categories needed to support resource descrip-
tion and retrieval: (1) registration (uniform resource names), (2) terms
and conditions for use, (3) document/object structure for instruction in
access, (4) history of use, (5) context, and (6) content, which includes
description and subject analysis (Michelson, 1995).

There are literally dozens of metadata schemes created by libraries,
scholarly associations, government agencies, and commercial entities.
Some are broad in scope and widely used, such as the *Anglo-American
Cataloguing Rules*, 2d edition (AACR2), MARC formats, and classification/
subject analysis tools from the Library of Congress, the National Library
of Medicine, and Forest Press (Dewey Decimal Classification). Others
were developed for specialized domains, such as the Text Encoding Ini-
tiative (TEI) Guidelines for Electronic Text Encoding and Interchange,
including the TEI header as a mandatory element in TEI-conformant
texts; the Encoded Archival Description (EAD), an SGML document type
definition for encoding finding aids; and the Content Standards for Digi-
tal Geospatial Metadata (CSDGM) developed by the U.S. Federal Geo-
graphic Data Committee to accommodate the unique characteristics of
maps and geospatial resources. Some of these metadata schemes are rela-
tive newcomers standardized only in the last decade with others still in
the formative stages. Collectively, these metadata content schemes form
the basis of a global resource discovery system.

Each of these schemes is constructed from an understanding of spe-
cific domains, information resource needs, and unique requirements for
describing document-like objects and was developed by experts closely
associated with the field. In a digital networked environment, these fac-
tors will not disappear. At a recent interdisciplinary research conference

on digital libraries, some 200 librarians and computer scientists agreed that thoughts of "one overarching plan for cataloging, searching and retrieving data from the many trillions of bytes of digital material that tomorrow's networked collections will contain" is not feasible (Jacobson, 1995a, p. A19). One size does not fit all. The ideal of universal bibliographic control and access can only be achieved through a system of access tools, each occupying a particular niche yet somehow connected to offer a logical and comprehensive set of tools.

THE DUBLIN CORE

Sophisticated resource description schemes, such as AACR2, yield a detailed bibliographic record with exact description and access points in standardized form. Despite greater assistance from computers and even declining per record costs, there remains a sense that it is neither possible nor necessarily desirable to bring all Internet accessible documents and objects under the rich bibliographic umbrella created by the application of AACR2 or similar schemes. Libraries and indexing agencies create access to documents selected to meet the needs of their constituencies with the result that, today and in the future, some documents are outside the boundaries of these indexes and catalogs. Some, even many, documents will be "self-indexed" with indexing terms extracted from the documents rather than through assignment by an external cataloging/ indexing agent. While indexing and library cataloging processes significantly increase the likelihood for effective retrieval where the keys must be supplied rather than extracted from the title page—e.g., a subject heading or links to other works by the author—there is nevertheless value in the accessibility of all documents without further provision of retrieval keys, a regard to where they may be located, or the kind of decisions made about their usefulness. That assumption prevails in designing the global digital library: "[I]nformation seekers benefit from self-indexing resources" that provide access where otherwise none would exist (*Organizing the Global Digital Library*, 1995, p. 2).

With the acceptance of a role for self-indexed documents in fostering universal bibliographic access, there is much to be gained from identifying and standardizing a core set of metadata elements that could be completed by the document creator and that is "more informative than an index entry but is less complete than a formal cataloging record" (Weibel, 1995, p. 1). From the OCLC/NCSA Metadata Workshops there emerged a consensus on a simple resource description set of data now known as the Dublin Core. Purposefully kept to a minimum number (13) (see Figure 1), the Dublin Core metadata rest on six principles to achieve ease of creation and broad applicability. The Dublin Core data elements are descriptive only of intrinsic properties, eliminating the use of external references (to cataloging rules or authority files), are extend-

able to include additional specialized information, are syntax indepen-
dent, are optional as well as repeatable, and can be modified through
qualifiers to convey a meaning beyond the commonly understood defini-
tion (Weibel, 1995, pp. 3-4).

In a September 1996 workshop sponsored by OCLC and the Coali-
tion for Networked Information (CNI), similar efforts were planned to
extend standard data elements, working from the Dublin Core as a model,
to nondocument like objects, such as images and image bases. Individual
projects in a wide range of disciplines, including art, architecture, engi-
neering, medicine, and physical sciences, are converting large numbers
of still images for which discovery and access tools are needed. As with
document-like objects, an identification of common requirements and
standard descriptors is a step toward consistency in resource description.

For information creators and producers to apply the Dublin Core, a
mechanism for embedding the data within HTML documents had to be
established. Additionally, there was considerable interest from the per-
spective of software and database creators/vendors in achieving some level
of compatibility with existing browser software and current means for
robot collection of data (Weibel, 1996, p. 1). As Weibel reports, a con-
vention was devised at a recent W3C (World Wide Web Consortium) Dis-
tributed Indexing and Searching Workshop for encoding metadata in
attribute tags in HTML-structured documents. It is anticipated that soft-
ware developers would, with assistance from those who are experts on
the Dublin Core, create templates for assistance in creating such a data
set for information creators and producers who are perhaps not accus-
tomed to creating this type of information.

In conjunction with other members of the bibliographic access com-
munity, libraries are challenged to expand the use of standard metadata
in digital documents and objects (*Organizing the Global Digital Library*

- *Subject:* The topic addressed by the work
- *Title:* The name of the object
- *Author:* The person(s) primarily responsible for the intellectual content of the object
- *Publisher:* The agent or agency responsible for making the object available
- *Other Agent:* The person(s), such as editors and transcribers, who have made other signifi-
  cant intellectual contributions to the work
- *Date:* The date of publication
- *Object Type:* The genre of the object, such as novel, poem, or dictionary
- *Form:* The physical manifestation of the object, such as Postscript file or Windows execut-
  able files
- *Identifier:* String or number used to uniquely identify the object
- *Relation:* Relationship to other objects
- *Source:* Objects, either print or electronic, from which this object is derived, if applicable
- *Language:* Language of the intellectual content
- *Coverage:* The spatial locations and temporal durations characteristic of the object

Figure 1. DUBLIN core element description

Conference, 1995, p. 4). Historically, libraries have addressed universal
bibliographic access (at the title level) through national bibliographies,
cataloging records, and the sharing of these bibliographic resources. Both
as bibliographic access coordinators and document publishers, libraries
are asked to "include metadata in digital resources and develop mecha-
nisms for integrating different forms of metadata (MARC, TEI, EAD, etc.)"
in online access tools. Libraries should identify incentives to encourage
information creators and producers to incorporate standard metadata in
their publications. Such incentives might be a function of copyright or
patent registration, revenue derived from increased access, or the pres-
tige associated with participation in national programs. One example is
the successful Library of Congress Cataloging in Publication Program in
which approximately 2,000 publishers send manuscripts for cataloging
before publication so that the completed publication carries its metadata
with it.

DUBLIN CORE AND OTHER SCHEMES

To the extent a core set of descriptive data elements (Dublin Core)
could be mapped into other metadata schemes—e.g., AACR2, TEI, or
CSDGM—these data could be a building block for records where addi-
tional description and access points are desired. Investigations underway
to assess the feasibility of mapping from the Dublin Core to MARC have
identified that the core issue is one of "translating from a simple descrip-
tive scheme to a complex one" (Caplan, In press). Some problems, such
as mapping from an undifferentiated personal name to a field that re-
quires explicit identification of entry under surname or not, can be re-
solved for mapping purposes although not necessarily meeting the de-
mands of the more complex scheme, through the addition of new fields
to MARC that will accommodate undifferentiated personal names. All
mapping endeavors will of necessity evaluate to what extent a mechanical
transfer of data from one scheme to another is cost-effective. Future use-
fulness will depend on factors including the existence of sufficiently large
collections of Dublin Core metadata records such that mechanical con-
version is worth doing and, for current cataloging, the level of assistance
provided by conversion rather than by rekeying.

Assisted conversion is a second alternative. The Library of Congress
Cataloging Directorate's Text Capture and Electronic Conversion (TCEC)
pilot project results in an accurate transcription and less time needed for
data entry (Davis-Brown & Williamson, 1996). Using homegrown soft-
ware, catalogers transfer data directly from electronic manuscripts, not
in MARC format, to a bibliographic record they are creating in MARC
format. Although not an automatic migration of data from one format to
another, this human driven transfer process takes advantage of publisher-

produced metadata and may be a more practical means for the near future in conversion practices.

LIBRARY CATALOG OBJECTIVES

In addition to issues of establishing a standard set of metadata and converting these data into a MARC formatted record, the library cataloging community is examining its cataloging objectives and principles. Comparisons with other systems continually suggest adapting cataloging practices to a world populated by computer robots, knowbots, and other intelligent software programs. While conversations hint at the desirability of a future in which intelligent software programs are the basic operators of the information system, the assumption remains that we are still building systems engineered for humans to operate (Lynch, 1995). It is in this context that librarians are evaluating whether the fundamental objectives and principles of library cataloging are valid and necessary.

Searches on the Web frequently result in hundreds or thousands of retrieved documents. While more can be better, the results often contain duplicate listings as well as documents of peripheral or no interest with no assurance that all indexed documents related to the search are found. These largely word indexes are constructed without reference to relationships among documents and little or no control over names or concepts. Frequently, there is insufficient information to determine if the document is what is sought although that disadvantage is partially offset by immediate document availability allowing searchers to scan and make decisions on whether the document is useful. Yet, despite these limitations, users do find relevant information on the Web.

This dichotomous situation (where some users find relevant information but many users, including librarians, consider the indexes or databases to be less than completely successful because successful retrieval depends on the underlying goals and expectations. The activities of searching the Web are the same as those of searching library catalogs, yet the expectations of librarians and many users differ in consulting the Web or a library catalog. They expect to find all documents by an author or on a topic and expect to get assistance in determining whether the document is the edition or character they seek when searching a library catalog, not simply documents which happen to have a prime keyword in the author or title. Searches retrieving many unrelated documents or missing related documents do not satisfy either their expectations of a catalog search or the goals of the catalog. However, from a perspective where such assistance or completeness are not goals, the search is considered successful when judged on that criterion.

Just as other indexing schemes or search engines, library cataloging conceptually is directed toward creating records for resource discovery. Library cataloging differs, however, in that it places discovery in the context

of bibliographic and subject relationships to other works. While library cataloging is not restricted to identifying relationships solely among items in a library's collection, the presence of a collection gives rise to, and visibly reinforces the value of, a contextual framework within which users can make their selections. As surrogates for library collection, catalogs insist it be possible not only to find specific works but also to identify all works related by author, title, or subject and to choose works of interest from among those collected or available.

FUNCTIONAL REQUIREMENTS OF BIBLIOGRAPHIC RECORDS

The most often quoted statement of the "objects and means" of library catalogs was made by the renowned Charles Ami Cutter (1904) in his setting forth of cataloging rules in a systematic manner. Formal reference to these objectives disappeared from cataloging codes during the first half of the century but eventually were again explicitly incorporated, now as functions, in the Paris Statement on cataloging principles (International Federation of Library Associations, 1963). The catalog must make it possible to find an item when the author, title, or subject is known, and to find what the library owns by a specific author or on a particular subject.

In 1992, an international Study Group on the Functional Requirements for Bibliographic Records was established with the formidable task of creating a framework that "would serve as the basis for identifying the specific attributes (such as title, date of publication) and relationships (such as translations, reproductions, parts, subject) required to support the various tasks that users perform when using bibliographic records" (International Federation of Library Associations and Institutions, 1996, p. 2). All types of media, applications, and user needs were considered in the Study Group's assessment of the value of individual attributes (and relationships to users in finding, identifying, selecting, and obtaining the desired works).

What emerges first and foremost from their recommendations is a reaffirmation of the assistance library catalogs must provide to users. Users typically enter a catalog or database with words anticipated to be in a document, such as keywords in title or author fields. Users then evaluate the matches or nonmatches to select desired items or reformulate the search to reduce or increase the number of records found. Their ability to evaluate and reformulate a search is dependent on the content of the records. Library catalogs furnish attributes in the way of subject headings, classification numbers, full names of authors, and relationships (such as sequels, translations, and reproductions) so that users can interpret the responses to their initial searches. From this point, they can expand, narrow, or otherwise reformulate their searches and navigate throughout the universe of documents represented in the catalog by methods

more directive than a simple addition or subtraction of words from search queries. In order, however, to go beyond sheer manipulation of the number of words included in the search query, attributes and relationships have to be identified and put into the record. A record without an indication that the item is a translation of another title or that the topic mentioned in the title is discussed from a historical or geographical point of view does not offer help beyond the obvious information found in the statement of authorship and title. Someone must supply the attributes and relationships belonging to the document which are not always stated in obvious places or not necessarily included in the documents.

Cataloging costs remain a concern, however, pushing the IFLA Study Group to examine whether any attributes or relationships could be omitted from the cataloging record without materially affecting the effectiveness of subsequent retrieval. Their qualitative assessment of attributes and relationship; assigned values of high, medium, and low; and, in accordance with their assignment, they identified some of lesser value, such as the intended audience of a musical work and the indication that a work was a summary of another, that could be omitted from a basic level of bibliographic record. The recommended basic records to be done by national cataloging agencies remain nonetheless very full records because most of the supplied attributes and relationships are deemed essential to meeting the objectives of the catalog. Unlike "minimal level cataloging" which was designed primarily to reduce costs, the recommended basic level records do not omit any categorical assistance—e.g., subject access through subject headings or classification.

Within North America, this same approach has been taken successfully in the definition of core bibliographic records for monographic, audiovisual, and serial resources. Defined and promulgated by the Program for Cooperative Cataloging (PCC) and the Cooperative National Serials (CONSER) Project, the core record concept is intended to fulfill cataloging objectives while reducing the cost of the cataloging (Cromwell, 1994). Accordingly, the core record concept suggests reductions are possible in the area of notes—e.g., eliminating the recording of notes to justify added entries—and introduces formally the sense of cataloging as a dynamic and iterative process. Over time and use, core records can be augmented as determined necessary.

OCLC is experimenting in a similar manner in creating its reference service NetFirst (OCLC, 1995, p. 4). NetFirst is a database of bibliographic records describing a diverse group of Internet-accessible resources. Recognizing the value of structured records in resource discovery and retrieval, the NetFirst records explore how much assistance can be provided through a more limited set of information than is found in a full AACR2/MARC bibliographic record. At OCLC, catalogers add structured access points (attributes and relationships in IFLA terminology),

including authors' names, subject headings, and numerical classification numbers to the records for WWW pages, library catalogs, electronic journals and newsletters, to name only a few of the selected resources. OCLC's assessment will include consideration of the adequacy of the data in the record and the relative costs of building NetFirst records (Jul, 1996).

The nature of Internet-accessible resources is a key factor in evaluating how much information is needed in the records. Surrogates, which are cataloging records, furnish sufficient information so decisions can be made about relevance and usefulness without examining the document itself. Where resources can be more easily accessed and reviewed, the amount of information required in the surrogate may be less than is now recorded. The library cataloging community is understandably cautious in considering this possibility; however, the interplay between surrogates and documents (or objects) may lead to new assumptions for some classes of documents as to the need for all attributes and relationships to be included in the bibliographic record.

NATIONAL FORMS OF HEADINGS

An international focus on library cataloging objectives and principles is appropriate because the exchange of cataloging data among libraries is at the heart of worldwide bibliographic control. Work in harmonizing bibliographic data from national cataloging agencies, such as the recent Moscow meeting on how the Russian cataloging rules and AACR2 might be brought closer, is ongoing (Patton, 1996, p. 16). It is, however, more difficult to reconcile differences among name headings, although the recent signing of a *Memorandum of Agreement on Convergence of Cataloguing Policy* by the Library of Congress and British Library paves the way for a joint international authority file for headings established in the United States and the United Kingdom (Library of Congress, 1996, p. 204). The difficulties of reaching agreement between even these two countries points to another solution where even greater differences exist among cultural and language traditions. To smooth the international exchange of cataloging data, the principle of establishing a single preferred form of name heading for worldwide use would yield officially to the principle of setting up the heading (in each country) in the language and form most preferred by national constituencies. This is happening in practice as the preferences of English, French, German, and Japanese speakers for familiar forms are legitimatized in cataloging name forms despite agreements of the Universal Bibliographic Control Programme. An international access record (authority record) would link the multiple preferred forms, with each identified for use in specific countries or in accordance with specific cataloging rules (Willer, 1996; Barnhart, 1996). Earlier work, such as that done by the Getty Vocabulary Coordination Group (VCG) for the Getty Art History Information Program, has shown the value and

feasibility of this approach. Where preferred name headings for identify-
ing art objects—as described respectively by museums, libraries, and ar-
chives—vary in form by language or other aspect, the variant forms are
linked to each other in the master authority file (Bower, 1992). The
principle of collocation is achieved, the cataloging data can be exchanged,
and the preferences of national constituencies are taken into account in
the forms of headings.

CONTINUING DISCUSSIONS ON COLLOCATION

The reaffirmation of library cataloging objectives and new means for
achieving collocation in the international arena have not eliminated ques-
tions of whether library cataloging principles can successfully be applied
to digital resources and the Internet environment. In 1992, the OCLC
Internet Resources Project examined this question and answered it largely
in the affirmative. With the addition of a field in the MARC format to
accommodate electronic location and access information, including Uni-
form Resource Locators (URLs), the USMARC format and AACR2 cata-
loging rules were judged sufficient for cataloging Internet resources
(Dillon & Jul, 1996).

About 200 libraries participated in the two-year OCLC Internet Cata-
loging Project, begun in 1994 and recently concluded, and created just
over 5,000 bibliographic records representing Internet resources. Lively
and continual discussions on the project listserv (intercat@oclc.org) illu-
minated problems and solutions, many of which focused on recording
access information in the 856 field.

Two factors supported the conclusion, reassuring to many, that the
cataloging rules could be applied to Internet resources: the cataloging
was done in the context of the library catalog and the nature of the re-
sources. Although initially libraries publicized their offering of access to
Internet resources in special printed lists or online menus, just as the
selection of Internet resources are gradually being brought into the main-
stream of collection development policies, so too is the bibliographic
access for some Internet resources being incorporated into the library
catalog. This cataloging is done within the context of the library collec-
tion and its catalog, not in the much larger and diverse universe of all
Internet-accessible resources. Establishing name headings and other cata-
loging activities is done in the context of the national authority files but
not in the context of all names found by Internet search engines.

In a recent thought-provoking article on the difficulties of applying
cataloging principles to resources in the Internet environment, Mandel
and Wolven (In press) suggest that "simply collocating the forms of names
found in such a large and diverse resource as the World Wide Web may
not be sufficient." The universe of names will be so large that the differ-
entiation and grouping of names, even if it is possible to do in this

environment, will not provide users with the means to make a choice among these names. This observation is similar to one often made by reference librarians that a list of authorized name forms presented to a user who doesn't know which authorized form (is it Smith, Martin D. or Smith, Martin D., 1961-) is the one of interest, is not really a help. More helpful is a list of authors and titles with the titles providing a context in which to make a selection. One suggestion is to identify the role of the individual or organization, such as author, editor, performer, or programmer (Mandel & Wolven, In press). This would provide yet another way to differentiate among the same or similar names.

The Internet environment may help us understand and accommodate the reality of a large universe. Without questioning the validity of collocation but anticipating an expanded universe of names, the question is being asked whether there are situations where complete collocation is not needed, due to retrieval capabilities, the nature of the resources, or the frequency with which the name occurs. Is the value of collocation more or less when the situation varies? If we could define situations where authority control might be considered less of an imperative and measure the impact on retrieval, what could be learned about where it is most effective in supporting retrieval? (Younger, 1995). An analysis of the largest national database shows that about 40 percent of the personal name headings are correctly established but lack authority records in the national authority file (Calhoun, 1996, p. 2). Further research on the attributes of these individual names may suggest where the presence of an authority record and the impact of rigorous ongoing authority control is or is not critical to retrieval. The assumption that the boundaries of the library collection are also the boundaries for applying cataloging principles is one that will undergo considerable stress with the rapidly increasing diversity and numbers of resources described and accessed through library catalogs.

The second factor is the nature of the Internet resources cataloged by participating libraries. Although not without the occasional Web page, the cataloged resources were first selected for the library collection, according to established criteria applied to other formats, and are more likely to have characteristics analogous to their printed counterparts. Specifically, resources such as electronic journals have a generally fixed form and title page information that are easily fit into existing rules and regulations. The cataloged resources were not, by and large, images without accompanying textual descriptions, five or six versions of the same title, resources with many component parts, or images without titles or authors.

Whether collocation of works is possible arises because many electronic objects and images simply don't have recognizable titles. Supplied titles can in time become well known, but a greater concern is "linking

works converted into electronic form without an obvious title with the descriptions of their nondigital forms, for example, in linking the description of a hologram letter with an ASCII text or digital image, particularly when those three formats are created and maintained independently" (Mandel & Wolven, In press). The ability to collocate is in doubt in these instances.

Libraries will acquire and catalog some Internet accessible resources. The demonstration that the cataloging principles and rules can be applied in the context of library catalogs to those with characteristics similar to resources in other formats is a step forward in determining how libraries will organize and provide access to other kinds of digital and Internet-accessible resources.

RESTRUCTURING MARC RECORDS

There is continuing dissatisfaction with the flat structure of MARC and the limitations that puts on handling version and hierarchical relationships in documents. Reproducing documents in microform or digital formats for preservation and access purposes and expanding online access to archival repositories are putting enormous strains on the current bibliographic record structures. In hopes of finding more viable solutions, the suggestions of reconceptualizing cataloging rules and MARC formats into a multiple object orientation are receiving attention from the national and international communities.

Each MARC bibliographic record represents a single information package according to the MARC formats and Anglo-American Cataloguing Rules. The "bibliographic object" is therefore a completed MARC record. Where items have only slight differences—e.g., in file types or formats—from other items, there are multiple full MARC records albeit with clear redundancies in the bibliographic data carried because the "object" of the cataloging is the whole document. There is an advantage in the one-to-one relationship between the document being described and the bibliographic record in the ease with which the cataloging records can be distributed to and from cataloging agencies. A primary function of the MARC formats was and is to support the communication and exchange of cataloging data. The discrete record structure has functioned effectively on the basis of this one-to-one relationship in building national databases and local catalogs. With efficient exchange of bibliographic data continuing to be an important goal in the national and international arena to date, the limitations of the flat structure, while much lamented, have not been sufficient to bring about a change in the MARC structure.

In contrast to treating the whole information package as the bibliographic object, current object-oriented cataloging proposals would deconstruct a single bibliographic object into multiple objects. Objects, which here is used synonymously with entities, fall into three groups in

bibliographic definitions: the products of creative endeavors (works, expressions, manifestations, and items); the parties responsible for the creation (persons, corporate bodies); and the subject (concepts, objects, events, places and, by extension, all of the entities in the first two groups) (International Federation of Library Associations and Institutions, 1996, p. 9). Each object type has attributes and relationships with other entities or objects. Attributes are associated qualities—e.g., for the work *Hamlet*, the date it was written. Attributes for a manifestation (the embodiment of a work) of *Hamlet* include a physical description (for any format) including file characteristics for computer files, and date and place of publication while attributes for an item (a specific copy of a manifestation) include provenance, condition, and access restrictions. Under this approach, a typical bibliographic record could contain many objects including creator(s), titles, and subjects.

Pursuit of a multiple object-oriented approach that would allow the evolution of cataloging rules to be more responsive in distinguishing between bibliographic and authority data (Tillett, 1989) and in handling complex relationships depends on changes as well in the MARC formats (Gorman, 1992, p. 91). The object-oriented cataloging and proposed operationalization as a series of linked records points to significant gains from grounding AACR2 in considerations of access requirements and record sharing rather than in an emphasis on the bibliographical description of a single package of information in a stand-alone record (Heaney, 1995, p. 138). Redundancies now evident in MARC records that describe the same work in slightly different versions could be reduced as the record for the work could be linked to other records describing the different manifestations or items. In that way, a single record for the work *Hamlet* could be created and presented to catalog searchers with accompanying listings of the different versions made accessible by the library. "Dashed on" notes on catalog cards that indicated the existence of photocopies now violated the framework of MARC and AACR which mandated a separate record for each item. For easing workloads and searching, the old practices were surreptitiously continued, and microform reproductions were "cataloged" through the addition of a local note on the MARC record for the original manifestation.

ADAPTATIONS IN ONLINE CATALOGS

Local online systems brought an integration of bibliographic access and circulation activities, item records for each physical piece, and the rudiments of a modular approach to description and access. To accommodate multivolume holdings for one title, up to a thousand or so item records could be attached to a single bibliographic record. Although intended initially for items belonging only to that bibliographic title and manifestation, item records quickly proved to be a means for recording

and controlling reproductions in varying formats—e.g., microform, pho-
tocopy, electronic files. Sometimes, the details of reproduction were ac-
commodated in the item record although more commonly this informa-
tion continued to reside in the local system bibliographic record as a
note. This offered an economical means of "cataloging" new versions
and avoided lengthy displays of titles often with nothing more than a date
of publication on the screen display to indicate the differences. Where
necessary, as in preservation microfilming projects, the catalogers would
create a new bibliographic record for the master microfilm and send that
record to the national databases. The new bibliographic record simply
wouldn't be used in the local system.

   Nowhere has the struggle with recording variant versions been of
more concern than in the realm of serials. User needs and efficient work
flows have made this a recurring issue on the CONSER (Cooperative
National Serials) and the American Library Association MARBI (Machine-
Readable Bibliographic Records) Committee agendas although with no
change in the status quo. A recent electronically issued "interim com-
promise" specifically on the issue of how to catalog remote access ver-
sions of printed journals distinguishes between providing access to an
online version through a bibliographic record for a print version and
cataloging the electronic version (Hirons, 1996). The compromise stresses
that the electronic version is not being cataloged; this is not a "single
record cataloging approach" but rather a means of noting the existence
of the electronic version.

   Nationally, the decade-long debate over "multiple versions" has
been quiescent as no further resolution seemed attainable. Item
records were and are used locally as coping mechanisms, yet the need
for an efficiency of exchanging full bibliographic records in the MARC
format continued to be an overwhelming force for retention of the
current record structure in national cataloging programs and data-
bases. However, experiments in creating digital libraries and online
formats for archival materials accelerated the stresses and strains on
the MARC record format to the point they could no longer be con-
tained. A groundswell in the library community moved to explore
how SGML (Standard Generalized Markup Language) conformant
records could be used for content designation of document types be-
yond bibliographic records and to find relationships between the SGML
and MARC bibliographic records in library catalogs.

HIERARCHICAL RELATIONSHIPS AMONG OBJECTS

   An early and influential project in the library world had already turned
to SGML (ISO Standard 8879, which has been an international standard
since 1986) for assistance in recording complex data on relationships.
The Berkeley Finding Aid Project (BFAP) had as its aim the development

of an electronic encoding standard for archive, museum, and library electronic finding aids, which typically are narrative documents describing collections and their contents. Of supreme importance is the ability to describe, control, and provide access to collections of related materials, which means providing access through hierarchical levels of analysis: collection-level, subunit, and item. Project participants did not want to create multiple bibliographic records, which would force users to navigate among multiple records with high levels of redundant data, nor did they wish to manage multiple bibliographic records for component parts or versions in the local online system (Pitti, 1994). With no alternative in the MARC structure (Leazer, 1992), the Project turned to SGML to find a means of handling successive levels of analysis.

The capabilities of SGML-based markup languages were known in the library community in part through the previous development of the Text Encoding Initiative and the TEI header. SGML-based markup supports not only a structuring of the text and the relationship of document components, but also allows references to be made from within SGML-based documents to other texts or other kinds of digital objects. While MARC is successfully used in the creation of a bibliographic record for a finding aid as a single document, it does not provide sufficient means for leading users directly to subunit records created and linked to higher level records. Minor attempts had been made to accomplish this within the MARC structure, primarily in the use of subfields and local fields (Davis, 1995, p. 52).

Many types of documents are definable in SGML. The Berkeley Finding Aid Project brought together parties with a shared interest in finding aids as one document type. Under the Bentley Fellowship Program, a team led by Daniel Pitti outlined the basic principles for the design of an encoding standard and agreed that finding aid documents consisted of two segments. The first segment, the header, has information such as title, compiler, etc. about the finding aid and the second segment contains information about a body of archival material, which may be hierarchically organized information describing a unit of records or papers along with its component parts or divisions or information to facilitate their use (Encoding Standard, 1996, p. 11). The Encoded Archival Description (EAD) conforms to the formal SGML requirements and is a document type definition (DTD) known as EAD.DTD.

SGML CATALOG RECORDS (SCRs)

As did the electronic encoding of finding aids, pilot projects exploring digital libraries are accelerating the search for new approaches toward handling new manifestations and versions. At Columbia University, the RLG Digital Image Access Project (DIAP) dramatically expanded document digitizing activities and quickly focused attention on how "to

incorporate the additional detail, hierarchy, and version information needed to adequately describe digital collections" (Davis, 1995, p. 45). Underlying their experimentation was a commitment to sharing bibliographic records nationally, which meant, therefore, some use of MARC records and led toward a two record approach—i.e., summary MARC records distributed nationally with pointers to locally held SGML Catalog Records (SCRs). As suggested in the name, the SCR would be an SGML-encoded bibliographic record of summary bibliographic information, detailed hierarchical and version-related data, as well as links to the actual or related digital items and related bibliographic records (Davis, 1995, p. 45).

The resultant cataloging data model is comprised of hierarchically related records representing collection, group, subgroup, item, and image cataloging levels. The DIAP participants took into account the unpredictability of the content and structure of archival records together with the need to allow the level of cataloging detail to reflect local institutional practices, making data elements repeatable at all levels and designing record displays that were sensitive to the presence or absence of data elements at various hierarchical levels.

MULTITIERED LIBRARY CATALOGS

The modest adaptations as well as the more dramatic changes in new proposals for recording data in bibliographic records are indicators of changes implemented and a sure sign further changes are still to come. To fulfill its function as the primary access tool to library resources, the library catalog is entering an era of new requirements. Without demands for access and delivery, creating bibliographic access to resources in different formats, such as computer files, was accommodated reasonably well in the confines of current cataloging traditions. Today, Michael Buckland (1994) speaks eloquently in pointing out that "the effects of linking online bibliographies to catalog records begins to extend the bibliographic power of the catalog beyond the dreams of catalog code compilers," and to work effectively, "the future catalog will have to be multitiered and flexible and adaptive in operation" (p. C).

The feasibility of providing immediate access to Internet-accessible resources via the library catalog was explored independently by OCLC and local system vendors. Begun in 1994, the second OCLC Internet Cataloging Project resulted in a functional catalog of Internet resources accessible via web browsing software (Dillon & Jul, 1996). Providing access via the library catalog instead of through a search engine approach brings the power of fielded searching, the benefits of subject analysis, standardized name and subject heading, and other value adding features of cataloging to the discovery and retrieval of Internet resources. When

the point-and-click ease of accessing Internet resources is added, the library model of access is successfully carried to these resources.

Local system catalogs, dubbed "webpacs," also utilize a WWW client to access the catalogs, conduct the search, and report the results back to the user who started the chain of events by initiating a search via Netscape, Mosaic, or other available web browser. During the search, the webpac's WWW client works from the MARC records to create the HTML (Hypertext Markup Language) records that are used to return the results to the user's workstation. HTML is the markup language in general use on the WWW and is an SGML application interpretable procedurally by web browsers, including those employed by users to access the library catalog. These catalogs answer the question in the affirmative of whether library catalogs can offer direct access (hypertext links) to Internet resources.

Earlier options taken by libraries were listing resources on the menus of other information systems, creating separate databases for Internet resources, creating guides to Internet resources or, most recently, establishing Web sites. Electronic full-text books and journals were listed by authors or titles in alphabetical order on "bookshelves" or "reference shelves" (on campuswide or other parent body information systems) to provide direct access to the journals stored or accessible from that computing location. Various types of protocols have been supported, including gopher, telnet, and now http protocols.

Establishing a Web site is popular in libraries for several reasons, not the least of which is because it offers direct access to Internet resources without waiting for a local "webpac." The distinct disadvantage is the separation of access to Internet-accessible resources from access to other library resources. With the technical capability of webpacs eliminating a primary reason for separate access and the expected mainstreaming of the selection of Internet resources in support of library "collections" (Demas et al., 1995), decisions about which and how many access paths the library should create can be discussed in regard to effective retrieval, not technical, capability.

The multitiered catalog described by Buckland would employ a hierarchical approach to descriptions of works, versions, parts, and related works. Many in the library cataloging community recognize the need and believe it may be best accomplished in a format other than MARC. On a local basis, the impact to the catalog's structure could be relatively minor. It is possible today to move TEI header data into a MARC record, to provide links to finding aids which then provide hierarchically interlinked records for levels of analysis—collection-level, unit, subunit, item, etc.—to attach information on various versions of a title to a single bibliographic record for the title through the use of multiple item-specific records, or to provide pointers from summary MARC records to

locally generated SGML catalog records (SCRs) as proposed at Colum-
bia University. The CIMI Cultural Heritage Online Information (CHIO)
project is digitizing and encoding art exhibition catalogs and other mate-
rials in SGML-based records. Some libraries will acquire these catalogs
and could logically catalog them in MARC records but would lose the
ability to describe multiple levels. The usefulness of creating a MARC
record to point to other records would apply here as well.

Millions of MARC records, however, form the basis of thousands of
catalogs but, more importantly from a universal bibliographic access per-
spective, form the basis of cataloging data exchange, making consider-
ation of even partial change an exceedingly complex matter. In full knowl-
edge then that any change must not be revolutionary in implementation,
there are suggestions that a move from total reliance on the MARC for-
mat is inevitable (Gaynor, 1996, p. D). This could take several forms,
such as using MARC records as pointers to records in other formats and
databases, integrating MARC and non-MARC records in a single catalog,
or converting MARC records into other formats for use in local catalogs.
Although the MARC format has an exemplary history in facilitating bib-
liographic access, the use of SGML-based records could provide new ways
to use the many nonlibrary-based automated systems, standards, and soft-
ware tools, such as the World Wide Web, and "anticipate future develop-
ments in integrating library generated data into the developing local and
national information environment as effective inventories of and indexes
to the electronic holdings of libraries" (Davis, 1995, p. 46). Data conver-
sion occurs now between USMARC and SGML, and it is possible the need
to encode bibliographic data in library systems in only one format may
be relaxed. A scenario allowing the use of different or multiple formats
in local catalogs would be an important step in adapting the catalog struc-
ture to provide multitiered access.

In one other important area, catalogs would benefit from accommo-
dations made for other formats. The Alexandria Digital Library project
is creating spatially indexed information that is basically nontextual. As
catalogs are, to date, largely text-oriented, there is clearly a need to posi-
tion nontextual and textual data into a coordinated framework.

GLOBAL RESOURCE DESCRIPTION
    New technology prompts comparisons of old and new approaches
and, it is hoped, improvement of existing methods of resource descrip-
tion. Current discussions within the library community are addressing
fundamental issues: cataloging objectives and surrogate requirements, a
multiple object orientation in bibliographic records, the application of
cataloging principles to digital resources and alternative record structures
for local catalogs to meet access requirements, making this an enormously
productive time in cataloging history.

At the same time, these discussions rest on the assumption that library catalogs fit squarely within a distributed system of resource description and discovery and lead inevitably to issues of how library catalogs are positioned and what kind of system is presented to users. The following three issues have been identified both within and outside the library community as important: names and addresses for Internet-accessible documents, managing multiple metadata schemes in catalogs and local information systems, and presenting a coherent bibliographic framework to information seekers/users.

NAMES AND ADDRESSES

While multiple World Wide Web (WWW) data formats exist—HTML, for example, is an important but not the sole format—there is only one naming and address technology on the WWW and that is the family of Uniform Resource Identifiers (URIs) (Connolly, 1996). URIs have three parts: Uniform Resource Locators (URLs), Uniform Resource Names (URNs), and Uniform Resource Characteristics (URCs), which are in different stages of development. URLs are the spine labels of the Internet and as a result of their early development, they are a stable and standard technology.

However, they are subject to change when hardware is reconfigured, file systems are reorganized, or organizational structures are revised. The longevity of an average URL is said to be measured in weeks, not years, giving rise to the specter of broken links as an impossible burden for libraries and other organizations maintaining URLs in databases. It is possible sometimes to find a document in the absence of a recorded URL by knowing the address of the host and browsing through its contents, along the lines of browsing in the stacks, but it is not a method recommended for efficiency.

To assure persistence of URLs across time, two methods of naming have been proposed in the United States: the Corporation for National Research Initiatives (CNRI) HANDLE System (Arms, 1996) and the OCLC PURL Resolution with a joint OCLC/CNRI project for creating a name system (URNs) for objects identified by URLs (Weibel & Jul, 1995). URNs have properties differentiating them from URLs: URNs are location independent, globally unique, and persistent across time. In addition, quick resolution is required because the resolution process inserts a step when documents are requested using HANDLE or PURL. The request goes first to a server that will look up the associated URL and return it to the web browser for subsequent linking to the document's server (Gardner, 1996, p. 48). Since 1994, OCLC has created free software for setting up a PURL server available to any organization and is itself assigning PURLs to records for Internet resources in the OCLC Internet Catalog. When a

URL changes, the associated PURL can be changed once on the PURL server.

Although it is not yet certain how URNs will be mapped to individual resources, there is clear interest in having a specific URN always associated with the same resource even though the resource is located in multiple places (Erway & Weibel, 1996). To construct a framework under which various URN systems could operate and meet this objective, the Internet Engineering Task Force (IETF) URN Working Group reestablished itself in June 1996 and will be discussing such proposals at its December meeting. Under one option, the assignment of names would be designated to naming authorities, who would define criteria for determining when new names are assigned and assign unique names or delegate that authority in turn to subauthorities. A central registry of naming authorities could be a vehicle for some level of cooperation and coordination among naming authorities, particularly for mirrored resources.

Naming versions and formats of an information resource are also issues, not new ones for libraries, which should be expected to bring considerable knowledge to developing criteria for when to assign new names and how to name versions. ISSNs, which are names, are administered by the Library of Congress and, in a similar role, national libraries and library associations such as IFLA (International Federation of Library Associations and Institutions) can be expected to take a role in conjunction with government and other agencies.

The last member of the URI family, the URCs, are undeveloped with some question as to whether they are needed. URCs are essentially surrogates—i.e., metadata or cataloging records—containing descriptive data about the resource, including any or all categories of metadata. Many in the computing community, however, are unfamiliar with the capabilities of library cataloging records or those in other metadata schemes, which inclines them toward the creation of a "new type of record," a URC record. Part of the reason is that library records, for example, have not typically contained data on terms and conditions of access, although the records could contain it, making new record types seem more necessary. Though the forum of IETF meetings may be new to librarians, along with other indexing and abstracting agencies, this is an area where the knowledge of library community is much needed.

MANAGEMENT OF MULTIPLE METADATA SCHEMES

Managing names and addresses within and across domains is made easier by the existence of only one naming technology for the World Wide Web, unlike the fact that there are already many more metadata schemes with new ones sure to arise. A data registry delineating each scheme and identifying common and unique elements between and

among them would serve several purposes identified at a meeting of the
ALCTS Task Force on Meta Access (ALCTS Task Force Minutes, 1996).

First, it would foster the awareness of existing schemes thereby pre-
venting an unneeded proliferation of schemes. The use of an existing
scheme would result in more resources accessible via a "standard" ap-
proach and serve as an important means of furthering cooperation in
providing access.

A data registry would also support conversions from one scheme to
another. Several tools for converting records from one to another scheme
already exist—e.g., TEI2MARC developed at the University of Virginia.
This program achieves "transferring all data found in a TEI-header to a
MARC format with all related fixed and variable fields intact" (Shieh, In
press). The output can then be used as the basis for a full MARC com-
puter file bibliographic record for subsequent entry into library catalogs.
The TEI2MARC was derived from a USMARC.DTD developed at the Uni-
versity of California, Berkeley, for conversion of US MARC records into
SGML format and back out again (Larson et al., 1996). Also, the Library
of Congress has made available its alpha version of an SGML/MARC and
converter, a document numbering hundreds of pages. Others, such as
one to convert a Dublin Core set of elements into the USMARC format,
are in progress (Caplan, In press). With such tools, one is free to imag-
ine how computer conversion can assist in cataloging—e.g., the Catalog-
ing in Publication process. A TEI encoded document with header is re-
ceived, the header is converted to a MARC record, which is then aug-
mented with classification, subject headings, and authorized access points,
and returned, as is now the case, to the publisher.

Although not the first or only conversion tools, these conversion tools
emphasize both the importance in the library community of the sizable
investment of records currently in the USMARC format and the desire to
make greater use of records created in other formats. Whether they lead
toward the development of a WWW-based catalog with SGML rather than
USMARC as its underlying record structure, as is suggested by Gaynor
(1996), or the reverse movement of data into the MARC format for use in
library catalogs, is not prescribed by conversion tools, which in either
case provide the straightforward ability to move data from one to an-
other and back again. Conversion tools in and out of MARC will be
important in allowing libraries to control in some way their ability to take
advantage of the power of newer and more generalizable formats.

Presentation of a Coherent Bibliographic Framework

The third issue of how library catalogs are positioned and what kind
of system is presented to users is closely related to data conversion. A
data registry would facilitate system management of data residing in vari-
ous schemes by making it possible for an automated system to know how

data elements carrying different tags relate to each other. Sorting like and unlike data into the appropriate fields for indexing is crucial to the ability to create single or linked databases accommodating records in various formats. The interoperability of library-created records with those based on other metadata schemes is fundamental to proposals suggesting that subject-based databases, rather than source of cataloging or access record-based databases, deserve future consideration (Drabenstott, 1996).

Construction of a data registry inclusive of major metadata schemes is a formidable task. It is, however, one that stands to offer significant assistance both in making more effective use of existing standard metadata schemes and in managing more than one such scheme in local online information systems. As such, it deserves to be considered first by the national and international standards organizations, specifically the International Standards Organisation (ISO) and National Information Standards Organization (NISO). Quite obviously, there are many challenges in determining the objectives of the data registry as well as the most efficient methods for building it.

CONCLUSION

Metadata, library cataloging objectives, record structures, persistent names and addresses for Internet-accessible resources, and the management of diverse metadata schemes are important concerns in building a coherent system of bibliographic access for information seekers. The prospect of "surfing the Web" may challenge some but, for others, it represents a stab in the dark with no sure expectation of success. Millions of objects are available to the searcher. None has been excluded: even "personal pages and other ephemera are accessible without requiring intervening selection, processing and cataloging decisions" (Taylor & Clemson, 1996, p. 1). Yet this same wealth, in its current amorphous and undistinguished state/mass, is a source of dismay and confusion offering little assistance to searchers in their attempts to navigate within and among these resources. In examining whether resource description and organization, which Levy (1995) grouped under the term "cataloging," will remain as important in the future as it has been in the past, he concluded the answer is yes, for without some organization and maintenance, digital collections will not remain either stable or usable. There is little doubt that our colleagues would agree.

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