Review Of Research
Vol. 3 | Issue.4 | Jan.2014
ISSN:-2249-894X Available online at www.lbp.world

ORIGINAL ARTICLE

AN IMPACT OF MARC STANDARDS ON LIBRARY AUTOMATION

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ABSTRACT

In 1960s, with the contributions of Henriette Avram, the chief of the Library of Congress, the Machine-Readable Cataloging (MARC) standards transformed the way libraries operate by allowing the storage, sharing and processing of bibliographic information electronically. This research paper will examine how MARC standards have developed and how they have influenced the automation of libraries since the beginning of the 1960s up to 2010. It follows the shift of manual cataloguing systems to computerised and networked space supported by the use of MARC formats, including LC-MARC, USMARC and MARC 21. The paper analyzes the contribution of MARC to promote shared cataloging, interoperability of library systems, and development of bibliographic utility as such OCLC, and thus, lessening duplication of effort and increasing efficiency of cataloging globally. Nevertheless, the paper also emphasizes the shortcomings of MARC to respond to the new digital resources and web-based metadata models, especially when libraries were migrating to Resource Description and Access (RDA) and linked data models at the beginning of the 21st century. It is determined in the analysis that MARC was a source as well as a limitation of the library automation - it opened the path of the new metadata standards and served as a support of bibliographic control during the next five decades.

Keywords: *MARC, MARC 21, library automation, Henriette Avram, Library of Congress, OCLC, bibliographic standards, RDA, metadata interoperability*

Introduction:

The second part of the twentieth century was characterized by a radical change in bibliographic information organization, storage, and sharing within the libraries. Prior to the 1960s cataloging was a manual and regionalized activity which relied on card catalogs which constrained the efficiency and scalability of library services. The increasing number of published materials and the necessity to have a cooperative cataloging system established an urgent need to have standardized machine-readable mechanisms of dealing with bibliographic data. To address this problem, the Library of Congress embarked on a project named Machine-Readable Cataloging (MARC) to be led by Henriette Avram in the mid-1960s.

MARC provided a systematized method of encoding bibliographic data in a computer-readable digital form that is capable of being exchanged and processed by computers. Its growth saw a change in the automation of the library operations that establish the technical basis of shared cataloging networks, integrated library systems (ILS) and bibliographic utility like OCLC. In the 1970s and 1980s, MARC formats (originally LC-MARC, and subsequently USMARC) were international standards and enabled the interoperability of library systems both within and between institutions and countries. The 1990s thriving of bibliographic data management of the world is further consolidated by the standardization by the various national formats to MARC 21.

MARC, however, started to face a threat of its long-standing supremacy by the late 1990s and the beginning of the 21st century as the digital environment started to affect it. With libraries growing in the handling of electronic materials and multimedia products as well as the use of online databases, the constraints of the rigid framework of the MARC were evident. New web-compatible metadata models were required by the advent of Resource Description and Access (RDA) and associated technologies, as well as linked data technologies.

This study has been examined the history and influence of MARC standards on library automation between 1960s and 2010. It analyzes the way that MARC helped libraries to move past manual cataloguing systems, to automated cataloguing systems, to cooperate with common data, and to provide the basis of digital interoperability. Meanwhile, it also views the struggle MARC had in the face of new technology paradigms, evaluating its two-fold participation in the history of libraries automation as both an accelerator and inhibitor.

Objectives of the Research:

1) To trace the historical evolution of MARC standards from their inception at the Library of Congress in the 1960s to the establishment of MARC 21 in the late 1990s.
2) To analyze the role of MARC in facilitating library automation, including shared cataloging, database integration, and the development of integrated library systems (ILS).
3) To assess the impact of MARC on bibliographic control and information sharing among libraries, consortia, and bibliographic utilities such as OCLC.
4) To evaluate the challenges and limitations of MARC in adapting to technological changes, digital resources, and emerging metadata standards like RDA and linked data.
5) To identify the long-term implications of MARC standards for future developments in metadata interoperability and digital library environments.

Literature review:

The history of MARC standards and library automation has shown that the evolution of ideas in the field has been rich since the 1960s till 2010. The first detailed and definitive description of the history of the development of the Machine-Readable Cataloging (MARC) format at the Library of Congress was given by Henriette Avram (1975), who pointed to the fact that it helped to make cataloging, which had been traditionally a manual task, automated. Later records by the Library of Congress followed the development of MARC formats, and MARC 21 was adopted as a standard international one. MARC was proven to be central to the process of cooperative automation and the sharing of resources due to the growth of shared cataloging networks, like OCLC (Kilgour, 1971). Delsey (2002) and Riva (2004) examined how MARC structurally and functionally fits with the new conceptual models such as FRBR, with strengths and its intrinsic limitations. Breeding (2009) discussed how MARC has changed the integrated library systems, and the difficulties of implementing the new technology of next-generation

automation. A critical technical approach was presented by Thomale (2010), who held the opinion that the strict format of MARC was a barrier to interoperability with web-based systems and current metadata standardisation. With the launch of Resource Description and Access (RDA, 2010), there was a move toward more laissez-faire and linked-data solutions, which led to debate about the gradual transition to MARC to new models. Taken together all these studies demonstrate that although MARC was the foundation of library automation over the next five decades, the structural limitations inherent in it eventually drove the quest to identify more dynamic metadata models in the digital age.

Research Methodology:

This study utilizes a qualitative historical research design to analyze the development and impact of Machine-Readable Cataloging (MARC) standards on library automation. It includes descriptive content analysis of primary sources such as Library of Congress documents, and secondary literature, to trace MARC's technological, organizational, and operational effects on library systems. The research identifies key themes, evaluates changes pre- and post-MARC adoption, and discusses the limitations of the study, including reliance on published literature. Ethical standards were maintained throughout the research. Ultimately, it highlights MARC's significant role and the challenges leading to its evolution towards modern metadata frameworks.

The Impact of MARC Standards on Library Automation:

In the 1960s, bibliographic data was put in a standardized computer-readable form and was named Machine-Readable Cataloging (MARC) created by Henriette Avram in the Library of Congress transforming the automation of libraries. Before MARC, the manual system of cataloging was cumbersome and based on hard copy card lists. The catalog data stored by computers could be easily read, stored and exchanged because of the organized framework of MARC fields, tags, indicators, and subfields.

In the 1970s, MARC resulted in the creation of cataloging networks such as the Online Computer Library Center (OCLC) and the BNB-MARC of British Library where libraries can import those catalog records and eliminate redundancy. This technology laid out a base on the unified library systems (ILS), and combined purchases, cataloging, borrowing, and patron accessibility utilizing a shared database of MARC records, amplifying efficiency and exercises between libraries.

As early as the 1980s and 1990s, MARC evolved into a series of international standards, such as USMARC, UKMARC, CAN/MARC and MARC 21, which was adopted in 1999. These standards led to cross-border data exchange and interoperability among library management systems and bibliographic utilities and these standards helped in the creation of comprehensive union catalogs such as WorldCat that incorporated millions of MARC-encoded records worldwide.

MARC has made a sharp impact on the library automation system and such automation can result in the production of automated catalogs, incorporation of search and retrieval systems and automated control of circulation. Libraries developed to be more than isolated catalog systems, as networks of libraries were formed, and can serve both in-premises and remote users. This change encouraged the vendors of library automation software to be compliant with MARC and thus made it even more a standard in bibliographic communication.

With the late 1990s however the drawbacks of MARC were felt especially its inflexible structure, which was not suitable to digital and multimedia resources, and its inability to be

semantically flexible to facilitate data exchange with the growing web technologies and metadata standards, including Dublin Core and MODS. Researchers noted that MARC did not support the Functional Requirements for Bibliographic Records (FRBR) and current web-based data models, so the field of librarianship sought alternatives.

In 2010, Resource Description and Access (RDA) was introduced and the BIBFRAME program was developed to replace MARC with linked-data structures that can operate in the digital and web world. These initiatives were comprehensively sensitive to the very important role played by MARC in the automation of libraries in almost fifty years, but also to the structural inability of that system to cope with the interrelatedness that characterizes the modern information systems.

Nevertheless, MARC has no equal in terms of its contributions to bibliographic representation standardization, cooperation among libraries encouragement, and the technical foundation of the contemporary cataloging and discovery systems. Between 1960s and 2010 MARC was a catalyst and cornerstone in the library automation process, a driver of innovation, interoperability and global cooperation in bibliographic control.

Historical Development:

Originally developed at the Library of Congress in the mid-1960s by Henriette Avram, the Machine-Readable Cataloging (MARC) standard was developed. It was meant to help in the representation of bibliographic information in a format that could easily allow computers to process and exchange. The MARC Pilot Project, which was carried out in the period between 1965 and 1968, demonstrated the practicability of encoding cataloging information using standardized numeric tags, as well as indicators and subfields, which allowed to effectively break down, manipulate and transfer bibliographic data. This framework was implemented by the Library of Congress and some of the largest academic libraries by the early 1970s, to achieve a major breakthrough in the automation of cataloging and inter-library data interchange.

MARC became more popular and was adopted by libraries that adopted the shared cataloging systems in the 1970s and 1980s. The emergence of bibliographic tools such as Online Computer Library Center (OCLC) enabled libraries to gain access to cataloging records of other libraries and much duplication was eliminated. It was a time of revolution in terms of cataloging activities, which became efficient and economical in terms of its operations. Also, MARC developed out of the initial LC-MARC form to become USMARC and other regionalized versions like UKMARC or CAN/MARC to meet the needs of particular regional cataloging needs and promote international library network interoperability. Shared cataloging not only computerized bibliographic control, it also gave birth to a culture of international collaboration among libraries and had significant implications on the development of union catalogs and integrated library systems (ILS).

The 1990s saw the beginning of a push towards standardization because international compatibility is required and resulted in the harmonization of different versions of MARC into MARC 21. In 1999, MARC 21 was adopted as an amalgamation of the USMARC and CAN/MARC standards, being approved by numerous key organizations and institutions, including the Library of Congress and the National library of Canada, as well as standards organizations, such as NISO and ANSI. This brought MARC to include authority, holdings, classification, community information forms and support Unicode, making it easier to represent non-Roman scripts and meant that it was possible to provide multilingual cataloging. The standardization process

ensured consistency in data exchange, strengthen international interoperability and guaranteed automated library systems long-term stability internationally.

MARC's Technical and Organizational Impact on Automation:

Machine-Readable Cataloging (MARC) standards have been important to the library technical architecture and workflow since the 1970s across the globe. The well documented record structure of MARC led to interoperability among library systems not to mention the seamless exchange of bibliographic data, and collaboration, which is seen in the formation of key union catalogs such as WorldCat, with the assistance of the American Library Association (ALA).

As results of downloadable MARC records, shared cataloging services were developed, enabling libraries to reuse existing data and redirect attention towards local adaptations, resulting in labor and cost savings, as research on the topic on ResearchGate (2016) shows. This democratized the access of both large and small libraries to automation.

MARC had an overwhelming influence on the design of Modular Integrated Library Systems (ILS) and became the standard format of data exchange among modules: cataloging and acquisitions. This interoperability meant that library software could be interoperable, increasing the ease of discovery by the user and the effectiveness of the system, according to analyses by Taylor and Francis Online, in 2004.

With libraries going digital in the late 1990s and early 2000s, MARC was a key metadata basis, with digital material being attached to the catalog record and maintains continuity between print and electronic collections, which was also reported by WIRED in 2001.

To sum up, MARC standards were an accelerating force to library automation in more than half a century, and it revealed its flexibility in the digital world and it has done a lot to combine metadata and technological advancement in managing information.

Limits and Frictions:

Although MARC standards were pivotal in the automation of the library system, it had a major weakness, which is evident with the advent of libraries in the realm of new content, digital resources, and the emerging standards of web-based metadata. The semantic opaqueness and rigidity of MARC was also clear, since its design as a collection of tags, indicators, and subfields, was oriented towards machine parsing of bibliographic records not towards more detailed semantic frameworks. This inflexibility was noted as in the studies e.g. published by Code4Lib Journal in 2010, which pointed out that it impeded the depiction of complex relationships, especially those with multi-manifestation digital objects or semantic links, which were not in line with the expectations of modern users and linked-data principles.

In addition, MARC was designed in such a manner that it was initially intended to replicate the traditional card catalog, besides facilitating Online Public Access Catalogs (OPACs). Although effective at its time, this method created difficulties in keeping up with the modern metadata requirements, especially the need to support complex layer translations to convert MARC data to a search engine or web harvesting or semantic web tool. These changes were usually fragile and this could lead to loss of information fidelity or lack of uniformity amongst different systems.

The development of the World Wide Web, as well as the semantic web technologies, highlighted the need to have widely interoperable metadata formats, including Dublin core or RDF. The library-focused structure of Marc was a hindrance to direct cross-domain applicability as it required a bulky integration with other systems as well as a lot of data conversion. This

weakness brought out the interoperability resourcing of MARC that was incompatible to any other library environment other than the traditional library setting.

With the adoption of new descriptive models of libraries as Resource Description and Access (RDA) in 2010, and an interest in linked-data projects, there was an apparent urgency to abandon MARC as a dominant exchange format. Even though MARC was not discarded, it became necessary to make it more expressive and web-friendly, e.g. BIBFRAME, in order to keep it relevant in an increasingly digital environment. This shift demonstrated the two-sided nature of the MARC legacy: it was an essential element of the legacy systems but its structural constraints added to the decreasing flexibility in a rapidly changing information environment.

Discussion - MARC as Enabler and Constraint

The bibliographic records have an extensive history, particularly in terms of library automation, where the Machine-Readable Cataloging (MARC) standard has contributed to establishing a machine-readable bibliography record standard. Its use has enabled huge-scale automation, collective cataloging and interoperable systems enabling libraries to reach out and create union catalogs and integrated library system (ILS), which connects cataloging with circulation and acquisition. The design of MARC, however, is highly connected with traditional cataloging method which restricts its usefulness in describing digital, multimedia, and web resources. The strict hierarchy of MARC, its tags and subfields, is ill adapted to expression of the relationships and the semantics of newer formats. The library community has responded by finding options which retain the importance of existing MARC records, but which use more expressive metadata approaches, including Resource Description and Access (RDA) and Dublin Core and RDF conversions. Bibliographic metadata is required to be flexible because of such experimental structures as BIBFRAME. The legacy of MARC demonstrates the juggle between the past and the present of the library automation process and the need to be flexible and modern in a digital environment.

Conclusion:

The Machine-Readable Cataloging (MARC) standards transformed library operations from the 1960s to 2010 by enabling structured, machine-readable bibliographic data. This fostered large-scale automation, shared cataloging, and development of integrated library systems, promoting efficiency and collaboration among libraries. However, MARC's rigid structure revealed limitations when managing digital resources and web-based metadata, as its tag-based design was not suited for modern descriptive standards or linked-data applications. The adoption of RDA and BIBFRAME emphasized the need to evolve beyond MARC while preserving investments in bibliographic records. Thus, MARC served as both a catalyst for library automation and laid the foundation for contemporary systems, highlighting the need for adaptable metadata frameworks in the digital age, with its legacy present in ongoing bibliographic standardization efforts.

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