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Smarter Libraries Through Technology

50 Years of Technology at OCLC

By Marshall Breeding

July 2017 marks fifty years since OCLC was founded as a pioneering organization to provide a new model of collaborative cataloging. OCLC has been a mainstay in the realm of cooperative services and in library technology. The history of OCLC has played out in terms of creating new services, expanding its reach through partnerships and acquisitions of other organizations, and evolving its products through new generations of technology. A detailed history of OCLC would consume volumes. In this issue of *Smart Libraries Newsletter*, we review some of the high points of the organization's evolution, focusing mostly on the technology trends behind its products and services.

The Ohio College Association formed the Ohio College Library Center in July 1967 and hired Frederick G. Kilgour as its first director. The new organization was housed in offices in the library of Ohio State University and developed and operated its services on computers housed in the university data center. In 1981, the organization changed its name from the Ohio Computer Library Center to OCLC as it grew beyond its original membership of Ohio libraries to a growing national and international presence.

A Complex Organization

From a business perspective, OCLC operates as a non-profit corporate based in Dublin, OH. It's complex organizational structure includes several international subsidiaries. Some of these subsidiaries technically operate as for-profit entities. In Europe, for example, service organizations such as OCLC are not eligible to be designated as charities. Therefore, OCLC's EMEA division operates as a for-profit organization wholly owned by OCLC. From its founding, OCLC has followed a self-sustaining business model, charging fees for its services to meet its expenses and to invest in future development and infrastructure. In its 2015/16 fiscal year, OCLC received $203.4 million in revenue for the services it provides to libraries. OCLC also receives income from its investment portfolio.

OCLC has expanded over its fifty years of operation both by attracting new members and through acquiring other non-profit organizations or for-profit companies. These acquisitions have diversified its products and services and extended its global reach.

Throughout its history, OCLC has developed and implemented important technologies that have had a major impact on libraries. It was established in an era prior to the internet and when computing was performed on large mainframes. In 1967, few libraries had implemented any type of commuting technology, and library automation systems were in the pioneering stages of development. In its early days, OCLC participants purchased or leased all the technical components needed to use its services, ranging from telecommunications links, communications equipment, data terminals, and software. Over the decades, technology has become pervasive in libraries, eliminating the need for OCLC to provide dedicated links and equipment. Today OCLC deploys most of its services through a modern cloud-based infrastructure. The path of its technical evolution parallels that of the cycles of business technology, stepping through mainframes and proprietary communications, the era of client/server computing, and more recently into the realm of web-based and cloud computing.

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Core Services: Cataloging, Catalogs, and Interlibrary Loan

OCLC's early work centered on the development of a union catalog spanning the collections of its participating members and a cooperative cataloging environment. The Online Union Catalog, put into operation in August 1971, ran on a Sigma 5 mainframe computer and was connected to terminals in libraries via dedicated telecommunications links. This service was the first online cataloging system developed worldwide. OCLC's cataloging system has been continuously maintained and enhanced, and it remains one of its core services.

The original Online Union Catalog has moved forward through multiple generations of technology as it has continually expanded in content. WorldCat currently includes almost 400 million bibliographic records, representing 2.5 billion individual library holdings. It is populated both by records contributed individually by members using the cataloging service and by batches of records received from organizations, such as national libraries and publishers. It is the largest bibliographic database in the world and represents collaborative resource of massive scale.

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Important milestones include

- the initial creation of the Online Union Catalog in 1971;
- Open WorldCat, which began in 2003, exposing bibliographic records to Google and other search engines for access through web searches;
- the launch of worldcat.org in August 2006, making the bibliographic database available for general searching on the web;
- WorldCat Local, which was launched as an interface with real-time availability status to provide integrated access of the holdings in a library's local integrated library system (ILS) and WorldCat; and
- WorldCat Discovery Services, which was launched in January 2014, joining the genre of index based discovery services providing article-level search results integrated with the traditional WorldCat bibliographic content.

In 1979, OCLC extended its Online Union Catalog with an interlibrary loan (ILL) subsystem. This service enabled participating libraries to leverage the holdings data associated with each record to place borrowing requests. The OCLC ILL subsystem managed, routed, and tracked the status of requests. ILL continues to be a core service of OCLC, recently redeployed on a new technical infrastructure as WorldShare ILL.

In recent months, OCLC has made additional strategic moves to expand its services related to ILL.

Complementing its centralized ILL service, OCLC acquired Relais International in January 2017. This Canadian company had developed Relais D2D (Discovery to Discovery), a peer-to-peer resource sharing environment. This product enables libraries participating in a consortium to implement mediated or unmediated borrowing. OCLC is also developing Tipasa, a web-based application for managing ILL requests and fulfillment based on the WorldShare Platform. Tipasa offers similar functionality to the Windows-based ILLiad product developed by Atlas Systems, which has been widely implemented by libraries using the OCLC ILL services.

OCLC continues to expand and enhance its core services. OCLC's founding coincided with the emergence of the MARC bibliographic formats. In recent years, there has been intensive conversations surrounding BIBFRAME as a possible successor to MARC as the carrier for bibliographic information in the library context. BIBFRAME is based on semantic web and linked data concepts, promising to bring libraries into a more modern and widely-embraced information architecture. OCLC has been deeply involved in work to investigate and promote linked data. It has been a participant in the BIBFRAME discussions and has implemented linked data mechanisms in its services, such as schema.org.

Evolution of Network Communications

At the time that OCLC began to develop its cataloging system, there was no internet, requiring communications lines to be installed to each library. Those telecommunications links installed by OCLC transmitted data at rates of 1200 to 9600 baud, which seems miniscule by today's expectations. These slow links demanded extremely efficient communications. The MARC formats, which were just beginning to be defined, were designed to store bibliographic data in the least possible allocation of storage. The combination of efficient block communications, proprietary protocols, and compact MARC data formats enable the system to communicate effectively via these links.

The equipment used to access OCLC's cataloging system has evolved from terminals, to micro-computers, to web-based interfaces. The original network was accessed via data

terminals, with attached keyboards and built-in monochrome monitors. The M100 was issued as standard equipment beginning in 1973, replaced by the M105 in 1978. To access the system, each library would install a multi-drop line to the OCLC data center. A communications controller would then enable up to eight terminals to be connected in a daisy chain configuration. Libraries needing more terminals would need to install multiple telecommunications links and controllers.

As libraries created records on OCLC, they would also need to be able to transfer them into their local integrated library system. This was accomplished via a serial cable connecting an OCLC terminal with an ILS terminal. The transfer sequence involved sending a MARC record out of the serial port of the OCLC terminal, which would be interpreted by the ILS terminal as if it were entered at its keyboard.

The microcomputer age began in the business arena by the early 1980s. OCLC introduced its M300 workstation in 1983, based on the IBM PC/AT with a synchronous communications adapter and its custom Passport terminal emulation software that enabled it to connect to the OCLC network. Once operating on a microcomputer instead of a data terminal, new functionality could be created in software as well as new communications methods. OCLC redeployed its system to a new computing and telecommunications infrastructure it called PRISM in 1990.

The technical underpinnings of the OCLC telecommunications network went through multiple technologies and was eventually phased out entirely as libraries became part of the internet. In 1992, OCLC introduced a new option called its Telecommunications Linking Project, which enabled a library to install a dedicated X.25 link to OCLC's network and use its own routers instead of proprietary OCLC communication controllers. The router would be configured to connect the library's local area network to the OCLC network and translate from TCP/IP to X.25. In 1997, OCLC enabled a new option, called Dedicated TCP/IP, to connect the library's local area network to OCLC via a dedicated telecommunications link using TCP/IP instead of X.25.

While each of these generations telecommunications configurations were essential at the time, they eventually were no longer needed once libraries had reliable internet connections that had faster performance and higher reliability. Today, libraries and patrons access all of OCLC's services through the internet, primarily using web-based interfaces. Its Windows-based Connexion cataloging client remains in use in many libraries as the fully web-based WorldShare Cataloging service continues to be refined. The original Online Union Catalog has undergone a radical transformation in technology from proprietary protocols and equipment to current-day technologies based on web-based and cloud computing while continuing its core purpose of collaborative cataloging and resource sharing with the widest possible access to library staff and patrons.

1980s: Initial Strategic Foray into Integrated Library Systems

OCLC had a vision of supporting a broad range of functionality through centrally provided services. In the 1980s, an industry of companies creating library automation systems was emerging, and libraries were increasingly interested and able to implement computer technologies to automate manual processes. With its Online Union Catalog well established to bring efficiency to cataloging, OCLC became interested in expanding its involvement into the full range of library automation.

In the early 1980s, OCLC began the development internally of a new project called Local Library System, which would be an integrated library system adding circulation and other features to complement its cataloging and ILL services. It was initially conceived as a system that would be operated centrally, with libraries accessing it through its telecommunications network. It was eventually evident that the computing environment of the time could not support the telecommunications requirements of such a system at affordable costs. Instead, OCLC entered the traditional ILS arena, acquiring and developing products that would be implemented locally in the library and optimized for integration to its existing services. The involvement of OCLC in the ILS arena was complex, with considerable success initially, but ultimately short lived.

In April 1982, OCLC acquired an integrated library system called the Total Library System that had been developed at the Claremont Colleges in California. This was a system designed to run on HP/3000 mainframe computers, which was successful at Claremont and was attracting interest by other libraries. The acquisition gave OCLC exclusive access to market the product. OCLC ultimately decided not to go forward with this product and instead pursued other alternatives.

Less than a year later in May 1983, OCLC invested in another product called the Integrated Library System, which had been developed at the Lister Hill Center of the National Library of Medicine. This system operated on Data General minicomputers. OCLC subsequently acquired a company called AVATAR in August 1983 that had been involved in developing an enhanced version of the system developed at Lister Hill. OCLC also entered into a joint development partnership with Online Computer Systems, Inc. of Germantown, MD, another company that was planning to enhance and sell a product based on the Lister Hill system.

This integrated library system became the basis of the LS/2000 system launched by OCLC in June 1983. Libraries initially responded positively, with LS/2000 becoming established as one of the major competitors in the ILS market of that era. By 1986, there were 87 libraries using the product, which grew to 126 in 1989.

OCLC also offered a timesharing option, where libraries would not install a local version of the system but would share access to a centrally provided system at OCLC. A version of LS/2000 was launched in 1984 that ran on microprocessor-based minicomputers instead of the larger Data General mainframes.

In 1985, OCLC entered into a partnership with a company called MetaMicro, which had developed a microcomputer-based serials control system. This product became OCLC SC350, a product available to run on M300 PC-based workstations. Later that year, OCLC engaged MetaMicro to develop software for acquisitions, which became the ACQ350 acquisitions sub-system.

The combination of its Online Union Catalog, ILL system, LS/2000, ACQ350, and SC350 formed a suite of products to fulfill OCLC's ambition of comprehensive library automation. Yet, the business results of the effort were moderate. The initial robust sales seen in the early years of LS/2000 tapered off and the product remained as a mid-level competitor. Companies including CLSI, Dynix, and Geac were seeing higher number of sales and installations.

In 1987, OCLC acquired the ALIS family of integrated library systems from DataPhase, which was experiencing financial difficulties. OCLC assumed support for the 38 libraries using that system and rebranded the product as LS/2.

In April 1990, OCLC exited the local systems business, selling its local systems division to Ameritech Library Systems. This move ended this phase of OCLC's involvement in the ILS market. It also marked the beginning of the rise of Ameritech Library Systems, which became a major competitor in the industry over the next decade, with its subsequent acquisitions of Dynix (1992) and NOTIS (1991). Ameritech eventually divested its library systems division (1999), which was renamed to epixtech (2003), then to Dynix, which was eventually acquired by Sirsi Corporation (2005) to form SirsiDynix.

1990s: TECHLIBplus

OCLC made a minor foray back into the world of integrated library systems in the 1990s. It acquired Information Dimensions, a spin-off from the Battelle Memorial Institute, a non-profit technology and development company also based in Dublin, OH in June 1993. Information Dimensions had developed an integrated library system called TECHLIBplus, designed primarily for corporate and government libraries. OCLC operated Information Dimensions as an independent wholly owned for-profit subsidiary until 1997 when it sold it to Gores Technology Group in July of that year. Gores sold Information Dimensions in June 1998 to OpenText, a Canadian-based company providing a wide range of document management and other technology solutions for corporate and special libraries. As a company that specialized in the special library sector, Information Dimensions lacked deep synergies with OCLC's core services as was anticipated with LS/2000 or in its current strategic technology initiatives.

2000s: Reinvesting in the ILS Industry

The next phase of OCLC's involvement in the ILS arena took the form of acquiring a variety of companies that had developed integrated library systems or resource sharing products. In April 1999, OCLC made a major investment in PICA BV, an organization based in the Netherlands, providing services and technologies to support cataloging, interlibrary loan, and reference to libraries in Europe. By 2007, OCLC gained full ownership of PICA. This marked a phase of business acquisitions of companies involved in producing library automation and related systems, including:

- Sisis Informationssysteme (June 2005), which created the Sunrise integrated library system used by public and academic libraries in Austria, Germany;
- Fretwell-Downing (November 2005), whose products included the OLIB integrated library system and the VDX (Virtual Document eXchange) resource sharing management platform;
- Openly Informatics (January 2006), which had created an electronic resource knowledge base and a a link resolver;
- DiMeMa, which had developed CONTENTdm (August 2004);
- EZProxy from Useful Utilities (January 2008);
- Amlib (September 2008), a company that had created the Amlib ILS used by many public and school libraries in Australia and other countries;
- BOND GmbH (April 2011), which developed and supported the Bibliotheca ILS for public libraries in Germany; and
- Kuijpers Automatisering BV (HKA) (October 2013) whose bicatWise ILS has been implemented by the majority of libraries in The Netherlands.

This series of acquisitions brings a large number of aging library automation products and the libraries that use them

into the OCLC fold. Each of these products has been integrated into the OCLC development and support organization, but none of the products have seen major forward development. They represent important business activity for OCLC's EMEA operations and a potential pipeline for OCLC's strategic technology development initiative, the WorldShare Platform.

WorldShare Platform

Technologies available today make it possible for OCLC to more realistically pursue the vision it has had since the 1980s of providing a comprehensive environment to address all aspects of library operations. The obstacles seen during that time no longer apply. Libraries have robust internet connections, essential to support all aspects of the services they offer to their users and to access the platforms and services underlying their collection resources and support services. Cloud computing technologies make it possible to develop complex and highly scalable platforms able to support resource management and access for thousands of libraries.

In this vein, OCLC began the development of what is now called Web-scale Management Services in early 2009. Subsequently branded as WorldShare Management Services, this new library services platform was created with the vision of providing all aspects of resource management based on the WorldCat database. Rather than the long-established approach of libraries moving copies of records from OCLC or other bibliographic systems into a local integrated library system, WorldShare Management Services enabled libraries to add items or inventory records directly to their holdings on WorldCat. This data model and a multi-tenant architecture enables WorldShare Management Services to support a dramatically new workflow for resource management, circulation, and acquisitions relative to traditional integrated library systems.

Following about two years of development, the Craven-Pamlico-Carteret Regional Library System became the first libraries to place WMS into production in January 2011. These libraries implemented an early release of the system following a major hardware failure of their incumbent integrated library system. Not only was this the first real-world use of the product, but it was also a bit outside market focus on academic libraries. In December 2011, OCLC formally announced WorldShare Management Services as a brand and a product, beginning a steady course of sales and implementations.

WorldShare Management Services has been implemented primarily by mid-sized academic libraries. It has been adopted by three members of the prestigious Association of Research Libraries, including the University of Delaware, University of New Mexico, and the University of Louisville. About three-fourths of the organizations using WorldShare Management Services are academic or research libraries and about five percent are public libraries. WorldShare has established a respectable position in the library services platform arena, though Ex Libris has a strong lead and has been selected by larger libraries and consortia. Even though OCLC does not dominate in this highly competitive sector, it provides an important competitive element and a conceptually distinct alternative.

Table 1: Number of Contracts, Libraries, and Installations of OCLC WorldShare Management Services from 2010-2016

Year	Contracts	Libraries	Installed
2016	83	97	440
2015	68	73	386
2014	79	90	303
2013	92	140	177
2012	163		73
2011	184		38
2010	130		5

Source: statistics reported for Library Systems Report 2017, published in *American Libraries*

In its 50-year history, OCLC has continually used technologies available to further its mission of facilitating cooperation among libraries. The organization has been able to maintain its services continually by migrating through multiple generations of computing and communications technology. Its business model has included the flexibility to support the needed investments in updating its technology infrastructure. These investments may represent one of its keys to long-term success in a historical context where many other organizations have not survived. Most importantly, OCLC benefits from talented individuals with the perspective and insight to look forward and discern the upcoming trends in technology, in library operations, and in the communities that libraries serve.

Enduring for 50 years is a remarkable accomplishment given the fundamental changes that have transpired in that interval. Libraries have transformed from managing print-oriented collections to ever-growing proportions of electronic and digital resources. Technologies have cycled through several generations. While each new generation offered immense leaps in capabilities, it demanded many costly reinvestments. This history of change reminds us that the current state of technology will not endure for long. We should expect continued upheavals and will need to adapt accordingly.

Smart Libraries Q&A

Each issue, Marshall Breeding responds to questions submitted by readers. Have a question that you want answered? Email it to Samantha Imburgia, Associate Editor for ALA TechSource, at simburgia@ala.org.

How do you determine if a SaaS solution is best for your library's integrated library system? What pros and cons should we be mindful of when exploring options?

One of the major issues in the implementation of any major technology product, such as an integrated library system, concerns whether it should be installed on equipment located in the library or if it should be hosted by the vendor. Both options have been available, in some fashion, since the earliest times of library automation.

The locally hosted option, where the library licenses software that is then installed on servers housed on its premises, has been the dominant way until recent years. These servers might reside in the library itself, but they are more likely to be placed in the data center of its parent institution. Academic libraries usually have some type of agreement with their university information technology department to co-locate servers within the institutional data center, as would a public library with their local government. Regardless where the servers are physically housed, the library would assume at least some degree of responsibility for its technical operation. This arrangement comes with the need for technical expertise to properly maintain and secure the server and manage a wide variety of tasks associated with operating a complex business application. The budget model of a locally operated system includes costs for technical personnel, server purchase and support contracts, software licenses, facilities fees, as well as other direct or indirect costs.

Operating an integrated library system in this way comes with a mix of advantages and challenges. On the plus side, the library has considerable control in its technical operation, in its configuration, and in any interactions with other systems within its environment. Data can be transferred to and from the system within the organization's own network without having to traverse the internet. This model also comes with some disadvantages, including the need to allocate personnel to its technical upkeep, the need to repair and replace hardware periodically, and the need to continually monitor and address security and other aspects of the operating environment. There may be limited redundancy of hardware and network components due to the cost of acquiring and maintaining multiple copies of each component.

Local hosting might be the favored approach for libraries that have

- a strong in-house technical support team;
- suitable facilities for the responsible housing of computer infrastructure, including uninterruptible power support, fire suppression, and cooling;
- specific needs for local control; or
- complex interoperability with other business systems within the enterprise network.

Software-as-a-service (SaaS) divides the roles and responsibilities in a much different way between the library and the vendor. The library configures and operates the system at a fairly high level but does not need to be involved in dealing with the hardware, operating systems, database management, or other lower-level technical details.

Integrated library systems can be implemented in a configuration where the vendor provides hosting services for the servers and assumes responsibility for their technical management. In some cases, library staff will access the system via Windows or Java-based client software installed on their computers. Alternatively, some integrated library systems offer web-based interfaces that avoid the need for special client software. Many of the developers of ILS products are creating new web-based interfaces to eventually replace the client software.

Library services platforms are based on multi-tenant platforms with all aspects of functionality accessed via web interfaces. For these products, local hosting may not be an option. Like the vendor-hosted integrated library system, libraries using these platforms do not have to concern themselves with the lower-level technical infrastructure but rather focus their efforts on their operational aspects.

In recent years, vendor-hosted integrated library systems and library services platforms have become the dominant model chosen by libraries for new implementations. Even when retaining the same integrated library system, many libraries are shifting from locally-hosted to vendor-hosted implementations. Libraries increasingly prefer this trend for many reasons:

- fewer technical personnel employed by the library and the need to make best use of these individuals for higher value services rather than maintaining local server infrastructure;
- availability of robust internet connections that are essential infrastructure for other aspects of library services and content offerings;
- higher levels of reliability can be expected on less redundant local servers;
- predictable annual subscription fee without the need to budget for equipment replacement; and
- price incentives offered by vendors to move from local to vendor hosting.

SaaS has become the norm for almost all technology-based products.

It is important to be aware that SaaS has become the norm for almost all technology-based products. We expect to access social networks, e-mail, and other business and consumer applications entirely through our web browsers. Core desktop tools, such as word processors and spreadsheets, are increasingly operated via web interfaces. Even those installed on desktop or laptop computers are increasingly offered only through subscription services with automated updates and built-in cloud storage rather than purchased standalone software, such as with the Microsoft Office 365 Suite.

Given these considerations, there are ever fewer downsides to acquiring major library products through SaaS subscriptions. We are well into the era of web-based systems and cloud computing. While there may be some circumstances where a library will have solid reasons to implement a new system on local infrastructure, this option will become increasingly rare.

Questions or suggestions for topics in future issues?

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Marshall Breeding's expert coverage of the library automation industry.

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