Robots in Academic Libraries:

Advancements in Library Automation

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Chapter 2

Beyond the ILS:
A New Generation of Library Services Platforms

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ABSTRACT

This chapter focuses on the changes in integrated library systems (ILS) over the past thirty years as the focus shifts from collecting physical items to electronic and digital materials. The relationship between the ILS and new specialized applications, including link resolvers, knowledge bases of e-content, electronic resource management systems, digital asset management systems, discovery services, and institutional repository platforms is discussed and placed in context. In addition to looking at workflows with these new systems, a general discussion of how academic libraries are likely to engage with these new systems, the time frames in which we can expect availability and widespread adoption, and any cautions or concerns to have in mind when selecting or implementing these systems.

INTRODUCTION

For the last thirty years or more, academic libraries have relied on integrated library systems to help them manage and provide access to their collections and services. The ILS was designed at a time when academic library collections consisted primarily of physical items and they provided automated support for a very broad range of the tasks related to the management and access of

these materials. The transition to ever increasing proportions of electronic and digital materials pressed the ILS beyond the limits of what it was designed to manage.

In order to deal with these new formats, the current phase of library automation leaves the ILS in place, but surrounded by other specialized applications, including link resolvers, knowledge bases of e-content, electronic resource management systems, digital asset management systems, discovery services, and institutional repository platforms. This approach, while filling in needed functionality, results in duplication of effort and

inefficiencies for library personnel in the way that they work and makes use of library resources difficult for patrons as they attempt to navigate through a complex matrix of interfaces and services.

This chapter will address the technologies emerging now that address the current and future needs of academic libraries. The chapter will describe and give perspective on some of the projects and products emerging in this context. An early section will describe some of the general concepts embraced by each, including unified workflows across all collection formats, highly shared data models, open API's and engagement with community developers, as well as general technology trends such as multi-tenant software-as-a-service. Sections will be devoted to some of the major products: Ex Libris Alma, OCLC WorldShare Platform, Serials Solutions Web-scale Management Solution, Innovative interfaces' Sierra, and Kuali OLE

The chapter will conclude with some analysis, perspective, and projections on how academic libraries are likely to engage with these new systems, the time frames in which we can expect availability and widespread adoption, and any cautions or concerns to have in mind when selecting or implementing these systems.

The State of the Integrated Library System

The model of the integrated library system has been the bedrock of library automation for around more than thirty years. The first automation systems introduced in the early to mid-1970s embraced a model of organization that grouped functional tasks into stand-alone systems specializing in a specific area of library operations, such as circulation, cataloging, acquisitions or serials management. Over time, these standalone modules consolidated into more comprehensive systems and have steadily gained more nuanced functionality, but many of the foundational prin-

ciples of the early automation efforts designed for a print world persist through the integrated library systems in use today.

The earliest days of library automation systems were created to address specific processes. Some offered cataloging and circulation capabilities, such as Libs 100 system introduced by CLSI in 1971 or the Gaylord Circulation 100 system in 1975. Others specialized in acquisitions, including Innovative's INNOVAQ. In these early days managing even a more narrow scope of functionality was a giant leap beyond the manual procedures previously in place. The ambition, from the beginning, was more comprehensive automation, and many of these early systems evolved accordingly, bringing together bundles of functionality.

The mold of the fully integrated library system germinated out of the previous generation of special-purpose applications, taking root by the 1980 when products began to be marketed that combined multiple modules that shared common databases and interfaces. The libraries of this era saw all their energies concentrated on managing collections of physical materials—books, serials, microforms, and manuscripts. Monographs existed only in printed form, and were purchased through approval plans, firm orders from publishers or book jobbers. Journals were published in print, and the functionality to perform check-ins to record issues received, make claims for missing issues, and to facilitate the binding into volumes was an enormous help over the manual procedures previously followed for tracking a library's holdings of newspapers, periodicals, and scholarly journals. This was also the time when researchers would find articles related to their areas of interest using printed indexes, such as the *Readers Guide to Periodical Literature* or one of the more specialized indexes.

It was in this print dominated time that the integrated library system entered the scene, with modules designed to work together to provide a comprehensive array of functionality. These

integrated library systems might be configured for a single independent library, including those with multiple branches or for consortia of multiple independent libraries. The standard integrated library system modules included:

- **Cataloging:** To create, import, or update bibliographic records. Common functionality would include the ability to create new MARC records when needed and to connect to bibliographic services such as OCLC Cataloging Service, or to major libraries that offer a Z39.50 service to identify and acquire records previously created that match an item to be cataloged.
- **Authority Control Module:** May be an optional product or a feature of cataloging that allows the library to add consistency and linking among the records in their bibliographic database making use of standard authority terms, such as the Library of Congress Subject Headings, the Library of Congress Name Authorities, MeSH, or those from other national libraries or cataloging agencies.
- **Circulation:** To manage the loans, renewals, returns, and overdue processing for physical materials. Circulation might include capabilities to support direct consortial borrowing for libraries that allow patrons to make requests from their partner institutions.
- **Acquisitions:** To handle the business details involved in the procurement of library materials, including the management of funds allocated for departments or disciplines, management of a database of the vendors from which the library orders materials, issuing invoices for items ordered, creating vouchers to issue payments for items received, check-in of items received, annual fiscal year close to reconcile budgets and funds, and reports related to budgets, funds, and vendors.

- **Online Catalog:** To allow library patrons to search or browse for library materials
- **Serials Management:** For the specialized tasks related to newspapers, periodicals and scholarly journals, such as issue check-in, routing lists, claims for issues not received, and invoice processing for serials suppliers.
- **Binding Module:** Might be available as an option or provided through a third-party vendor to facilitate the process of creating bound volumes out of the single issues received.

The earliest versions of these integrated library systems ran on mainframe computers, but were also implemented on lower-cost midrange systems and servers as those became available.

The integrated library system has survived major transitions in computer architectures. Text-based interfaces, based on menus and transaction directives were employed during the reign of mainframe and midrange hardware. The basic deployment involved a central processor which did all the work with text-based terminals that provided staff and end-user access to the modules. A typical arrangement would involve physical terminals provided within the library at circulation desks, throughout technical services, and in public areas for patron access. Through terminal server controllers and other communications devices, access to the integrated library system could be provided outside the library on campus networks, to dial-in users, and eventually on the Internet. Terminal emulation software made it possible for those with personal computers to access these systems.

An age of client/server computing emerged in the 1990's which aimed to tap into the powerful capabilities of the desktop computers increasingly deployed in both office and home settings. These personal computers had ample processing power, ran multi-tasking operating systems, and offered graphical interfaces that could be operated

more intuitively by persons without a technical background. Mainframes eventually were phased out due to their high cost and modest storage and computing capabilities compared to the server-class computers that come onto the market.

Driven by this transition in the broader information technology realm, a new line of integrated library systems were created that followed the client/server architecture. These new systems operated on servers under operating systems such as some version of Unix, OS/2 from IBM, or Windows NT from Microsoft. The client software for these new client/server integrated library systems would operate on desktop computers running Microsoft Windows or the Macintosh OS and offered graphical interfaces that used menus, selection, and editing techniques that could be operated using a mouse rather than the cryptic commands and directives of the text-based systems. These new client/server systems included: Horizon from epixtech, Taos from DRA, Millennium from Innovative Interfaces, Virtua from VTLS, Library. Solution from The Library Corporation, or Polaris from Gaylord Information Systems. Some of the incumbent text-based systems morphed into the client/server realm such as Unicorn from Sirsi Corporation with the introduction of the InfoVIEW and later WorkFlows clients.

Although a new cycle of technology drove the change to a new roster of integrated library systems, the basic operational approach and functionality did not change dramatically. By the mid-1990's libraries continued to manage collections of mostly physical materials. Some forms of electronic information were emerging, primarily in the area of indexing and abstracting products, but library collections themselves remained primarily in print during the onset of the client/server era. The new products consequently continued to offer the same basic modules with the same general sets of features as the previous era. The key challenge was to bring forward all the nuanced functionality present in the mature mainframe-based systems in to the nascent client/server products.

With these new client/server products mostly already in place, the age of electronic information came into libraries with great force. The first wave of changes came in the serials side, with a rapid, and by now nearly complete transformation to electronic publication. Academic libraries shifted ever larger proportions of their journal subscriptions to electronic form as well as to great number of indexing and abstracting services and aggregated databases of citations and full-text articles available on the Web. This growing body of subscriptions to electronic resources, unfortunately, found little help in the existing functionality of the integrated library systems of the time. To meet these needs, a variety of additional products and services emerged to support libraries with the management and access of electronic resources. These included: OpenURL-based link resolvers, federated search environments, and electronic resource management systems.

- **OpenURL Link Resolvers** to deal with the unsustainability of manually coding links to e-journal titles and to individual articles, providing an infrastructure based on OpenURLs embedded in content sources, parsed and interpreted by a library's link resolver, which relied on a knowledge base of detailed holdings data to create context-sensitive links to the target resource. Examples of these OpenURL-based link resolves include SFX from Ex Libris, 360 Link from Serials Solutions, LinkSource from EBSCO, or community-based projects such as CUFTS/GODOT. [For a detailed report on OpenURL-based link resolvers and their supporting knowledge bases, see Breeding, Marshall. "Knowledge Base and Link Resolver Study: General Findings."

- **Electronic Resource Management Systems:** Assist libraries with the procurement and management of their subscriptions to content products. Their features include specialized acquisitions capabilities for the

procurement of new resources and subsequent renewals, administration of the terms of licenses, authorization details, vendor profiles, management of the detailed holdings within each content package, and many other features. While some of these features overlap with the acquisitions and cataloging modules of the integrated library system, they operate mostly independently. The points of integration with the organization's link resolver were stronger than with the integrated library system. Some of the major electronic resource management systems include Verde from Ex Libris, 360 Resource Manager from Serials Solutions, and Electronic Resource Management from Innovative Interfaces, Inc., and ERM Essentials from EBSCO Information.

- **Federated Search Tools:** Allowed users to search many different library resources simultaneously, providing a simplified research process compared to serially searching many content products. The federated search tools, such as those from MuseGlobal, MetaLib from Ex Libris, WebFeat, or 360 Search from Serials Solutions, were based on sending queries to multiple remote information resources in real time, intercepting responses, and presenting results to users. This methodology had the benefit of allowing users to more easily simultaneously search multiple related resources, but these tools were limited in the number of targets that could be addressed simultaneously.
- **Discovery Interfaces:** Have emerged in recent years to provide more modern and comprehensive ways for uses to gain access to library collections and relevant services than the online-catalogs packaged with integrated library systems. These discovery interfaces include relevancy-based search technologies, faceted browsing to help us-

ers narrow and navigate through search results, and offer many of the features that uses have come to expect in a Web-based search environment.

Libraries increasingly expect discovery services to provide access to broad representation of their collections. In addition to the traditional scope of the online catalog such as books, media materials, journal titles, it is increasingly desirable to include access to the individual articles contained within a library's subscriptions to electronic resources. The genre of index-based discovery services has emerged to address this expanded scope. While implementation details vary, the general approach involves the creators of a discovery service making arrangements with providers of information resource to provide content that can be loaded into a large index to support end-user discovery. Items selected for use from the discovery service would be fulfilled by the original publishing source. These index-based discovery services include Summon from Serials Solutions, EBSCO Discovery Service, Primo Central from Ex Libris, and OCLC's WorldCat Local.

A typical academic library would not only operate its integrated library system to manage its print collection, but will likely also depend on a cluster of these additional management and discovery applications to fill out missing functionality related to electronic and digital resources. This assemblage of independent systems imposes a high level of overhead for the library, both operationally and technically.

TRANSITION FROM CLIENT/ SERVER TO CLOUD COMPUTING

In the same way that client/server computing displaced an earlier generation of mainframe-based systems, the current wave of technology is based on a service-oriented architecture, Web-based interfaces, and designed to be deployed through

multi-tenant software-as-a-service. The previous shift was driven by the presence of powerful desktop computers and the unsustainability of mainframes. One of the problems with the client/server architecture involved the client software that needed to be developed for multiple operating environments. Developers need to choose to create clients for different types of computers, such as Windows or the Mac OS. New versions of the application would require users to download and install new software. Today, Web browsers have become the preferred end-user client platform. The service-oriented architecture involves applications created out of small units of functionality that can be combined together to create more complex features. Lower-level services can be re-used in many different parts of an application, resulting not only in programming efficiency, but in the ability to compose new functionality through the recombination of existing services. The services can also be exposed to customers or to third parties, resulting in application programming interfaces that can be used to extend functionality or for interoperability.

The other key technology trend involves cloud computing. Rather than design applications to be installed on a server housed at the customer's site, they can be implemented on highly-scalable clusters of computing equipment capable of supporting large numbers of organizations on the same instance. Systems designed for multi-tenancy can be expanded incrementally as new organizations or individuals implement the service, with data segregated or aggregated as needed. For both personal use and business, cloud computing has become increasingly dominant.

Any new applications will be created with these characteristics and the legacy client/server architecture eventually diminishes. In the library automation arena, were in a time where products developed in recent years have been designed for multi-tenant software-as-a-service using Web-based interfaces with some of the existing client/server products evolving toward this architecture.

In addition to the technology shift underway, new applications developed today have the opportunity to take into consideration the fundamental changes that have transpired in the nature of library collections and operations. Instead of simply replicating the functionality of the traditional integrated library system focused on print materials into new technology platforms, a variety of products have emerged that address the current reality of library collections comprised of materials in many different media or formats.

THE EMERGENCE OF A NEW GENERATION OF LIBRARY SERVICES PLATFORMS

The major trend in the library automation industry in play since about 2008 involves the development of products to address both the failings of the traditional integrated library system and the advent of this new age of cloud computing. This new generation of library services platforms brings together a more comprehensive approach to providing support for current library realities and current technology architectures.

This new genre of software differs substantially from the incumbent integrated library system. These products diverge significantly from the functionality addressed and in technical architecture and constitute a new product category. Some of the organizations developing these products posit their own labels for this new category, tailored to their design and concepts. Ex Libris uses "unified resource management," OCLC and Serials Solutions both use the label "Web-scale." In order to have a vendor-neutral label for this group of products, the author has coined "library services platforms" to describe this slate of products that embody these characteristics. While each product offers a distinctive approach and may emphasize some characteristics more than others, they differ substantially from the scope, functionality, and architecture of integrated library systems.

Some of the key characteristics of library services platforms include:

- Comprehensive management of library materials including electronic, digital, and print.
- Designed to be deployed through multi-tenant software as a service.
- Reliance on shared knowledge bases for bibliographic and e-content holdings.
- Service-oriented architecture.
- Reliance on Web-based interfaces for staff functionality.

In general, these systems provide a more comprehensive approach that can displace a set of independent applications with a single unified framework. In addition to the core integrated library system, these new library services platforms also incorporate functionality that may have also been separately managed in electronic resource management systems, or digital asset management systems. The groupings of functionality within the products may also differ from the traditional integrated library system. Features related to circulation, resource sharing, document delivery, and interlibrary loan, may be organized into a broader set of workflows centered on resource fulfillment, for example.

MAJOR PRODUCTS

The transition toward these new products is just now underway. The inception of this new generation of library management products began in 2009, with product announcements coming out through 2011. The roll-out of the products lags behind a couple of years. We can anticipate the competition to be fully underway by about 2013, with larger proportions of research and academic libraries adopting these products over the course of subsequent years. The tipping point where library services platforms dominate integrated library systems can't accurately be predicted, but may be anticipated to occur by about 2016.

OCLC WorldShare Platform

Organizational Background and Strategy

OCLC, a global library services organization was originally founded in 1967 to provide cataloging services to libraries in Ohio, and has steadily expanded geographically and in the breadth of its products and services. The organization today offers a wide range of products and services including resource sharing, interlibrary loan, collection analysis, virtual reference, among dozens of others, all generally oriented toward amplifying the efforts of individual libraries through cooperation.

Organized as a non-profit in the state of Ohio, OCLC has an executive management team overseen through a system of governance that includes a Board of Trustees as well as set of advisory global and regional councils. OCLC operates throughout the world, with almost 26,000 member libraries in 170 countries. OCLC has also grown through the acquisition of other organizations and for-profit companies. In the bibliographic services arena, organizations acquired include UTLAS (1991), Bibliocentre (1997), authority control services from Blackwell North America (1997), WLN (1999), Library Technical Services (1999), and the Research Libraries Group (2006). OCLC has also acquired a number of for-profit companies involved in the library automation industry, including PICA (1999-2007), Sisis Informations systeme (2005), Fretwell-Downing Informatics (2005), Openly Informatics (2006), Amlib (2008), EzProxy (2008), CONTENTdm (2006), and BOND (2011). Through these acquisitions, OCLC has gained ownership of relevant technology products, responsibility for the support of a

number of traditional integrated library systems, and a pool of experienced developers, product managers, and executives. In recent years, OCLC has channeled its attention not only to the ongoing maintenance and support of these acquired products, but it has been especially focused on developing a new generation products for resource discovery and library management.

WorldCat Local Discovery Services

Leveraging the massive WorldCat bibliographic resource, OCLC developed WorldCat Local as a discovery services that could work with a library's existing integrated library system. Based on the holdings set in WorldCat, patrons are able to find items owned by the library, supplemented by a vast number of additional materials from other OCLC member institutions. WorldCat Local is able to show the status of items held in the library through behind-the-scenes interrogations to the local ILS. Consistent with the trend toward extending the scope of discovery services to also include electronic resources at the article level, OCLC has made arrangements with publishers and other content providers to index an ever expanding array of these materials in WorldCat.

WorldCat Local was launched as a pilot product in April 2007. OCLC reported over 1,500 libraries using WorldCat Local in 2011.

WorldShare Management Services Design and Concepts

In a move that takes OCLC even deeper into the library automation industry, OCLC has embarked on a strategy to provide products and services for the management of library operations. With products and services already in place that provide cataloging, resource discovery, and interlibrary-loan, providing additional capabilities including circulation, acquisitions, and electronic resource management could be accomplished with incremental, though still substantial development. But with these services in place, a library would no

longer need to maintain much of its local infrastructure, including its integrated library system.

OCLC articulates a vision that amplifies the impact that libraries can have on their clientele and that the broader library community can have on society through cooperation on a global scale. Instead of individual libraries operating individual and isolated automation systems and catalogs, they can join together, facilitated by OCLC's services, to not only operate with much more efficiency, but to provide powerful resources that compete on a par with major commercial enterprises such as Amazon.com. OCLC characterizes this global cooperation as Web-scale, or operating "at the network level."

In order to support these new library management services, OCLC has created a new technology infrastructure capable of supporting a massive volume of transactions with global redundancy. This new infrastructure, now called the WorldShare Platform, not only was designed to handle a transaction load equivalent to global library activity, but also provides access to key data resources, such as the WorldCat bibliographic database, the WorldCat knowledge base of e-journal holdings data, and other collaboratively managed information resources. The WorldShare Platform follows a service-oriented architecture and exposes a full suite of application programming interfaces and Web services. OCLC has used this infrastructure to create its own applications such as the WorldShare Management Services and WorldShare License Manager, which offer functionality for the management of a library's print and electronic resources.

Beyond these and other applications that OCLC might develop, OCLC member libraries and authorized third-party organizations can also develop additional services or applications on the WorldShare Platform. The same API's that OCLC uses to create its own major applications, such as WorldShare Management Services will be made available to support applications created by programmers external to OCLC. OCLC provides an "App Gallery" as a repository for libraries to

share the applications and services they create using the WorldShare Platform. Once an application has been completed, tested, and certified by OCLC, it can be made available to other libraries. Some applications may use content resources freely available, others may tap into content or services made available only through specific subscriptions. The applications that libraries use will need to align with their own subscriptions to OCLC products and services. It would not make sense, for example, for a library to make use of an app that extends some aspect of WorldShare Management Services if they did subscribe to that product.

The BIBSYS consortium in Norway, for example, has a long history of developing its own library management systems and subscribed to WorldShare Management Services with the intention of extending its capabilities through their own development efforts using the APIs. The 105 member BIBSYS consortium, which includes the National Library of Norway and all the major academic libraries in the country, selected OCLC WorldShare in November 2010, following a competitive procurement process. In August 2012 BIBSYS discontinued its project to implement WorldShare Management Services.

Consistent with its ever expanding global strategy, OCLC has established data centers in multiple global regions to support the WorldShare Platform. OCLC's original data center at its headquarters in Dublin, OH has been protected through a redundant site in Westerville, Ohio for several years. OCLC has since activated data centers outside the United States including the United Kingdom (December 2011) and Sydney (March 2012).

Functional Design

OCLC WorldShare Management Services provides functionality traditionally been made available to through an integrated library system. Rather than rely on an integrated operated either for an individual library or through a limited number of

libraries through a consortium, municipal, county, or regional system, WorldShare Management Services provides a platform designed to be shared at a global level to provide support for library operations. Extending OCLC's existing services of cataloging, resource sharing, and discovery, WorldShare Management Services addresses functionality related to circulation, acquisitions, and serials management. An additional set of services, the WorldShare License Manager, provides tools to help libraries manage their subscriptions to electronic resources.

The functionality in WorldShare Management Services builds on the massive WorldCat bibliographic database, which held around 240 million records in May 2012 and continues to grow rapidly, both through new cataloging performed directly on the system by OCLC members and through records loaded from national catalogs and other sources. The basic data model underlying OCLC's new services is based on moving libraries away from individually managed bibliographic and other supporting databases toward basing management tasks on linkages made to shared records in WorldCat.

The cataloging functions of WorldShare Management Services are based on the existing OCLC Cataloging capabilities. Bibliographic records in MARC format can be created and enhanced according to well-established procedures and authorizations, with support for new metadata formats such as Dublin Core.

WorldShare Management Services provides acquisitions functionality with capabilities to handle both print and electronic materials. A global database of vendors is provided, with the capability for each library to add local data as needed. Workflows are included to order materials, receive items, to process and manage invoices, to manage budgets, and to manage vendor records. The system automatically creates holdings records associated with the bibliographic record in WorldCat for new orders, making the items available for circulation upon receipt.

WorldShare License Manager is available as a separate optional subscription and provides additional tools for managing electronic resources. It relies on the WorldShare knowledge base of detailed holdings within electronic resource packages to support tasks related to their acquisition, management, linking, and access.

Development and Deployment Roadmap

The strategy to develop the WorldShare Platform has been underway since before 2009 when OCLC made its original announcement for Web-scale Management Services, as the product was called prior to the launch of WorldShare as the brand for this suite of services to support library management. A group of early adopter libraries began implementing WorldShare Management Services in July 2010, and the service has been available in general release since July 2011. OCLC launched WorldShare License Manager in January 2012 bringing in additional capabilities to manage electronic resources.

Target Library Segments

The OCLC WorldShare Platform has been designed for all types of libraries, consistent with the broad scope of the organization's membership and commercial customer base. Early adopters represent a diverse set of libraries, both in size and type.

Early marketing efforts were focused in the United States, attracting a variety of libraries as early adopters of WorldShare Management Services. Examples of the early libraries to place the product into production include:

- Craven-Pamlico-Carteret Regional Library System, with 10 public library members in North Carolina (Jan 2011)
- Boundary County District Library (Dec 2010)
- Lawrence Technological University (Feb 2012)

- Ogeechee Technical College, in Statesboro, Georgia (Oct 2011)
- Bucknell University
- Spring Hill College

By February 2012, OCLC reported that 35 libraries had completed migration to WorldShare Management Services to replace their previous integrated library system.

In January 2012, the University of Delaware announced its intent to implement WorldShare Management, the first member of the Association of Research Libraries to select the product.

Alma from Ex Libris

Organizational Background and Strategy

Ex Libris, based in Israel and with a broad international presence, specializes in developing products and services for academic and research libraries. Today the company ranks as one of the largest companies in the global library automation industry and offers a broad slate of products related to the discovery and management of library resources.

Ex Libris traces its roots to Hebrew Union University in Jerusalem, where the original Aleph software was created for the needs of this library, beginning around 1980. Its success in its home university lead to interest in other universities, leading to the establishment of Aleph Yissum founded through the technology transfer unit of the university to commercialize the system, initially with Israel and beginning in 1986 through a new company called Ex Libris, Ltd., among other countries. In 1995 the two separate companies were merged together into a single corporate structure, Ex Libris Group. Ex Libris has grown steadily through the adoption of Aleph in many regions of the world, both through distributors and in corporate offices established for specific regions. The company has also grown through the

acquisition of other companies, beginning with Dabis in 1997 and with Endeavor Information Systems in 2006.

The ownership of Ex Libris has gone through several transitions through its organizational history. Initially Hebrew Union University and Ex Libris founder Azrael Morag shared ownership. In 1999 venture capital firms Walden Israel and Tamar Ventures gained ownership stakes. Francisco Partners, a large private equity firm, gain exclusive ownership in 2006 through a deal that also resulted in the merger of Endeavor Information Systems into the company. In August 2008 the company was sold to Leeds Equity Partners.

The business strategy of Ex Libris has consistently been based on investing in the development of new products for the academic and research library market. The company has continually developed its own Aleph integrated library system, taking the product through multiple generations of technology, beginning with its original COBOL-based mainframe versions, to midrange systems, to the current version using Unix and Oracle-based servers and Windows-based clients. Following the acquisition of Endeavor, Ex Libris also channeled development resources into Voyager. In addition to its core ILS products, Ex Libris has created other products, mostly related to the management and access of electronic materials in library collections. Ex Libris acquired the SFX technology from the University of Ghent in 2000, performed additional development and commercialized it to establish the genre of OpenURL-based link resolvers. Other link resolver products have also entered this market and Ex Libris has continued to maintain its lead in terms of the total of installations. The company has also developed MetaLib, announced in July 2000, as its offering in the federated search arena. In 2004 Ex Libris introduced Verde to help libraries manage their electronic resources.

Primo for Discovery and Delivery of Library Resources

With a slate of well-established, through aging products, Ex Libris began its initiative to develop a new generation of technologies initially with a discovery layer for end-user access to library resources, to be followed later by a new platform for internal library operations and resource management. The company described this strategy as "unified resource and delivery" responding to the increasing strategic priority of electronic and digital resources in academic libraries, involved bringing all types of resources into access and management platforms instead of the previously established model that treated them separately.

Ex Libris announced Primo as its end-user discovery and delivery platform in mid-2006. The early versions of Primo aimed to provide access to all types of library resources using a locally maintained index that a library would populate with metadata from its integrated library system, local digital repositories, as well as other collections, supplemented by the use of MetaLib to bring in results from the library's subscribed electronic resources. Primo was designed to be highly customizable for each library, allowing the library to set its own indexing and presentation rules, relevancy weightings, as well as many other configuration details.

In July 2009, Ex Libris announced Primo Central, a hosted index of scholarly resources that could be seamless integrated into Primo or other discovery interfaces. Primo Central brought Primo into the ranks of the new Web-scale or index-based discovery services initially established by Serials Solutions with the introduction of Summon in January 2009. Ex Libris has continually expanded Primo Central with the addition of collections of e-journal aggregations, e-book collections, and other scholarly resources.

Alma Design and Concepts

Ex Libris began its early design of Alma beginning in 2009 based on the concept of unified resource management. The company's existing product line included Verde for the management of electronic resources as well as Aleph and Voyager that followed the traditional integrated library system model generally optimized for print resources. One of the foundational concepts of Alma involves bringing the management of all types of library resources under a single platform rather than providing separate products for print, electronic, and digital resources. Primo brought together end-user access of the multiple components of a library's collection; Alma aims to bring the same unification to staff operations relative to different types of resources.

Alma has been designed for a multi-tenant software-as-a-service deployment, though implementations on local infrastructure will be possible as well. Ex Libris has established data centers to host Alma and its other products, including on in the Chicago area of the United States and another in The Netherlands (activated in July 2011), with additional sites planned in other geographic regions.

Though offered through a proprietary software license, Alma will include APIs that expose all areas of functionality so that libraries can access the data and functionality of the system through external programs and applications. These APIs, for example, make it possible to access Alma through other discovery layers other than Primo. Libraries will also be able to use the APIs to enable Alma to dynamically communicate with other components of campus infrastructure, such as enterprise resource planning systems (ERP) or learning management systems.

Alma will include knowledge base components in support of various aspects of resource management. The management of electronic resources requires knowledge bases that describe such details as the specific titles and issues associated with any given aggregated database or other resource to which a library might subscribe. Profiles of the library's subscriptions can then be applied to the knowledge base to determine the specific materials available within the library's collection. Products such as the SFX link resolver and the Verde electronic resource management system relied on a knowledge base maintained by Ex Libris. An extended version of this knowledge base will also drive the management of resources in Alma and will be made available as a component of the Community Zone, available to all the institutions that sue the product.

Alma follows a hybrid data storage model, with some databases shared across all the users of the product in a set of data stores called the Community Zone and other data specific to individual institutions stored in segregated areas called the Local Zone. Content in the Local Zone can still be hosted in Ex Libris data centers, but each library's Local Zone cannot be accessed by other institutions.

Ex Libris will provide a bibliographic database in the Community Zone to which any library can attach its holdings to shared records. Libraries may also choose to implement their own separate bibliographic database in ways similar to current ILS implementations. Initial deployments, for example, may take place initially with bibliographic data held in a Local Zone, with subsequent transition to a more shared bibliographic data model. This hybrid approach for the management of bibliographic records contrasts with OCLC's WorldShare that requires all libraries to share records and does not support the concept of individual bibliographic databases per institution.

Functional Design

The staff interface to Alma is entirely Web-based, requiring no installation of software on local workstations. Since the product is deployed through software-as-a-service, the library also does not operate local servers.

Once a library staff member signs into Alma, he or she will be presented with a customized page, called a dashboard, which provides access to the specific aspects of functionality appropriate to that job position or role. System administrators have the ability to selectively activate the tasks available to any given staff member, not only simplifying the menu of options, but also securely limiting access to only those features authorized for use.

Alma offers functionality to support all the standard operations expected in an integrated library system, though in many cases workflows may be somewhat different. Libraries can expect full support for their routine operational tasks such as circulation, acquisitions, cataloging, and the management of print and electronic serials. Alma includes Metadata Management System that supports multiple metadata formats, initially including MARC, Dublin Core, and MODS. Implementation strategies may also impact workflows, such as whether the library chooses to place its bibliographic records in the open Community Zone, or to keep them within their Local Zone.

Development and Deployment Roadmap

Ex Libris has been working with a group of development partners since the initial announcement of the product in 2009. The libraries engaged as development partners include Boston College, Princeton University, Purdue University, Katholieke Universiteit Leuven Libraries in Belgium which includes the LIBIS network of 30 independent libraries.

Alma has been developed incrementally, with multiple releases provided to development partners for testing and feedback. The following partner releases were completed:

1. **June 2010:** Basic functionality from a selection of modules, including basic circulation features, management of staff accounts, staff search capabilities, basic acquisitions, and system repository.

2. **December 2010:** Including unified acquisitions for print and electronic resources, cross format search through staff client, a metadata editing workbench with MARC support,

3. **May 2011:** Including advanced integration capabilities with discovery layer interfaces, support for multiple metadata formats for resource description, complete acquisitions workflows for ordering, processing invoices, and receiving, and the initial set of functionality for electronic resource management, and workflows for digitization of materials upon patron request, and role-based user dashboards, providing access to features required for library personnel based on their functional position.

4. **September 2011:** Advanced integration with Primo, including complete end-user account functionality and other standard online catalog features, improvement to the user interface, further refinements to the Alma resource editor for streamlined management of inventory and cataloging features, and enhanced fulfillment capabilities

5. **November 2011:** A version delivering all remaining functionality planned for the initial release of Alma, subject to final testing and quality assurance.

Alma was first put into production at Boston College on July 2, 2012.

In addition to the initial group of development partners for Alma, a number of libraries signed commitments to become early adopters, including additional universities in Australia, Europe, and the United States. The planned implementation of Alma in its development partner and early adopter sites from 2012-13 mark the beginning of the deployment phase of the product.

Target Library Segments

Alma, like all Ex Libris products, has been designed for academic and research libraries as well as national or state libraries, and consortia.

It will be marketed across all geographic regions. While many of the initial development partners will be migrating from the company's own Aleph or Voyager integrated library systems, the group also includes libraries previously using products from competing companies.

Intota from Serials Solutions

Organizational Background and Strategy

Serials Solutions operates as a wholly owned business unit of ProQuest, a major provider of content products to libraries. ProQuest is owned by Cambridge Information Group.

Serials Solutions was founded in March 2000 by brothers Peter McCracken, Steve McCracken, and Mike McCracken along with Chris Pierard. The initial product of the company was a database that described the e-journal titles held within various content packages to which a library subscribes. The effort involved in assembling and organizing this data was beyond the resources of most libraries, making it difficult to maintain lists that described the individual e-journals available to users. Serials Solutions worked with e-journal publishers and aggregators to acquire detailed data regarding these content products and incorporated them into a knowledge base that could then be used to dynamically generate e-journal lists and other tools for access and management of these resources. The effectiveness of these products depended on improving the data received by publishers, resolving inconsistencies, omissions, and errors. This emphasis on high quality data as the basis for creating products for libraries has been an ongoing strategy for Serials Solutions from its founding through its latest products.

ProQuest Information and Learning acquired Serials Solutions from its founders in March 2005. In December 2006 ProQuest became part of Cambridge Information Group. Serials Solutions as a technology company specializing in products to help libraries manage and provide access to their electronic resources operates as an independent business unit of a large corporate entity that offers a wide range of content products to libraries.

Serials Solutions has developed a growing suite of products, built on its knowledge base of e-resource holdings to facilitate the management and access of a library's electronic resources. The company has developed a set of products, including the 360 Link OpenURL link resolver, a federated search environment called 360 Search, and a full electronic resource management product called 360 Resource Manager. The knowledge base that drives each of these products has been branded KnowledgeWorks.

Summon an Index-Based Web-Scale Discovery Service

Serials Solutions launched Summon in 2009, the first major commercial discovery service based on an index that includes the print materials owned by a library and the individual articles held within its subscriptions. Summon also ties into KnowledgeWorks for OpenURL link resolution and into 360 Core for profiling the content to be made available in the discovery service according to the library's subscriptions. Consistent with the broad strategies of Serials Solutions, Summon relies on aggregating and managing data to drive the functionality of a service. In this case, the data component takes the form of an index created from the metadata or content contributed by publishers which facilitates the discovery of that content.

All the technology products created by Serials Solutions have all been deployed as multi-tenant software as a service rather than as software that would be installed locally in a library. These products include the entire 360 product suite, KnowledgeWorks, and the Summon discovery service. All access to the products, both for staff management tasks and services accessed by patrons is delivered through Web-based interfaces, with no software installed on local servers or

workstations. The products can be configured for each library through a Web-based customer portal for branding and cosmetic appearance, to profile content subscriptions, and to select functional options. These are not products where the company hosts individual installations for each customer site, but rather follow the multi-tenant software as a service architecture where the same instance supports all sites using the product.

Serials Solution Expands into Print Management through Intota

From its earliest days, Serials Solutions focused exclusively on products related to the management and access of electronic resources. In June 2011 at the American Library Association Annual Conference, the company announced that it intended to expand the scope of its products to also encompass a library's print materials and other resources managed within the traditional integrated library system. Serials Solutions strategy did not involve offering a traditional integrated library system, but rather to apply the techniques it employs for the management of electronic resources to the library's print inventory.

When initially announced, Serials Solutions gave the product the provisional descriptive name Web Scale Management Service. In January, 2012, the product was branded as Intota.

Serials Solutions positions Intota as designed to support the complete lifecycle of library materials, beginning with selection, procurement, description, discovery, through end-user fulfillment. In expanding the scope addressed in its management products, Serials Solutions aims to enable libraries to decommission their integrated library system, relying instead on functionality delivered through their software as a service offering.

Intota will follow the knowledge base driven approach to resource management as previously established in the 360 suite of products on electronic resources. The knowledge base will be expanded to include bibliographic records in MARC format as the basis for tasks such as acquisitions and circulation of physical materials.

Intota will be designed to make use of Summon as its patron interface. Summon was conceived to provide access to both print and electronic materials, though relying on an existing ILS. With Intota, Summon will take on all the functionality needed for patron services related to print materials.

The design of Intota, as described by Serials Solutions, will include a full set of documented APIs that will allow libraries to take advantage of all aspects of its functionality and data. Although Summon was designed to use Summon as its patron interface, libraries interested in providing an alternate discovery service would be able to do so through the APIs. Likewise, libraries can make use of the Summon APIs to allow other discovery interfaces, such as Blacklight or VuFind to tap into its index or to allow Summon to serve as the front end for other library services platforms or integrated library systems.

Development Roadmap

As of August 2012, six libraries have opted to work with Serials Solutions as development partners for Intota, including Oklahoma State University, Ball State University, Johnson County Community College in Kansas, Marist College, State University of New York in Genesco, and the University of Buffalo.

Target Library Segments

Serials Solutions from its beginning has focused primarily on providing products for academic libraries. Intota likewise has been designed for this segment of the library industry. All of the development partner sites are academic libraries, ranging large research institutions that belong to the Association of Research Libraries to smaller community college libraries. Initial adopters of

Intota will likely come from the ranks of those already using Serials Solutions products for electronic resource management or discovery. Intota will attempt to draw from the installed base of academic libraries using traditional integrated library systems, such as Voyager and Aleph from Ex Libris, Symphony and Horizon from SirsiDynix, or Millennium from Innovative Interfaces.

Serials Solutions comes into the library services arena as much as two years later than some of its direct competitors. While being first to market comes with significant sales advantages, given the long cycle of transition from integrated library systems to library services platforms there will be ample opportunities for the product once it is completed and enters its marketing and implementation phase.

Kuali OLE

Kuali OLE aims to create a new generation library management platform for all formats of materials designed for academic and research libraries managed as a community project to be made available as open source software. The Andrew W. Mellon foundation has provided significant support for Kuali OLE, funding three grant proposals, including a one-year planning process, a two-year software development project, and collaborative endeavor with JISC to develop a knowledge base for electronic resource management. Participating institutions provide matching funds and contribute in-kind resources.

Organizational Background and Strategy

The initial phase of the project was supported through a one-year planning grant awarded to Duke University to work toward an initial design of a new generation library management environment, consistent with current library needs and modern technology architectures. A grant award of $475,700 from the Mellon Foundation funded the Open Library Environment project that commenced in August 2008 and was concluded in September 2009. Led by Duke University, other institutional participants included University of Kansas, the University of Florida, Lehigh University, Columbia University, the University of Pennsylvania, Vanderbilt University, Library and Archives Canada, the National Library of Australia, the University of Maryland, and Whittier College. The work of the project included refining the general concepts surrounding a new system, gathering information on desired capabilities from libraries through a series of regional workshops, developing workflow charts for functionality through a business process modeling process.

Follow-up activities from the initial project included identifying institutions that would participate in a follow-up project to build the software and joining with the Kuali Foundation as its governance body. The Kuali Foundation oversees a variety of other projects that create enterprise software for higher educational institutions, including the Kuali Student System, Kuali Financial System, Kuali Coeus research management system, and several others. The Kuali Rice project developed the enterprise class middleware that provides support for each of the other Kuali projects. Rice provides a strong Service Oriented Architecture foundation for other enterprise applications. By relying on Rice, each Kuali project avoids the need to develop low-level support services but rather focus on higher-level functionality.

The Kuali OLE build project is a partnership among several major educational institutions, including Indiana University, the University of Pennsylvania, a consortium of members from the University of Florida system (representing: Florida State University, Florida International University, New College of Florida, University of Miami, the University of South Florida, and the Florida

Virtual Campus),, the University of Michigan, the University of Maryland, the University of Chicago, Lehigh University, Duke University, and North Carolina State University.

Support for the build phase of the project comes from $2.38 million awarded by the Mellon Foundation, with each partner institution making a significant financial investment and contributing personnel allocations. Indiana University serves as the lead institution. Brad Wheeler, the Chief Information Officer of Indiana University also serves as the board chairman of the Kuali Foundation. Much of the programming will be performed by a commercial software development firm. The Kuali OLE project engaged HTC Global Services as a strategic partner. HTC makes use of programmers in India in addition to its offices in Troy, Michigan.

An additional project was defined to focus on creating components required for electronic resource management. A collaborative project between Kuali OLE and JISC was announced in June 2012 to develop an open access repository of e-journal holdings and tools based on open source software for housing and managing the data. The Mellon Foundation awarded $499,000 to support this project, known as the Global Open KnowledgeBase, led by North Carolina State University and scheduled for completion in November 2013.

Discovery Services

The software created by Kuali OLE will focus on library management processes and will not include a patron discovery interface. One of the early decisions made in the initial planning grant was to consider discovery out of scope since there are several open source and proprietary products already available. The Mellon Foundation, for example, had previously funded the eXtensible Catalog project, which provides a variety of tools and utilities to support the creation and integration of discovery services. Other open source discovery

projects include Blacklight and VuFind that both rely on the Apache SOLR search technology. The key strategy for Kuali OLE is to create all the APIs needed to operate well with any of the discovery products.

Kuali OLE Functional Design

The Kuali OLE project embraces a vision of comprehensive resource management and will create a platform with the capability to manage all the many different types of materials that comprise library collections and their corresponding metadata. There will be a family of metadata editors that will be used as needed for MARC, Dublin Core, EAD, and other formats. Each type of metadata will be stored and edited in its native format.

The scope of Kuali OLE does not correspond directly to a traditional integrated library system. Its functionality is broader than an ILS in that it delivers support for the management of electronic materials, and accommodates multiple metadata formats other than MARC, and aims to accommodate other workflows prevalent in academic libraries. It also shifts some functions traditionally bound within the ILS to external systems to avoid redundancies with other business systems in the broader academic enterprise environment, such as a centralized authentication service. Kuali OLE is designed to be integrated with student management systems and enterprise resource planning environments.

One of the important strategies in the management of electronic resources involves the use of a knowledge base that tracks the different titles and holdings bundled in the many content products to which libraries subscribe. These knowledge bases such as KnowledgeWorks from Serials Solutions, the Global SFX Knowledge Base from Ex Libris, and the OCLC Knowledge Base play an important role in the management of electronic resources by allowing a library to track the individual titles and issues of e-journal titles available by creat-

ing a profile of the subscriptions to aggregated databases, e-journals, and other content products to which it subscribes. Kuali OLE launched the Global Open Knowledgebase project to develop this essential capability with the need to rely on proprietary knowledge bases and to provide capabilities beyond that delivered in the commercial products such as use of unique identifiers for organizations involved in the supply chain, data regarding the publication history if titles, and increased opportunities to repurpose the data.

Kuali OLE has been designed to be implemented in an enterprise environment rather than in as multi-tenant software as a service. At least initially, each of the development partner libraries will install the software locally, though in some cases the installation will serve a fairly large number of libraries. This approach differs from those such as OCLC's WorldShare Management Services or Serials Solutions Intota where a single instance of the software is shared by all the institutions subscribing to the service. Kuali OLE emphasizes the integration among systems across the campus rather than pooling resources among separate implementations.

Development and Deployment Roadmap

Kuali OLE will rely on software from other Kuali projects and other open-source components. The Kuali Rice Version 2 middleware provides the lower-level service-oriented architecture layer, including such support functions as workflow management, messaging, action triggers, and connections to identity management services. Kuali Ole incorporates the Kuali Financial System to support business transactions, such as those in collection acquisitions processes. The system will also use Apache Jackrabbit as its document store and Apache SOLR for to deliver APIs for faceted discovery. The use of these major components will allow the project's developers to focus on programming unique library-oriented functionality.

The project organized the development of the software into four incremental releases. (See http://www.kuali.org/OLE/Timeline for details).

- **November 2011:** Version 0.3. Implementation of Core Technologies
- **May 2012:** Version 0.6 Cooperative Infrastructure and Services
- **October 2012 (Planned):** Version 0.8 Describe and Deliver
- **First Quarter 2013 (Planned):** Version 1.0 Ready for Implementation

The initial release of the full Kuali OLE Version 1.0 is expected to be completed in the first quarter of 2013. This release will include data migration and implementation tools. Some of the development partner libraries are positioned as early adopters, such as Lehigh University and the University of Chicago, with implementations beginning in 2013. Others will migrate on a later cycle in 2014-2016.

It is early to anticipate how broadly Kuali OLE will be implemented beyond the initial development institutions.

Target Library Segments

The Kuali OLE project focuses directly on libraries associated with higher educational institutions. Although the planning phase included two national libraries, the current group of partner libraries consists entirely of academic libraries, with some organized in consortia.

Sierra from Innovative Interfaces, Inc.

Organizational Background and Strategy

Innovative Interfaces, Inc., based in Emeryville, CA, has been developing library automation products for libraries since its founding in 1978

by Jerry Kline and Steve Silberstein. The company's initial product allowed libraries using the Libs 100 circulation system to connect to OCLC for catalog records. The company created the INNOVAQ product to automate acquisitions in 1982, adding serials control in 1985, an online catalog in 1987, and circulation in 1989. This course of incremental development produced one of the early fully integrated library systems, named INNOPAC. Innovative launched a Web-based online catalog in 1995. INNOPAC was based on a proprietary database management system that Innovative created and it was implemented on minicomputers with text-based terminal interfaces.

In 1997, Innovative began the transition to Millennium, redeploying the functionality of INNOPAC through a client/server architecture to meet the growing expectations for graphical user interfaces and distributed computing. The Millennium clients were developed in a Java environment, allowing them to work with both personal computers and Macintosh computers. Innovative was one of the earliest adopters of Java for staff clients of an integrated library system. The transition from INNOPAC to Millennium followed an evolutionary approach, preserving the business logic that underlies the functionality of the system while morphing the product into a technology environment consistent with then-current expectations.

Innovative interfaces was owned by its two founders through 2001, when Jerry Kline acquired the interests of Steve Silberstein. The company recently went through an ownership transition when in March 2012 two private equity companies, Huntsman Gay Capital and JMI Equity made strategic investments in the company. Co-founder Jerry Kline retained partial ownership of Innovative and serves as Chairman of the newly-constituted board. In August 2012 Kim Massana was named as the company's new Chief Executive Officer, with Neil Block continuing as President.

Throughout its corporate history, Innovative has followed a technology strategy of incremental, evolutionary development and a business strategy of steady organic growth in library customers. The company has stayed mostly out of the mergers and acquisitions arena, with its 1997 acquisition of UK-based SLS as the only exception.

Discovery Services

Innovative Interfaces developed Encore as its strategic discovery product, initially released in May 2006, offering the features expected, such as relevancy-ranked results, faceted navigation, enriched display of results, including cover images, tables of contents, and a simple interface with a single search box. Innovative has developed a proprietary search technology, called Right Results, which aims to retrieve results and sort them according to library-specific criteria.

Encore Synergy, launched in April 2010, brings article-level content into the discovery process through real-time connections to remote resources using Web services. Encore does not follow the index-based search model in the same way as seen in Summon, EBSCO Discovery Service, or Primo Central. In June 2012 Innovative formed a partnership with EBSCO to develop the capability to allow libraries using Encore to incorporate results from the EBSCO Discovery Service index.

Functional Design

Millennium, through one of the integrated library systems generally regarded as having the most sophisticated functionality, especially for technical services support, also had a reputation as a relatively closed and proprietary application. Sierra, in contrast, follows a service-oriented architecture, exposing a full set of documented RESTful APIs for programmatic access to the functionality and data within the system, and a SQL-compliant database.

Sierra, though offered as proprietary licensed software, makes use of many open source components. Innovative selected PostgreSQL as the primary database technology for the transactional database for Sierra instead of its own proprietary technology or Oracle which were the options for Millennium. Libraries will be able to access data within Sierra through SQL, either through APIs or through third party reporting products such as SAP Crystal Reports. Apache Lucene supports the search and retrieval operations of Sierra needed for staff functions and for interactions with discovery services.

In contrast to Millennium, which divided functionality into separate modules for circulation, cataloging, acquisitions, and serials, Sierra offers a unified, non-modular staff client with access to all the capabilities of the system, activated selectively according to the security profile of the staff member.

One of the key design elements of Sierra is a services layer that resides above the business logic that presents all the functionality of the system through services delivered though SOAP wrappers. Higher-level applications can then be composed from these services, including the Sierra Desktop App and the Sierra Web App. Another module at this layer will organize lower-level services into bundles of RESTful Web services or APIs that can be accessed by library programmers and third-party applications.

Unlike the other competitors in the library services platform arena, Innovative has not created knowledge bases as part of its product strategies for the management of electronic resources. Ex Libris, Serials Solutions, and OCLC created knowledge bases of e-content holdings in support of their OpenURL-based link resolvers. These three organizations also leverage their knowledge bases to support their electronic resource management products and are extending them further in support of their comprehensive resource management platforms. Innovative offers the Web-bridge link resolver but does not populate it with its own knowledge base content. Rather, customers can import data from 360 Link or SFX, or can license a product called CASE (Content Access Service) from Innovative which is based on data provided through OCLC.

Sierra is also not designed for deployment through multi-tenant software as a service, such as with WorldShare Management Services and Intota where all libraries using the product share the same instance. Rather, deployment options will be similar as for Millennium where the software can be installed locally in a library or consortium or as separate instances hosted by Innovative.

Development and Deployment Roadmap

By taking carrying forward business logic and coding, Innovative was able to provide all the existing functionality in Millennium and Electronic Resource Management in the initial release of Sierra. Consistent with the company's long-standing evolutionary process, the transition from Millennium makes some wholesale changes in technology underpinnings while preserving the steady advancement of features and functionality. Innovative will also continue to enhance and support Millennium for many years, as it did for INNOPAC once the transition to Millennium began.

Innovative began its marketing efforts for Sierra in 2011. According to data provided for the annual *Library Journal* "Automation Marketplace" report, the company signed 206 contracts for Sierra, representing about 700 libraries and 1,616 individual facilities, setting an industry sales record. Almost all were to libraries already using Millennium, reflecting a very positive response from within the Innovative customer base.

Implementations of Sierra began in April 2012, with Hillsdale College as the first library to place the software into production use.

Sierra has also attracted libraries from outside Innovative's existing customer base. The PrairieCat Consortium of 155 academic, public,

and school libraries in Illinois placed Sierra into production in July 2012, migrating from Sirsi-Dynix Symphony.

Target Library Segments

Sierra targets the same types of libraries as Millennium, which includes a mix of academic, public, and special libraries. Innovative has not developed its strategic automation products for any given sector of libraries, but rather has worked to include the functionality needed by a very broad range of sizes and types. Early implementers of Sierra are accordingly diverse, ranging from law, academic, and public libraries as well as a large multi-type consortium.

EVOLUTIONARY PATH

We've described the main products that were developed anew in this new genre of library services platforms. These new products will likely gain adoption through the next phase of library automation, especially in those libraries heavily invested in electronic resources. We've talked about these new products taking a fairly dramatic departure from the course set by the incumbent generation of integrated library systems.

In parallel to the development of library services platforms, the existing integrated library systems will evolve in ways to extend their viability into the future. The traditional integrated library system will continue to flourish long into the future, especially in support of public libraries.

Not all types of libraries face the same challenges. While research and academic libraries, for example, face enormous pressures relative to management and access of their electronic and digital resources, many public libraries deal with a pattern of continued, or even increased, circulation of their physical materials, coupled with dramatic interest in e-book lending. The kind of technical infrastructure needed for these use pat-

terns differs considerably from that of academic libraries in dealing with large bodies of electronic scholarly resources.

The patterns of activity seen in public libraries have proven amenable to the evolution of existing integrated library systems. While the issue of integrating e-book management and access stands as an enormous challenge for public library automation, the responses so far have been at the level of the discovery layer rather than a more complete reinvention of the core system.

The library automation arena has generally favored the evolutionary approach over the revolutionary. Many established products have survived for multiple decades and through multiple technology cycles:

- **Innovative Interfaces:** INNOVAQ, INNO-PAC, Millennium, Sierra
- **Sirsi Corporation / SirsiDynix:** Unicorn to Symphony. Original text-based terminal clients, InfoVIEW graphical client to WorkFlows client, originally developed in C and later in Java.
- **Spydus:** Offered by Civica, represents a long line of evolution from the Urica automation system originally developed in South Africa.

In the case of Innovative, its latest generation product steps into the realm of library services platforms while the products of SirsiDynix and Civica remain more within the realm of integrated library systems. All continue to be viable products for their target library customers.

RE-CONVERGENCE OF DISCOVERY WITH MANAGEMENT SERVICES

One of the trends in place since about 2005 has been the use of discovery products in addition to, or instead of the online catalog module supplied with the integrated library system. Consistent with

the reality that library collections extend beyond what is directly managed within the integrated library systems, these discovery products not only provide a more modern interface, but also address electronic resources and digital collections. Most of these discovery services are based on indexes that incorporate a broad representation of the body of electronic resources to which libraries subscribe, which can be profiled according to a given library's specific subscriptions.

These discovery services have been designed to work with a library's existing technology infrastructure, generally supporting all of the major integrated library systems. These systems do, however, have affinities and dependencies. Discovery services make use of the knowledge bases that also support OpenURL link resolution. While it is possible to operate an OpenURL link resolver from another vendor, it may involve an additional layer of overhead in synchronizing knowledge bases. There is a general trend toward libraries coalescing toward discovery services and link resolvers from the same providers.

In the next phase, the coalescence will extend to bundle library services platforms and discovery services. While it will remain possible to use products provided by different vendors, it will require the library to implement and maintain a process of integration inherent when acquiring them together as a suite from the same provider.

LOOKING FORWARD

This survey of the offerings available within this new genre of library services platforms reveals that within this slate of new-generation library services platforms, several distinctive options are available as libraries consider their automation strategies. While these products have some commonalities, each brings its own strategic vision, technical architecture, and level of completeness and functional maturity.

The products vary in the extent to which they embrace cloud technologies. OCLC's WorldShare Management Services and Serials Solutions Intota fully embody the multi-tenant software as a service model, with all libraries using the service sharing a common infrastructure, including bibliographic and e-content databases. OCLC starts from an advantage on the traditional bibliographic database side with its massive WorldCat database; Serials Solutions comes in with deeper resources in the management of electronic resources. Ex Libris' Alma also follows the multi-tenant software as a service model, though with a hybrid option for common and locally scoped data stores. Kuali OLE and Sierra do not press as much into cloud computing, with dedicated installations for each organization deploying the software.

Three of these products have been developed specifically for academic and research libraries: Alma, Intota, and Kuali OLE. Sierra and WorldShare Management Services were designed for a wider range of library types.

We also see a range of development and deployment timelines and corresponding risk factors. OCLC's WorldShare Management Services has been out in its initial production release the longest. Sierra likewise has seen its general release and has the largest number of libraries using it in production environments. Ex Libris has completed the initial version of Alma with one library now using it in production. Kuali OLE and Serials Solutions are on a later development schedule and currently do not have libraries using them in production.

These varying implementation schedules give some of the candidate products a short term advantage in the ability to demonstrate real-world use. All the systems fall toward the beginning of their development cycles. Academic libraries that wish to wait until the products reach full maturity may incur less risk, but staying with legacy tools during those years may have strategic implications on their ability to fully manage their collections of electronic resources.

While it is not possible to project how well these products will compete among each other going forward, it does seem clear that over the next phase of library automation in academic libraries, playing out over a period of 5-7 years, we will see a near complete turnover from the current legacy of integrated library systems to the new slate of library services platforms. The need for more appropriate functionality, especially related to the management of electronic resources, and for more open technical architectures will drive a cycle of migrations. Just as the transition from mainframe computing to the client/server area brought about the demise of one set of library automation systems in favor of new ones in an earlier phase, we can expect a similar changing of the guard as cloud computing, service-oriented architectures become the mainstream technical platforms and as comprehensive resource management becomes the standard expectation in academic libraries.

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