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FROM ACTING LOCALLY TO THINKING GLOBALLY: A BRIEF HISTORY OF LIBRARY AUTOMATION

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ABSTRACT

Over a period of thirty years, goals for library automation have shifted from an emphasis on local concerns to an emphasis on global concerns. These goals evolved through three incremental stages — efficiency of internal operations, access to local resources, and access to resources outside the library — before reaching the present stage of addressing interoperability among systems and services. The challenge facing libraries today is how to act locally — implement systems that ensure internal efficiencies and high levels of service to the community — while thinking globally, assuring that local systems are able to exchange data with other systems located around the world. Each of these stages in the history of American and British library automation are discussed. Their experiences then are contrasted with recent developments in Central and Eastern Europe, raising issues of how to support expansion into regions with different traditions of library service and practices, different technical standards, different political, economic, and cultural circumstances, and a lower installed base of information technology. Technology and policy issues involved in library automation and in its role in the global information infrastructure are summarized.

Over the last thirty years, the use of information technologies in libraries has evolved from managing internal operations to providing access to information in many forms and in many locations. This new technological environment enables libraries to serve a global, as well as local, clientele. In exploring the role of libraries in the emerging Global Information Infrastructure, we need to consider how past conditions and choices influence future directions. Thus, we should pause to reflect upon the technical, political, and institutional foundation we have laid for information technology in libraries. We should consider not only whether this foundation will support the expansion of extant systems and services, but whether it is capable of incorporating institutions in countries with different traditions of library services, different professional practices, and different histories of information technology.

This article focuses on the history of automation in the United States and Britain, for they share a core set of standards and practices for library operations, particularly with regard to the cataloging data that serve as the basis for automated library systems. These two countries have similar traditions of resource sharing and are among the most advanced countries in information technology, with high penetration of telecommunications and computing technology in all social and economic sectors.

While libraries on the European continent have much in common with American and British libraries, especially since the advent of cooperative programs through the European Union, they have many differences as well. One of the most significant differences with regard to library automation is the use of different cataloging rules and bibliographic formats for data exchange. Similar parallels and contrasts can be drawn with most other regions. Rather than attempt a global history of library automation, the article focuses on the foundations laid by American and British libraries over a period of thirty years, acknowledging that many important contributions were made by other countries and by international organizations.

American and British libraries began experimenting with modern computers in the 1950s, and in the 1960s began automating internal processes in earnest (Avram, 1975; Bolt, Beranek, and Newman, 1963; Hayes & Becker, 1970, 1974; Kilgour, 1969a, 1969b; Larsen, 1992; Licklider, 1965; Salmon, 1975; Stuart-Stubbs, 1996; Tedd, 1987, 1993). Automation spread quickly to other English-speaking countries, to Western Europe, and to other countries around the world.

Several conditions in the United States and Britain were critical influences on the direction of library automation. Automation in these countries built upon long traditions of shared and distributed cataloging, resource sharing and cooperation, and ready access to a highly-developed telecommunications infrastructure. As in other sectors of their economies, efficiency and productivity were factors motivating the automation of libraries. Changes in library economics, as well as the availability of computer systems, led to a gradual shift in mission from a focus on

collections to a focus on access to information. By coupling computing and communications technology, access perspectives shifted from local collections to remote collections, removing geographic constraints on library services. The expansion and extension of the Internet and other information technologies and services to form the Global Information Infrastructure (GII) provides an opportunity for libraries to share resources and provide access to information located around the world.

But will the foundation laid by American and British libraries support global expansion? How well did that foundation serve libraries in other English-speaking countries, Western Europe, and other regions that evolved in parallel, even if starting somewhat later? Automated systems that first were designed and tested in the U.S. and Britain are now in use around the world, with interfaces translated into many other languages. What adaptations are required to suit local environments? Libraries in other countries are automating now without the same history of shared cataloging, cooperation, or access to communication networks, without making the shift from collections to access, and under different conditions for labor and economics. Can these libraries, and these countries, join the GII as equal partners with libraries in the United States, Britain, Western Europe, and elsewhere? What contributions has library automation made to the ideals of "universal bibliographic control" and "universal access to publications"? Have we collectively laid a foundation that enables libraries around the world to "act locally" in the design and implementation of automated systems and to "think globally" in terms of universal access at the same time?

These research questions arise from a multi-year study of emerging national information infrastructures in Central and Eastern Europe[1] (Borgman, 1995, 1996a, b, c, in press-a, b). While the history of this region is tightly coupled with that of Western Europe, they have a contrasting history of library automation, given the political separation and the low penetration of computing and communications technology from the late 1940s through the late 1980s. Since the political changes of 1989-91, these countries have made substantial investments in information infrastructure, including library automation. Central and Eastern European developments are discussed briefly to illustrate alternative paths for automation, and only a few events in the rich history of Western European automation are mentioned. The purpose of this article is to examine the history of library automation in America and Britain as a point of departure for considering how to integrate countries with different library traditions and circumstances into the Global Information Infrastructure.

[1] In literature and politics, the phrase "Central and Eastern Europe" sometimes includes the entire former Soviet Bloc and the former Yugoslavia and sometimes refers to a subset, distinguishing Soviet satellite states in the Western part of the Bloc from "The Former Soviet Union," the Commonwealth of Independent States, the present and former Yugoslav republics, or other subsets such as the Baltic States or the Caucasus. In this article, the phrase "Central and Eastern Europe" refers to the region of Europe that was under Soviet control until 1989, plus Yugoslavia, which was a non-aligned nation.

While newcomers have the advantage of hindsight gained from other's experiences, they also have the legacy that available systems and techniques may be predicated on traditions different from their own. Implementing these technologies in other countries and other environments requires that we identify those traditions and assumptions, so that we can adapt the technology as needed to the local environment while maintaining the commonalities necessary to share information resources on an international basis. This brief history of library automation is framed around the question of why to automate a library, exploring the transition from a focus on local concerns in the 1960s to today's focus on global concerns.

WHY AUTOMATE A LIBRARY?

What motivates a library to automate its operations, resources, and services? We often ask *how* to automate, but all too rarely ask *why*. This was a topic of hot debate in American and British libraries in the 1960s and 1970s, immortalized by Ellsworth Mason's provocative rejection of computers (Mason, 1971a) and his public debate with Robert Hayes and others (Avram, 1972; Mason, 1971a, 1971b, 1972; Hayes and Mason on Automation, 1971; More on Mason, 1971; Salton, 1971; Veaner, 1972).

Questions of "Why automate?" and "What to automate?" are difficult to separate from issues of "What is the mission of the library?" and "What is the mission of the parent organization?" Today we are concerned with the role of the library and the institution (university, government, business, etc.) in meeting the information needs of multiple communities. A public or academic library, for example, serves a local population but also may be part of a network responsible for serving the region, state, or country. Similarly, states and countries have reciprocal arrangements. Individual corporate and private libraries often need to serve a broader constituency, such as employees and customers of an international company, or need to exchange resources between libraries with similar missions (law libraries, medical libraries, etc.). Libraries' choices in balancing services to their multiple constituencies influence why and how they automate.

The automation goals of American and British libraries evolved through three stages: (1) efficiency of internal operations, (2) access to local library resources, and (3) access to resources outside the library. We are now in the fourth stage, in which the goal is to achieve the interoperability between information systems necessary to build a Global Information Infrastructure. These stages are incremental; new goals emerge, but the prior goals must be met as well. These four stages are discussed individually, considering the transition from local to global interests, then are compared to the events in Central and Eastern Europe in each of these

stages.

Stage 1: Efficiency of Internal Operations

Library automation first flourished in the 1960s, which was a time of expansion in higher education and increasing funds for library collections. As the rate of publication increased, libraries realized they could not acquire and process materials fast enough with traditional manual systems, and that automation also could help to control costs on labor-intensive operations (Hayes & Becker, 1970, 1974). Although automation can provide more services for comparable expenditures, it rarely saves much money (Hayes & Becker, 1974; Kilgour, 1969a; Matthews, 1980; Tedd, 1993). The earliest library automation projects computerized core library operations for local collections: circulation, acquisitions, serials, and cataloging. Libraries gained efficiencies through automation both by improving workflow within the library and by sharing data between libraries.

Improving Internal Workflows

Automation in the 1960s and 1970s addressed data processing problems; most systems were locally-developed custom applications with batch processing of records. Librarians and programmer-analysts applied standard systems analysis techniques to identify individual operations that could be mechanized, to determine relationships between tasks, and to isolate the points at which human judgement was required (Borgman, 1977; Hayes & Becker, 1970, 1974; Matthews, 1980; Reynolds, 1985). Automation changed work tasks, workflows, and relationships between technical processing functions; it also reduced the number of professional staff and resulted in the delegation of tasks to the least-skilled (and lowest paid) workers that could accomplish them (Buckland, 1992; Dyer, Fossey, & McKee, 1993; Gorman, 1987; Horny, 1987). These efficiencies improved services by getting materials on shelves faster and by simplifying loan procedures for library patrons.

Library automation, inventory control systems, industrial automation, and office automation had much in common in those early days. Although we have much more local computing power on desktops today, and computing philosophy is evolving from mechanization to empowerment, the requirements for efficiency of internal library processing operations remain today.

Sharing Cataloging Data

Substantial efficiencies and control of internal costs have been gained by sharing cataloging data. Cataloging is one of the most expensive operations in libraries -- each item must be described physically, so that it can be identified uniquely, and intellectually, establishing authorship and

publication and usually assigning subject terms or classification so that it can be identified by content. Shared and distributed cataloging practices rely on the fact that most library materials are published in many identical copies. If a high-quality catalog record is created for a work (e.g., a book), then other libraries should be able to use that record and not have to re-create it for each copy. Further, if all libraries use the same catalog record, then the work will be described consistently across libraries, making it easier for readers to identify and locate. The one publication/many copies rule applies to published works in all media, and cataloging rules have evolved accordingly. Unique materials such as those held in special collections, archives, and museums can be cataloged using the same rules, however.

In manual systems, libraries employed the one publication/many copies rule to obtain catalog records for their copies from a central source such as a national bibliography or cataloging distribution service. With online systems, it became possible to share records directly and immediately between many libraries, rather than the one-way flow from a central distribution point to individual libraries. Catalog data from national bibliographies and other authoritative sources form the core of online shared cataloging systems. Participating libraries search the database to determine if a catalog record exists for an item they own. If so, the record is captured for local use; if not, the library catalogs the publication and contributes the record to the database, where it is available for other participating libraries. The principle underlying shared cataloging systems is that a work should be cataloged once and only once, and all subsequent catalog records should be copies of the original. Libraries can add data to the record in their local catalog about their copy(ies), such as the physical storage location of the item, and make other amendments in the local record, such as locally-significant extra access points (names, subjects, etc.).

The first major online shared cataloging system was OCLC (then Ohio College Library Center, now the OCLC Online Computer Library Center), established in 1967. Others quickly followed, such as RLIN (Research Libraries Information Network) and WLN (Western Library Network) in the U.S., BLCMP (Birmingham Libraries Cooperative Mechanisation Project) and CURL (Consortium of University Research Libraries) in the U.K., and PICA (Project on Integrated Catalogue Automation) in the Netherlands (Tedd, 1993). In Europe, at least 30 cooperative networks exist in 14 countries, offering a variety of services; some, but not all, of these offer online shared cataloging services (Dempsey, 1990; Hein, 1991; Holley, 1993). The creation of the European Union has led to multi-national cooperation within the context of the *Plan of Action for Libraries in the European Community*, including the development of shared databases of major European collections (Dempsey, 1990; Rau, 1990).

It is doubtful that these shared cataloging utilities would have developed when they did without the establishment of standards for exchanging bibliographic data in computer-readable form in

the latter 1960s (Avram, 1975, 1976; Avram & Markuson, 1967). The Library of Congress (LC) began work toward the MARC (MAchine-Readable Cataloging) format in 1961, conducted a pilot project from 1966-1968, and began the MARC II distribution service in 1968. The British National Bibliography (BNB) and the Library of Congress began work toward a UKMARC pilot project during the initial LC MARC pilot, leading to the international exchange of records between the U.S. and the U.K. beginning in 1969 (Avram, 1975). Also in 1969, the International Federation of Library Associations (IFLA) convened an international meeting of cataloging experts that led to the establishment of the International Standard Bibliographic Description (ISBD) (Avram, 1975; Gorman, 1969). As other countries began to establish their own MARC formats, IFLA developed UNIMARC ("universal MARC") in the late 1970s to assist in international cooperation and data exchange between MARC formats (McCallum, 1989).

The shift from a one-way flow of cataloging data to direct sharing of records in computer-readable form is perhaps the most significant transition from local to global concerns in the history of library automation. With a one-way flow, libraries could adapt cataloging copy to their own local practices and no one else need ever see it, whether input to manual or automated systems. With a multi-way flow of data maintained in computer-readable form, libraries still could adapt records to local practices, but they also had to contribute records to a shared database and had to maintain those records as they added or removed copies from their collections. Contributing records is a condition of membership. At the time that membership is established, technical specifications for record transfer are established as well. This arrangement provides economic incentives to follow cooperative standards and to modify records as little as possible. The more modification, the more local costs incurred. It also provides incentives to cooperate with other libraries, for the shared database quickly becomes a union catalog of the holdings of participating libraries. The number and quality of records contributed to the database is a sign not only of the value of the local collection, but of the institution's contribution to the regional, national, or international collection.

Shared cataloging systems were accepted as a necessity for major libraries in the United States and Britain by the mid- to late-1970s, whether or not their internal library processes were automated. Libraries could obtain their records on cards while capturing catalog data in computer-readable form for future online catalogs. Some libraries had many years of automated records ready to load before beginning automation of their internal processes. Other libraries now can build their local databases relatively quickly by obtaining records from shared cataloging systems rather than keying data from their own manual records.

Bibliographic utilities now are very large operations. OCLC alone serves more than 17,000 libraries in 52 countries, and its database contains over 30 million bibliographic records in more than 370 languages (Mitchell, 1994; OCLC Annual Report, 1994; Smith, 1994). While few

comprehensive cost studies of shared cataloging exist, libraries appear to be achieving substantial efficiencies, as predicted by early proponents of shared cataloging (Cummings, 1986; Becker, Dodson, & Yoakam, 1984; Maciuszko, 1984). A recent analysis of multiple studies of American library cataloging practices indicates that they obtain the vast majority of their catalog records on domestic materials from these systems (Leazer & Rohdy, 1995). Finding suitable records from which to catalog foreign materials is a much greater problem for American libraries, according to Leazer and Rohdy's data, reinforcing the need for global cooperation in the exchange of cataloging records.

Stage 2: Access To Local Library Resources

In the first stage of library automation, the greatest improvements came in back room processing functions; computers were visible to library users only at the circulation desk. As computer hardware decreased in cost by the early 1980s, libraries were able to operate all processing functions online. Integrated systems enabled libraries to create bibliographic records at the time of ordering materials and augment them with data needed for acquisitions, accounting, and cataloging. Not only did workflow and management reporting improve, library users had direct online access to library resources for the first time. Access quickly expanded from terminals in the library buildings, to terminals on university and organizational networks, to dial-up access by modem, and now to Internet access.

This period was marked by several trends: the creation of a marketplace for automated library systems, online catalogs, and retrospective conversion of records, all of which contributed to a shift toward global concerns.

Library Automation Marketplace

The period from the late 1970s to early 1980s was marked by rapid growth in the number of libraries automating their operations. One of the most significant reasons for achieving critical mass at this point was the emerging market for automated library systems. Until that period, libraries wanting to automate had few alternatives to funding their own development costs. The textbooks of the early 1970s explained how to design and develop library systems (e.g., Hayes & Becker, 1970, 1974; Salmon, 1975), while 1980 marked the first text on how to select from the commercial systems available (Matthews, 1980). Library systems no longer were unique, user groups developed around vendor products, and librarians shared experiences for the common good. Sessions on automation at library conferences (e.g., American Library Association, American Society for Information Science, Aslib) proliferated and new conferences were founded (e.g., European Library Automation Group, Library and Information Technology Association Annual Meetings, Integrated Online Library Systems Conferences).

While the early systems relied upon proprietary hardware, software, and even proprietary operating systems, the market moved toward open systems that support library and computing standards (Hayes, 1996). This shift followed overall trends in computing from in-house development to purchasing commercial software and from closed systems based on local practice to open systems based on technical standards. In the library community, the trend toward open systems also was driven by the need to migrate to new generations of hardware and software. After painful experiences in extracting their data from proprietary systems to transfer it to newly-purchased systems, librarians pressured vendors to support open standards (Hallmark & Garcia, 1992; Hayes, 1996).

Online Catalogs

Online catalogs first came into existence for on-site use in libraries in the mid- to late-1970s, reached critical mass by the early 1980s, became available on local area networks and by dial-up modem by the mid-1980s, and accessible via the Internet starting in the late 1980s. Until hardware, software, and communications costs were low enough to maintain local catalog data online, automated records were output from shared cataloging utilities as printed catalog cards, book catalogs, or microform.

Online catalogs brought significant qualitative improvements in access to library resources. Even though the content and structure of the records was little changed from card catalogs, online catalogs provided new searching capabilities such as keyword access, Boolean logic, and limits by date and type of material (Borgman, 1986, 1996d; Lynch, 1992; Matthews, Lawrence, & Ferguson, 1983; O'Brien, 1994). By combining circulation, acquisitions, and cataloging data, integrated systems changed the nature of the catalog from a record of materials owned to a database indicating what is owned, available, and on order.

Universities and other organizations with multiple libraries could treat all their holdings as one database, searchable from any terminal. Prior to online catalogs, only the central campus (city, government, corporate, etc.) library was likely to have a union card catalog; each branch library had a card catalog of its own holdings. With online catalogs, all catalogs could be union catalogs, allowing simpler and more comprehensive access to the full array of library resources. Conversely, online union catalogs can be viewed as local catalogs by filtering only local records to the user interface of the system. Thus online catalogs marked a shift in focus from individual local collections to the convergence of multiple collections, and from access in the library building to remote access, removing geographic constraints.

Retrospective Conversion

Libraries established their online catalogs with newly-cataloged materials; however, by participating in shared cataloging systems prior to internal automation, they might begin with five to ten years of catalog records already in computer-readable form. Major research libraries are trying to convert all of their records to create comprehensive databases of their collections so they can gain the full advantages of automation, such as union catalogs and comprehensive management reporting, and avoid the duplication of effort required by maintaining older records in manual form (Bossers & Law, 1990; Bryant & Beaudiquez,1990; Gregor, 1985; Schottlaender, 1992). By the mid-1990s, many smaller university and college libraries had converted 100% of their records. The result is the first generation of comprehensive and current academic library catalogs.

Conversion of older records is a costly and labor-intensive process, because older records usually have to be improved to modern standards of cataloging and classification (Schottlaender, 1992). Data cannot be converted simply by keying or scanning manual records; rather, each record first must be segmented into the proper fields based on current cataloging rules, augmented if incomplete, and the data assigned to those fields in a structured format based on international standards for catalog data representation. Unless sufficient effort is invested in quality control and in normalizing the records to current practice, the online catalog risks being a morass of inconsistent data from decades, or even centuries, of cataloging practices.

For each library to upgrade all its own records is prohibitively expensive, particularly at Western labor costs. Capturing records cataloged to current standards from shared cataloging databases usually is much simpler and more cost-effective -- at least for American and British libraries, because they have ready access to such resources for cataloging data. Cooperative efforts are underway in both the U.S. and the European Union to complete retrospective catalog conversion of major research libraries (Gregor, 1985; Rau, 1990; Schottlaender, 1992). As shared cataloging databases grow in size they become increasingly valuable resources for other libraries to use for their own retrospective conversion projects. Decreasing library budgets have resulted in many research libraries concentrating on maintaining core collections, at the price of concentrating in specialized areas (Cummings, et al., 1992). Thus the contents of smaller libraries tend mostly to be subsets of major collections. Once the holdings of the major collections are available online, smaller libraries can capture records for the majority of their materials, creating new records only for unique items. Public and private funding agencies often are willing to fund the conversion of major collections into shared cataloging systems due to the multiplicative effect on conversion for all libraries with overlapping collections.

Despite these extensive efforts, universal bibliographic control has yet to be accomplished, even

in American and British research libraries. Shared cataloging utilities have created very large databases, but they are by no means complete, nor do all libraries participate in them. Further, shared cataloging databases do not reflect a library's entire collection until (and unless) they complete the full retrospective conversion of their holdings. However, the existence of large online bibliographic databases, data content and representation standards for record exchange, and links between these databases forms the foundation for creating universal access to records of all published materials.

Stage 3: Access to Resources Outside the Library

Once basic operations were automated, libraries began employing communication technologies to acquire access to the collections of other libraries. Economics was a motivating factor, as was the availability of the technology. After the expansion of higher education in the 1960s that fueled library budgets, funds for acquisitions began to decrease in terms of real purchasing power, while the rate of publication and production of information resources in all media continued to expand. Library purchasing ability continues to decline (Cummings, et al., 1992; Dempsey, 1990; Ford, 1984; Line, 1988, Higginbotham & Bowdoin, 1993; Horsnell, 1988). To maintain quality services, libraries must offer access to resources held elsewhere, leading to ever more complex tradeoffs between collecting and borrowing. The shift in perspective from building exhaustive local collections to providing access to information as needed is a consequence of changing economics and of higher service expectations on the part of the user community (Sewell, 1981). The shift also reflects an orientation toward a global community of information seekers, as access to information becomes less and less constrained by geographic and political boundaries (Lynch, 1993a).

Highlighted here are three developments in access to resources outside the library that are a result of library automation: (1) new means of identifying, locating, and obtaining documents, (2) direct online exchange of data, and (3) integrating local collections with other types of information resources.

Document Delivery Developments

Shared cataloging databases become union catalogs of their members' collections by indicating which member libraries have cataloged items for each record in the database. OCLC alone now carries holdings data for several hundred million items held by libraries, providing a rich base for interlibrary loan services.

The United States and Britain are the heaviest users of OCLC interlibrary loan services (Bishoff, 1994). The British National Lending Library at Boston Spa continues to be a major international document supplier, as it was prior to automation. Their services continue to expand and their

database is accessible via the Internet. Although the United States and Britain have some of the world's largest library collections, they also have a much stronger tradition of sharing resources than do most other countries (Dempsey, 1990; Ford, 1984; Line, 1988; Higginbotham & Bowdoin, 1993; Horsnell, 1988). Thus the automation of local collections has created a massive set of resources for libraries available to libraries worldwide and thus to their user communities. The heavy use of these services reflects libraries' dependence on sharing resources for economic survival.

The terms "interlibrary loan" and "interlending" are being replaced by "document delivery," a more general term that reflects the use of electronic mail, file transfer over computer networks, and telefacsimile delivery of documents, rather than simply borrowing physical materials from another library and sending them through postal mail. Under manual operations, document delivery is a process largely separate from internal processing operations. Under automated operations they can be linked, allowing people to search local and remote resources and make direct requests through the system for obtaining documents. Information-seekers can acquire documents directly by mail, fax, or online delivery through various document delivery or online retrieval systems, avoiding libraries entirely. The economics and politics of document delivery are becoming increasingly complex due to changes in copyright laws, legal interpretations of fair use, and the preference of publishers for contractual arrangements for the lease of information resources rather than direct purchase (Lynch, 1993a).

Online Data Exchange

The gradual convergence of computing and communications technologies over the last thirty years has improved access to information resources both inside and outside of libraries. In the early days, data exchange between systems was limited to batch tape-loading and custom programming. Loading records from shared cataloging systems into the early automated library systems was difficult due to proprietary formats and inconsistent application of standards. Even with standards in place, differences in interpretation and application of rules, and differences in system implementation, made the exchange and merging of records a non-trivial task (Baker & Lysiak, 1985; Borgman & Siegfried, 1992; Coyle, 1984; Dolby, Forsyth, & Resnikoff, 1969; Horsnell, 1988; Leazer, 1994; Lynch, 1993a, b; Sloan, 1991).

One of the first breakthroughs in automated bibliographic data exchange was the Linked Systems Project, begun in the mid-1970s by the Library of Congress and the major American bibliographic utilities. The project's purpose was to facilitate the online exchange of bibliographic authority records and cataloging records. After about ten years of development, the protocols enabled library consortia to establish their own exchange programs on a local or statewide level and ultimately enabled libraries to establish direct online connections between

their internal integrated library systems and their bibliographic utilities (Sloan, 1991). Now all the major automated library systems sold in the United States support the direct transfer of bibliographic records between the bibliographic utilities and local integrated systems (Barry, Griffiths, & Lundeen, 1995; Griffiths & Kertis, 1994).

Integrating Online Resources

Automated library systems now connect directly with other systems and with computing networks. Online catalogs were among the first information resources of any kind to appear on the Internet, beginning in the mid-1980s (Lynch, 1992). By the late 1980s, American libraries began to mount databases in addition to online catalogs, which became known as "online public access systems" (Bailey, 1989; Crawford, 1987; Fayen, 1989; Lynch, 1992). Some were published sources, others locally-created sources. The British took a different approach to providing commercially-produced information resources, contracting with publishers for rights to mount databases on the national computing network, rather than mounting individual databases at individual universities or libraries (Dempsey, 1990). Resources now available through online public access systems of major research libraries in America and Britain also include organizational resources such as telephone directories, bookstore holdings, course schedules, and activity calendars. Some databases are bibliographic, but increasingly they contain full text, numerics, graphics, and images as well.

By the mid-1990s, many of these public access systems became the hub of organizational information systems, supporting not only locally-developed databases but functioning as the core of gopher, WAIS (Wide Area Information Servers), World Wide Web (WWW), and other information services.

Online catalogs, databases on public access systems, and many other online resources to which libraries provide access can be viewed as "digital libraries." Although the term "digital library" dates back only to the late 1980s, already it is losing value as a distinct idea by being used to describe a variety of entities and concepts; definitions abound (Bishop & Star, 1996; Fox, 1993; Fox, Akscyn, Furuta, & Leggett, 1995; Levy & Marshall, 1995; Lucier, 1995; Lynch, 1993a; Lynch & Garcia-Molina, 1995; Zhao & Ramsden, 1995). The term is especially problematic because it obscures the complex relationship between collections of electronic information and libraries as institutions (Lynch, 1993a). Digital libraries are defined as sets of resources and associated technical capabilities for creating, searching, and using information. Digital libraries contain information collected and organized on behalf of a community of users and include functional capabilities to support the information needs and uses of that community (Borgman, in press-a).

Digital libraries may consist of bibliographic data alone or in combination with the full content of the information resources they describe, or other forms of digital or digitized information, provided the resources are collected and organized on behalf of a user community. As the variety of information resources to which libraries provide access in computer-readable form increases, we begin to view online catalogs, online public access systems, CD-ROM databases, and other databases as digital libraries.

Stage 4: Interoperability of Information Systems

Now that American and British libraries have efficient local systems, access to their local resources, and access to external resources, we face the technical and policy challenges of achieving online, real-time interaction between computers distributed over international telecommunications networks. Interoperability between computer systems and services is an essential element of the Global Information Infrastructure (Branscomb & Kahin, 1995; Brown, Irving, Prabhakar, & Katzen, 1995; G-7 Ministerial Conference on the Information Society, 1995a, b; Kahin, 1995; National Research Council, 1994).

In the next section, the progression from bibliographic data exchange to interoperability is discussed, followed by a section addressing what interoperability means for libraries in the transition from local to global concerns for access to information.

From Bibliographic Data Exchange to Interoperability

Although we now can exchange bibliographic data between computer systems, each exchange agreement is planned carefully. While the MARC formats determine the mapping between fields for data exchange, and the MARC formats are recognized technical standards, the content of those fields are determined by cataloging rules. Cataloging rules are guidelines, rather than technical standards (Crawford, 1991; Lynch, 1993b; Tomer, 1992).

No matter how carefully and consistently libraries interpret cataloging rules, and how little they modify records from shared cataloging utilities, minor variations occur. Because of these variations, participating organizations usually perform some amount of custom programming to enable bibliographic data to be interpreted correctly by the receiving system (Lynch, 1993b). Processes of loading records into shared cataloging utilities and into local online catalogs, and of merging records from multiple sources into a common database typically are done on a batch basis because it is easier to reconcile variations this way. Often records must be compared on many different fields to determine if they represent the same work and should be merged or if they represent similar or related works and should be maintained separately. In some cases, candidate matches that cannot be reconciled automatically are diverted to human experts for a

final judgement (Borgman & Siegfried, 1992; Coyle, 1984; Hickey, 1981; Lazinger, 1994; O'Neill & Vizine-Goetz, 1988).

When partner organizations exchange records on a regular basis, such as the transfer between shared cataloging services and local systems, these arrangements are manageable. Similarly, when libraries migrate their data to a new generation of automated system, they can plan and implement a one-time data transfer (Hallmark & Garcia, 1992). Today's requirements are much more complex, however. Ideally, libraries would like to treat multiple bibliographic databases as comprising an online, real-time, virtual digital library. Such a structure would enable libraries to exchange records on a casual, ad hoc basis and would enable information seekers to search one or more external digital libraries as though all were one resource.

As an interim step, we can build upon the mechanisms established for online searching of remote systems. Early information retrieval systems avoided the data exchange problem by maintaining all the computing resources on the host system, treating the searcher's machine as a "dumb terminal" (Borgman, Moghdam, & Corbett, 1984). Search output was captured by the host system and printouts mailed to the searcher; the only local record of the search was the log sheet from printing terminals, and later, screen captures from video display terminals (VDT). When personal computers began to replace printing terminals and VDTs as local workstations, system vendors offered custom-designed "client" interfaces that supported offline search query formulation and captured results in computer-readable form from their systems (the "servers") (Sullivan, Borgman, & Wippern, 1990). In the same manner as with bibliographic data exchange between integrated library systems, advance arrangements between the parties were necessary to achieve direct data exchange.

Only recently has it become possible to support generic client-server relationships between information systems. The most advanced is the Z39.50 standard that is being implemented for online catalogs and other bibliographic retrieval systems (Tomer, 1992). This standard enables a local system to act as a client to another system, such that the local user can search the remote system through the local interface. In the present implementations, Z39.50 supports searching of one remote system at a time, passing the results back in a form that can be displayed on the local system. These standards do not yet enable people to search multiple systems concurrently and merge the results into a common data stream. Merging results from multiple systems is a more complex computational problem than one-to-one interactions, and entails all the problems in reconciling variant data forms involved in other data exchange agreements. Merging results in real time while a searcher is waiting to see them is even more difficult than merging them offline in batch mode.

We are seeing progress in searching and data exchange and in other applications, albeit with less

complex record structures and content than entailed in bibliographic data exchange. The most successful example is the World Wide Web (WWW), with multiple generic clients (e.g., Netscape, Mosaic, Explorer) that can search any WWW server whose data is structured in current HTML (Hyper-Text Markup Language) standards. These search engines simply list results from multiple sources and make no attempt to merge them, however. The situation is changing with new competition in the marketplace between client software packages, leading to a divergence in standards, with each offering customized features (Berghel, 1995, 1996a, b). Servers optimized for any one client may not work well when accessed by a different client. Libraries employ WWW technology for external access to their systems via the Internet and for internal access within their institutions via intranets, and thus are involved in data exchange efforts on multiple fronts.

Interoperability between Digital Libraries

As we enter the age of ubiquitous computer networking, the necessary connections between computing and communications are becoming far more complex. Computers need to exchange information on a casual, ad hoc basis, interacting usefully with each other (Kahin & Abbate, 1995; Lynch, 1993b). It is not possible to establish advance agreements with each of the millions of computers already on the Internet, nor is it possible to mount local custom software for more than a few remote systems that might be accessed regularly.

The amount and type of information being exchanged also is much more complex. Rather than exchanging highly-structured catalog records or bibliographic records containing indexing and abstracting data, now we are exchanging records containing the full content of information resources, associated metadata, and transaction data such as technical characteristics of the computers involved in the exchange, search, display, and user authorization parameters. Our concerns are shifting from bibliographic data exchange between local integrated systems and between local systems and shared cataloging utilities to interoperability between digital libraries.

The definition of "interoperability" of networked computer systems is itself an open question. At one extreme, it means superficial uniformity achieved by common tools and interfaces, relying on human intelligence to achieve coherence of content. At the other extreme, it means deep semantic relationships between "digital objects" (individual information resources containing text, video, audio, or other medium or a combination of media) with mediating software that compensates for variations between heterogeneous systems (Lynch & Garcia-Molina, 1995). Others distinguish between interoperability, as getting systems to work together in real time; portability, which permits software such as computer languages to work with heterogenous systems; and data exchange (Libicki, 1995). Interoperability, portability, and data exchange vary by the degree of interaction required and the amount of program code usually required to

maintain the interaction and prevent communication failure.

For the purposes of this article, interoperability means the ability of information systems to interact in a useful way on a real-time basis over communications networks. The meaning of "useful" will vary widely by context. Achieving efficient and effective batch exchange of catalog records is a sufficient interoperability goal for some institutions. For others, the ability to search the catalogs of all major libraries in a country as though they were one virtual library is an interoperability goal. For others, it may be the ability to search all the information resources in one language, regardless of form, location, ownership, content, or purpose — library holdings, museum holdings, publicly-available personal databases, commercial databases of news and entertainment, etc. For those seeking information, the interoperability goal may be the ability to search the world's information resources — in all media, in all languages, at all locations — in one easily-formulated request, and receive a coherent, organized, and synthesized result. We are far from achieving this goal, given the limitations of information retrieval systems and the inconsistencies within and between collections.

Although libraries are leaders in addressing interoperability, having established standards in the late 1960s to exchange catalog and other bibliographic records in computer-readable form, we are only beginning to understand the scope of the real-time global interoperability problem, must less to solve it. The international library community has been relatively successful in establishing, maintaining, and implementing standards and exchange agreements for bibliographic data — the metadata *about* information resources. However, as we move from online catalogs to online public access systems to digital libraries, we also are moving from the management of bibliographic data to the management of the *content* of information resources in digital form.

Thus the interoperability challenge reflects the need for libraries to think globally. Libraries must exchange data with other institutions — libraries, bibliographic utilities, system vendors, publishers, governments, other information providers, and individual searchers — which requires systems that meet international standards and that are based on cooperation, exchange, and resource sharing agreements. At the same time, they need to design systems that support the information needs of their local communities and do so efficiently.

WHY AUTOMATE A LIBRARY IN CENTRAL AND EASTERN EUROPE?

While the above discussion of four stages of automation goals in American and British libraries may seem like an obvious sequence of events to a librarian in either of these countries, it is not an obvious sequence to librarians in parts of the world with different library traditions, economic conditions, and information infrastructures. The more we understand about the different

circumstances and assumptions in other countries, the more likely we will be to achieve global interoperability and global exchange agreements, and to balance those requirements with the need for local efficiencies and access to local resources.

Central and Eastern Europe provides a unique opportunity to assess the influence of library traditions on global automation goals. After forty years of relative isolation and minimal access to information technology, this region is investing heavily in its information infrastructure as part of the transition to a market economy and democratic political system. They are adopting information technologies developed and tested in the United States, Britain, Western Europe and elsewhere, and wish to participate in the global economy and global society. The pace of developments and the parallels to American and British experience enable us to identify some of the effects of their different traditions on automation goals and to observe the creation of new information infrastructures.

In the next section, the experiences Central and Eastern European libraries through the four stages discussed above are briefly contrasted with those of American and British libraries. The comparison is based on a survey of library automation and network development in six countries (Croatia, Czech Republic, Hungary, Poland, Slovakia, Slovenia) (Borgman, 1996b, in press-b), an analysis of library roles in the Global Information Infrastructure (Borgman, 1996a), an evaluation of library automation and network development in Hungary (Borgman, 1996c), site visits to other countries in the region (Lithuania, Russia, Ukraine), and interview data that are not yet published. Only a few highlights of this extensive research are mentioned; the reader is referred to the other published research reports for further background and for a description of the differences between these countries.

Background Conditions

During forty years of Soviet influence, most information technology was unavailable, unaffordable, or discouraged throughout Central and Eastern Europe (CEE). Until 1990, few libraries had access to computers, and most of these were personal computers. Other communication technologies such as telefacsimile machines, photocopiers, and typewriters were registered and controlled to varying degrees. Although the Internet is expanding rapidly in the region, network development is constrained by the low telecommunications penetration in these countries — about fifteen telephones per hundred persons in the region overall — and the weak technical infrastructure based on pre-Cold War mechanical switching technology, lacking digital transmission systems, fiber-optics, microwave, and automated systems control and maintenance (Zonis & Semler, 1992).

Library services in CEE are characterized by a few large collections and hundreds or even

thousands of small collections within each country, managed under a complex mix of centralized and decentralized control[2]. Although national library laws under the previous system created national networks and specified some cooperative activities, they also created structural barriers to cooperation such as organizing sub-communities of libraries reporting to different government ministries, divided both by type of library and by subject area of the library's collections (Davies, 1992; Rozsa, 1992; Segbert, 1996). Within universities, from dozens to over 100 individual libraries report to the heads of departments and faculties; some universities have no central library to coordinate services. These conditions reflect the combined influence of European library traditions and socialist philosophy.

Libraries in CEE entered the 1990s with minimal automation — mostly bibliographic databases on personal computer applications software, with a few notable exceptions. Integrated systems were very rare. They have made rapid strides in a few short years, but are facing all at once the challenges addressed by American and British libraries over the last thirty years.

Stage 1: Efficiency of Internal Operations

Efficiency appears to be much less a concern in this region than in the United States and Britain, due to a complex mix of political, social, and economic factors.

Improving Internal Workflows

These countries operated under a "full-employment" model, in which a certain number of workers were assigned to an organization and job roles were less differentiated than in the U.S. and Britain. Organizations had few, if any, incentives to reduce their labor force, although they could improve productivity through training and reorganizing staff. Even today, reducing staff is the lowest priority as a reason to automate (Borgman, 1996b). Systems-analytic methods were not considered "politically correct" under socialist theories, according to a number of respondents, and thus few libraries or other organizations have experience with such formal analyses of work flows.

Sharing Cataloging Data

Although the national libraries distribute cataloging records in all the countries studied, very little copy cataloging is performed. The data show that on average, excluding national libraries, 83% of records are cataloged originally (i.e., 17% copy cataloging from various sources) in

[2] A number of interviewees mentioned that the Soviet formula for public libraries was one library per 1,000 population, thus providing at least a small reading collection for each community. The Ukraine, for example, with about 52 million population, has more than 50,000 public libraries.

research libraries (Borgman, 1996b). These libraries do not have the tradition of sharing cataloging data that exists in the United States and Britain. Individual libraries are more autonomous in many respects, each tailoring its collections and services to a local clientele. As a result, CEE libraries are oriented more toward collections than access. Slovenia is the only country of those studied to develop an online shared cataloging system; that system, COBISS, served most of the former Yugoslavia and now serves Slovenia almost exclusively. Until recently, the telecommunications infrastructure in these countries was inadequate to support an online service. Although a few national and major research libraries are beginning to use OCLC, the costs are prohibitive for most libraries in the region.

Only now, with the rapid introduction of automated systems and services, are standards and data exchange becoming a major priority. Each of these countries employs a different set of cataloging rules, however, and a variety of formats for machine-readable data are in use.

Stage 2: Access To Local Library Resources

Libraries in CEE have quite different experiences from American and British libraries in acquiring systems, constructing online catalogs, and accomplishing retrospective conversion, all of which they are facing at once.

Library Automation Marketplace

Establishing a market for any kind of information technology is difficult in countries that represent unique language groups and whose population may not achieve critical mass for a given technology[3]. Local cataloging rules and data formats must be supported, often requiring custom programming. User interfaces, documentation, training materials, and sometimes even program code must be translated. Most problematic of all in many cases is supporting the character sets for local languages. Each of these countries has a slightly different character set and multiple standards exist for representing each of them (Agenbroad, 1992; ALA character set, 1989; Lazinger & Levi, 1996). Unicode, the only viable multi-lingual standard (Brickell, 1996; Peruginelli, Bergamin, & Ammendola, 1992), is not yet supported by the major library automation vendors nor the bibliographic utilities.

Some domestic systems are marketed in the region, and versions of ISIS, the database program distributed by UNESCO, are popular. Vendors from the United States, Britain, Israel[4], and

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[3] Poland is among the larger countries in the region, with about forty million people; Hungary, Czech Republic, and Slovakia each have ten million or fewer; Croatia about four-and-a-half million; and Slovenia about two million.

[4] Aleph, an integrated system marketed by Ex Libris of Israel, is among the most popular systems in CEE, although it had no installed base in the U.S. as of a recent survey (Barry, Griffiths, & Lundeen, 1995). Aleph has

Western Europe did not enter the CEE market actively until the 1990s, after the technology embargoes were lifted. Most new automation of research libraries is based on integrated systems purchased from foreign vendors, although some libraries are developing their own systems (Borgman, 1996b).

Online Catalogs

Cataloging processes and online catalogs are these libraries' top priorities for automated functions, and improving access to local resources is their top reason to automate. Often they mount their online catalogs on the Internet as a first step in implementing automated systems. Most are searchable via user interfaces in the domestic language and English and often in German, Italian, or French as well.

The decision on which cataloging rules and associated MARC formats to employ in new online catalogs is forcing libraries to make explicit choices between acting locally and thinking globally. Some choose to tailor the systems to established local cataloging rules and data formats, following earlier practices and easing data exchange with domestic partners. Others choose to adopt and translate the Anglo-American Cataloging Rules on which most of the foreign commercial systems are based, easing data exchange with foreign partners at the risk of domestic conflict. Intense discussions are under way within and between these countries as to which bibliographic standards and cataloging rules will support their goals for building national information infrastructures and their goals for participating in the Global Information Infrastructure (Segbert & Burnett, in press).

Retrospective Conversion

Retrospective conversion is a major problem for these libraries. In addition to the unsettled debates over cataloging rules and data formats, they have legacy data in a variety of data formats, with character sets in multiple representations. No large resource of domestic cataloging data in computer-readable form yet exists in any of the countries studied except Slovenia. As the national libraries automate, they will become primary resources for data on domestic materials, but these libraries need records on foreign materials as well. Most of these libraries consider the cost of matching records against OCLC, for example, to be prohibitive; at current labor costs, it is far cheaper to scan or key data from local records and upgrade the records manually. Even if they can afford foreign records of their own or foreign materials, many question whether those records are authoritative in terms of complete character set representations and recognition of local cataloging rules. Records acquired from foreign sources are more useful if they can

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similar features to integrated systems marketed by U.S. and British companies and supports multi-library cooperative networks (Lazinger, 1991).

exchange them with other libraries in their own countries.

Stage 3: Access to Resources Outside the Library

CEE libraries are implementing modern integrated library systems in an environment with different traditions and computing and communications infrastructures from those of the United States and Britain. Not surprisingly, they are following different models for document delivery, data exchange, and integration of local information resources.

Document Delivery Developments

Slovenia, the only country studied with a large shared database of domestic holdings, supports resource sharing and document delivery through its network. Document delivery otherwise tends to be centralized through national libraries, given the cumbersome process of managing decentralized resource identification without online union catalogs such as OCLC and a minimal domestic telecommunications infrastructure. Research libraries in CEE rely heavily on the British Library, OCLC, and commercial services for acquiring foreign materials.

Online Data Exchange

As they begin to automate, CEE libraries are realizing that online data exchange is both their greatest need and greatest challenge. Most research libraries are building online catalogs by entering current catalog data — mostly original cataloging — and by converting older card and book catalog records manually or through computer-assisted scanning methods. This is a very slow process with considerable duplication of effort among libraries.

Bibliographic data exchange is difficult when all parties are using the same cataloging rules (AACR2) and similar MARC formats (USMARC and UKMARC), as American and British libraries learned. It is far more difficult when multiple rules and formats are in place. While each of these countries has its own national cataloging rules, implementation is subject to more variation in local practice than in the U.S. or Britain, given the minimal amount of copy cataloging performed. Some national libraries are translating AACR2 for domestic use, adding more variations to the mix. Newer bibliographic data are stored not only as USMARC, UKMARC, and UNIMARC, but in country-specific MARC formats tailored to local cataloging rules. Catalog data in older systems, particularly those based on earlier versions of ISIS, consist of minimal records that do not conform to MARC formats (at best, they might conform to ISO 2709 or ISBD). To complicate matters further, CEE bibliographic data are represented by a variety of domestic and international character sets. In sum, legacy data exist in a wide variety of formats that must be mapped to some agreed-upon common format before data exchange will

be feasible.

Integrating Online Resources

Libraries are among the first non-industrial institutions in CEE to adopt automation on a large scale, and thus have few other institutional information resources available to mount on their systems. CEE libraries tend to build their own databases of local materials such as journal articles, theses, special collections, and government documents rather than purchase indexing and abstracting services, most of which are prohibitively expensive. They are making these resources available on local networks and providing Internet access to them. Many are acquiring CD-ROM databases, whether as standalone systems or on local area networks.

Stage 4: Interoperability of Information Systems

The libraries of Central and Eastern Europe provide an important test case for global interoperability of library systems and services. By implementing commercial systems that were designed and tested in different parts of the world, they can adapt their practices to these systems, taking advantage of lessons learned elsewhere, or they can adapt the systems to their local circumstances, taking advantage of the technology to meet their own requirements. Both kinds of adaptation are taking place.

From Bibliographic Data Exchange to Interoperability

The need for bibliographic data to achieve critical mass in local online catalogs is one of the important motivations for interoperability. If each library works independently, manually converting its collections, the process will take decades and entail substantial duplication of effort among libraries. If libraries work cooperatively and share records as they create them, collectively they can move much faster.

If sharing records were merely a technical problem, all the libraries in the region could simply adopt American and British standards, systems, and practices, and exchange records with each other, with international shared cataloging utilities such as OCLC, CURL, and BLCMP, and with libraries elsewhere who conform to these technical standards and practices. These are not merely technical issues, of course; rather, they cut deeply into politics, economics, and culture. The real issues are policy choices: which standards, which systems, which practices, with whom do we exchange, and who decides?

Libraries in CEE, and the agencies that fund them, are confronting the local vs. global tradeoffs directly in the arena of bibliographic data exchange. The choice of standards varies depending

on whether "local" means this library, this university, libraries within the jurisdiction of this ministry (e.g., medical, technical, education, public), this city (e.g., a consortium), this country, this group of countries in economic partnership (e.g., alliance of the Visegrad countries, alliances with the European Union), or some other scope. Similarly, "global" may imply the need to exchange with all other libraries and prospective partners (e.g., publishers, suppliers) and users, or may imply some subset, such as the country, the CEE region, the European Union, or the set of all partners represented by the major shared cataloging utilities.

At present, no single set of cataloging rules, MARC formats, or character sets provides universal exchange, so choices must be made. The Anglo-American Cataloging Rules appear to be the only serious competition to the national cataloging rules in CEE. Although AACR2 normally is implemented with USMARC, UKMARC, or the Canadian or Australian MARC formats[5], some libraries in CEE are implementing AACR2 with UNIMARC. Other libraries are implementing national cataloging rules in USMARC. Others are implementing national cataloging rules with national MARC formats; HUMARC (Hungary) is a variant of USMARC, while COMARC (Slovenia) is a variant of UNIMARC. Global data exchange will require, at minimum, batch translations between these and the other formats in use in Europe and North America. UNIMARC was intended to be a universal format, but translation from UNIMARC to other MARC formats is proving to be more difficult to accomplish than was anticipated, despite the best efforts of IFLA and the European Union (McKercher & Chang, 1995; Wehner, 1995; Segbert & Burnett, in press). Data exchange is not merely a technical problem. Cataloging rules and data formats are coupled, and thus mapping formats involves interpretation of cataloging rules. Rules embody theories of knowledge representation, therefore reconciling rules can be a difficult theoretical and computational problem itself.

Even if mappings can be found between the cataloging rules and associated data formats, character set representations must be mapped as well. Although a wide range of character set representation standards are in use by CEE libraries, the American Library Association (ALA) character set is not among them, despite the fact that this is the standard employed almost exclusively in American and British systems. Librarians, system vendors, and network administrators generally agree that Unicode is the best common solution for multi-lingual databases, but it is not yet widely implemented in any part of the world. The simplest solution may be to map most present standards to Unicode and then use Unicode to transfer data between systems.

Although libraries need common standards for all materials, the issues are somewhat different

[5] USMARC, UKMARC, and CANMARC are expected to merge into a common format under the next revision of the Anglo American Cataloging Rules, however.

for domestic and foreign materials. Each country preserves its own cultural heritage by maintaining a national bibliography of domestic materials[6]. The national bibliography is the authoritative source and thus cataloging must be to the highest standards and must preserve the linguistic characteristics of the material. These are the materials of most interest to libraries elsewhere — if the authoritative record from the national bibliography could be contributed to shared utilities, it could serve as the international authoritative record — yet are the least likely to meet international standards because of the need to respect local practices. Keepers of the national bibliography, usually the national library, in consultation with the many other agencies who need those data, must decide whether to convert to the standards and practices of international shared systems, construct mapping programs (if feasible), produce duplicate cataloging records in national and international formats, or find other solutions.

CEE libraries also require records on foreign materials held within their countries. Although these libraries have a tradition of cataloging foreign materials by local rules, the need for efficiency and data exchange argues for accepting foreign records on these materials, provided their local systems can support them. Respondents generally were more concerned about access to materials held in the European Union and North America than to materials held elsewhere in Central and Eastern Europe, which also argues for accepting records in foreign formats.

Interoperability between Digital Libraries

If a simple solution existed for interoperability between Central and Eastern European libraries and between CEE and other regions, they probably would have found it by now. The path ahead for these countries is not yet clear; at this writing they are engaged in active discussions within and between countries. Even talking to each other is a giant step forward, after decades of operating independently within their countries and separate from other countries and other regions of the world. Many scenarios are possible at this point. They may construct domestic shared cataloging systems and networks of interoperable local systems within each country. They may implement competing shared databases systems and incompatible local systems. They may join OCLC or other international bibliographic utilities instead of building domestic mechanisms for resource sharing. Most important of all, they are working to understand the issues, learn from the experiences of others, and find solutions that work for them on a local and global basis.

SUMMARY AND CONCLUSIONS

[6] The term “domestic materials” is employed loosely, as the scope of national bibliographies varies widely. They usually include everything published within the country regardless of language, as well as materials published elsewhere about the country, materials published elsewhere in the national language regardless of topic, and foreign language translations of domestic publications.

Over a period of thirty years, goals for library automation have shifted from an emphasis on local concerns to an emphasis on global concerns. These goals are complementary, although they can conflict at some decision points. Objectives evolved through three incremental stages — efficiency of internal operations, access to local resources, and access to resources outside the library — before reaching the present stage of addressing interoperability between systems and services. The challenge facing libraries today is how to act locally — implement systems that ensure internal efficiencies and high levels of service to the community — while thinking globally, assuring that local systems are able to exchange data with other systems located around the world and ultimately to function as a part of a "virtual digital library."

American and British libraries laid the foundation for global models as the first to automate and the first to establish a market for automated library systems, many of which are now sold around the world. Automation in these countries built upon long traditions of shared and distributed cataloging, resource sharing and cooperation, and ready access to a highly-developed telecommunications infrastructure. These conditions are by no means universal. Although many other countries have automated their libraries and expanded their information infrastructures in this period of time, a new generation of libraries is automating based on different traditions, different economic and political environments, and a lower installed base of information technologies. Libraries around the world have a vested interest in joining the global information infrastructure, but each institution wishes to do so on their own terms, participating as equal partners while respecting local traditions. How well will the foundation laid by American and British libraries and many other players — such as library associations, bibliographic utilities, automation vendors, and automation researchers and developers — support an expansion into new regions and new environments?

Central and Eastern Europe (CEE) offers a unique environment in which to ask these questions. They are automating so quickly, and on such a low installed base of technology compared to the United States, Britain, and many other countries, that we can observe their progress. Many of the automated systems being implemented were developed in the U.S. and Britain, providing a direct contrast in the implementation process. Because CEE libraries wish to exchange data with libraries in the European Union and North America, they are encountering global interoperability issues much earlier in their automation process than did previous generations.

By viewing the world of library automation through the eyes of our Central and Eastern European colleagues, we can see the developments in the United States and Britain in sharper relief. In the first stage of library automation, we achieved internal efficiencies by developing custom systems tailored to local circumstances. Now we achieve internal efficiencies by acquiring as much data as possible from external sources, minimizing local record creation. To do so, American and British libraries optimize their systems to meet international standards

rather than to optimize on unique local practices. According to recent research (Leazer & Rohdy, 1995), American libraries are successful in acquiring most of their records on domestic materials from external sources, but much less successful in acquiring cataloging data on foreign materials. This finding argues for yet more global interoperability and data exchange.

In contrast, CEE libraries are undertaking automation without a history of data exchange. Instead, they create almost all their own records locally. While they have agreed-upon national cataloging rules, these rules often must be modified to be effective in automated systems and in some cases are being abandoned in favor of translating AACR2. Although domestic cataloging data exists in the form of a national bibliography, little of it is available in machine-readable form, and thus they have no shared cataloging utilities or comparable data sources from which to build local catalogs. They stand at a crossroads for data exchange, having to choose among cataloging rules and data formats. Their decisions are influenced by their choices of resource sharing partners and by the library governance structures in their countries.

CEE libraries also are at a crossroads for deciding how to achieve internal efficiencies. While the survey data indicate that CEE libraries do not view efficiency or staff reductions as a reason to automate, they are experiencing severe budget cuts (along with other public institutions in the region) and will be under continuing pressure for productivity improvements as their countries continue the difficult transition from command to demand economies. While labor remains inexpensive compared to capital, many libraries are investing that "excess" labor in data conversion.

Many American and British libraries now have records online for all of their cataloged materials and are adding a variety of other digital libraries to their public offerings. By converting the majority of their records to computer-readable form and contributing them to shared utilities, American and British libraries have facilitated access to resources outside the library, supporting new forms of document delivery, online data exchange, and integration of local resources. They have achieved access to local resources, begun in the second stage of automation, and access to external resources, begun in the third stage. CEE libraries are in the early stages of achieving critical mass in online catalogs.

All automated libraries face the challenge of global interoperability. American and British libraries have not yet solved the problem of online, real-time, data exchange between multiple systems, even using common cataloging rules, data formats, and communication standards. Decisions made now about revisions of cataloging rules, data formats, and technical standards, as well as decisions about local policies and practices, will have far-reaching and long-term effects. We need to make these decisions in consultation with representatives of the many countries affected, whose data also are part of the "global virtual library."

Central and Eastern European libraries may have a rare opportunity to "leapfrog" over several generations of technology, jumping from manual systems or minimal automated systems to the most modern integrated systems. They can learn lessons from the experiences of others, avoiding our errors, and perhaps build the first interoperable systems, setting the mark for the rest of us. However, we need to be cautious in applying the lessons of American and British libraries to Central and Eastern Europe or to any other part of the world. Their circumstances are different in terms of installed base of computing and telecommunications, history of resource sharing, and traditions of education, politics, economics, and culture. By studying their circumstances, we can understand our own environment better. Most important of all, as Central and Eastern European librarians build upon the experiences of others, they may have lessons to teach librarians in North America, the European Union, and the rest of the world as well.

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