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Union Catalogs in a Changing Library World: An Introduction

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Union Catalogs in a Changing Library World: An Introduction

Andrew Lass and Richard E. Quandt

1 The Background

The papers in this volume were presented at a conference sponsored by The Andrew W. Mellon Foundation in Tallinn, October 17-19, 2002. The date of this conference was almost exactly on the fifth anniversary of another Mellon conference that took place in Warsaw and was devoted to library automation.

In 1989 and 1990, Hungary, Czechoslovakia and Poland abandoned their long-term obeisance to the Soviet system and began to chart a new course that would embrace democracy and market economies. It was quickly recognized in the West that the intellectual and financial restrictions under which these countries had operated would make the transition to a new political and economic system long and arduous, and western donors descended on these countries in droves to provide financial and technical assistance in democracy building, western style economics and modern management techniques. Notable government agencies in these efforts included USAID and USIA in the United States, and the European Bank for Reconstruction and Development, the PHARE program and the Tempus program in Europe; prominent among foundations were the Ford Foundation, the Pew Charitable Trusts, The Andrew W. Mellon Foundation, the Soros Foundation(s), the German Marshall Fund of the United States, and

numerous others.[1] In 1991, the Baltic countries achieved independence from the Soviet Union and became additional targets for western generosity.[2]

While numerous donors supported the development and modernization of the higher educational sector in these countries (and PHARE and Tempus were particularly noteworthy in this respect), relatively few donors realized either the crucial importance of research libraries to education and research or the extent to which ideology and financial stringency in the pre-1990 period had contributed to their inability to develop their collections and to keep up with modern western advances in library technology and user friendliness. The Mellon Foundation had accordingly decided to devote substantial resources to introducing modern western library automation technologies in the research libraries of the region.

The 1980s were not kind to authoritarian regimes. While the Communist system was experiencing strains as a result of Solidarity in Poland, the Civic Forum in Czechoslovakia and the increasing demands for independence in the Baltic countries, the system of apartheid in South Africa came under growing pressure from demonstrations, strikes and courageous academic leaders such as Stuart Saunders, the Vice Chancellor of the University of Cape Town (UCT). By February 1990, the Prime Minister, F. W. de Klerk, announced the removal of the ban on organizations such as the African National Council and the freeing of Nelson Mandela; by November of that year, Mandela could receive an honorary degree from UCT, and in 1994, general elections were held and Mandela was installed as President.[3] It was appropriate that the Mellon Foundation should, as did the Ford Foundation, the Soros Foundation and others, step into the breach

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[1] See Richard E Quandt, *The Changing Landscape in Eastern Europe: A Personal Perspective on Philanthropy and Technology Transfer* (New York: Oxford University Press, 2002), chapter 2.

[2] Independence also came to the Balkan countries, but in comparison with their more northerly neighbors they appeared to be neglected by donors, if for no other reason than the disorderly situation that prevailed in the former Yugoslavia for a long time.

[3] Stuart Saunders, *Vice-Chancellor on a Tightrope* (Claremont, South Africa: David Philip Publishers, 2000).

and help repair the damage caused by the many years of apartheid. True to its general emphasis on and expertise in higher education, the Mellon Foundation took up this challenge, and libraries and their modernization constituted, as in Eastern Europe, one of the important foci of its activities.

By 1997, a substantial number of libraries in Eastern Europe had introduced western library automation techniques, and South Africa was on the verge of doing so. It seemed appropriate to pool the experiences of these transitional countries and to examine the ways in which they responded to their differing needs and circumstances, which was accomplished through the Warsaw conference in 1997.[4] Over a number of years, the libraries tried to overcome the Communist legacy of being merely passive repositories of knowledge and to become more user-friendly, cooperate with one another, and overturn the awkward institutional and organizational arrangements under which they were often forced to operate. Many libraries in Eastern Europe and South Africa formed consortia for the purpose of automation and were largely, if not immediately, successful in these efforts. The impetus toward operating consortially was largely economic—better terms from vendors, better utilization of manpower, greater unification of standards—but there were substantial differences in how consortia were implemented.

While it may have been premature in the late 1990s to declare victory in library automation, the fact is that much was accomplished, and the quality of the libraries in the various countries changed appreciably over the decade. One other consequence of consortial library automation was the discovery that it made excellent sense to think of library catalogs that covered not one library but an entire consortium of libraries; particularly one in which users could not only determine where in the consortium a particular item was held but what its borrowing status was at any one time. Focus turned to union catalogs, and it was only a small step from consortial union catalogs to national union catalogs.

Thus came about the interest in a second Mellon conference, this time devoted to various implementations of union catalogs and related mechanisms.

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[4] See Andrew Lass and Richard E. Quandt (eds.), *Library Automation in Transitional Societies: Lessons from Eastern Europe* (New York: Oxford University Press, 2000).

On October 16, 2002, some ninety-two librarians and information technology experts from thirteen different countries came together at the National Library of Estonia in Tallinn to share their experiences with building union catalogs and discuss a whole range of issues that inform their present strategies and future developments.

The international gathering was again funded by The Andrew W. Mellon Foundation and was organized by the Foundation in cooperation with the National Library of Estonia, which hosted it. The conference program included 34 papers, presented in eight panels over two days. Twenty-eight of these reported on Mellon-assisted projects in the Czech Republic, Slovakia, Hungary, Poland, South Africa, Estonia, and Latvia. Six specialists, from North America (USA and Canada) and Western Europe (Finland, Norway, Holland and Germany), shared their own experience with developing union catalogs and offered a more general perspective on some of the underlying technical and organizational issues. The morning of the third day was devoted to a lively panel discussion that was organized around the topics that had emerged as key, and even controversial, over the previous days.

As is the case with successful conferences, the possibility of hearing interesting and intriguing presentations was matched by an opportunity to talk to colleagues and discuss ideas and problems in detail. Add to this the wonderful ambience of the venue and the impeccable behind-the-scenes logistics of the hosts, and you have the makings of what turned out to be a both productive and memorable meeting.

The purpose of this volume is to present the wider audience of specialists with a selection of the papers presented at the conference. While all the presentations were very interesting, we decided to include in this volume those that we think best illustrate, in detailed case studies or retrospective analyses, the key problems facing the development of union catalogs in societies caught at the crossroad of two historically significant trajectories: the fundamental socio-political and economic transformations that are being experienced by these countries at a time when library and information services are themselves facing radical changes in their organization and mission, and in which the development of electronic technologies and the demands of globalization play a decisive role.

It is one of the ironies of the digital library age that many of the developments in the fields of science and technology have an increasingly

shorter half-life and traditional paper copy publications are increasingly expensive. It could be argued that it is not worth printing the proceedings from the conference on works in progress; after all, much will have changed by the time the book appears. We wish to argue an alternative perspective: it is precisely because any report on the status of union catalogs must be tentative and provisional that it is important for those facing the challenge of building union catalogs, as much as for those scholars interested in the history of library science, that we offer a report that captures this stage of development in printed form. A printed version is all the more important, since the archiving of purely electronic material is, if not in its infancy, not well developed, and standards are still being debated in the profession.[5]

2 Union Catalogs and the Mellon Foundation Initiative

Since 1997, all countries that have received library grants from the Mellon Foundation enabling them to implement an integrated library system have also started to work on or plan for union catalogs. The aim of the conference was to provide an opportunity to share their experience and compare the chosen methods and technologies with practices in other countries.

The experiences that the participants brought to the conference were wide-ranging and varied. In the Czech Republic, the Mellon Foundation supported union catalog efforts built on the CASLIN framework, which had implemented integrated library systems in a number of key libraries in the Czech Republic and Slovakia. In Slovakia, union catalogs were promoted by Foundation support for the National Library in Martin for retroconverting the Slovak National Bibliography, and by assisting the University Library of

[5] An important step toward standards is "Preserving Digital Information: Final Report and Recommendations," a report by Donald Waters and John Garrett, under the auspices of the Commission on Preservation and Access and RLG. See http://www.rlg.org/ArchTF/. Also relevant here is the Mellon Foundation's Ithaka Project, which has electronic archiving as one of its objectives.

Bratislava in its efforts to build a union catalog of periodical literature. In Poland, the Foundation funded NUKat, a centralized union catalog initiative based on the VIRTUA system of VTLS, Inc. (A second and independent union catalog initiative, KaRo, is also implemented in Poland. However, it is likely that both efforts will benefit from their coexistence.) In Estonia and Latvia, employing the automation systems INNOPAC and ALEPH 500 respectively, the union catalog efforts stemmed directly from the consortial implementation of library automation. In South Africa, Mellon funded SABINET to replace the older SACat catalog with a technologically advanced national union database. Only in Hungary did union catalogs (VOCAL and MOKKA) come into being without direct Foundation assistance. More varied approaches are difficult to imagine, and we hoped that juxtaposing the experiences of such a varied group would provide instructive lessons.

3 Case Studies

Most papers presented at the conference were essentially case studies that provided an overview of specific union catalog projects. Some focused on the implementation of technologies aimed at introducing specific functionalities, while others chose to introduce the system in place, often against a historical background, and highlighted the problems encountered along the way. All projects addressed specific needs in untraditional ways as they juggled to make creative use of new technologies in a radically changed library information environment, and do so under a variety of real constraints (budgetary, legislative and organizational). And, as was to be expected, opinions differed on a whole variety of themes as much as the individual project strategies differed from each other. This diversity of approaches underlines the extent to which the concept of the union catalog has changed, a point well illustrated by the broad spectrum of answers offered by the panelists when asked, on the last day, to suggest a definition of the union catalog.

The Czech and Slovak Library Information Network (CASLIN), which has involved cooperation between several libraries in both countries since 1993, is represented in this volume by four papers. On the Czech side,

Stoklasová and Krbec discuss the cooperative effort between the National Library of the Czech Republic and Charles University (both in Prague) in developing and implementing a Web-based Uniform Information Gateway using SFX and MetaLib (Ex Libris). On the other hand, Krčmařová and Trtíková look at an effort, also at the National Library in Prague, to develop a centralized union catalog emphasizing the advantages of a locally developed system, CUBUS (based on Oracle), that recognizes international standards but caters to a heterogeneous environment in a cost-efficient way. While the UIG is designed with the end-user in mind, CUBUS was designed to empower technical services, particularly shared cataloging, among all the participating libraries. Finally, the trials and tribulations of developing a union catalog for the complex library system of the Czech Academy of Sciences, comprising 65 institutes, is the topic of Lhoták's paper. On the Slovak side, Sedláčková and Alojz Androvič describe the development of the Slovak Union catalog of periodicals, located at the University Library of Bratislava.

The situation in South Africa is covered by three papers, each devoted to one of the components of what amounts to an ambitious national library automation and union catalog project. The Western Cape library consortium (CALICO), consisting of four universities, is discussed in the paper by Reed and Noble. Theirs is a detailed discussion of the problems that were encountered along the way, which allows them to draw attention to the role that politics and human resource management play in projects that might be assumed, naively perhaps, to be dominated by mostly technical and economic hurdles. The perspective on developing a regional union database in the Gauteng consortium (GAELIC), comprising 16 separate institutions, is the topic of Man and Erasmus. While their paper focuses on the implementation of a shared cataloging protocol, it does so with reference to the adverse effect that the initial failure of the South African Bibliographical and Information Network had in the early efforts at library automation in South Africa. SABINET was to help introduce a proper cataloging protocol and develop a national union database. The full story of SABINET, established in 1983, and Sabinet Online, a new private company that took over SABINET's operational responsibilities, is the topic of a separate, detailed account by Malan.

The Estonian Library Network Consortium (ELNET) is the topic of Olonen and Andresoo's discussion. They provide a rare step-by-step description of the initial implementation process (INNOPAC being their system of choice), and turn their attention to the development of the shared union catalog ESTER that also functions as a national bibliography database.

Three Polish projects are discussed in this volume. Hollender offers a thoughtful meditation on the past and present vicissitudes of union catalogs. His discussion of the NUKat project (The National Universal Catalog of Poland) illustrates the challenges posed by the ever-present, but always changing, tension between the logic of cataloging and different search habits. NUKat is also the focus of Paluszkiewicz and Padziński. Their detailed discussion follows its development from the early stages, in which the focus was on the authority file, through the preparatory stages for the development of the actual catalog to its early stage of functioning. It concludes with an evaluation of the costs, as well as advantages, of the system in place. Finally, Wolniewicz explains the philosophy behind the recently launched Polish distributed library catalog KaRo (conceived as an alternative to NUKat). He discusses the functions, limitations and successes of this service, including some general observations about distributed services.

The Hungarian shared cataloging project (MOKKA), discussed by Bakonyi, once again illustrates the complexities of drawing together a large heterogeneous group of libraries (in this case 16) with different cataloging rules, five different integrated library systems, three different archiving formats, two different MARC formats, etc., into a fully functioning consortium. Koltay's paper focuses on subject access in the cooperative cataloging environment and uses as examples three cooperative databases in Hungary: the bibliographic databases of the Hungarian National Shared Catalog (MOKKA), the National Document Delivery System (ODR) and the Matriksz database (which itself consists of three subject heading systems used in Hungary, in addition to the UDC system). Vajda unveils the background and decision-making process that went into getting MOKKA off the ground in order to offer some interesting lessons for others to draw on, including the pros and cons of centralized and distributed union catalogs.

4 Functionalities

That technical and public services of libraries have faced a whole series of dramatic transformations in the new digital information age is, by now, a tired cliché.

The fact nevertheless remains that the union catalog has, as a consequence, moved to center stage of new library information systems. The traditional needs (such as shared cataloging, record quality control) or services (bibliographic searches, ILL) are now augmented by new ones: the possibility of online search and text delivery, single point of access, and a broader range of objects, including Internet sites, 2D (paintings, photographs) as well as 3D (museum) objects, sounds and moving images.

All of them raise questions about the appropriate description rules and linking standards, search engine algorithms, storage memory, licensing, user identity, and security, to name a few.

Within this ever-expanding and changing array of technological possibilities and implementation pitfalls, the final decision on the type of union catalog, its architecture, functionalities and, finally, vendor choice must lie with the libraries themselves. A thoughtful and step-by-step analysis of this decision-making process is the topic of Coyle's paper on the conversion of the University of California centralized union catalog MELVYL (that worked with broadcast searches of participating libraries) with a virtual catalog that could accomplish the same satisfactory results more efficiently, that is, both faster and at "a potential cost saving to the University."

Her discussion also highlights the one issue that comes up repeatedly: the relative advantages of distributed (virtual) and centralized (real) systems. While the virtual catalog could be said to be more current (in real time), it favors the more homogeneous environment (similar local systems, cataloging, indexing) and assumes that all systems are up at all times. The 'real' union catalogs are costlier, but have better control over record quality and operate independently of the participating institutions.

While the majority of case studies presented at the conference would fit on one or the other side of this dichotomy, some would argue that, in fact, the debate over the relative virtues of either type of architecture is somewhat misleading. For example, several of the papers (Gatenby and van

Charldorp, Husby) make reference to the OAI (Open Archive Initiative) protocol, known also as 'metadata harvesting,' designed as "an application-independent interoperability framework"[6] that enables a union catalog to be maintained by libraries that operate different systems. Since this protocol enables libraries to run a union catalog in a heterogeneous environment without the use of standards (such as Z39.50), it also raises the possibility of operating them independently of the primary system vendors.

The uneasy relationship with vendors was, of course, one of the topics that came up several times during the conference, and the OAI protocol also illustrates the option of in-house development of union catalog modules that are tailored to specific needs. For example, the Oracle-based union catalog of the Czech National Library was designed locally, and was meant to supplement the main library system (ALEPH 500) and allow participation with libraries that could not afford the Z39.50 protocol license.

5 Links and Clicks

Perhaps the most significant development in the area of information delivery is the World Wide Web and its various search engines. The question becomes: what is the exact relationship between the Web-based information service and the electronic library (union) catalog? If information is organized differently in the two systems, what happens when information in one points to information in the other? To what extent can two different mechanisms for the organization of information coexist in what could be considered a hybrid setting? Gradmann's paper takes on the task of identifying these differences "in terms of mutual redundancy, competition and (sometimes and hopefully) convergence". While several of the papers actually identified the Web as the proper vehicle for the union catalog, it was also clear that preferences were very much linked to the primary purpose that the catalog was intended for. Those catalog projects that were focused on

[6] See http://www.openarchives.org/OAI/openarchivesprotocol.html for full discussion of the protocol.

traditional library needs and materials (such as bibliographic descriptions, copy cataloging, etc.) seemed less concerned with this issue than those that aim to provide the user with a single access point to 'one-stop' shopping for a range of types of information. Here the cooperation between Charles University and the Czech National Library, using the Open URL protocol (and MetaLib), is particularly interesting (Stoklasová and Krbec).

But, as Husby's paper on linking in union catalogs points out, whether one is working with a Web-based or the more traditional electronic-based database (catalog) or, more precisely, because today one needs to work with both, the very concept of reference—the principal mechanism of any library information system providing the link between metadata and a specific object, or between objects—demands further clarification. As does the concept of holdings: among other things, network documents do not reside on library shelves and an increasing number of objects are complex, consisting of text in addition to other materials, themselves residing in different 'locations.'

6 Costs and Benefits

It is fundamental in the design of capital improvements to consider the costs and benefits of the proposed changes. Only if the discounted value of the stream of future benefits exceeds the present value of costs could one argue rationally that the improvement should be carried out. This principle is, of course, a direct consequence of placing library decisions in an optimization framework and requiring that the decisions made satisfy some social optimality conditions.

While such calculations may not be easy, particularly because the stream of benefits is difficult to identify, let alone quantify, optimality calculations are typically not undertaken in the library context, not even in the simplest cases such as the question of purchasing the optimal number of software licenses when introducing an integrated automated library system. But optima have been determined in some such cases, and it would be extremely beneficial if librarians and those who control budgets would at

least be willing to think in these terms.[7] On the whole, it seems to be the case that those who work in the Anglo-American tradition, being perhaps more used to formal economic modeling, are somewhat likelier to think in terms of cost-benefit analysis. A notable exception to this generalization is the paper by Feret, who wants to determine the benefits that users derive from union catalogs. Malan's paper may be the only one that explicitly deals with costs and benefits due to shared cataloging, and contrasts the explicit costs of original and copy cataloging. Man and Erasmus pay significant attention to the financial benefits that accrued to libraries as a result of the GAELIC consortium, and note that cost savings arise from copying records from OCLC WorldCat. Read and Noble note that rising prices of print subscriptions have serious implications for library policy, while Jauhiainen asks whether centralization of functions could save money. But for most authors, the discussion of costs and benefits is peripheral, and it is fair to say that the papers do not on the whole come to grips with these questions.

7 Cooperation

If there is a central underlying theme to most of the papers in this volume, then it is the importance of cooperation, whether intra- or inter-library and whether defined by consortial agreements are not, to the success of library automation project and most particularly to the building a union catalogs. From the very outset, libraries must agree on basic strategies (for example, whether to follow a distributed or centralized model), agree on standards, cost sharing, network strategies and, finally, the approach to the various technical and public services pursued. And of course it is not enough to agree; these agreements must be upheld, as library managements need to make a transition to strategies that allow their institutions to thrive in a separate but equal setting. And how does one judge the success of a union catalog project, given the multiplicity of players and factors involved? Two

[7] For a case in point, see Richard E. Quandt, "On the Optimum Number of Library Software Licenses," *Journal of Economic Behavior & Organization* 38/3 (1999): 349–56.

papers in this volume address this issue. Feret discusses the importance of establishing benchmarks for the evaluation of union catalog functionalities, including performance indicators that reflect user satisfaction for the development and running of union catalogs. He also suggests the appropriate methodologies for designing user satisfaction surveys. Caidi's paper presents the results of her survey of the Mellon-funded union catalog projects in Eastern Europe. This comparative study takes a closer look at the extent to which the development of national union catalogs was influenced by choices that were not technical. She makes the point that while the technologies used are globally available, their implementation is always local. Any library's vision (or "philosophy") of a union catalog is therefore informed by different social practices and cultural histories.

8 Politics

Many authors have made a point of highlighting the political dimensions of union catalog projects. In the most general sense, developing and maintaining a union catalog of any type rests, explicitly or not, on several social factors that may appear to lie outside the purely technical issues although, in fact, they are inseparable from them. As noted above, union catalogs are, by definition, built with the idea of cooperation between different libraries, even competing ones, on the continued support—financial, logistical and even legislative—of oversight organizations (e.g. universities, regional or national governments, different ministries) and, in no small manner, on the internal cooperation between the different parties that are directly involved in the functioning of the catalog (librarians, IT personnel, vendors and even users). In the end, any union catalog "emerges as a result of the interaction between these different players; it becomes an artifact that is socially constructed by people who have a stake in its development." (Caidi) But even in cases where differences of opinion and personal agendas are a matter of organizational management, external (to the institution) political factors also play a decisive part.

The close ties between national political agendas and the direction that union catalogs pursue is, of course, the underlying theme of all the case studies. Two reasons stand out.

First, the very point of the Mellon funding was to assist with the development of UC projects in institutions that had not only just gone through the library automation challenge, but that had done so as part and parcel of the political transformation of the whole country (the fall of Communism and the end of apartheid). The type and condition of union catalog initiatives, to the extent that they existed, can be directly linked to the policies (and resources) of the previous regimes, and in several instances the new projects tried to work from these rather than start entirely new ones. It is important to keep in mind as well that the union catalog concept has a well-established historical precedent in all the countries represented here. The present projects' trajectories are therefore informed by the past, and often by a very conscious attempt to work with existing databases and established obligations, while introducing new standards or moving away from constraints that had political agendas and negative consequences. For example, the cooperation and division of labor between libraries in the Czech and Slovak case reflected the existence of one country. Up until 1993, the National Library in Prague (Bohemia) focused on a catalog of foreign literatures, while the University Library in Bratislava (Slovakia) focused on periodicals. The breakup of Czechoslovakia into two countries had a profound impact on how these national union catalogs were conceived and what form of cooperation, if any, would exist between the new, separate entities. Similarly, the end of apartheid in South Africa made it possible to bring existing but failing initiatives back to life, but also called for new and untested levels of cooperation between institutions previously separated by the racial divide.

Second, many of the initiatives—and this is particularly so in the case of European libraries—are located at the National Libraries and therefore are meant to fulfill their role as a central comprehensive service. In several cases, developing a national union catalog is mandated by law and may even require that all participating libraries operate under the same architecture (vendor). In other words, technical discussions regarding the relative merits or challenges of union catalogs operating with homogenous or heterogeneous environments may be decided by external political considerations. Compare, for example, the Slovak library legislation, which stipulates a unified system for all major libraries, i.e. single vendor, and the Czech legislation, which mandates the National Library to house the national

union catalog but allows for multiple systems. Ironically, as traditionally centralist systems try to give way to relative regional autonomies, national institutions such as national libraries become key players and lobbyists for regulations that can be perceived by other libraries as undermining a process that would support horizontal cooperation amongst administratively decentralized institutions.

University library UCs may be no less politicized by the nature of their relationship with the university's administration, such as a Dean in cases where the union catalog is meant to integrate individual departmental libraries within one school (e.g. School of Humanities of Charles University, Prague), or the Rector's office in all-university catalogs. Inter-university consortia pose their problems as well. The Polish example and two South African examples illustrate the potential hazards. The CALICO and GAELIC projects are particularly telling, as both of these try to integrate institutions that had minimal, if any, contact under apartheid rule (also a strong presence in the SABINET case). It could be argued that the degree of success of these politically 'heterogeneous' consortia is a direct reflection on their ability to develop and sustain social relations that transcend the dysfunctional, though well-entrenched, order.

Similarly, it would be interesting to speculate whether the degree of success of international consortia is a direct consequence of the relative stability of the institutions involved, the relation between the countries involved and the actual functionalities offered. For example, EUCAT, originally established in 1979 as a catalog linking both national and individual union catalogs in France, Germany and the Netherlands, is set up to grow and function as a pan-European index of union catalogs providing 'one-stop' access to full bibliographic searches with links to individual libraries (and ILL), document delivery services or links to full electronic texts.

9 Concluding Remarks

The past few decades have witnessed a revolutionary expansion in the functions, services and methodologies of libraries, and an equally remarkable growth in information resources that are no longer synonymous

with the traditional library. The traditional library today is only one of a multitude of information providers, and has had to adapt to, and indeed exploit, the availability of the World Wide Web. In the process of doing so, librarians have had to address many tough questions ranging from the user-friendliness of access to information to the proper role of union catalogs and the advantages or disadvantages of various ways of implementing them. The papers in the present volume amply illustrate the very substantial progress that has occurred, not only in technical accomplishments, but also in developing new modalities of cooperation in an environment in which it seems increasingly wrong-headed to strike out on one's own and in recognizing the 'political' dimension of problems that might have been naively thought to be purely technical. But we must end our introduction to this volume with a plea for more attention by librarians to a relatively neglected characteristic of providing access to information, namely the efficiency of the process and its costs and benefits. Libraries have the potential of providing rich data about their own operations that permit the application of techniques, usually developed in other contexts many years ago, for determining how efficiently a library operates and what the costs and benefits are of alternative ways of providing access to seekers of information. We have already alluded to one optimization model in a library context (see footnote 7). We mention here three more in the hope that the ever-present scarcity of resources will induce librarians to include economic analyses in their planning. A statistical study that relates the aggregate cost of various library services to the quantity of those services delivered is provided by Lewis G. Liu.[8] The well-known technique of frontier production functions, which employs econometric methodology to find the relationship between inputs and the maximum output that can be secured from them, is discussed in the context of museums by Bishop and Brand.[9] Data envelopment analysis, a technique based on linear programming

[8] Lewis G. Liu, "The Cost Function and Scale Economies in Academic Research Libraries," *Library Trends* 51/3 (2003): 293–311.

[9] P. Bishop and S. Brand, "The Efficiency of Museums: A Stochastic Frontier Production Function Approach," *Applied Economics* 35/17 (2003): 1853–58.

and originally developed by Charnes et al.,[10] is applied to libraries by Shim.[11] What all these studies have in common is that they apply formal mathematical or econometric techniques to evaluating library performance from the economic point of view. We hope that the application of such techniques will become as commonplace in library circles as the discussion of library and Internet technology.

[10] A. Charnes, W. W. Cooper, A. Y. Levin and L. M. Seiford, *Data Envelopment Analysis: Theory, Methodology and Application* (Boston: Kluwer, 1994).

[11] Wonsik Shim, "Applying DEA Technique to Library Evaluation in Academic Research Libraries," *Library Trends* 51/3 (2003): 312–32.