The Digital Library: A Biography

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Acknowledgments

This report was born in the spirit of congenial collaboration that so characterizes the Digital Library Federation (DLF). The idea for the study took shape in a New York City steakhouse where four DLF directors met to reflect on the new roles and responsibilities that were emerging for their libraries as they entered an increasingly networked digital age.[1] Realizing that lessons from the past were easier and perhaps more predictive than prognostications about the future, they suggested that a study of DLF member programs would reveal the history, aims, organization, and immediate challenges in their libraries.

The study progressed quickly, following the development of a lengthy (104-question) survey that was received and completed without complaint at DLF member institutions. We learned subsequently that numerous hands had to be called into play to supply the answers to the questions we posed. Once compiled, the data provided a rich source of information that indicated the very different developmental trajectories and experiences in DLF institutions. Review by a slightly broader group of library directors suggested that the study be extended to include the case studies that are presented here.[2] These, they argued, would breathe the life of human experience into otherwise dry, if informative, statistical data. The research was destined from this point to impose even more heavily on already overcrowded schedules that were opened graciously and with the utmost concern for congenial hospitality to accommodate the authors' site visits.

In addition to the support we received from the library community, we acknowledge the assistance of the Center for Survey Research at Indiana University, which produced, compiled, and analyzed the data. With a Herculean effort, Doug McKinney, Assistant to the Dean at Indiana, summarized the survey data and offered numerous insights into their meaning. The case studies benefited from the wisdom, experience, and gracious hospitality of DLF colleagues too numerous to name at the California Digital Library, Harvard University, New York University, Indiana University, the University of Michigan, and the University of Virginia. At the Council on Library and Information Resources (CLIR), Kathlin Smith provided welcome encouragement and sound editorial direction. Cassie Savage, of CLIR, and Shawny Taysom, of Indiana University, ensured that the authors met deadlines and stayed in touch through the course of the investigation. Despite the best efforts of all the aforementioned, this report will sadly be lacking in ways that can be attributed uniquely to its authors.

Daniel Greenstein, California Digital Library
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[2] Peter Botticelli, Cornell University; Nancy Eaton; Elaine Sloan, Columbia University; Suzanne Thorin; Duane Webster, Association of Research Libraries; Wendy Lougee, University of Michigan; Bill Forden, University of Washington; Marty Runkle, University of Chicago; Bill Britton, University of Tennessee; and Daniel Greenstein.

Preface

Digital libraries, once project based and largely autonomous efforts, are maturing. They are finding value in cooperating with other units on campus, and their services are being promoted in the broader academic community. Many are obtaining core funding. Although digital libraries have a long way to go before they reach their full potential, there has been significant development in the past decade. Nonetheless, referring to the digital library generically masks the fact that digital libraries exist in diverse forms and with quite different functions, priorities, and aims. As individual programs have matured, each has developed its own personality, reflecting the circumstances of its birth, its environment, its caretakers, and its leaders. This report draws on the results of a survey and case studies of DLF members to reveal how these influences have molded a range of organizational forms that we call the digital library.

Precisely because of the distinctive quality of the programs surveyed, it may seem odd that we have chosen to title this report "A Biography," rather than "Selected Biographies." Digital libraries are likely to retain their distinctiveness even as they become more deeply integrated and build upon commonly available collections and services to meet users' needs. But it is worth considering, as the authors do, where the developmental trajectory will lead, and it is worth thinking about how we will describe the body of information that is being made available for research and teaching through the efforts of numerous not-for-profit institutions. We have learned that users of electronic resources do not care where their information comes from, as long as it is authoritative and authentic. I suspect the user will refer to this rich and growing body of information not as a collection of individual efforts, but as one digital library.

Deanna B. Marcum
President, CLIR

SECTION 1: THE BIOGRAPHY

INTRODUCTION

Digital libraries are new, and investment in them is fraught with unknowns. Consequently, librarians and library directors are hungry for information about different institutional experiences, including what digital library investments are considered good, meaningful, and cost-effective, and what influences have helped shape successful digital library programs.

To respond to these needs, the Digital Library Federation (DLF) undertook a study of its members' digital library programs.[1] The survey was intended to document how DLF member libraries are focusing their digital library programs: how and under what circumstances their programs were initiated; the influences that shaped their development; the programs' current organization and funding; and the challenges they anticipate. The primary aim of the study was to help inform libraries in their strategic planning and help them assess their own programs in light of what others have set out to achieve. The study had a number of secondary aims as well; for example, to identify what new roles are emerging for academic libraries; to assess the opportunities and pitfalls that may be associated with these new roles; and to help libraries promote themselves to their faculties and to the university administrators to whom they report.

The study began with a survey questionnaire circulated to the academic libraries that were members of the DLF in January 2001. Twenty-one institutions responded.[2] The data they supplied were illuminating on several points, including the different approaches that libraries have taken to build their digital library programs and the extent to which the complexion of any program is tied to campus personalities, circumstances, and needs (Greenstein, Thorin, and McKinney 2001). The data compelled a closer look at the softer influences not so readily identified by a survey. Accordingly, extensive interviews were conducted with key staff members at six DLF member libraries: the California Digital Library (CDL), Harvard Universi-

[1] The survey instrument can be viewed at: http://www.diglib.org/roles/survey1a.htm.

[2] A list of these libraries appears in Appendix 1.

ty, Indiana University, New York University (NYU), the University of Michigan, and the University of Virginia.

These six programs were selected because they represented distinct variations in attributes that the survey identified as being potentially key determinants of a program's distinctiveness. Among those attributes is *age*. Virginia and Michigan are two of the oldest digital library programs in the United States. NYU was included because it is a relatively new program, begun in earnest only in the last two years. Harvard and Indiana represent the middle-age members of the sample.

Another distinguishing characteristic is a program's *orientation*—that is, the main focus of its work. Not all digital libraries focus primarily on digitally reformatting analog items in their collections and distributing them online. Harvard and NYU, while possessing digitization capacity, focus principally on providing systems environments and infrastructure capable of managing digital assets as may be acquired or used within their host institution. The CDL is similarly focused but is actively assessing funding and business models that may support more investment in digitization. Michigan has focused both on digitization and on the development of access systems. Indiana stresses digitization in the context of teaching and learning. Virginia, on the other hand, emphasizes innovative use of information technology (IT) in support of research and teaching. Its main focus is consequently user services, with collections and system development playing a supporting role. The range in orientation of DLF digital libraries is illustrated by data from the DLF survey. In the year 2000, digital conversion costs for member libraries ranged between $38,000 and $1,145,000; the average spending on all aspects of digital library programs was $4,341,798 ($2,641,798 if the costs of acquiring access to commercial electronic content are excluded). Fewer than half of the DLF libraries surveyed invest primarily in digital reformatting programs. Most have oriented themselves toward the development of technical infrastructure and of various reference and other end-user services.

A third characteristic used to select programs for case study interviews was *organization*. Information about how digital library programs are organized is available for 18 of the DLF's members. Two—Harvard and the CDL—are confederal organizations to which a number of libraries contribute at some level. Harvard's program supports the more than 90 libraries that make up the Harvard library system. The California Digital Library is a library in its own right, but it provides services to faculty, students, and libraries at the 10 University of California (UC) campuses. As confederated organizations, Harvard and CDL are unique within the DLF as well as among academic libraries generally. An additional six DLF member digital library programs are managed as separate departments or units within the library. Michigan and Indiana are representative of this approach. The University of Virginia represents another organizational form—one in which digital library effort is found in several library departments but

coordinated through a committee. This distributed but coordinated approach is common to 4 of the 18 DLF members for whom organizational details are known. Two further approaches were evident in the survey data but are not represented in the case studies because they are indicative of very small and immature programs. Two DLF member libraries reported in the survey that their programs were too small to have some determinate organizational form, while a further four claimed that their programs comprised a range of uncoordinated activities taking place in different library departments.

A final attribute that distinguishes a digital library program is the library's *relationship with surrounding academic departments and information services*, such as academic computing and IT. Although not easily quantifiable, closeness may be measured by such factors as the facility and experience of collaboration between the library and these surrounding departments, and the extent to which strategic planning in one department includes representatives from and takes substantive account of planning in other departments. Size may have something to do with closeness. Among the surveyed institutions, Virginia and NYU are the smallest and also have the closest relationship with other departments. They are joined by Indiana, however, which, at more than 33,500 students on the Bloomington campus alone, can hardly be characterized in terms that describe a liberal arts college "feel." Harvard and CDL, because of their confederal character, are perhaps furthest from faculty and IT units.

This study, although based on the results of the survey and interviews, has also been informed by other investigations that the DLF has sponsored in its attempt to understand various aspects of the digital library and by the numerous formal and informal discussions that have supported or resulted from those investigations.[3]

ASPIRATION AND THE "SKUNK WORKS": THE YOUNG DIGITAL LIBRARY

Origins

The circumstances surrounding the launch of a digital library program vary considerably, but it is possible to point to several important common influences. Among them are a guiding mission, an institution-wide mandate, the support of library and university leaders, a protected experimental environment, and sufficient funding. Each of these influences is developed in greater detail in this chapter, which will then characterize the aims and orientation of early digital library programs.

[3] See Jewell 2001, Pitschmann 2001, Smith 2001, and Troll Covey 2002. The DLF also commissioned Outsell, Inc., to conduct a survey of the dimensions and use of the scholarly information landscape. A report is forthcoming.

Mission

Digital library programs are initiated for different reasons, any one or more of which may be at work at a single institution. Most programs derive from innovative thinking about the future role of libraries (for example at Virginia) or the future role of the library in an extensively networked teaching and learning environment (Michigan), but there are other motivations. The role of blue-sky planning may be particularly significant at institutions that entered the digital library business early and had few models to draw on. Institutions that entered later could be imitative as well as creative. In this regard, it is worth noting that academic institutions compete at nearly every level: they compete for grant and philanthropic funding, good students, and respected faculty. Their libraries are not immune from competitive impulses, which also have a hand in initiating digital library investments. Thus, the progress of digital library programs that are located at a library's peer institutions cannot be discounted as a powerful driver.

In sum, we encountered digital library programs that were developed

- as part of a campus-wide initiative to develop as a leader in the use of information technology;
- as a means of modernizing overall university services to attract better students;
- to keep up with the digital library programs being developed at peer institutions; and
- as a commitment to the delivery of high-quality library services.

Most of the programs we surveyed are at some level deploying innovative technologies to deliver very traditional library services. For example, Harvard's Libraries Digital Initiative is preparing to collect and preserve scholarly and cultural outputs that happen to be in digital form, and to encourage their use in research and teaching. NYU's digital library program is supporting an institution that has a strong cross-disciplinary interest in theoretical and applied aspects of the performing arts. Michigan is supporting the development and conservation of out-of-copyright monograph and serial holdings and efforts to provide highly functional access to digital content. Indiana is using streaming audio to deliver listening assignments to students in its School of Music.

Leadership and Ownership

Leadership is required at three levels: the political, the creative, and the executive. Political leadership may stem from the university librarian, as it has at Harvard, Virginia, Indiana, and NYU. NYU is an interesting case. It is a latecomer to the digital library arena in part because there was no IT or library leadership until a new president was appointed, who, in turn, selected a new chief information officer (CIO) and a dean of libraries.

Whether a library director's support is sufficient to launch a successful digital library program remains an open question. The hands

of university presidents and provosts are clearly at work in our case studies. Since 1995, UC President Atkinson has been a great champion of the CDL. University of Michigan President Duderstadt (1988–1996) identified issues surrounding an information and IT agenda as being among his priorities. He invested in the transformation that created a School of Information and in the aggressive development of the technology infrastructure. Both ultimately benefited Michigan's digital library interests.

Creative leadership, another important ingredient, comes from a number of sources. At Michigan, it emerged from close collaboration among three people: one in the School of Information and Library Studies (now the School of Information), one in the university's Information Technology Division, and one in the library. Such collaboration is apparent at Harvard, in a triumvirate whose members are drawn from within the university's library system; at NYU, in a combination that is orchestrated and shared by the dean of libraries and the CIO; and at Indiana, in a group modeled closely on Michigan's and comprising members of the library, the IT service, the library school, and the School of Informatics. Creative leadership can also stem from an individual. At Virginia, the digital library program owes a great deal to a single librarian who, in the 1980s, was already thinking deeply about what a twenty-first-century academic library should be.

The need for executive leadership is self-evident. No digital library program, however well supported and envisioned, can develop without people who possess the appropriate technical, tactical, and even diplomatic skills. Programs that otherwise had key elements in place, such as funding and mission orientation, were delayed to some extent until such leadership could be found. This was the case at Indiana and NYU.

Just as digital library leadership is required at several levels, ownership of the digital library program needs to be felt widely across its host institution. This may be less important for the startup phase of a digital library program than for its long-term operation. All six programs represented in the case studies traced their origins to inclusive strategic planning exercises—exercises that involved academic faculty, senior university managers, some library staff, and, in some cases, representatives of other information services. Representatives of Michigan's triumvirate traced their program's origins to a planning process that included a yearlong, campus-wide faculty symposium on electronic information and a report prepared for campus administration on this process. The work included intensive analysis of distributed computing operations and the economics of campus information provision. NYU's mandate stems from library and IT planning vetted by faculty advisory groups and university administration. Harvard's stems from a planning committee that included deans, librarians, and faculty. CDL's grew from a planning process that was initiated by librarians but was ultimately ceded to a committee comprising representatives of all constituencies: faculty senate, campus administration, system-wide administration, infor-

mation technologists, and libraries. The committee itself was instituted by the chancellors (campus chief executives) and the university provost. Of the 21 digital libraries surveyed, 76.2 percent (16) are guided by digital library development policies created as part of a broader university IT strategy. These data suggest that digital library development is at some level conceived as part of a university-wide planning process.

Organizational Location

Foundling digital library initiatives seem to favor safe-haven environments where those involved can experiment without the operational demands made of other library units. Michigan created a "skunk works"—a research laboratory where digital library staff could, through a series of highly focused projects, "road test" new technologies and gain competencies in key areas. The reliance on digital library laboratories is apparent in both early- and late-starting programs. At Michigan, the early program involved a number of projects loosely coordinated by a program director and fulfilling the evolving vision of the founding triumvirate. Early work with the JSTOR project and with the Making of America provided a range of experiences associated with large-scale digital reformatting, while cooperation with Elsevier Science (in projects TULIP and PEAK) provided data management experience as well as a context for a large-scale field experiment in pricing electronic journals. Crucially, the digital library program was outside the library's normal management line: its director was responsible to the triumvirate. She was also physically independent from the library's key operational services.

The model of a digital library program that is relatively autonomous in its early days is evident elsewhere with significant variation. Virginia cut its digital library teeth in experimental units that were outside the normal line of management—in the library's Electronic Text Center and, in the academic unit, the Institute for Advanced Technology in the Humanities (IATH), which is located in the main library. Through a series of digital library projects, staff (and through the staff, the library) gained competence in creating, managing, and distributing electronic information. The Electronic Text Center was located in the library but was initially independent of other library departments and services. Even IATH reported directly to the associate provost for research and was thus removed to some extent from the "academic line." Virginia continued for some time to foster experimental efforts in relatively autonomous organizational units. Thus, as it sought to develop experience and capacity with new digital materials (e.g., images, statistical data), it opened new media centers that focused on the technical and other challenges that these materials introduced without being clouded by traditional library practices or even by practices that were growing up around the Electronic Text Center and IATH.

Indiana's program introduces a variation on the same theme. Here one can point to a number of experimental initiatives, each

mounted with a considerable degree of autonomy from mainstream operational departments and from one another. VARIATIONS, originally an audio e-reserve, was a flagship project run out of the Music Library as a personal project of that library's director. The Library Electronic Text Resource Service (LETRS) is an e-text center much like the one at Virginia. It is located in the library but is relatively autonomous of the traditional library departments. Digital Images Delivered Online (DIDO) was an early experiment that served faculty in the School of Fine Arts.

In 1996, Indiana established the Digital Library Program (DLP), which brought together these three projects. Through amalgamation, Indiana achieved economies and cross-fertilization at virtually every level, enabling a more coherent approach to research and development, selection and deployment of digital library technologies, and staff appointments. Amalgamation was not intended to bring the DLP into a more traditional library unit and thus out of its skunkworks environment**.** Organizationally, the DLP reports directly to the dean of libraries rather than up the normal operational chain. Moreover, the DLP is funded discretely, rather than from operational budgets that support traditional library services. Programmatically, initiatives are still mounted at least in part to build on digital library competencies as they accrue, to add staff to complement skills already in place, and to acquire technology as may be needed across the program.

Trajectories at Harvard and the University of California differ from those at Indiana, reflecting the programs' confederal nature and system-wide orientation. At Harvard, the digital library program grew out of technical services developed on a system-wide basis, notably around shared cataloging needs. The CDL was instituted in parallel with a system-wide technical service (the Department of Library Automation), which it then subsumed. Although evolving from these more established services, digital library initiatives at CDL and Harvard also took on at least some of the attributes of the skunk works. Thus, while CDL made a point of launching at least one new operational service every six months, it fashioned numerous experimental initiatives and even established a small unit under a director for education and strategic innovation. At Harvard, where the Library Digital Initiative was organizationally housed in the same unit that supplied system-wide technical services, the program's emphasis on digital library infrastructure assumed a five-year development path during which time few infrastructural components became operational. The program was seen as a highly practical applied research program that would lead ultimately, but not immediately, to the development of operational systems.

The digital library's initial locus in experimental units a step or more outside the traditional management line was important. It created a space where experimentation could happen in a way that could not disappoint the service expectations of faculty and students, or even of other librarians. In some cases, digital library staff members were spared the normal bureaucratic decision making, hiring,

staff development, and procurement procedures that applied to other more traditional library services.[4] As such, they could more quickly populate, launch, redirect, or even end experimental initiatives, and could respond to funding, staffing, and other opportunities as they arose. This nimbleness was secured at a cost, however. With few exceptions, institutionally based digital library programs (as opposed to programs such as those at Harvard and CDL, which operated at least in part on a system-wide basis) were challenged later to integrate their staff, work, and thinking about library collections and services into the mainstream of the library.

Funding

Funding—especially external grant funding—is critically important to the startup digital library. Because it reduces the risk inherent in highly uncertain and technologically dependent activities, external grant funding is a mechanism that is particularly appropriate for the experimental orientation of embryonic digital library programs. Grant funding also gives fledgling programs national stature and local legitimacy and helps secure subsequent funding from external and internal sources. Securing external funding depends to some extent, however, on the ability to write convincing grant proposals and on the use of marketing and promotional techniques that many libraries have not yet developed and are not yet associated with their digital library programs.

The need to promote digital library programs was felt acutely by the programs that were launched in the early 1990s. At that time, few of the agencies to which libraries had a natural or historic entrée were making any substantial investment in activities that we would today associate with the digital library. The National Science Foundation's (NSF's) DLI1 initiative changed the profile of digital library activities and the amount of federal dollars that might be available to support them. Libraries, however, did not appear on lists of the first successful NSF digital library grants. The inexperience on both sides of the funding fence only emphasized the importance of marketing, as digital libraries were forced to consider how best to present their research interests and needs to members of a scientific community with which they had hitherto had only limited contact.

The role of foundations (particularly The Andrew W. Mellon Foundation but also the J. Paul Getty Foundation and the W.K. Kellogg Foundation) was also important in kick-starting digital library initiatives. Here too, however, libraries were obliged to get themselves on the agencies' informal bidding lists and to make their case for being there. It would be interesting to know how many failed funding applications a digital library program made on average before achieving its first success.[5] Certainly, such failures were

[4] This is also true in the development of the Library of Congress's American Memory program.

[5] For example, Indiana tried three times without success to obtain relatively small amounts of funding from the Library of Congress / Ameritech competition. Three years after its first attempt at that competition, the program received a $3-million grant from the National Science Foundation.

learning experiences that helped digital libraries focus their aims and build their technology expertise. These experiences also helped libraries learn to present their funding cases convincingly, in a language that was comprehensible to those outside the library community and in a way that demonstrated the broader significance of their institution's own efforts.

No amount of external grant funding, however, can replace the need for a substantial institutional commitment. So-called core funding—whether obtained from gifts, from additions to the library's permanent budget, or from a reallocation of existing funds—was claimed as essential by all 15 of the survey respondents who answered questions about how their digital library programs are funded. Such commitment takes different forms. At Michigan, Indiana, and NYU, it is in the form of contributions from university departments that are co-investing in the digital library's development. At Harvard and UC, local funding flows directly to the digital library from the office of the university president. At Virginia and Indiana, most startup funding came from money the university librarian had reallocated from other library purposes. Interestingly, as digital library programs mature, reallocated library funding becomes more important, at once reflecting and contributing to the challenges of mainstreaming the digital library.

Characteristics

Because startup digital libraries are fundamentally experimental, it is difficult to summarize what they do. They tend to set upon experimental tasks that reflect purely local circumstances and opportunities. Still, looking across a range of early initiatives, it is possible to get a feel for the startup digital library's practical orientation and for its rather severe limitations.

Innovation

Very early programs—those from the early to mid-1990s—are defined by the library's effort to harness the Internet to fulfill historic roles. Although innovative in many respects, these programs may be best characterized as "old wine in new bottles." At least initially, the digital library exploits the Internet as an additional means of delivering traditional services, notably access to the library catalog and to some reference materials and scholarly journals.

Greater innovation is apparent from the mid-1990s—for example, in experimentation with digital reformatting. Surrounded with lofty rhetoric about universal access to all human knowledge, innovative scholarship and teaching, and national and international digital libraries, some startup programs focused on providing online access to selected holdings. It is too soon to judge the results of these early initiatives. The risks involved for early adopters may have been so great that they were forced to exaggerate the claims for their work. Consequently, few of the earliest digitally reformatted collections stood a chance of meeting the expectations that grew up

around them. Judged in light of initial expectations, the earliest online collections are, with notable exceptions

- too small to support more than very casual kinds of browsing
- too idiosyncratic to be integrated meaningfully into larger virtual collections
- too passive to maintain a user's interest for very long

Judged against more modest or realistic claims, however, early digital collections were remarkably successful, particularly since so many were developed as technical experiments rather than as means of redefining scholarship.

Quest for "Killer Apps"

The young digital library is also known for its quest for "killer applications." Like the Holy Grail, these killer apps were elusive and appeared to different seekers in very different places—in data and metadata formats, in network protocols, even in systems and system architectures. The logic of their appeal is simple enough. Digital libraries are complicated to build and hard to maintain. Complexity is compounded by the fact that few libraries have more than a handful of appropriately skilled research and development staff. The killer app was the silver-bullet solution that promised to propel the library into a networked age without undergoing the fundamental restructuring, staff retraining, and soul-searching mission reorientation that information technologies seem to have forced on virtually every other organization known to late twentieth-century society.

Competition

The young digital library is competitively disposed toward its peers. Competition is hardly new; research libraries have always vied for endowments, collections, and position. Where they are embedded within academic institutions, as so many are, they are part of a broader and possibly even more aggressive competitive dynamic. The competitive disposition is notable only among young digital libraries, because it runs contrary to the deep information and service sharing that network technologies permit. Perhaps competition at this stage can be explained by the risk that early adopters embrace and by the need they feel to justify that risk in terms of demonstrable innovation. Whatever the cause, young digital libraries struggle to find distinctive furrows to plow. Some attach themselves to systems or standards that they hope will be codified in the ascendant. Others wed themselves to collections that will redefine or inform whole fields of inquiry. The competitive culture of online experimentation may help explain the slow progress of standards work into the mid- or late 1990s. Although few would question the need for standards, young digital libraries have difficulty agreeing on *which* standards—a question that is conceptually equivalent to "whose standards," and that, consequently, cannot easily be addressed on the true merits of any particular case (Greenstein 2001).

The competitive dynamic is still apparent in startup digital libraries, and it may be intensified as unsettled space on the digital

library frontier becomes more difficult to locate. Interestingly, fewer startup programs appear to be staking their claims on a particular technology or practice. Instead, they are emphasizing service orientation (as at Carnegie Mellon, for example, which emphasizes user support services) and local collections and scholarship (as at NYU, whose digital library program reflects a local orientation toward art and performance across disciplines).

The competitive disposition of young digital libraries may also help explain the relatively slow, sometimes fractious progress of associations of digital libraries and of collaborative digital initiatives. There are, to be sure, interesting examples of fruitful information interchange and shared investigation, particularly in the development of metadata standards, e.g., the Text Encoding Initiative (TEI), Dublin Core, and Encoded Archival Description (EAD).

One can also point to early and successful information exchanges, notably the task forces, which still exist, sponsored by the Coalition for Networked Information. Still, the ubiquitous penetration of networked technologies creates opportunities for deeper forms of association and resource sharing (with collection development, for example) that have been left almost entirely unexplored. Constrained organizationally from pushing technologies to their logical extent, young digital libraries fell back on safer modes of cooperation in talking shops that explored new ideas and in shared cataloging activities. The former resulted in statements of principle**.** The latter extended the purview of shared cataloging to some nonbibliographic records (e.g., archival finding aids and descriptions of some digitally reformatted materials) and explored mechanisms for constructing virtual, as opposed to union catalog, databases.

The young digital library is, in summary, an immature, experimental organizational form. It explores new opportunities and gathers new competencies. It does this within the safe harbor of soft-money projects and other activities that are organizationally, financially, and even culturally removed from traditional library services.

ROLLING PROJECTS INTO PROGRAMS: THE MATURING DIGITAL LIBRARY

The developmental trajectories of digital library programs are as diverse as are their origins. However, common trends begin to emerge out of the experimental phases and into the mainstream of library collections and services. The digital library program's drift into the library mainstream occurs at practical, technical, and organizational levels and requires new ways of thinking about how programs are funded and promoted. These changes are explored in this chapter, following a brief survey of how the digital library's practical work and its orientation are also changed as a consequence of its maturation.

Characteristics

Practically speaking, the maturing digital library is transformed as the fruits of experimental efforts become apparent in operational online collections and services. Having acquired core competencies and technical understanding, the maturing digital library abandons the "build it and they will come" philosophy that characterized earlier approaches to collection development. It focuses instead on integrating digital materials into the library's collections and on developing (and supporting with core funding) the policies, technical capacities, and professional skills needed to sustain it. Work by Timothy Jewell, Louis Pitschmann, and Abby Smith demonstrates this trend across a range of digital information.

Jewell (2001) shows the extent to which leading research libraries have routinized the complex processes of identifying, evaluating, negotiating access to, and supporting use of electronic information that is commercially supplied by third parties. Pitschmann (2001) demonstrates an evolving and highly sophisticated understanding of the pitfalls, opportunities, and real costs for libraries that choose to organize access to "free" external Internet resources through various subject gateways, portals, and other linking services. Smith (2001) demonstrates that the digital libraries that were reformatting materials from their collections in the late 1990s (and not all digital libraries were), did so strategically rather than experimentally. Reformatting was being done, for example, to profile selected rare and special collections, to support specific teaching and research needs, or to manage and conserve selected general holdings.

Interest in Modular Systems Architecture

Maturing digital libraries are far less interested in killer apps than are young digital libraries. The maturing libraries view the digital library as a complex online service environment that is supported by local and global systems, each of which supplies specific functions and interrelates with others in a way that can be represented in a modular architectural schematic (Powell and Lyon 2001). The model is not only sophisticated but also practical and economical. It permits greater freedom in the selection of service components and enables the library to manage and respond to technical change with greater facility. Relying on a modular systems architecture, the digital library can select a new authentication service, for example, or integrate a new authentication technology without re-engineering its entire service environment. It can concern itself primarily with the authentication system and the mechanism (the application programming interface [API]) through which that system communicates with others. This modular approach is fundamentally liberating, because it permits libraries to think creatively about how to build on services supplied by others. The extent to which libraries are able to realize any part of the grander vision, however, depends almost entirely on their ability to transcend their historic organizational independence and insularity.

Desire for Common Standards

The maturing digital library's approach to standards setting is shaped by nascent aspirations for a more deeply networked future. In brief, it becomes fashionable for digital libraries to lead from the rear with respect to the standards and practices they adopt, whether for their objects or their modular system components. That is, maturing digital libraries prefer to claim adherence to practices that are already vetted and endorsed by at least one peer institution, rather than to make bold claims for local innovations. This approach has become increasingly apparent. DLF members have recently reached a consensus on a diverse array of essential digital library tools. These tools include the following:

- a model for negotiating access to commercial journals and databases
- minimum requirements for digitally reformatted book and serial publications
- minimum requirements of a digital archival repository for electronic journals, and a data-encoding and transmission scheme that will serve as a means for conveying information about the structural, administrative, and technical characteristics of digital objects[6]

The trend is readily apparent elsewhere, for example, in a framework for evaluating digital collection development practices advanced by a digital library forum convened by the Institute of Museum and Library Services (IMLS 2001).

The sea change in attitude and approach is partly economic. As part of the maturation process, digital libraries transform interesting skunk-works projects into essential library infrastructure. At this stage, failures can no longer be written off as learning experiences gained at limited cost and subsidized with external or soft money. Attitudinal shifts also reflect changing understandings of digital collections and digital library architectures. Where online collections are concerned, maturing digital libraries recognize that they are unable, by themselves, to supply end-users with what they really want—enough online information to meet their specific and evolving information needs. Consequently, they set a high premium on interoperability and on definition and adoption of the standards required to achieve it. The drift toward modular systems architecture is also responsible for new attitudes that favor adoption of more established standards, since systems modules (locally and globally arrayed) must interoperate at a fundamental level. Libraries at this stage demonstrate a desire to pool their collective uncertainties and to define, and then frame, a broad suite of practices as benchmarks in which they can all invest and upon which they can more safely and predict-

[6] DLF-endorsed standards are available at: http://www.diglib.org/standards.htm. Criteria for a digital archival repository of electronic journals are available at: http://www.diglib.org/preserve/criteria.htm.

ably build. Attempts to develop and codify digital library standards and best practices are tapping into this very fruitful seam.

Focus on the User

The maturing digital library also seems to rediscover users. Users do not figure much in the antecedent experimental phase. Why should they? The library at that stage is experimenting with new technologies—a purely internal affair—or looking for additional means of giving users access to holdings catalogs, reference materials, and some journals—areas where users' needs are deemed to be well-known. As the integration of new technologies begins to transform the library and the possibilities for constructing innovative networked services, libraries see a pressing need to engage users and to reassess their interests and needs. By the late 1990s, there was already evidence to suggest that the proliferation of Internet-based information was fundamentally altering the expectations, behaviors, and preferences of library users.[7] Accordingly, the maturing digital library needs to know what users want from the networked library and what role users perceive for the library in a constellation of networked information and service providers.

Some of the library associations that take the lead in quantifying traditional aspects of library use have been relatively slow to respond to this new and pressing need. The reasons for this are complicated. To begin with, the metrics are complex and difficult to agree upon. How, for example, should we define what constitutes a "use" of a networked information object? Second, the library associations that are so well suited to developing statistics for traditional library use are typically membership organizations that are driven by consensus, which, in this case, is difficult to engineer. Further, the measures themselves can potentially disrupt the organization by fundamentally altering the criteria by which it admits and excludes new members. Debate about e-metrics is quickly transformed into debate about what institutions should be recognized as leading research libraries and is accordingly difficult to resolve.

Some of the best analyses of user behavior and need take place at the grassroots level in what can only be described as a series of largely uncoordinated guerilla attacks that are mounted at the institutional level and by ad hoc and informal associations. Denise Troll Covey uncovered a wealth of these in a survey of use-assessment methods at numerous digital libraries (Troll Covey 2002). Among the revelations emerging from these fragmented efforts is the extent to which users want to work in highly personalized and malleable online environments, that is, environments that present them with the information and services they actually need at any one time. The operational lessons for the library are twofold: (1) users want seamless presentation of collections and services, irrespective of where, by

[7] This is becoming evident in work conducted by the DLF with Outsell, Inc. The work is described in Dagar, Greenstein, and Watson Healy (2001).

whom, or in what format they are managed; and (2) libraries should consider deploying user-profiling technologies that enable users to configure a networked information environment that meets their specific needs. Both lessons, if taken seriously and reflected in new operational services, have revolutionary implications for the library. The first would integrate the library into a globally arrayed network of information services in a way that challenges its historic organizational insularity. The second potentially obscures from the user's view the library's importance as a portal to that global network, because chunks of the library's collections and services are removed from the library environment and placed into new contexts.

The maturing digital library takes very seriously its users' needs and interests through its support for a suite of activities that have become known as "e-scholarship." Although the phrase has a frustrating tendency to take on new meaning every time it is used, its definition usually includes initiatives that enable scholars to produce and disseminate "publications" with minimal intervention from third-party commercial publishers. Overall library interest in supporting innovative forms of scholarly communication (or e-scholarship) at this point perhaps has less to do with transforming scholarship than it does with a strategy to increase pressure on publishers, who have increased prices dramatically in the past 10 years, particularly in the sciences.[8]

Technical and Organizational Integration

The changing practices associated with the maturing digital library have profound implications for how that library is sustained technically and organizationally and for the manner in which it is promoted. The quest for high-level modular architectures has already been mentioned. It is arguably the most common tendency that is evident among maturing digital library programs. Interestingly, not all digital library programs turn toward general technical solutions for the same reasons. At Indiana and Michigan, general technical solutions are sought for the economies they promise. Indiana, for example, is thinking hard about how to afford the technical development work it requires to integrate the diverse systems environments and data content in use across its various projects. The problem had little to do with local expertise, which is amply available in seven full-time-equivalent staff members who contribute to the DLP through the library and its partners. Rather, it has to do with how—without completely disrupting the parallel projects where their services are

[8] Libraries, as collectors of cultural and scholarly heritage, are in a strong position to supply the services that help researchers, teachers, and learners navigate, find, interconnect, interpret, and use information in whatever form it exists. Libraries are also poised to capture those interconnections and interpretations and manage them as new information. Instead of concentrating on introducing new electronic scholarly journals that attempt to compete with expensive and traditional commercial e-journals—a business that libraries know little about—libraries may find that they are better off building and exploiting traditional services to support and nurture new forms of scholarly communication.

required—skilled staff can be released to the tasks of specifying general technical requirements and investigating potential solutions. Michigan, an older program, reached the same roadblock before Indiana did and for the same reasons. After several years of project work, Michigan found itself re-engineering its online distribution services each time it launched a new digital collection. By late 1999, Michigan's Digital Library Production Service had launched a key project—to build an access system capable of providing user access to the numerous and heterogeneous digital objects that were being supplied through various digital reformatting and other content development initiatives. The fruits of that effort are available in its Digital Library Extension Service (DLXS) system. By mid-2002, Michigan was supplying support and software for that system to 27 digital library efforts around the world.

Virginia's quest for general technical solutions is more a response to users' needs than to economic forces. The media centers at Virginia have adopted their own range of approaches to the production, management, and distribution of the electronic information for which they were responsible, and each has an independent and highly distinctive online presence. The problem is that, from a user's perspective, the fragmentation of digital collections makes little sense. As Virginia thinks about capitalizing on the mass of digital information it has created or acquired through its media centers, it is beginning to envision an online environment that allows patrons to search seamlessly across collections, regardless of whether they were available in print or digital form, and, if in digital form, regardless of whether they were managed as texts, digital images, geospatial information systems, or other types of data. Virginia's notion of an online environment through which scholars can obtain high-quality information—irrespective of how, where, by whom, or in what format it is managed—required it to think hard about building a technical infrastructure that could be generalized and would be capable of supporting its heterogeneous collections.[9]

The apparent importance to the maturing digital library of a general core infrastructure is only amplified by investigation into newer digital library programs. NYU's initial investments in its digital library have been made with explicit reference to the experiences of older programs whose project work stumbled temporarily on a proliferation of diverse data objects and delivery systems. Not wanting to repeat a development path that was becoming well worn, NYU focused its earliest investment (as did Harvard, Columbia, and one or two others) on the development of core infrastructure, assuming that content and services could eventually be built on top of that infrastructure.

The maturing digital library's quest for core technologies seems to bolster rather than to undermine its emphasis on applied research. Michigan, Virginia, Harvard, and CDL, for example, have obtained

[9] See details about Virginia's work with FEDORA at: http://fedora.comm.nsdlib.org/.

or are seeking permanent, base-budget funding for the research and development efforts that are focusing on the identification of core technology. They recognize that such research and development funding is essential to their programs' successes, and that the programs cannot be sustained exclusively, or even largely, on external funding and soft money. At Michigan, investment flows into the development of DLXS.[10] At Virginia, it is reflected in the Digital Library Research and Development Unit, established in 1999. At CDL, it is evident in the establishment of a small unit under a director for education and strategic innovation. Harvard is arguably the most interesting example. As a service to a confederation of largely independent library organizations, the Libraries Digital Initiative (LDI) did not launch as a series of independent projects. It began instead by building a common digital library infrastructure that would support Harvard libraries in their development and exploitation of digital collections. As it reaches the end of its first four years (and the end of the $12-million, one-time funding that launched the program in 1998), the LDI has developed first-generation infrastructure. In its second phase, it will seek a means of ensuring that the infrastructure will be developed and maintained out of whatever base-budget funding is available to the program.

The digital library's organizational integration into mainstream library services is another aspect of its maturation. In its startup phase, the program may be relatively unknown to library staff. Interviewees at more than one institution noted how the programs in their earliest phases were better known nationally than on campus or even within their host libraries. As digital library collections and services develop, their impacts are increasingly felt on local library staff. Reference staff find themselves fielding queries about digital library collections; catalogers consider descriptions for digital objects where once they focused exclusively on bibliographic materials; conservation officers find their work flow and priorities shaped to some extent by the progress of local digital reformatting activities.

The impacts do not flow in one direction only. Library staff members who are responsible for the development of print collections assert their perspective in setting priorities for digital collection development decisions. Bibliographic cataloging practices are considered as the library develops systems that allow users to search across collections, irrespective of their format and location. The hardware, network protocol, and systems choices that technical services make have implications for platform choices in the digital library. If the maturing digital library program emerges out of the skunk works and into the mainstream of library services, it does so in part because the program's work at some stage can neither be safely ignored by nor conducted in isolation from other library services. Ra-

[10] Core or base-budget funding is not the only means by which Michigan supports what it sees as essential technical development work. Having developed a suite of digital library tools in DLXS that can be generalized, Michigan supports their adoption by other programs, thereby supplementing its technical development funds and offsetting some of its development costs.

tionalization is encouraged by the library's relatively inelastic personnel budget. Simply put, digital library programs are able to develop collections and services beyond their experimental phase only by organizing themselves so they may achieve an appropriate functional division of labor. At the very point when a digital library program is ready to hire its second (possibly even its first) metadata librarian, for example, it may also be ready to think seriously about establishing a stronger liaison with the cataloging department.

Rationalization is most evident at institutions such as Michigan and Virginia, which have older digital library programs. At Michigan, the program that reported directly to its three founding partners from the library, the School of Information, and the campus computing service was incorporated into the library, and the program's executive director was appointed as an associate director with responsibilities for IT services and electronic collections. This initial reorganization may have had more to do with changes in the personnel and priorities of the university's senior management than it did with any intrinsic need to rationalize digital library programs.

Still, once implemented, this structure created opportunities for—and even required—further organizational adjustments. Once the program was embedded within the library line, senior library management took pains to smooth its operation with existing library services. New money allocated to the library by a friendly university administration helped considerably in firming up infrastructure support and providing continuing funds for new program development. The library also introduced a committee structure that maximized opportunities for cross-fertilization among library managers in traditional and nontraditional units. By placing the Digital Library Services Division under the associate director, the digital library obtained representation on the library's senior management group—its executive council. From that perch it participated in thinking strategically and operationally about a broad array of library functions that interrelate with digital content, systems, and infrastructure. At the same time, managers responsible for those traditional functions helped think about and shape the digital library's future. As the program evolved, additional departments (the Scholarly Publishing Office, for example) were added as peer units to the existing operational one—the Digital Library Production Service.

Virginia's experience of reorganization is not altogether different, though it was not quite as fundamental. Virginia's program, unlike that of Michigan, was always represented in the library's senior management group through the deputy university librarian**.** One consequence is that the library's senior management had early opportunities to encourage the cross-fertilization of library staff in new and existing units. From an early date, the Electronic Text Center provided basic HTML instruction to library staff—offerings that were as popular as they were effective in giving those staff members insight into the opportunities, as well as the pitfalls, inherent in the online environment. Virginia's staff-share program was also effective in developing mutual understanding across library units and in support-

ing two-way transfers of professional skills. Structural reorganization, which came later, focused primarily on aligning effort at Virginia's media centers and on developing common services, such as digitization facilities and research and development units that they can share.

The DLF survey showed some evidence that consolidation of digital library activities is beginning to take place generally, at least with respect to the development of digital collections. For example, digital library staff members have a limited role in acquiring access to commercial electronic information. At 95 percent of the libraries responding to the DLF survey, that responsibility was vested in the subject bibliographers and other professional staff who were responsible for acquiring print materials. With respect to selecting materials from library holdings for digital reformatting, three-quarters of the survey respondents said that such responsibility was located largely, if not exclusively, in digital library departments and initiatives. Surprisingly, however, in half of those institutions, responsibility was shared with subject bibliographers—that is, with staff in traditional library services.

Reorganization of the maturing digital library has a number of practical implications. As staff members from outside the original skunk works become more involved in developing or supporting the use of digital library collections, the program is at pains to document its practices in various process recommendations, including, for example, guidelines for standards implementation, flow control, and rights clearance. Indeed, the extent of this gray literature provides some measure of a program's maturity. In the skunk works, processes and practices are in flux, and few are responsible for developing and implementing them. As the digital library matures, its collections and services rely much more on professional staff who are distributed across the library and who will require access to such reference materials. Again, the influences flow in two directions. While the maturing digital library typically takes responsibility for practical and process guidelines, the library's senior management, assisted by staff from across the library, supplies the policy framework in which the program's practices are applied. Early in the adolescent stage, for example, collection policies are revised so they can govern the selection of commercial electronic resources as well as bibliographic materials. Later developments include preservation policies that take account of digital as well as bibliographic materials and policies that articulate the library's orientation toward intellectual property and the exercise of the fair-use exclusion with both digital and print materials. Regardless of whether the documentation guides or reflects evolving practices, it is significant. Its very existence recognizes initial thinking about how digital library activities fit into and help fulfill the library's overall collection and service goals. For this reason, it is an important milestone of the maturing digital library.[11]

[11] The local policies, standards documents, and implementation guidelines that have grown up around DLF members' digital library programs are listed in a database at: http://www.diglib.org/pubs/techreps.htm.

Institutions are differently positioned to effect the reorganization that is required to integrate digital initiatives into the fabric of the library. Staff development is a significant issue. However well suited professional librarians are to developing and maintaining high-quality digital libraries, they apply their skills differently in digital and traditional environments. Mastering different techniques requires training opportunities that all institutions are not equally positioned to supply. In addition, reorganization may require libraries to think anew about how, by whom, and in what combinations certain tasks are done. Here, too, there are numerous and substantial differences between institutions. Some lack the nimbleness and facility that is needed to effect such changes, which, at a fundamental level, will determine whether and at what pace a digital library program will mature.

Marketing and Promotion

As a digital library grows, there are subtle shifts in the way it is promoted and presented to the world. Marketing is not unknown to startup programs. Although the target audience is confined to key decision makers on campus (both inside and outside the library) and potential external funders, the marketing challenges in the early phase are important. At the University of California, it took years of committee work and a few well-placed champions to sell the CDL to key decision makers on the nine UC campuses and to the Office of the President. The case for Harvard's LDI was similarly made through committee work, although over a much shorter period of time. Michigan relied on a yearlong symposium.

As digital library programs mature, they gain visibility through their online presence, their success in acquiring external funding, or their ability to attract regional, national, or even international acclaim. They rely as much as ever on effective promotions to senior managers and to external funders. They also find themselves having to appeal to new audiences: to their faculty and other patrons and to other library staff whose own work, as we have seen, is influenced by and contributes to the digital library. Faculty members have a substantial stake because the campus library supports their research and teaching. They also have very different needs with respect to library collections and services—needs that turn on discipline, age, and personal preference. Without exception, the programs where interviews were conducted took pains to promote themselves to the faculty. This was true even of Harvard's LDI, which serves the faculties through the libraries.

At the institutions where interviews were conducted, promotional activities had three things in common. First, the programs took pains to demonstrate that digital libraries could be supported in a way that did not threaten funding for traditional library services, in particular for the development of print collections. It is unclear whether this is a realistic assessment of future funding models or merely an anticipation of future battles for the digital library.

Second, the programs capitalized wherever possible on successful services—that is, services that were well received by patrons, and by faculty patrons in particular. Senior managers at CDL, Harvard's LDI, Indiana, and Virginia were well aware of how much support for their programs is built on early successes, even those successes that owed little or nothing to the digital library program. CDL claims Melvyl (UC's union catalog) as a birthright, even though it was developed by the Department of Library Automation some years before the CDL's founding. CDL's continued maintenance and enhancement of Melvyl (e.g., with electronic "request" services) helps garner the public support it needs to run more experimental initiatives such as those associated with its e-scholarship program.

The credibility that Harvard's LDI requires to develop operational services that do not see the light of day for several years grows out of its host unit's successful and timely delivery of core services such as Hollis (the university libraries' shared catalog). Indiana's DLP builds on the visible successes of LETRS, the audio e-reserves VARIATIONS, and IUCAT, its union catalog. Virginia wrapped its first digital library forays in the cloak of earlier successes, notably with VIRGO, the library's online catalog, and with course tools, the instructional technologies that the library supports in tandem with the university's computing service. In addition, the programs take pains to promote new successes as they become available. In its first several years, CDL as a matter of policy launched a new service or a service upgrade every six months with appropriate system-wide publicity. Virginia's Electronic Text Center vigorously promotes the success it has had delivering its online texts as e-books. Michigan promotes an array of digital initiatives for users, such as geographic information systems (GIS), numeric data, humanities texts, and visual resources that have grown out of research projects.

Early digital library experience at NYU provides an interesting counter-example of the importance of service successes in garnering support for programs that might otherwise be perceived as experimental, or even peripheral, to core library activities. At NYU, in an early digital library initiative supported by foundation funding, the library attempted to place records for full-text electronic resources into the OPAC catalog environment. The initiative encountered several insurmountable obstacles. The host library was inappropriately organized to support an initiative that had both research and operational service components. It also lacked the needed technical expertise. Perhaps the largest hurdle had to do with the poor understanding of metadata that existed at that time. The project concluded, but it was never deemed to be successful by library staff and others who were involved in building and supporting use of the campus's scholarly information environment. This negative experience hampered the digital library program when it was begun again in earnest, and on a far more ambitious and comprehensive footing, years later. Professional staff had to be convinced that not all digital library initiatives were so speculative and so unfruitful.

A third common thread exists in the way that digital library programs promote themselves on campus. Interestingly, they portray themselves as fostering innovation while helping the library fulfill traditional roles. At Harvard, for example, the LDI presents itself both as a means of enhancing the university libraries' abilities to acquire, manage, and encourage scholarly exploitation of the digital scholarly and cultural record and as a mechanism for integrating digital and nondigital holdings. The innovative aspect of the LDI grows directly out of its traditional function, i.e., through the development of new collection management techniques, some of which allow faculty to search for the first time across Harvard libraries' disparate collections. Michigan's digital library program is also promoted as a means of developing and extending traditional collections, notably through digitization and robust access mechanisms that complement traditional bibliographic systems. Where Harvard finds innovation in integrated searches that the LDI permits, Michigan finds it in the enhanced functionality that scholars and students find in monograph and serial collections that can be explored as databases. Michigan's digital library program, especially its digital reformatting of monographs and serials, is a vital component of its traditional preservation program. It has recently moved its preservation-reformatting program from paper to digital as the default strategy for preserving brittle materials. NYU's embryonic digital library program, meanwhile, is oriented around the university's strong interdisciplinary interest in aspects of the performing arts and its location in New York City, capital of the performing arts. Virginia promotes its program's support for the library's historic service orientation toward students and faculty. Through the media centers, Virginia's digital library program helps faculty members in their research and teaching. It also supports faculty innovation in the classroom and in scholarly publishing.

FROM INTEGRATION TO INTERDEPENDENCY: THE ADULT DIGITAL LIBRARY

The digital library is an organizational form that is in flux. It is much too soon to describe the adult program with anything more certain than references to common trends and the challenges they reflect. It is not yet possible to identify any single program that could comfortably describe itself at as fully grown or mature.

Digital Libraries as Infrastructure

It is becoming apparent that the adult digital library program will no longer be organizationally or functionally distinct from the library as whole. When digital libraries mature, we will talk about libraries in a manner that assumes electronic information, computer technologies, and networked collections and services are as much a part of the in-

frastructure as book stacks and catalogs were for the traditional library. It is interesting to speculate whether digital library programs will preserve their distinctive organizational status in anywhere other than in confederal initiatives such as those at UC and Harvard.

Move Toward Permanent Funding

Many believe that as the digital library becomes library infrastructure, the financial resources needed to maintain it will come from numerous budget lines rather than from one line that is earmarked for digitization. In the adult digital library, electronic resources will be acquired from general collection budgets, and digital preservation activities will be supported with general preservation funds. This integration makes sense at a number of levels. If a research library is concerned with collecting, maintaining, and ensuring access to cultural and scholarly information, then it will set priorities for collection, preservation, and access that take into consideration all the differently formatted information that comes under its purview. These integrating tendencies are becoming apparent. The survey responses demonstrated how important core funding is to the digital library. Seventy-one percent of the surveyed institutions noted that their digital library programs depended on some measure of core funding that is reallocated from other budget lines. The same number said that external funding was important, while about 51 percent noted the importance of new money. Everything learned through the interviews suggests this trend is likely to continue. Thus, it is possible that an adult digital library will be characterized in part by its overwhelming reliance on core funding. In addition, there is evidence of digital library activities being supported with funds not earmarked for the digital library per se. UC libraries, for example, are funding a digital archival repository with the same funds used to support preservation microfilming, and, as already indicated, Michigan has made digital reformatting a fundamental part of its book preservation program. Other institutions are changing their collection-development practices in a way that suggests that digital and nondigital materials will soon be funded with general collection development money.

Continued Experimentation

Perpetual experimentation may also be a characteristic of the adult digital library. Interestingly, maturing digital libraries place more emphasis on research and development than do the most experimental startup facilities. We have already noted this emphasis at Harvard, Virginia, and CDL. It is also apparent in data gathered from the survey questionnaire. Those data demonstrate that, on average, DLF member libraries have access to 2.3 full-time employees who are devoted to research and development work. In 2000, DLF member libraries on average spent 10 percent of their digital library budgets (more than $425,000) on research and development. This figure increases to 16 percent if the subscription and acquisition costs for

commercial content (which average about $1,700,000 per institution) are not included as part of the digital library budget. The persistent research orientation was emphasized repeatedly in the interviews. David Seaman stressed how the University of Virginia's digital library program was constantly reinventing itself in a "virtuous" cycle that plowed evolving skills and capacities into the development of new collections or services and the growth around them of new library applications and user communities. Elsewhere, it became evident that digital libraries that had focused their efforts in one area—access systems and digitization at Michigan, the development of core infrastructure at Harvard—require permanent research and development effort to help them play catch-up in others as they develop elsewhere (e-scholarship at Michigan, digitization at Harvard).

Deep Interdependency

Deep interdependency with off- and on-campus information organizations also characterizes mature digital libraries in an academic setting.

Off-Campus

The assumption that libraries will become more interdependent with information organizations off-campus is predicated on the logic of the network's development. Historically, the academic library brought together the information, people, and services necessary to organize, preserve, manage access to, and support the pedagogical and research use of scholarly and cultural information.[12] The rapid penetration of network technology undermined the academic library's underpinnings—the foundation of its physical, cultural, organizational, financial, and professional form. In a networked world, where access to information no longer requires proximity to the physical medium on which it is carried (e.g., printed paper, film), it no longer makes sense for academic libraries to develop research and teaching collections. This is not a question of whether libraries should preserve newspapers and other non-unique cultural artifacts—of course, they should. It is about whether it is economical, or even sensible, for every library to own, manage, and preserve those artifacts. Indeed, if one were to jettison our cultural and professional baggage and start to conceptualize how to manage and secure access to society's information outputs in all formats, we might imagine a close network of information services sustained in part by free-market principles of supply and demand and in part by the philanthropic subsidies supplied by universities, libraries, and organizations that maintain access to our heritage.

[12] Colleges and other institutes of higher education that emphasize teaching over research also developed academic libraries to physically assemble and collocate information, individuals, and services. Their collection and service purview, however, is more defined by local pedagogical requirements than is that of the research library.

As an example, take the large legacy of non-unique print materials. In an extensively networked environment, one can access the information (on screen, on paper, and in other ways) that is carried by these materials without accessing the materials themselves.[13] Does it therefore not make sense to minimize the redundant management of the physical materials and to rely more heavily on electronic access? In a rational economic system, one might at a minimum envision the following:

- service points (academic libraries) managing access (online, print-on-demand, and other means)
- digital repositories (managing electronic corpora and ensuring they are available for different service points)
- print repositories that preserve the physical artifacts and make them available to scholars whose research requires that they handle the objects

One may also imagine a range of services essential to the operation of repositories and service points—services that include registries (or union catalogs) that record information about repository holdings (print and digital) and name-resolution services (assisting in the persistent identification of peripatetic digital files and physical artifacts). In this scenario, many academic libraries are able to relinquish functions having to do with the management of physical and digital materials without impinging on the collections and services they offer to their patrons. In fact, the collections and services they offer are greatly improved and extended as the library takes its place as part of a networked constellation of interdependent information collections and services.

The model is not so fantastic. Indeed, it is already beginning to emerge. JSTOR acts as a distribution agent responsible for ensuring online access to many scholarly journals. It is also an archival repository that ensures that these journals persist in their digital form. As libraries develop trust in JSTOR as both a distribution point and a digital archival repository, and as library patrons get used to accessing scholarly journal content in electronic form, libraries are beginning to remove from their shelves copies of the print journals upon which the JSTOR collection is based. “Deaccessioning” print volumes makes economic sense and allows the library to redirect scarce resources once tied up in the management of JSTOR journals—resources that paid for shelving space, print preservation, circulation, and reshelving work, for example (Lawrence, Connaway, and Brighman 2001). The scenario evolving around JSTOR is missing only one ingredient—a small number of print repositories that ensure persistence of the printed journals that make up the JSTOR collection. Still,

[13] This does not suggest that, henceforth, printed books should be read only “on screen” or on some hand-held device. Rather, we should begin to think more creatively about delivering electronic information through a variety of means, including, for example, localized print-on-demand services.

one hopes and suspects that it is only a matter of time before at least a few such repositories emerge on national and regional bases.[14]

The model that relies upon distributed provision of interlocking service functions works as well—or better, given the volume of information—for materials that are born digital (i.e., those that exist from the outset in a digital form, whether as databases, geospatial information, images, sound, video files, or mixed media applications). The model is being tried in the delivery of library reference services, but it is too soon to assess the result (McClure and Lankes 2001). There is evidence that the model's development need not be impeded by legal and business considerations such as those that may surround the distribution of copyrighted material. The experience of JSTOR and other services, such as the Art Museum Image Consortium (AMICO) and HighWire Press, suggests that there are models that satisfy those who hold intellectual property rights or copyright to information as well as those who have an interest in using that information for research and teaching.

One might argue that the library itself is the single greatest obstacle to a more distributed and economically rational provision of information services. It is difficult to cede to third parties responsibility for collections and services that have historically been provided in-house and upon which library patrons rely so heavily. It is especially difficult when those who are forced to consider such fundamental reorganization are encumbered with professional, cultural, and organizational baggage that defines a high-quality library as one that supports in a single place a very wide range of collections and services—a range so wide that it may now be beyond the reach of any single library.

On-Campus

Assumptions about adult digital libraries becoming more interdependent with information organizations on campus are also predicated upon the dynamic logic of the network's development and use. As the academic library develops into a service organization that supports access to scholarly information in all formats, to users both on- and off-campus, it requires a highly sophisticated technical infrastructure. Although circumstances vary across campuses, the library nowhere manages the sum total of that infrastructure, and it will never do so. Libraries rely on local campus networks that they do not build or manage. In many institutions, they provide access to electronic research and teaching resources but rely on campus units outside the library (e.g., academic computing services, instructional technology divisions, audiovisual departments) to support faculty and students in their use of these materials.

The fragmented organizational approach to information provision that exists on most large campuses harkens back to a prenet-

[14] The Center for Research Libraries is attempting to acquire a complete file of the print copies of journals available through JSTOR. See http://www.crl.uchicago.edu/info/jstor/crljstor.htm.

worked world when discrete information service functions were built on and delivered through distinctive technical platforms. In the early 1970s, campus telecommunications, mainframe computing, audiovisual departments, and libraries delivered discrete information services using very different technologies. In 2002, these discrete functions have migrated into a networked space where they are vastly more difficult to distinguish from one another, in part because they rely upon the same infrastructure. Convergence is evident to some extent in the DLF survey data: 55 percent of the libraries responding noted some formal relation with their IT or academic computing service. Ninety percent claimed either a formal or an informal relationship. Only two respondents (11 percent) indicated they had no relationship, formal or informal, with any other information organization on campus. Convergence has also fostered competition as information organizations assert their claims against that portion of the university's resources that can be devoted to information management generally.

Competition Within the University

Archiving University Information

Interdepartmental competition can impede provision of a new service where no single organization is able to assert a legitimate claim to that service. The best example may be the lack of coordination in the provision of digital archival repositories on campuses. Like corporate entities, universities produce an increasing amount of digital information, much of which has significant long-term value. That value, however, can be realized only if records are maintained. Databases of student records are a foundation upon which future fundraising efforts may be built. Their value can be measured in financial terms. The value of other records is measured differently. Electronic financial and administrative records, most of which have no print equivalent, need to be kept for accountability. Data produced as a by-product of research are a crucial part of the scientific record.[15] Online course materials and a rapidly growing gray literature of pre-prints, working papers, and research data to which faculty and student Web sites contribute are an important part of the pedagogical and scholarly record. Together, these information resources constitute invaluable university assets that are at risk of loss because it remains difficult to locate responsibility and capacity for their long-term maintenance in any one department or in a departmental collaboration.

The DLF survey documents not only the problem's complexity but also some interesting opportunities for addressing it. Excluding administrative and financial data from its purview, the survey sought to determine where libraries perceived the loci of responsibility for the production, distribution, and maintenance of electronic

[15] This is evident in the heavy use that scholars make of the few archives that have been established to collect and manage these data, for example, the Inter-University Consortium for Political and Social Research in Ann Arbor, Michigan.

information produced on campus resulting from or supporting research and teaching. Responses demonstrated that the production and distribution of online research and teaching materials was taking place outside the library—in academic departments and the units responsible for providing academic staff with technical support.[16]

At the same time, libraries perceived themselves as one of the few units on campus with an interest in preserving these materials. Therefore, the library may be positioned to stake a credible claim to some custodial role with respect the campus's digital information assets. The library may fulfill this role in cooperation with other units that have better capacity for providing some of the technological functions associated with large-scale data management and preservation. Some progress is clearly being made. The survey demonstrates that 4.8 percent of the DLF member libraries have developed or contributed to digital preservation policies that include electronic information created on campus but outside the library. At the same time, of four DLF member libraries that are developing digital repositories, only one is doing so in collaboration with other campus-based information organizations.

Instructional Technologies

Competition among campus information organizations has other effects that may impede the library in fulfilling important roles. Such effects are overwhelmingly apparent where the development and use of instructional technologies are concerned. In virtually every DLF member institution, responsibility for instructional technologies is located outside the library. Organizational location need not be a problem; in this case, however, it has resulted in the near-universal deployment of instructional technologies that do not integrate with the digital library. In many cases, instructional technologies or course management systems and digital libraries are being developed independently of one another. Because of the distributed structure of IT on most campuses, this practice appears to be as true on campuses with well-developed digital library programs as it is on those where such programs are just getting under way.

The waste is excessive, even in good economic times. Bibliographic references that may be included with online course materials are not automatically hot-linked to the library's online catalog; in some instances, they cannot be linked. The digitally reformatted materials produced by the library, and the many more such materials produced at other libraries, museums, and archives, and to which most libraries now link through various means, are placed outside the pedagogical purview as it is defined online by instructional technologies. The digital library as a learning resource is therefore put at risk. Meanwhile, faculty and students work in isolation from a

[16] The library's role in producing and distributing electronic information was focused almost entirely on digitally reformatted materials drawn from library holdings. Although the library developed the materials in support of research and teaching, they were frequently not developed in consultation with scholars involved in those research and teaching activities.

wealth of well-organized, high-quality information that is directly relevant to their learning and for which they have already paid, for example, through university and library spending.

CONCLUSION

At research universities, the birth and early growth of digital libraries took place in the 1990s, the time when information technology units and faculties on large campuses were investigating the potential of networked technology for research and administrative support. Each of these libraries has migrated its bibliographic catalogs online and most are turning aggressively to the construction of online finding aids that support discovery and use of archival materials, recorded sound, prints and photographs, and other special and non-bibliographic collections.[17] Research libraries are also aggressively building online journal and reference literature as it becomes digital.[18] Most digital libraries have evolved from nimble and often externally funded projects that are located somewhere just outside the regular "line" into maturing programs that are becoming fundamental and integral parts of the library. Digital library programs seem to take on different complexions that reflect their host organizations' mission, leadership, available funding, and specific collection and service strengths. Although no program is monolithic in its orientation, certain emphases are readily identifiable in maturing programs.

Some emphasize the digital library as a collection development arm. CDL, Cornell, Harvard, NYU, and Stanford, for example, are exploring means of archiving selectively those scholarly materials that are uniquely available in electronic form. Michigan, Cornell, and Yale are using or have used digital library techniques to develop and manage fragile printed materials. There, digital surrogates are created for fragile books and used to develop print and online access copies to save wear and tear on the originals.

Some libraries are beginning to realize how digital technologies might help reduce the costly and redundant management of print materials held by numbers of research libraries. Where libraries can reliably deliver access to online editions of scholarly journals (edi-

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[17] Costs for cataloging collections and making the catalogs accessible online are probably a library's greatest cumulative expenditure. Although bibliographic information for print and electronic holdings is now regularly funneled into the online catalog, much remains to be accomplished in special and archival collections, prints and photographs, microforms, slide libraries, sound recordings, maps, and the numerous other special collections that research libraries own and manage. The task is much larger if extended to Internet resources.

[18] At this point, the amount of money spent annually by DLF members on subscriptions to commercial electronic information dwarfs all other digital expenditures. Electronic journals and reference databases are paramount, but libraries also collect or provide access to electronic texts, statistical data, digital images, geographic information systems, and other digital objects.

tions that evidence suggests faculty and students prefer anyway [Dagar, Greenstein, and Watson Healy 2001]), they are beginning to be able to reduce redundant print copies while ensuring that at least some print editions are made persistently available.[19] Nine campuses of the UC are canceling redundant print editions of selected journal titles while ensuring that sufficient print copies remain in selected campus libraries or shared storage facilities. The 11 Midwest university libraries in the Committee on Institutional Cooperation are beginning to use the Center for Research Libraries in Chicago as an archive for the print journals included in JSTOR. Similar approaches are being explored for other materials.

Some digital library programs emphasize services over collection. But almost half of the DLF members digitize selected rare, special, and other collections as a means of encouraging access to and use of those collections by scholars, students, and a broader public. Library digitization programs were driven initially by curatorial interests. They targeted unique special collections that research libraries owned. Today, an expanding dialog between libraries and scholars is allowing libraries to consider what online resources humanities scholars need. In the humanities, scholars investigate meaningful bodies of information and build ideas and conclusions from a context. Therefore, which collections are digitized will make a difference in how quickly online scholarship will grow. Research using digital resources is beginning to have an impact in the humanities, although it has not replaced the traditional critical mass of books and archives that scholars investigate. Research projects such as the Valley of the Shadow and Perseus are moving disciplines into uncharted and exciting online research territory, and some online journals now link to digital repositories.

Conversion of analog materials to digital is often confused as representing the sum total of what digital libraries do. Clearly, it is not. Experimentation in new forms of scholarly publishing, notably at Virginia, but now increasingly elsewhere, is another kind of service orientation. So is the provision to students of online class resources, such as sound recordings and art history images at Indiana. Other variations can be seen at Carnegie Mellon University, North Carolina State University, and the University of Illinois, where digital library programs explore in depth how users behave in online environments with a view to improving those environments.

The digital library pioneers who led their organizations at an exciting and exploratory time created diverse programs, but with synergies that hold promise through the application of network technologies. It is obvious that network technologies permit users to access information regardless of where information is located, but there are still significant obstacles to deep resource sharing, including the effect that competition among universities has on library cooperation. In addition, the question of whether and to what extent the net-

[19] Most large research libraries use off-site warehousing for less-used print and other materials (Association for Research Libraries 1999).

worked activities of research libraries will affect or inform public libraries, or even those academic libraries that are more oriented toward teaching, remains unanswered.

Historically, libraries fulfilled diverse functions by acquiring and assembling collections, services, and professional staff in a single place. Access to the library and its professionals required proximity to them. The rapid development of network technologies has not eradicated the significance of the library as place and as owner of collections, but it has diminished and will continue to diminish it. Network technologies are forcing a fundamental transformation of the library and the university itself. Against this background, the record of accomplishment recorded in these pages is extraordinary.

In the research library, achievements occurred precisely because these libraries were located in large and complicated environments. First, they existed within the framework of research and development that occurs on large campuses and were, in some instances, able to harness that expertise to their advantage through collaboration. Second, with significant budget, staff, and space, they were able to move discreetly some resources from traditional library activities into digital research and development. To do this, they needed to have a strong vision of the future that enabled them to push a largely process-driven environment into a research and development arena—something that was mostly unknown in the research library in the late twentieth century. This is why so many young programs relied on skunk works or laboratories where library staff worked away from daily operations.

In the traditional environment, the size of the academic library's collection was the single biggest determinant of its national and international status. How the collection was used and how often it was used were matters of smaller concern. In a networked environment, the reverse is true. Print collection size and scope continue to be important in the research library community, but as rich local holdings are supplemented by the ever-broadening array of networked information that includes digital collections, the importance of the physical collection's size is diminishing in favor of instant desktop access. In some disciplines, books from the library's stacks are still used heavily and will continue to be used, but in other disciplines networked resources are eclipsing print.

Because large research libraries are developing and presenting information online, they are grappling with how to present networked information—its look, feel, functionality, and context—and taking on new interpretive and publishing roles. For the first time in decades, research libraries are thinking hard about how to develop and support use of their scholarly and teaching resources. Not surprisingly, the expertise required to plan and create online collections and services that bring together resources for teaching and scholarship is rarely found completely within the library. It occurs instead through the combined thinking of scholars, information professionals, and technologists. The quest might have the beneficial result of integrating the library into the academic community after decades of

it being a stand-alone resource. In some cases, the survey and case study data suggest that this trend is already occurring.

The coordinated provision of networked information services is probably the biggest challenge that libraries, along with everyone else in the academy, face today. In fact, the "stovepipe" organization that is common within universities and the tradition of faculty working as individual entrepreneurs are both significant barriers to the inclusion of the library in enterprise-wide planning. The current rush by faculty to create online learning environments is a good example. Without a campus-based technology approach and collaboration with the library to include digital resources already available, course management systems are doomed to be redundant and limited endeavors at a time when budgets are already stretched too thin. In an environment that has long valued individual, department, or school achievements and that mostly markets itself in bits and pieces to its various constituent groups, the notion of a more coordinated approach to the provision of networked information services, e.g., the digital library, course management tools, or preservation of the university's digital assets, is one that is strange to many in the academy. (More than four years ago, Brian Hawkins and Pat Battin [1998] explored the critical interrelationship between the library and the higher education enterprise as well as the need to transform the academy's traditional organization in order to use technology effectively.)

Early digital projects initiated within the research library have now grown into programs. Programs that began in separate organizational units within the library are moving into the fabric of everything the research library does. As research libraries develop new digital collections and access tools, new physical spaces where scholars, information professionals, and technologists can work together on digital challenges, and new ways to assist scholars in their work (e.g., helping to preserve and access research in digital repositories or assisting scholars to publish with minimal intervention from commercial publishers), the next challenges will include the ability of the research library to embed itself ever more deeply in the scholarly environment and in the transformational change that will occur in the academy at some point from the pervasive use of information technology.

SECTION 2:
CASE STUDIES

California Digital Library (University of California)

University Profile
• Founded 1868
• 9,600 faculty members on 10 campuses: Berkeley, Davis, Irvine, Los Angeles, Merced, Riverside, San Diego, San Francisco, Santa Barbara, and Santa Cruz
• 634 bachelor's degrees; 476 master's degrees; 437 doctoral degrees

Library Profile
The University of California (UC) Board of Regents and President Richard Atkinson founded the California Digital Library (CDL) in 1997. Calling the CDL a "library without walls," Atkinson charged it with selecting, building, managing, and preserving the university's shared collections of digital resources and with applying new technologies to increase use of the university's physical collections across all UC campuses and the state at large. CDL's vision encompasses four strategies: building, sharing, and preserving digital collections; creating tools and services; influencing and supporting innovation in scholarly communication; and fostering strategic partnerships for digital library development. Located in the Office of the President in Oakland, CDL operates with about 45 full-time staff members within the office's complement of 1,500 staff members.

History

The California Digital Library emerged from a series of discussions, begun in 1991, on enhancing Melvyl, a union catalog of UC and other California libraries. Clifford Lynch, then head of the Division of Library Automation for the UC system, presented a draft plan for the future of the online catalog for discussion by UC librarians from all campuses at their regular meetings. The librarians considered the plan and recommended that it be broadened to address what the UC libraries could do together to create a digital environment that they could not build separately. Richard Lucier, who was then the university librarian at UC San Francisco, obtained release time to rewrite the document in consultation with a Digital Library Executive Working Group. Concurrently, the campus chancellors were becoming concerned about the rising cost of the UC libraries and the potential impact of digital technology. UC was in the midst of a budget crunch of significant magnitude at this time.

The result was agreement by the chancellors and the president to create the Library Planning and Action Initiative (LPAI). Lucier was appointed to head this 18-month effort, which was guided by an advisory committee of provosts, faculty, administrators, and librarians. The report of the LPAI (1998) and subsequent regents' budgets embodying the report's recommendations identified seven strategies to help guide the UC libraries through a transition from a campus-based and print-centered service model to one that blends print and digital information and more effectively leverages the shared resources and capabilities of the UC system. The three principal strategies were to (a) sustain adequate campus print collections, (b) expand the sharing of collections among the UC libraries, and (c) establish the California Digital Library as a shared digital collection and digital library environment for the UC system. After a national search, Lucier was named the founding university librarian for system-wide scholarly information and executive director of the CDL, which emerged as a "co-library" of the University of California system.

Because CDL was born during a fiscal crisis, the plan that the advisory committee developed bound the budgetary crisis with the electronic future. By sharing existing print collections and developing a shared digital collection, the system could make the most of its limited resources. The budget proposal, which was finally approved by every academic senate and by the UC administration, emphasized resource sharing but also made up for some of the drastic reductions

that campuses had experienced in their print budgets owing to the recession. The proposal included some money for resource sharing (an improved interlibrary loan program among the campuses that later turned into circulation of the "university-wide collection") and financial support for building a system-wide electronic environment. Upon the urging of UCLA Provost Charles Kennel (chair of the LPAI advisory committee) it also included an increase of more than $12 million over three years to campus libraries for their print collections.

Initial Progress and Future Challenges

The CDL helps provide infrastructure that lowers the cost to campus libraries of delivering high-quality online collections and services. Its investment in bibliographic catalogs, electronic collections, digital library tools and services (reference linking, persistent object naming, cross-collection searching), and consensus building around various standards and good practices provides what the campus libraries commonly require but are unable to develop independently. Work in three areas—Melvyl, a consorital licensing operation, and an e-scholarship program—is indicative of the progress but also of the challenges incumbent in this approach.

Melvyl remains the jewel in CDL's crown. Well before the CDL was established, it had gone some way toward encouraging scholarly exploitation of campus collections as if they formed a part of a single university collection. The addition by the CDL of a request service through which patrons can initiate interlibrary loan (ILL) requests online from the catalog interface, and a courier service through which interlibrary loan requests can be delivered overnight, greatly fostered the trend. Since the inception of these services in 1999, the number of interlibrary loan requests has increased dramatically. In fall 2003, the ILL service will be further enhanced with the addition on each campus of high-volume digitization facilities capable of digitizing requested items and delivering them to patrons online. Yet Melvyl and its ancillary services cast a long shadow. Their maintenance absorbs scarce technical resources and as such could impede the pace of innovation and development that may be required of a maturing digital library.

In support of a shared university collection, the CDL hosts a consortial licensing operation that systematically acquires access to and, where appropriate, enriches commercial electronic materials under terms and at costs that are favorable to the UC libraries. The shared collection of commercial electronic journal and reference databases is available system-wide and extends local holdings at marginal additional cost to campus libraries. Experience with shared electronic collections is cautiously being extended into the domain of print, but by the libraries as a collective rather than by the CDL. As UC libraries cancel subscriptions to printed journals that are also available electronically, they are asking whether they can act together to ensure that a physical copy of record is maintained at least somewhere within the university. They are also taking an in-depth look at strategies

for managing distributed collections of printed government documents. The discussion forces libraries to confront very difficult issues of ownership as well as access—issues that could test the limits of collaboration.

An e-scholarship program stimulates and facilitates innovation in scholarly communication in support of research and teaching, and includes tools and services that facilitate the creation, production, peer review, management, and dissemination of scholarly publications. The program responds to a recommendation of the LPAI task force to experiment with new means of scholarly publishing. The task force found that "the present system of journal publication no longer meets faculty needs to distribute information quickly and effectively" and in a manner that makes economic sense to the university. The e-scholarship program's biggest success is its working papers and e-prints repository. Still in its early days, the repository is attracting deposits from UC faculty. Changing scholarly communications, however, requires a great deal more than new technical services and experimentation on the part of some faculty at a single university. It requires change in scholarly practice generally. By providing alternative forms of scholarly communications, libraries can exert some influence. Also required is the active participation of—even leadership from—academic quarters.

The CDL's early progress is due in part to fortuitous timing. The rising cost of information and a state budget crisis helped move CDL planning to implementation. The success of the Red Sage Project at UC San Francisco, the creation of a statewide consortium in Ohio (Ohiolink), and the emerging licensing models from publishers supported the concept of shared or consortial acquisitions of electronic scholarly journals, reference databases, and other commercial content.

Support of all the campus libraries was also important, especially from the largest, i.e., Berkeley and UCLA. By 1996, the Berkeley library was already a nationally known center for digital library development. Given the severity of the budget crisis in the 1990s, some at Berkeley were concerned that funding for CDL would decrease resources for digital library development at the campuses. UCLA was enormously supportive; in fact, the support of University Librarian Gloria Werner was a key factor in the successful start of the CDL. In time, Berkeley, through sharing its expertise and experiences, also became enormously helpful. It has taken a lead in important collaborative digital library developments, including the Online Archive of California (a union catalog of finding aids) and the planning of a digital archival repository for UC libraries.

Strong political alliances were equally important. The provost of UCLA, the chair of the advisory board, and key librarians, who had worked together and had developed trust, provided underlying support. The health sciences librarians, who had a long history of collaboration, provided support early on. Lucier, Werner, and Phyllis Mirsky, deputy university librarian at UC San Diego, were three critical leaders with health sciences backgrounds. The CDL also benefited from a densely interlocking committee structure that exists to this day.

The CDL's ability to deliver on its service promises, to move quickly from planning to action, and to demonstrate its benefits to the campus libraries in real and quantifiable terms has also been important, though may be under threat as the service grows. In its first few years, CDL released new collections and services on a regular semiannual basis. It continues to report out on the real savings that are involved in the development of shared collections and digital library infrastructure. The CDL has also fostered interchange among the campus libraries by bringing campus staff to work at the CDL on a short-term basis (and paying them), by hosting digital library development forums jointly with other library committees, and by co-developing with campus libraries various digital collections, services, and tools. It has finally built relations with faculty who need to drive and endorse the goals of the CDL and the system-wide library planning agenda more generally.

According to Lucier, now librarian at Dartmouth College, CDL's continued success depends on the spark of individuals who are willing to work together and on their drive to accomplish this work. Other challenges facing the CDL include (1) maintaining its fiscal health during the current state budget crisis; (2) facilitating development of a shared university library collection that comprises both digital and print materials; (3) developing a technical and organizational infrastructure that enables it to manage legacy services while supporting more speculative development initiatives undertaken on behalf of the UC libraries; (4) encouraging faculty exploitation of alternative means of scholarly publishing that are being developed by the e-scholarship program; (5) continuing to stimulate and find rewarding challenges for the CDL's very high-caliber and energetic staff; and (6) maintaining agility in the context of a large and rambling bureaucracy. Confronting these challenges will require a more stable operations environment within the CDL; continued collaboration, trust, and understanding among the UC libraries; inclusive discussions and decision making within the CDL; and a perpetually refreshed vision of the university libraries' strategic directions.

Harvard University (Cambridge)

University Profile
- Founded 1636
- 18,000 students
- 2,000 faculty members, plus 8,000 faculty members in the teaching hospitals
- 164 bachelor's degrees; 74 master's degrees; 72 doctoral degrees

Library Profile
- 14,437,361 volumes held
- $80,862,137 total annual expenditures
- 1,088 staff members (excludes hourly employees)

The Harvard University Library (HUL) is part of Harvard's central administration and serves as the coordinating body for the more than 90 separate libraries that make up the Harvard library system. HUL develops and implements library services and programs that are centrally provided, including library systems, off-site storage; preservation, university archives, and digital initiatives. The largest group of Harvard libraries is found in the Harvard College Library, which administers 11 libraries for the Faculty of Arts and Sciences, including the Widener Library.

History

In the mid-1990s, there was comparatively little digital library activity at Harvard. One exception was the development of Web portal services that opened to electronic journals and other commercially supplied content. The reason Harvard was less active than other universities may be due in part to the highly decentralized structure of the university. Each of the faculties has its own endowment, receives tuition dollars from its students, and is taxed for common services. On the Harvard campus, the name that has been given to this decentralized system is "Every Tub on Its Own Bottom" (ETOB).[1] The faculties are expected to be entrepreneurial and autonomous, and because the libraries in effect belong to the faculties, they are also highly decentralized. Cost recovery is an integral ingredient in ETOB; therefore, just as the Harvard faculties pay the university for some services, individual libraries pay the HUL for systems, storage, and some digital library services. In turn, the HUL provides services and products that the libraries want and need.

By the late 1990s, the involvement of HUL Associate Director for Planning and Systems Dale Flecker in the Digital Library Federation's program and architecture committees brought him into contact with early major innovators. They included staff from Michigan and Cornell, and peers in other research libraries that were beginning to build digital library infrastructures. As a result of discussions with Flecker and others, HUL Director Sid Verba convened a group of administrative deans, faculty members, and librarians. Under the chairmanship of Harvard College Librarian Nancy Cline, the committee was charged to consider how Harvard should begin its digital library program.

The committee recognized that building a common infrastructure was of prime importance. The group's focus on building infrastructure, as opposed to digitizing collections, reflected the recognition that collections responsibilities were highly distributed

[1] Outside Harvard, ETOB is called Responsibility (Revenue or Value) Center Management (RCM) and has been adopted by numerous large universities, including the University of Pennsylvania, University of Southern California, University of Minnesota, and Indiana University. The opposite approach to the traditional centralized or general funding concept, RCM makes each academic unit responsible for generating its own income through tuition and other revenue and for managing its own expenditures. In RCM, libraries can be funded by the academic units as a common good or remain a separately "funded off the top" entity.

throughout the 90 libraries. The committee believed that a strong infrastructure could help lower the overhead to the libraries creating digital collections and help build coherent information solutions. It envisaged that the central program would have a consulting and educational role as well as responsibility for building centralized systems and services that would be shared by all the libraries. Through grants made to the libraries and other parts of the university, the committee hoped to entice the community to participate in a coordinated infrastructure. The program was named the Library Digital Initiative (LDI) and was placed in the Office for Information Systems of the HUL.

Sid Verba argued to the university administrators, particularly to then President Neil Rudenstine, that if Harvard could replace its central accounting systems, a very expensive project, it should also provide funding to develop the digital library, an endeavor more important to fulfilling the university's core mission. Verba requested and received one-time funding of $12 million to be allocated over five years from President Rudenstine's discretionary funds. Five million dollars of this sum is being spent on the grant program, leaving $7 million for building the infrastructure. This initiative, like others at Harvard, will eventually be supported at least in part by cost recovery. The plan to establish and fund a digital initiative was virtually unopposed by the faculties, in part because new money had been found to support it and because the library had already achieved considerable success in developing a highly regarded Harvard union catalog.

The LDI's focus is practical and systems oriented; it has no direct ties to faculty research. A reflection of Harvard's decentralized organization, the LDI provides services to the university's many distributed libraries. Because the role of LDI is to provide the infrastructure and that of the libraries is to use that infrastructure to provide services appropriate to their particular clientele, the Harvard libraries, and not the LDI, are meant to connect directly to the faculty. Harvard's librarians work well with one another, sharing values, a common profession, and a growing recognition of their interdependence. Their success in developing a microfilm and an online catalog, as well as completing the retrospective catalog conversion of more than five million titles, has prepared them to look for opportunities to develop other shared activities.

Now and the Future

Because of the strong book culture at Harvard, particularly in the Faculty of Arts and Sciences, Nancy Cline has approached digitization as a logical extension of the continuum of recorded knowledge. She believes it is Harvard's responsibility to access and preserve digital materials in the same way that it has accessed and preserved print materials. The LDI offers Cline and others a place to become involved with digital library activities and to begin to build an infrastructure even while many of the faculty are not yet interested in or

aware of the research potential of digital materials and services. The College Library is making a substantial commitment to e-journals and promoting this commitment in terms of its historical role in developing collections. Because of its strong preservation and conservation program, the College Library is also using digital preservation to manage heavily used print collections.

Three digital reformatting facilities are being created: one in Widener to digitize page material; one in the art museum to digitize photographs, slides, and art works; and one in the music library to digitize sound and related materials. The LDI supported building one of these centers, and the Harvard College Library financed the other two. Each of these centers is being integrated into the LDI infrastructure, and the digitized output will feed directly into the depository. At this point, digitization occurs when the library needs to minimize the handling of selected materials or to conserve deteriorating materials and when faculty members request that materials be digitized (e.g., some slide and pamphlet collections). Given the size of the collections, conservation at a very large scale is a primary driver at Harvard.

To increase the use of digital materials, a number of libraries that are being renovated are creating new kinds of spaces for collaborative learning and for learning in a multimedia setting. Major renovations are occurring in the business, law, divinity, and medical libraries and in the Widener Library. Renovations are being coupled with outreach by librarians, who are teaching students and faculty members how to use the Web and other digital resources.

The activities of the LDI staff consist of consulting, training, and raising the awareness of the issues in digital libraries, e.g., metadata, reformatting, and digital acquisitions, as well as building a technical infrastructure. LDI is a central resource for education and consulting, and its consultations have now extended to the museums and other parts of the university that have research collections.

For the future, a primary activity will be to continue building the infrastructure.[2] The first-generation systems now in place include those for converting and storing technical and descriptive metadata, access management, naming, and cataloging. Most of the LDI effort to this point has been spent developing systems rather than content. LDI is only now beginning to populate its systems.

To access objects in the repository, metadata about the objects must be made accessible through various LDI-maintained online catalogs. Libraries (and others) fund the cost of preserving and accessing materials stored in the repository. A number of libraries are using the repository, as are the art museum and the School of Public Health. The professional schools are the least involved at this point. The major cooperative effort across the libraries is still consortial purchasing, which is accomplished at HUL by at least two full-time employees who oversee the processes of identifying, evaluating, and negotiating access to commercial digital content.

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[2] Flecker was influenced strongly by Robert Kahn's and Robert Wilensky's seminal article, A Framework for Distributed Digital Object Services (May 1995). Available at: http://www.cnri.reston.va.us/k-w.html.

HUL recovers the marginal cost of storage and preservation from units using the repository. LDI has defined three levels of preservation responsibility for materials deposited in the repository. First, LDI will assume full preservation responsibility for materials deposited in preferred ("normative") formats, along with the prescribed metadata. LDI will provide only "bit preservation" for materials in a second list of formats. Preservation of materials in formats not yet listed remains undefined. Over time, LDI will address the preservation status of a widening range of formats. Libraries must adhere to the standards and expect to be billed for migration. Metadata standards for text, images, and sound have been completed; film and video are not. Flecker expects the repository use to grow substantially.

Because President Rudenstine allocated one-time funding to the LDI, Flecker and his office must address the issue of funding in the next phase of the program. He worries that digital libraries are developing more slowly than had been predicted, that the cost of infrastructure development will be larger than estimated, and that they may have underestimated the time needed to develop a mature infrastructure.

Challenges

Harvard faces the following challenges in developing its digital library:

1. Because Harvard is highly decentralized and wealthy, the various faculties frequently have little reason to collaborate. On the other hand, collaboration among the libraries has been noticeably successful and has produced services that faculty and students appreciate across the institution.
2. Information technology (IT) services are fragmented throughout the institution and within the libraries. For example, the Widener Library relies on HUL for its integrated library system and digital library services, on the central IT Department and the Faculty of Arts and Science's Academic Computing Department for network support, and on both central departments and the Faculty of Arts and Sciences for administrative data. The difficulty of developing digital library initiatives in a distributed computer environment is matched by the difficulty the university is experiencing in developing tools for online course management.
3. The book budget is sacred, especially to the Faculty of Arts and Sciences. Fifty-five percent of the collections budget is endowed (and therefore restricted); the remainder is faculty-driven. It is difficult to use acquisitions dollars for anything other than books and journals. This is not to say that the faculty members do not want electronic resources: they do want them, but they want them to be supported through funds that supplement the traditional collections budgets. At Harvard, senior faculty members strongly influence many decisions in the library.
4. Faculty interest in technology is wide but conflicting. Some faculty members want to take full advantage of the newest technology;

others, many of whom are senior faculty, do not. Those who have a strong interest in newer options have smaller voices; for this reason, some librarians fear that Harvard will miss opportunities that other institutions will seize. Many wonder whether President Lawrence Summers's notion that Harvard should be giving more to the country will lead him to urge that the Harvard libraries become leaders in digital preservation and access.

5. LDI needs to make its cost recovery in digital initiatives work. It may request significant additional presidential funding because the required infrastructure will not be completed within the five-year period, even though there is a solid first generation of production systems in place. Over time, LDI hopes to move the cost of building and updating the production systems to one of the common goods (ETOB) paid by the faculties. LDI also requires core funding that may exceed $1 million annually for ongoing innovation, consulting, and outreach.
6. Future priorities for LDI include more concentration on born-digital materials, on integration of digital library content and infrastructure with other systems within the university (course management systems) and with other libraries nationally, and on digital preservation.

Conclusion

Harvard is developing an interesting and creative program in a unique and difficult environment. The argument that the library needs to demonstrate a role in digital space as a natural outgrowth of a historical role in nondigital space is beginning to work, but very slowly. By emphasizing infrastructure, conservation, and preservation, the library may be able to build a substantive collection of digital materials of all kinds, much as the Library of Congress has done. Because of the environment, however, library involvement in end-user services that could actively support research and learning will vary greatly across the university. With the approach the Harvard libraries are taking, scholars will use the materials in the digital repository in their research, much as they do now with books, but the library could remain more or less in a traditional role for some time into the future.

People Interviewed

Sid Verba, director of the university library; Dale Flecker, associate director for planning and systems in the university library; Nancy Cline, librarian, Harvard College; Tom Michalak, executive director, Harvard Business School, Baker Library; Harry S. Martin III, librarian, Law School Library; Hugh Wilburn, librarian and assistant dean for information services, Frances Loeb Library; and Barbara Graham, associate director of the university library for administration and programs.

Indiana University (Bloomington)

University Profile
- Founded 1820
- 37,963 students
- 1,709 faculty members (full-time equivalent)
- 5,204 bachelor's degrees; 1,582 master's degrees; 401 doctoral degrees

Library Profile
- 6,314,658 volumes held
- $26,459,375 total annual expenditures
- 313 staff members (excludes hourly employees)

History

When Suzanne Thorin assumed the post of dean of libraries at Indiana University (IU) in 1996, the libraries had no formal digital library program. There were, however, three "bright-light" initiatives: VARIATIONS, a streaming audio music e-reserves project; LETRS (Library Electronic Text Resource Service); and DIDO (Digital Images Delivered Online), an art-image data bank that served the School of Fine Arts. None of these projects had base funding in the libraries, although LETRS had been provided staff from University Information Technology Services (UITS) since the former's inception in the late 1980s.

VARIATIONS, one of the earliest streaming audio experiments, operated in a "skunk-works" environment in the campus music library. The music library was headed by David Fenske, now dean of the College of Information Science and Technology at Drexel University. Fenske drew funds for the project on an ad hoc basis from the deans of the music school and libraries and from UITS. IBM provided some equipment and advice. Jon Dunn, an information technologist who has had a major role in shaping the Digital Library Program (DLP), was the primary technical force behind VARIATIONS.

LETRS was begun in the early 1990s as a partnership between the libraries and the computing center, with joint staffing, space provided by the library, and equipment provided by the computing center. It provided the model upon which the DLP was eventually built.

One abiding characteristic at Indiana, which exists in part because of limited funding, is a robust collaboration between the libraries and information technology (IT) units. In the 1980s, with the advent of NOTIS, the first eight-campus library management system, the two entities recognized that they would be forever joined—for better or for worse. The libraries had long relied on UITS for storage and security of their digital output. During the late 1980s, the relationship grew. Librarians and technologists established INFORM, a discussion group where the two cultures informally explored matters of mutual interest and got to know each other's worlds. These discussions produced a series of campus forums that culminated in a national Public Broadcasting System teleconference called "Networked Information and the Scholar."

In January 1997, six months after Thorin arrived at IU, Michael McRobbie, who came from the Australian National University, became Indiana's vice-president and chief information officer (CIO).

With academic computing and administrative computing already merged and the addition of telecommunications to the IT organization nearly completed, McRobbie began to direct IT at the Bloomington and Indianapolis campuses, which had previously been administered separately. With funding from President Myles Brand, McRobbie was able to transform long-term and divisive discussions about equipment into an action plan for campus-wide purchases through life-cycle funding. Brand and McRobbie also obtained additional state funding for technology to support teaching and learning.

All eight campuses subsequently participated in extended discussions that led to the adoption of a three-year IT strategic plan under which base and one-time funding was allocated for existing digital library projects, including VARIATIONS; the digital library program, including research and development; and electronic records management. Thus, through a plan that incorporates resources to implement it, a centralized ("czar") model for IT has evolved at the eight-campus university.

Before the discussions that led to the IT strategic plan took place, Thorin struggled with how to shape decentralized and underfunded digital projects and to build a broader, more cohesive digital environment in the libraries. (Thorin had planned the first technology conference at the Library of Congress when Librarian of Congress James Billington sought advice about turning American Memory into a real national digital library.) She engaged Michael Keller, university librarian and director of academic resources at Stanford University, as a consultant. She also explored activities taking place at the University of Michigan, where Dan Atkins and others were building a robust digital library environment. McRobbie, as well as Blaise Cronin, dean of the School of Library and Information Science (SLIS), were enthusiastic about adopting the Michigan model, with UITS, the libraries, and the SLIS as partners.

With Keller's recommendations in hand, Thorin reorganized Library Information Technology by merging two departments and appointing a new director, Phyllis Davidson, to a joint UITS/libraries position. Kristine Brancolini, long-time head of media and reserves for the library and a copyright expert, was appointed director of the DLP.

This early developmental period was filled with change, and not all library staff were happy with what was unfolding. The creation of the DLP and related events temporarily destabilized what had long been a predictable environment.

With respect to presidential leadership in IT, the situation at Indiana was similar to that at Michigan. At Michigan, then-President James Duderstadt worked through a number of colleagues in the School of Engineering and in IT to foster change. Indiana's Brand has given consistent and enthusiastic support to IT, primarily through McRobbie's leadership. McRobbie's support has helped numerous efforts, including the DLP, proliferate, particularly on the Bloomington and Indianapolis campuses. This approach is also making implementation of current multicampus efforts, such as building an effec-

tive course management system and dealing with e-scholarship, a more cohesive process than it is in the decentralized environments at some large institutions.

Growth

At first, Brancolini and Dunn were the only full-time DLP staff members other than the technical UITS staff in LETRS and the full-time systems administrator in the music library. Others who participated part time included the head of preservation and an area studies catalog librarian, who added metadata expertise. The team's early efforts to obtain grants were unsuccessful. These failures were learning experiences both in writing grants and in building technical expertise. By the time Indiana was awarded a $3-million National Science Foundation grant in 2000 to expand VARIATIONS into a digital music library for teaching and learning, the program had achieved great success in grantsmanship.

As DLP staff grew as a result of support from the UITS strategic plan and reallocation of library staff, the roles of the partners changed. Perhaps because the SLIS gets its academic credibility from linking with other academic units rather than with library or technology services, its involvement has diminished, except where it contributes funding for a specific purpose, e.g., encoded archival description (EAD) training.[1] The recent addition of the School of Informatics to the DLP partnership gives the program a new opportunity for an applied research component.

Overall, the maturing program has worked in the following five areas:

1. building program, staff, organization, structure, and funding
2. stabilizing funding and technology for VARIATIONS, LETRS, and DIDO
3. building expertise through national collaboration
4. building integrating technology at the lowest level (server storage that can be used by multiple projects) and at the next level (the software infrastructure)
5. integrating the DLP into the libraries' operations

Organizationally, the program reports to the dean and has a mandate to roam and create both in the Bloomington libraries and on the other IU campuses. To explore program integration, Brancolini, Davidson, and associate deans Martha Brogan and Harriette Hemmasi have held weekly discussions for more than a year and have codified all the libraries' digital efforts to set the stage for developing a plan for the future.

The DLP is also exploring how faculty can interact more deeply with the program and how the program can exert influence in Indi-

[1] This situation somewhat parallels that at the University of Michigan, where the School of Information is heavily involved in digital library research, but its partnerships with the library have diminished in the past few years.

ana's research environment. There are a number of faculty-led DLP projects, including one in folklore being considered for Mellon funding and another in archaeology/informatics, but there is as yet no consistent or organized participation. Now that it has emerged from the nuts-and-bolts stage and is maturing, the program has an opportunity to move to a more integrated and strategic institutional approach.

Challenges

Indiana now faces challenges in technology and strategic thinking.

- *Technology*. When the program began, it inherited the infrastructure available to VARIATIONS and LETRS to deal with audio and texts, and since that time, staff have built up technology expertise in images (e.g., DIDO, the Hoagy Carmichael Collection). With the technology infrastructure being built piece by piece, the present challenge is to integrate digital content now located in a variety of software and hardware environments. The DLP has an opportunity to take advantage of the IU mass storage service, which includes tape and disk base storage for all types of data, in 1- to 2-terabyte disk caches and tape libraries that have a 300-terabyte total capacity. Research data of all sorts are being stored, and VARIATIONS is the second-largest user through its WAV and MPEG files. (The largest user is high-energy physics.) With UITS facility providing a general low-level infrastructure, the DLP will work on the administrative and management access software layer that would sit on top of the mass storage and enable cross-collection searching.

  To explore the creation of a digital repository, the DLP is looking at general services that it could provide to units in the library and on the campuses that might want the DLP to manage, preserve, and provide access to digital information. With the new emphasis on partnerships within the libraries and an evolving role for Library Information Technology, staff will have increasing roles in these endeavors.[2] Through a working group of librarians, IT staff, and faculty, this concept will be explored in fall 2002. The DLP's participation as a beta site in FEDORA (Flexible and Extensible Digital Object and Repository Architecture), a University of Virginia Libraries venture to build a repository, is part of IU's own repository exploration.

  The other main technology ingredient in IU's digital library program is the University of Michigan's DLXS (Digital Library Extension Service) software, which is used in LETRS, where they have implemented the text class and will be implementing the im-

[2] The IU libraries are a partner with Stanford University Libraries in building a production system for LOCKSS (Lots of Copies Keep Stuff Safe), a way to archive electronic journals. Funded by The Andrew W. Mellon Foundation, the National Science Foundation, and Sun Microsystems, the IU libraries IT unit is creating software to manage the archived electronic journals within library operations.

age class in the future. The extent to which DLXS integrates with FEDORA and other work remains to be seen, but DLXS does not provide a repository solution at any rate.

- *Strategic Thinking*. The DLP is struggling to find effective ways to codify and to communicate its knowledge to a broader community. In some respects this is a promotional activity—and opportunity. In addition, the program needs staff who are dedicated to infrastructure development and do not have project responsibilities. With such success in obtaining grants, the number of projects keeps growing, and the thinking that needs to take place about the overall infrastructure keeps moving into the background. The program believes it can make its mark in the humanities and the performing arts.

  Because it is unlikely that numbers of additional staff will be hired (except temporarily through grant support), the DLP is challenged to use existing resources to build an integrated program. The meetings involving Brancolini, Davidson, Brogan, and Hemmasi have been productive in sorting out what parts of the library and the DLP can take leadership on any issue. In the case of the Teaching and Learning Technology Center, now being built in the main library, for example, there are opportunities for DLP staff and bibliographers to interact with faculty who are learning how to integrate technology into their classes. Leadership for placing the libraries' created and purchased digital information into the course management system, OnCourse, is also a shared responsibility.

  Potentially fruitful points of contact between DLP and other parts of the library include the following:
  - Research and Development (R&D): Does R&D occur mainly in the DLP and cross into the library? Can the libraries request that the DLP conduct R&D for needs in their areas?
  - Metadata: What is the relationship of the new metadata librarian in technical services to the DLP and to the repository project?
  - Equipment: How can Library Information Technology partner with the DLP to ensure that the libraries have an IT framework that suits the DLP ventures?
  - Faculty projects: Some faculty will approach bibliographers, and others will come to the DLP. How can efforts be integrated so that the faculty members get the best services?

The absence of a shared vision concerning the library's digital future will lead to focusing on second-order issues, such as who does what or who is stepping on another's boundaries. It will also promote duplication and limit progress. Therefore, the fruitful discussions that the four managers have had and that have produced an impressive list of existing endeavors need to be transformed into real strategic planning.

Summary

Although Indiana was not one of the early digital library pioneers, it has developed its digital program rapidly in the past six years. Capitalizing on a coherent, multicampus IT environment that is adequately funded, the digital library program has concentrated on building expertise and gaining a national reputation. Its current challenge is to build an integrated library through system-wide planning and implementation—a library system that capitalizes on the university's strong centralized IT structure and is motivated by critical changes taking place in teaching, learning, and research.

People Interviewed

Michael McRobbie, vice-president for information technology and CIO; Kristine Brancolini, director of the DLP; Gerry Bernbom, assistant to the vice-president for digital libraries; Perry Willett, assistant director, DLP; Jon Dunn, assistant director for technology, DLP; Martha Brogan and Harriette Hemmasi, associate deans; Phyllis Davidson, director of Library Information Technology; Jennifer Riley, digital media specialist, DLP; Jake Nadal, acting head of the Preservation Department; Jackie Byrd, acting head of the Acquisitions Department; Sybil Bedford, digital imaging specialist and metadata cataloger, DLP; Randall Floyd, digital library system administrator, DLP; Ken Rawlings, programmer analyst, DLP; Radha Surya, electronic text support specialist, DLP; Andy Spencer, project manager for the Russian Periodical Index, DLP; Natalia Rome-Lindval, electronic text specialist, DLP. Suzanne Thorin participated in some of these interviews as Indiana University dean of libraries.

New York University

University Profile
- Founded 1831
- 48,000 students
- 3,100 faculty members in 14 schools and colleges
- Six locations in Manhattan
- 89 bachelor's degrees; 108 master's degrees; 91 doctoral degrees

Library Profile
- 3,936,625 volumes held
- $28,694,958 total annual expenditures
- 324 staff members (excludes hourly employees)

History

When Carol Mandel was appointed dean of libraries at New York University (NYU) in April 1999, she found little digital library development under way. The reason for this vacuum was a very traditional approach to teaching and learning at the university—an approach that was mirrored in the library.

Before 1998, NYU's information technology (IT) infrastructure was highly fragmented, comprising three independent units that reported to three vice-presidents: administrative computing, academic computing, and telecommunications. The units were operationally successful each year, but no strategic or multiple-year planning took place. In fact, at that time the university administration did not view IT as being a significant factor in NYU's planning.

For years, the library administration had discouraged collaboration with the IT units; as a result, none occurred, except where creative staff worked together across lines by stealth or at least without formal sanction or encouragement. Although the library provided television services and media support for campus classrooms, there was little synergy among and within the organizations. Lacking a strong campus technology infrastructure, the library network was cobbled together.

Things began to change in the early 1990s, when the library received a grant from The Andrew W. Mellon Foundation to produce an online catalog that would provide links from the catalog to full-text commercial and government resources via a Z39.50 interface. This initiative was soon overtaken by new technology, notably the World Wide Web. The grant enabled NYU libraries to test some technology applications; e.g., they developed online finding aids that linked to digital surrogates for selected holdings. However, the original purpose of the grant was not realized, which disappointed staff and impeded progress in planning for the digital future. Additional factors that impeded progress included the unsupported technical environment, the absence of standards, and the lack of library staff who had the technical skills to apply the few standards that were available and who had relevant project design and management skills.

In 1992, the university administration convened a faculty committee to investigate the effectiveness of academic computing. Libraries were included in the committee's mandate. A subsequent

committee recommended that a chief information technology officer (CITO) be appointed to look after a full range of computing.

In 1998, Marilyn McMillan was appointed CITO and the IT units were merged. McMillan instituted a stronger technical support system and increased the hours of the help desk from eight hours a day to 24/7. By the time Mandel was interviewed, she recognized that the university had come to view the effective use of IT as essential to its research and teaching missions. The new administration expected that the CITO and the dean of libraries would work as a team.

Together, Mandel and McMillan worked, as they put it, "to take the clippers to the barbed-wire fence" that had been built between the separate information organizations. They formed a team of staff members who had collaborated on technology-related matters behind the scenes, and this team identified areas where the two units could work together. These areas included infrastructure, the library's network, digital library development, authentication, and publications. As a first and highly symbolic effort, the organizations merged their existing handbooks for faculty and students into a single publication. The team offered other suggestions that helped Mandel and McMillan restructure, retool, and staff their respective organizations.

In the recent past, new money had not been available, but the library and the IT units often saved what they called "budget dust," or year-end funds. Since Mandel and McMillan have been working together, a limited amount of new money has been made available to the units. In fiscal year 2000/2001, each organization received program improvement funds that are being used to build infrastructure. In addition, in March 2001, the board of trustees voted to impose a technology fee of $50 per term for full- and part-time students enrolled in degree programs and to earmark the proceeds for the improvement of student computing services.

With some restructuring in place, Mandel and McMillan are exploring how to effect other needed changes. They are discussing the merit of some shared library/IT positions. Librarians have academic status and tenure, but Mandel has some flexibility to appoint new staff who have digital library skills and experience. Although the two have no formal plan for building their digital presence, they have used a shared approach to articulate the purposes, goals, and benefits of the digital library initiative in various planning and budget documents. These descriptions will be part of a discussion in a new deans' working group on libraries and information technology that will feed into planning under way as part of a new presidential administration. The plan will need to be in alignment with the administration, but seminal work being accomplished now will create the platform on which to develop specific digital goals.

The Future

The platform being built includes the following tactical initiatives:

1. *Hiring appropriately skilled personnel.* Although NYU has a number of talented digital library staff (most of whom are supported by grant funds and some of whom are on loan from IT), they need to build a stable team using base funding.
2. *Conducting selective experimentation* through discrete projects to help design the infrastructure requirements for the future.
3. *Building storage capacity*. David Ackerman, director of *e*Services, and Peter Brantley, director of library information technology, have been working with Sun Microsystems to create a Digital Library Center of Excellence. NYU had been building a portal using Sun infrastructure, and the libraries took the initiative to interest Sun in building the center. The libraries also made Ex Libris a third partner in this effort, after working with the company to implement SFX reference linking. Sun products will supply very significant computing and storage capacity (SF 15K), which the library will divide into two areas: (1) research and development and (2) production and other necessary digital library infrastructure components.
4. *Designing a program around NYU's strengths and needs while positioning the library nationally and internationally in a leadership role*. The current thinking is that NYU will build on its strengths in the performing arts (audio and video) and on its orientation toward visual and multimedia materials from many subject areas taught and researched at NYU, including performance and film studies. The program will build on NYU's location in a city that values visual and performing arts. It will emphasize the university's strengths in computer science, in intellectual property law, and in selected special collections. Mandel and McMillan want to make progress in the difficult area of copyright for multimedia and believe they can provide national leadership in this area.

   Through a program funded by The Andrew W. Mellon Foundation, the libraries are focusing on how to clear copyright for recorded music so that it may be used in educational settings. Rights and authentication issues are main emphases of the NYU programs. In the Napster debate, for example, NYU students were concerned not only about sharing music files but also about maintaining the rights to the materials they had created themselves.

   The University Press reports to the dean of libraries. Mandel hopes to position the press to produce reference works electronically. Mandel and the press director are debating how and what to digitize. In addition, Mandel wants to digitize material that is high profile—i.e., that has eye-catching content—to bring the libraries good publicity. The library is highly regarded by the faculty already because it consistently publicizes its efforts.

   Mandel and McMillan also muse about other issues: How can we increase production? Who are our natural partners? What born-digital material should we collect and preserve? Should we digitize our brittle books? How can we relate more closely to

teaching and learning? How can we use Mellon support to preserve moving images? How can we develop a program that is integrated into both the library and the campus?

Obstacles

Potential obstacles lie in two principal areas: technical and personnel.

Technical. There is considerable demand for bandwidth at NYU, with 20,000 students in residence halls and others in rented facilities where ISP services are needed. Although this problem exists nationwide, it is more intense at NYU because of its city campuses, which use instructional learning technologies heavily. In spring 2000, 30 courses used Blackboard, Inc., software for online teaching; by spring 2001, 700 classes with 8,000 students were using instructional technologies. NYU offers some 7,000 classes with online components, and growth is exponential. Another obstacle is the unpredictable nature of the market for technology. Different components of the university's core infrastructure will become obsolete at different times, fundamentally changing the nature and demands for interoperability. Again, this is not a problem that is unique to NYU.

On the other hand, the work that NYU has accomplished in developing its portal has given the staff broad and deep experience with front-end applications. They have confidence that they can continue to meet and exceed the expectations of their community.

Personnel. Challenges include finding appropriately skilled new library staff members as well as developing and retraining the existing staff. The differences between library and IT cultures is also a concern. The culture of librarians with tenure may be a barrier at a time when teamwork and the amalgamation of library, professional, and technical cultures are necessary for success. There is also a lingering legacy of skepticism among library staff members, who witnessed earlier failed efforts at technology innovation. Finally, a major issue is whether the library and the IT groups can obtain enough financial support to build a viable program.

Conclusion

The energy in NYU's startup program is contagious. While the staff and dean think out loud (they call it "trolling and sniffing"), they have actually created the time needed to reflect, explore, and shape their program while they build the infrastructure needed for continued excellence.

University of Michigan (Ann Arbor)

University Profile
- Founded 1817
- 39,439 students
- 3,710 faculty members
- 186 bachelor's degrees; 229 master's degrees; 145 doctoral degrees

Library Profile
- 7,348,360 volumes held
- $41,368,972 total annual expenditures
- 459 staff members (excludes hourly employees)

History

Distributed computing was emerging at Michigan in 1991 in a campus-wide mainframe environment with a proprietary but robust operating system, the Michigan Terminal System, that had its origins in the 1960s. Daniel Atkins, then interim dean of the School of Engineering, and Doug Van Houweling, vice-provost for Information Technology, became concerned about how distributed computing would change Michigan's information environment and whether the library could adapt to the change.

Along with Donald Riggs, director of the University Library at that time, the two administrators led a yearlong symposium on library information technology and on how the library would need to transform itself in a networked environment. In another group, which was chaired by former University of Michigan President Robben Fleming and included Dean Robert Warner of the School of Library and Information Studies, Atkins, Riggs, and Van Houweling distilled the first report into three recommendations:

1. The complementary expertise of the library and the campus information technology (IT) communities should be harnessed.
2. The university should invest in visible projects to learn by doing.
3. An information community based on library principles should be created.

Provost Gil Whitaker presented the recommendations to an enthusiastic President James Duderstadt. Meanwhile, the authors had already decided to take a next step: investing $375,000 to develop their ideas and to jump-start the changes. They asked Wendy Lougee to take a one-year leave of absence from her position as head of the graduate library to assume responsibility for building a collaborative digital environment. She was given independence from the library administration, a separate budget, and an office in the graduate library. Lougee was charged with developing projects that would test technologies and bring the three partners together synergistically.

When Lougee began her work, the three organizations were very different from what they are today. The Information Technology Department (ITD) was a large organization with more than 600 full-time employees that focused mostly on infrastructure; the School of Library and Information Studies (SILS), under Atkins, was just beginning to think about re-engineering itself; and the library operated in a traditional mode.

Atkins, who had already developed close ties with a number of publishers and foundations, especially Kellogg Foundation and the National Science Foundation (NSF), took the lead in applying for grant funding. He brought leading figures to Michigan to observe the program and to engage in discussion about its future. Atkins always included representatives from the library in these discussions because he valued librarians' knowledge about how to organize information. Van Houweling removed some ITD staff from day-to-day operations and lent them to the digital effort.

A big boost to the program's credibility occurred in 1994, when NSF, the Defense Advanced Research Projects Agency (DARPA), and NASA awarded SILS a Digital Library1 grant. The grant supported an investigation of agent architecture (decomposition of query mode with various software programs) to define and develop interfaces and an infrastructure for users and providers that would create a comprehensive "library" environment. At this point, the library and SILS began to work effectively together. Librarians brought their expertise in the principles of librarianship, service ethics, and an understanding of collections to the research team, which included economists, psychologists, and educational researchers. Engineers, who mostly guided the project, were somewhat dismissive of librarians' input**.** Michigan's participation in the TULIP project,[1] its early JSTOR testing of 10 economic journals, and its leadership in PEAK[2] provided complementary research and helped infuse content into the project.

By 1996, Lougee believed the digital library program needed dedicated staff. Van Houweling contributed $400,000 so that Lougee could hire IT staff; the Media Union's IT director, Randy Frank, agreed to provide machine-room support for digital library services and equipment up to $250,000 per year.[3] The library also contributed funding. The result of this financial support was the birth of what is now called Digital Library Production Services (DLPS) and the involvement of expert campus technologists who worked on evolving models for storage and connectivity. (NSFnet began at the University of Michigan.) A few years earlier, Lougee had recruited John Price Wilkin to return to Michigan to head the Humanities Text Initiative (HTI), and in 1996 he was appointed to head DLPS. DLPS pulled to-

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[1] TULIP (The University Licensing Program) was a collaborative project (1991–1995) of Elsevier Science and nine American universities, including the University of Michigan, to test systems for networked delivery to and use of journals at the user's desktop. For more information, see http://www.elsevier.nl/homepage/about/resproj/trmenu.htm.

[2] PEAK (Pricing Electronic Access to Knowledge) was a collaboration between Elsevier Science and the University of Michigan (1997–1999) that explored pricing and delivery alternatives for more than 1,100 Elsevier science journals. PEAK gave Michigan experience with large document stores and enabled staff to develop expertise quickly. The final report on the PEAK experiment is found at: http://www.dlib.org/dlib/june99/06bonn.html.

[3] The Media Union offers traditional and digital library resources, while also supporting high-performance computing, virtual reality, and multimedia experimentation.

gether various activities that had hitherto been scattered across the campus and initiated creative thinking about how to integrate a range of projects and to build the infrastructure necessary to do so.

In the mid-1990s, Michigan participated in or directed a number of format-based projects: the Museum Educational Site Licensing Project (images), HTI (encoded text), JSTOR (page-based documents), and fledgling work with numeric data. Also during this period, Michigan developed, with Cornell University, the Making of America (MOA), a digital library that documents American social history from 1850 until 1877. Michigan scanned about 1,600 monographs and nine journals and focused on access (searchable text), while Cornell focused on preservation (facsimiles).[4]

In 1995, Lougee was promoted to an assistant director of the University Library. At this point, the digital library program was represented through her membership on the library's administrative team. She used financial incentives to entice library staff to participate in the initiatives and allocated funding for staff development in the digital arena. Lougee was also given responsibility for selecting e-content for the library and began to work with library selectors, vendors, and publishers. During the period of collaboration with Atkins and Van Houweling, Lougee's independence and role as a change agent made some in the library administration uncomfortable. But with a different library director, William Gosling, Lougee's new role as a high-level administrator in the library, and increasing opportunities for staff, the digital library program began to gain some of the recognition internally that it already received nationally.

Abrupt Change

In fall 1995, James Duderstadt announced his resignation. A new president, Lee Bollinger, was appointed in November 1996. He appointed Nancy Cantor as provost. Atkins resigned as dean of the School of Information and resumed a faculty position, and Van Houweling left Michigan to become the president of the University Corporation for Advanced Internet Development. Active university support for and interest in the digital library program vanished almost overnight. However, Provost Cantor did give the library significant unrestricted money, which enabled Gosling to move a number of digital library staff from soft to base funding. Within two years, the atmosphere at Michigan, along with the priorities of the institution, had completely changed. Gone were the days when Atkins and Van Houweling could walk in the back door of the president's home and discuss the digital future.

While moving from a mainframe to a distributed environment, the ITD, under Van Houweling, was still a large organization that included telecommunications and academic and administrative com-

[4] A second phase of Michigan's MOA, also funded by The Andrew W. Mellon Foundation, focused on documenting the methods and economics of digitization but also produced nearly 10,000 additional digitized volumes for Michigan.

puting. Jose Marie Griffiths, who succeeded Van Houweling and also was appointed Chief Information Officer, had both a conceptual and operational role during her five-year tenure. She was charged by the provost to re-conceptualize the information technology environment and to move some operations to the schools and departments. As schools and departments accepted responsibility for their information technology operations, she developed a federation among information technology staff to foster collaboration. She also had responsibility for the operation of all centralized campus systems and the staff who supported them. She was an advisor to the digital library program and helped to ensure that the program's funding was strengthened by transferring to it significant base funding from her operations.

In 2001, with Griffiths's departure, along with that of Bollinger and Cantor, psychology professor James Hilton was appointed associate provost for academic information. He does not hold the title or responsibilities of a chief information officer. Hilton argues that the pendulum has swung so far to a distributed environment that it is likely to swing back to some centralized functions in the future. His philosophy is that the central IT unit should provide the core infrastructure, with the schools and colleges adding applications on top of it. Hilton defines core services as the network, security, and other elements that the smaller schools and colleges would define as core.

At present, Michigan's IT environment could be described as fairly chaotic. The institution moved suddenly from a president who was evangelical about IT to one who seemed to believe it was tangential. Seven years after Duderstadt's departure and the appointment and departure of other high-level administrators, a new president will need to address the legacy of two dramatically different approaches to information technology.

According to Hilton, the most distinctive feature at Michigan today may be the depth of its distributed IT environment. Like Harvard, Michigan has considerable financial support, and the various schools and colleges operate autonomously—"tubs on their own bottoms"—as at Harvard. The IT environment is diverse, and the individual units have few reasons to cooperate with one another or to invest in an institutional approach. Central IT provides services by agreement only with units that choose not to develop their own information technology infrastructure. The challenge is how to build collaboration in the present distributed environment. Creating common course management tools is a special challenge, as is bringing library resources and services easily into a Michigan instructor's online environment.

Today

The rich collaboratory that flourished under Duderstadt diminished with his departure. However, library funding added by former Provost Cantor and funding transferred from Griffiths to the library have increased the library's digital library base to $6 million. DLPS

currently supports 30 full-time equivalent positions. The School of Information, under Dean John King, continues to support a percentage of three digital library salaries, but at this point the school's collaboration with the library is minimal. The digital library program is now embedded solely in the library. At the time Lougee left Michigan in June 2002 to become university librarian at the University of Minnesota, her portfolio had expanded to include the Library System Office, Desktop Support Services, Digital Library Production Services, and the recently created Scholarly Publishing Office (SPO). She was instrumental in overlaying a traditional library organization with groups that deal with issues such as access to electronic resources, networked information, e-collection, and information technology policies and priorities.

The program itself has moved into a production phase. No longer do staff members encode every text; instead, DLPS has built a core infrastructure with a framework of minimal encoding that can be supported across media. They have defined various object classes and produced several interchange formats that enable them to leverage similar functionality across corpora.

With digital preservation now the policy in the library, DLPS has responsibility for digitizing books for preservation purposes. Specific collections are not targeted; instead, preservation staff select titles to be digitized using the condition of the object as the measure. In cases where the books are disbound (and sometimes even when they are not), the book is not recreated in paper, rebound, and returned to the shelf or even returned to the shelf after digitizing; instead, it is available only online. Selecting materials for this growing database of digitally reformatted content, for the most part, takes place at some distance from the scholarly community.

The chief purposes of the SPO are to increase interaction with the faculty and to experiment with new publishing models. The SPO aids faculty authors in finding alternative venues for publishing. It also works with small society or university presses to migrate existing print publications to digital. The office specializes in creating born-digital publications and in developing and enhancing electronic versions of conventional print publications. It also helps develop mechanisms for publication and distribution of scholarly digital research projects.

Finally, the digital program sells memberships to other libraries to its search engine and middleware so that they can develop their digital library collections. This Digital Library Extension Service offers members a suite of tools for mounting collections, including text, images, bibliographic data, and finding aids. Training workshops and e-mail support are provided with membership, which has expanded to 27 institutions worldwide.

Conclusion

The history of the University of Michigan's digital library program is extraordinary in nearly every way. Its beginnings document what

can only be called planets in alignment: a visionary president who contributed funding and nurtured an experimental environment and administrators who encouraged collaboration across the academic community. Michigan's digital library program, while still supported magnificently, is now a library-based program that is focused primarily on reformatting and providing services to other libraries and organizations. Changing leadership at the university level has forced changes in the digital library program. With the departure of Lougee, the last of the adventurers from the Duderstadt period, it will be interesting to track how Michigan's program evolves in the next years.

People Interviewed

The authors met with William Gosling, director of the University Library; Wendy Lougee, associate director for Digital Library Services; John Price Wilkin, head of the DLPS; Christie Stephenson, assistant head of the DLPS; Christina Powell, coordinator of Encoded Text Services; Maria Bonn, head of the SPO; James Hilton, associate provost for academic information and instructional technology affairs; Daniel Atkins, former dean of the School of Information, now director, Alliance for Community Technology and professor of electrical engineering and computer science; and Doug Van Houweling, former vice-provost of information technology and now president and chief executive officer, University Corporation for Advanced Internet Development (Internet2).

University of Virginia (Charlottesville)

University Profile
- Founded by Thomas Jefferson in 1819
- 18,848 students
- 1,904 faculty members (including clinical faculty)
- 44 bachelor's degrees; 63 master's degrees; 54 doctoral degrees

Library Profile
- 4,678,553 volumes held
- $25,844,109 total annual expenditures
- 298 staff members (excludes hourly employees)

History

In the early 1990s, the University of Virginia (UVA) libraries were largely traditional in their services and thinking. Kendon Stubbs, a visionary and long-time UVA library administrator, began scanning the horizon looking for trends and markers that could point to future directions that the library needed to consider. He encouraged interested colleagues in the library and the university to talk about the future. Stubbs realized that the impact of technology on the academy would create fundamental changes within the library. As a bold first step, he appointed David Seaman,[1] then an English Department graduate student, to establish an Electronic Text Center in Alderman Library. The center opened in 1992. Since then, it has sought to build and maintain an Internet-accessible collection of SGML texts and images and to establish user communities adept at the creation and use of these materials.

Therein lies the heart and soul of Virginia's digital library program: it is focused on the scholar. The center's goal was to encourage e-text creation within the scholarly community, and it structured its work around faculty interests, using scholars and graduate students to help select and encode the texts. The staff of the Electronic Text Center are direct links to the faculty and have work spaces in areas of the library where faculty can find them easily. Early on, their efforts "created a buzz," even though the first projects were opportunistic. Seaman contacted high-profile faculty and persuaded them to use electronic materials and to spread the news across the campus. From 1993 until 1997, the center taught many faculty members how to create searchable texts. Seaman characterizes this service as a "big honey pot—a real attraction for the library." But, at that point (as now) faculty interested in using electronic resources were outnumbered by those who either were not interested or who actively defended traditional library services.

At the same time the Electronic Text Center was being set up, the Institute for Advanced Technology in the Humanities (IATH) was being created for faculty. Stubbs made sure that IATH in effect "grew up in the library," where it now supports a full-time staff of nine. In addition to staff, two fellows in residence and nearly two dozen other fellows have active research projects, several of which have their

[1] David Seaman left the University of Virginia in July 2002 to become director of the Digital Library Federation.

homes in the Alderman Library. Having IATH located in the library enabled the library to enrich its experimentation with faculty-led production and use of electronic resources. Through the University's support for IATH, the library, which is usually short on resources, receives an infusion of benefits.

University Librarian Karin Wittenborg recalls that during the early years of digital library development, she worked hard to elicit the support of the deans. The university president, an advocate of the library generally, did not climb aboard the digital library effort until he visited the Electronic Text Center and learned what was being done there. Fortuitously, Martha Blodgett was the successful candidate in a national search for the position of associate university librarian for information technology. Blodgett had been at UVA in the campus Information Technology and Communication (ITC) Department. Since her appointment in the library, she has been instrumental in fostering collaboration between ITC and the library. The *Instructional Toolkit*, a project Blodgett headed while in ITC, is an example of an ITC service that had not previously interested the library, even though the toolkit included a module for "library resources." The toolkit provides the resources to create, distribute via the Web, and manage instructors' online course packets. Once in the library, Blodgett was able to identify electronic reserves as a potential toolkit use that fit with library priorities. Now, 80 percent of the faculty members have toolkit pages, and the library receives regular accolades from the faculty for the range of scanning and toolkit support services it offers. At first, Wittenborg notes, the students were not a driving force in the digital program, but now she can count on them to push new technology developments.

One of the interesting aspects of Virginia's human resources environment is flexibility, both in the use of space and in staff assignments. Instead of building a production facility outside the library organization, the program at Virginia has worked within the organization from the start. To provide space for IATH and the Electronic Text Center, staff were, as Wittenborg put it, "clumped." Those doing traditional work who occupied prime space were moved to less publicly accessible spaces. As the success of the program grew, the staff members who were physically displaced, along with others, could and did take credit for that success. It is useful to note that librarians at Virginia do not have tenure or teaching faculty status, even though they are included in the category of "general faculty." Instead, they have three-year appointments that are renewable. The basic requirement for a librarian position is a master of library science degree or some other relevant master's degree. The staff is not unionized. These qualities maximize the library's flexibility in appointing and reassigning staff. In addition, for the past 10 years, staff members have been encouraged to spend 10 to 20 hours a week working in units outside their own. As the digital centers evolved, staff members from all parts of the library participated through this "staff-sharing" program. Ideas hatched and skills acquired were brought back to home units. Also, subject selectors were required to

develop Web pages for the academic departments that they serve, thereby giving them firsthand experience with creating an online resource. Flexibility is also evident in the higher administration. Wittenborg described a time when the library had no funds and appealed to the provost to make a critical hire. Her request was approved within a day.

Now and the Future

The fluidity within the library has nurtured interdisciplinary collaboration among the faculty members. Where they used to retreat to their studies, faculty members now confer with one another in the library in collaboratory settings. These spaces have been cobbled together, not through renovation dollars but because of an entrepreneurial spirit. The library supplies physical space, equipment, and large-scale support for almost any kind of digitizing operation, including support for grant-funded and other faculty research projects. The digital future, including the development of digital collections and any new services, is closely linked to faculty needs.

In its early stages, the library made a commitment to purchasing e-resources with a view to developing a critical mass—or, in David Seaman's words, "enough stuff to make it interesting." The library also made a commitment to integrate e-resources in the catalog—wherever there is both a print and an electronic version, the catalog employs a single record. In recent years, the library has created a digital content fund, that is, an allocation from the acquisitions budget that is targeted to specific nonbibliographic digital content, full-text, image, or statistical or other data. That funding is provided for one-time purchases and for subscriptions for up to three years, at which time each subscription is evaluated for continuing support within the regular acquisitions budget. This transitional mode helps subject librarians think about how to use collections funds for both digital and traditional materials. As for e-resources, Virginia has purchased fewer than the median of Association of Research Libraries (ARL) until recently, when the library set a goal to be in the top quarter of all ARL libraries.

To move this successful program further into the future, Wittenborg and the associate library directors have initiated the development of the "library of tomorrow," which seeks to blend digital and traditional library services. In beginning this project, the library formed five planning teams to explore issues and to make recommendations. The library administration expected to have about five volunteers for each team, but when they sent out a call for participation, they received requests from more than 80 staff members, or a third of the staff. As a result, each of the five planning teams had more than 15 members. Documents were posted electronically as they emerged. Thus far, groups have recommended a digital library production services unit and more emphasis on digital library research and development.

The central production service, established in August 2001, is the vehicle for library-initiated digital production. The staff is deciding

what to digitize and what to purchase in all the formats. There is some tension between the centers and the central production unit over roles and responsibilities, but this conflict will likely be worked out in time. The second recommendation has resulted in a prototype digital repository using FEDORA built in collaboration with the Computer Science Department at Cornell University and funded by The Andrew W. Mellon Foundation (Payette et al. 1999).

The dual emphases of the digital program are (1) to serve as a central repository and a production unit, both of which leverage and support the work of what are now three digital centers (e-text, geostat, and digital media); and (2) to build a set of robust services for the faculty through information communities.

Conclusion

The relatively small size of the University of Virginia and the physical environment of the campus have contributed to the success of this program, which is tailored to the research and teaching needs of the faculty. With the library sharing its spaces with scholars and concentrating on their continued active involvement, this program emerges as a fine example of an integrated, holistic approach to building a digital library.

The library is contending with a number of challenges. These include the integration of different formats (e.g., text, images, GIS) that will be archived in the repository. It will be a challenge to manage content and to deliver it into different and often unimaginable service environments. A further challenge is to identify what higher-level services should be built. In this respect, Virginia's strength is in its centers, where strong relationships with faculty, and hence a good understanding of future needs, have been developed. Without much additional funding from the university, the library at Virginia has reallocated and redistributed its own resources, has been enormously successful at obtaining grants, and has built what may be the only deeply scholar-centered digital library program in the country.

People Interviewed

Karin Wittenborg, university librarian; Kendon Stubbs, deputy university librarian; Martha Blodgett, associate university librarian for information technology; Diane Walker, associate university librarian for user services; Thornton Staples, director, digital library research and development; David Seaman, director, Electronic Text Center; Melinda Baumann, director, digital library production services; James Campbell, director, Internet access services; Michael Furlough, director, Geospatial and Statistical Data Center; Anne Whiteside, fine arts librarian; Judith Thomas; director, Robertson Media Center; and Benjamin Ray and David Germano, faculty members in the Department of Religious Studies who use technology in their research and teaching.

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Coalition for Networked Information: http: / / www.cni.org

Perseus Digital Library: http: / / www.perseus.tufts.edu /

Valley of the Shadow: Two Communities in the American Civil War. http: / / jefferson.village.virginia.edu / vshadow2 /

APPENDIX 1

Survey Respondents

California Digital Library
Columbia University
Cornell University
Emory University
Harvard University
Indiana University
North Carolina State University
Pennsylvania State University
Princeton University
Stanford University
University of California, Berkeley
University of Chicago
University of Illinois at Urbana-Champaign
University of Michigan
University of Minnesota
University of Pennsylvania
University of Southern California
University of Tennessee
University of Texas at Austin
University of Virginia
Yale University

APPENDIX 2

Survey Data: Principal Preliminary Results

1. Policy environment

Statistically speaking, the policy environment is well developed with respect to university information strategy, intellectual property, and copyright. Policies for distance learning and preservation are less prevalent, though possibly in a way that represents a trend toward their development.

Table 1.1. *Prevalence of different types of policies within DLF member institutions*

Policy type	% claiming this type of policy
University-wide information technology policy	95
University policy pertaining to IPR assignment	95
University copyright policy	90
University policy on distance learning	62
Preservation policy	33

2. Funding for digital library programs

New money, grants and gifts, and reallocation of core funding are almost equally important in funding digital library initiatives.

Table 2.1. *Funding sources for digital library initiatives*

Funding source	Number responding to question	Yes as % of those responding to question	Yes as % of total responding
New money	12	86	57
Grants/gifts	15	100	71
Reallocation	15	100	71

3. Objects of digital library expenditure

The principal costs for digital libraries, based on average 2000 cost, are as follows:

- commercial content (40%)
- equipment and infrastructure (23%)
- digital library personnel (18%)
- content creation (7%)

Libraries spend an average of $95,000 per year on subscriptions to membership organizations.

Digital library expenditure	Range of costs 1999	Range of costs 2000	Average cost 1999	Average cost 2000	Change in average costs	% change in average cost
Commercial content	$1,507 - 2,000,000	$1,061 - 3,000,000	$1,500,000	$1,700,000	$200,000	13
Digital conversion (content creation)	$2,400 - 1,090,600	$37,992 - 1,145,000	$277,418	$285,766	$8,348	3
New forms of scholarly communication	$0 - 119,700	$0 - 225,685	$27,400	$32,240	$4,840	18
Digital library personnel	$2,400 - 1,622,600	$100,000 - 1,703,730	$631,369	$786,000	$154,631	24
Equipment and other infrastructure	$1,500 - 4,000,000	$7,500 - 3,514,350	$720,011	$987,700	$267,689	37
Systems R&D	$5,000 - 1,200,000	$0 - 3,200,000	$280,716	$255,907	-$24,809	-9
Participation in consortial DL activities	$0 - 300,000	$0 - 100,000	$29,732	$29,265	-$467	-2
Support for grant-funded R&D	$0 - 159,000	$0 - 320,000	$52,550	$169,900	$117,350	223
Subscription to membership organizations	$59,000 - 174,974	NA	$95,775	NA	NA	NA

Table 3.1. *Objects of digital library expenditure, 1999 and 2000*

The fact that more money was being spent on equipment and infrastructure than on personnel was initially surprising, but it may indicate that libraries are gearing up their digital library initiatives and have to equip them.

4. Creation of digital content

Digital libraries have, on average, as many digital imaging as encoded text creation projects and have produced an average of 270,000 images and 1,000 encoded texts. The variation across digital libraries is considerable.

Content created	Number of projects	Average number of projects	Number of FTEs (range)	Average Number of FTEs	Annual investment in content creation (range)	Average annual investment in content creation
Digital images	2 - 25	8.4	1 - 4.5	3.1	$5,000 - 3,000,000	$270,000
Encoded texts	0 - 31	6	0 - 6	2.6	$0 - 4,341	$975
Digital sound and video/film	0 - 6	2	0 - 2	0.65	$0 - 13,940	$1,240

Table 4.1. *Investment in content creation*

5. Organization of digital libraries

The variation in organization of digital library initiatives is illustrated in Table 5.1.

Location of digital library initiative	Number	%
Confederally organized	2	11
Within independent unit of library	6	33
Distributed across library/ coordinated by some team approach	4	22
Distributed across library/ not coordinated by some team approach	4	22
Too small to say	2	11

Table 5.1. *Organization of digital library activities*

Few digital library initiatives, centralized or otherwise, operate without at least some formal or informal relationship with another university unit that has some role in developing and managing the university's information assets.

The most important "other unit" is the information service or academic computing department. About 90% of those responding have some connection with such a unit, followed by a connection with the university press (41%), and an LIS or equivalent academic department (21%).

Only 10% of those responding to the question had digital library initiatives that were entirely independent of other units.

Type of unit	Formal connection with unit (number/total responding to question and percentage)	Informal connection with unit (number/total responding to question and percentage)
IT or academic computing	11/20 55%	7/20 35%
University press	2/20 10%	6/20 30%
LIS	2/20 10%	2/20 10%
No other department	2/20 10%	0/20 0%

Table 5.2. *Contact between library-based digital library activities and other university units outside the library*

6. Staffing of digital library initiatives

Staffing levels for digital library initiatives vary considerably across DLF member institutions (from about 7 FTEs to about 48 FTEs). The average is 18 FTEs.

Table 6.1. *Level and functional distribution of digital library staff employed by the library*

Digital library activity	Staff FTEs in library (range)	Average staff FTEs in library
Library management systems	2.75 - 15	6.5
Content creation	2.5 - 11.5	6.1
Development/maintenance of access systems	1.5 - 21	5.7
Total	6.75 - 47.5	18.3

On average, library-based digital library staff members are distributed about equally between library management systems, content creation, and development and maintenance of access systems.

Responsibility for various digital library activities (content selection, content production, user support) is taken largely by subject bibliographers and staff members located in digital library units, with subject bibliographers taking a lead role.

- Subject bibliographers are predominately responsible for selection of commercial content at 95% of respondent institutions and for development and maintenance of Internet gateways at 71% of responding institutions.
- Digital library staff members are predominately responsible for digitized library collections at 71% of responding institutions, but they share this responsibility with subject bibliographers at 51% of responding institutions.

Responsibility for user support is thinly spread across different groups of library staff with no single group taking primary responsibility. This suggests that user support is either widely shared or not considered a priority.

About half of the libraries responding said their digital library initiatives had access to staff in other (non-library) departments. On average, those who used staff outside the library had access to 9 FTEs distributed as follows: 4 FTEs for library management systems, 4 FTEs for content creation, and 1 FTE for access systems development.

Table 6.2. *Staff outside the library involved in digital library initiatives*

Digital library activity	Staff FTEs outside of library (range)	Average staff FTEs outside of library
Library management systems	.5 - 16	3.8
Content creation	.25 - 12	4.0
Development/maintenance of access systems	.25 - 4	1.1
Total	1 - 32	8.9

7. The library's relative role in creating, providing access to, and preserving digital assets within the university that contribute new forms of scholarly communica-tion (e.g., e-journals, e-print repositories, digitized content, library content)

Creation. Many units within the university are taking responsibility for producing digital content that contributes new forms of scholarly communication. The library is primarily responsible for the production of that content based on library holdings: 95% of respondents claim this responsibility for the library over other units.

Responsibility for other such content is spread across units with academic departments taking primary responsibility for e-print repositories (52% of those responding), e-journals (52% of those responding), and distance learning materials (62% of those responding). IT and academic computing departments have limited responsibility for producing digital content of any kind.

Access. The library is primarily responsible for providing access to digitized library content in 90% of the institutions responding, e-journal content in 81%, e-books in 76%, and e-prints in 57%. No other unit approaches that level of responsibility for any type of collection listed.

Preservation. Only the digitized library holdings (the creation and distribution of which the library is primarily responsible) appear to be secure. Most respondents claim that the library takes responsibility for preserving these holdings. Other kinds of digital content (e.g., e-journals, e-prints) are apparently at risk. Very few of the responding institutions located preservation responsibility for these materials in any one of the departments listed.

8. Preserving the university's digital information assets

The highly distributed approach to digital preservation is evident in answers to questions about preservation responsibility for digital materials created or used within the library, within academic departments, and within administrative departments.

The library takes primary responsibility for preserving library catalog files at 71% of responding institutions, finding aids at 76%, and the digital content produced by the library at 76%.

The library has little or no responsibility for university records and administrative data (MIS) or for data developed in academic departments. Where digital content produced in academic departments is concerned, nearly half of all respondents (9 of 21) were unclear about who was responsible for preserving that content.

9. Computer-based learning materials

Support for production and use of computer-based learning materials is widely shared (or highly fragmented).

Units within the library take primary responsibility for supporting pedagogical and classroom use of digital content produced by the library at 81% of those responding, and for advice on copyright clearance and IPR issues involved with that content at 62%.

IT and academic computing departments take primary responsibility for production of computer-based learning materials not based on library holdings at 76% of responding institutions and for the pedagogical and classroom use of those materials at 57%.