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The Digital Library as Place

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Abstract

Purpose: This paper is a high-level investigation of the physical-conceptual continuum occupied by both digital and physical libraries. **Methodology/Approach:** A framework is provided for thinking about the notions of place and library. The issue of materials and the ideas they represent is considered. Places for people are considered, including issues of people's sense of place in physical and digital spaces. The issue of physical and digital spaces as places for work, collaboration, and community-building is considered. **Findings:** As more digital libraries are built, and as more physical libraries offer electronic access to parts of their collection, two trends are likely to result: (1) The role of the library as a storage space for materials will become decreasingly important, and (2) The role of the library as a space for users, for individual and collaborative work, and as a space for social activity, will become increasingly important. **Research limitations/implications:** Digital libraries are unable to fulfill some of the functions of the physical library as physical spaces, but are able to offer functions beyond what the physical library can offer as cognitive spaces. **Practical implications:** Areas of likely future development for digital libraries are suggested, as vehicles for enhancing cognitive space by augmenting representations of ideas in materials. **Originality/value of paper:** This paper argues that in many ways digital libraries really are places in the conceptual sense, and will continue to broaden and enrich the roles that libraries play in people's lives and in the larger social milieu.

Keywords: Library as Place, Digital Libraries, Information Commons, Information Environments

Categorization: Conceptual paper

Introduction

A library is more than a pile of books. A library adds value to information resources by organizing them and making them available. Additionally, a library serves distinct sets of stakeholders: communities of frequent, casual, and potential users. Unlike museums, it is seldom the materials in libraries that attract people but rather the ideas carried by the materials, the conceptual structures that support access, and the community of stakeholders who use the library. Because books and other physical information resources and people occupy physical space, libraries have evolved complexes of buildings, rooms, and mobile spaces in which books and other materials and people come together. These spaces are manifestations of the library as place. Place, however, is more than physical space – just as a home is more than a house. Places are defined by functions and communities, just as are libraries. Places stimulate and can represent states of mind: it is easy to understand that when someone says "I feel out of place," they are not only referring to the physical space they occupy. Thus, places are as much about ideas and states of being as they are about physical space. This physical-conceptual continuum parallels what we mean by libraries: places that marry physical space with intellectual space, to link people to ideas and to each other.

These fundamental characteristics of libraries – systematic access to information resources, the ideas represented by those resources, and sets of human stakeholders – also extend to digital libraries. Marchionini and Fox (1999) argue that digital libraries are extensions and augmentations of physical libraries. We suggest that with respect to this broader notion of place both physical and digital libraries are instantiations in different media of the same base type: the library. In either case, both physical and digital libraries occupy the physical-conceptual continuum with respect to ideas, materials, and people. The distinction between physical and digital libraries is thus not always a clear one. For the sake of this discussion, physical libraries are considered to maintain a collection of exclusively physical materials, while digital libraries are considered to maintain a collection of exclusively electronic materials. In between these two extremes is the more typical physical library that maintains digital components, such as digitized

representations of physical materials in its collection, or subscriptions to databases or other electronic resources: what Buckland (1992) calls the "automated library" and Rusbridge (1998) calls the "hybrid library." In this paper, we argue that digital libraries are extensions toward the conceptual side of this continuum, and that the incorporeal nature of digital libraries makes them suitable replacements for physical libraries in meeting people's information needs. Because libraries serve more than information needs, however, digital libraries are not suitable replacements for physical libraries in all aspects of library functionality. Physical libraries will continue to evolve and thrive, often adding digital appendages that augment both functionality and community. Because digital libraries are relatively new, there are as yet no examples of digital libraries that have added physical appendages, but this is not an unreasonable expectation in the future.

This paper is intended as a high-level investigation of the physical-conceptual continuum occupied by both digital and physical libraries. The plan of this paper is as follows. First, we provide a framework for thinking about the notions of place and library. We then consider the issue of materials and the ideas they represent, looking at physical space, collection development, preservation, maintenance, and reference services in turn. Places for people are considered next, including issues of people's sense of place in physical and digital spaces. Finally, we consider the issue of physical and digital spaces as places for work, collaboration, and community-building. In each section, we juxtapose physical and digital libraries in order to sharpen the similarities as well as differences. Our goal is to demonstrate that in many ways digital libraries really are places in the conceptual sense, and will continue to broaden and enrich the roles that libraries play in people's lives and in the larger social milieu.

A Framework for Thinking about Place and Libraries

Places both occur naturally and are deliberately designed. Kalay & Marx (2001) suggest that place-making is a deliberate process involving "arranging or appropriating objects and spaces to create an environment that supports desired activities, while conveying the social and cultural conceptions of the actors and their wider communities" (p. 4). Based

on this conception of place, we postulate that there are three key elements for thinking about place, and specifically about libraries as places: (1) the physical-conceptual continuum, (2) the people who hold stakes in the place, and (3) the functionalities that bring people to the place. By the physical-conceptual continuum, we mean the range of concreteness of a space: from the actual physical reality one finds one's body in, to a physical space that reminds one of another physical space, to simulations of actual physical spaces that media such as television and film evoke, to representations of imagined physical spaces that new media such as virtual reality evoke, to the mental places we can imagine. The stakeholders in a library include the users, the librarians, the library administration, the town government or institutional management, the community at large, and others. The key functionalities for libraries as place are: the selection of ideas as manifested in materials for inclusion, the preservation of these ideas, and the creation and use of organizational structures to support access. We are interested in overlaps and distinctions between functionalities and communities associated with physical and digital libraries over the physical-conceptual continuum.

In this framework, we claim that the concepts of place and library both have physical and conceptual senses and that we can consider a library as a place either at the literal or at the conceptual extremes of the continuum. The people who have a stake in the library as place are likely to be similar whether the library is physical or digital, but some people may adopt exclusive stakes in either. Because many physical libraries have digital components, and digital libraries are often associated with physical libraries, we believe that this overlap in stakeholders is significant. Ideas are not space dependent but are manifested in materials that require matter or energy. We will refer to the manifestations that require mainly matter as physical and those that require mainly energy as virtual or digital materials[1]. For our purposes here, we distinguish the idea or the 'work' from its manifestation in material form. These artifacts may be physical or virtual. We use the term 'material' to emphasize that these manifestations are made by humans and are not

[1] We use the modification 'mainly' in these definitions to acknowledge the integral relationship of matter and energy. A book is mainly matter, although there is energy in the atomic vibrations that make up the book; likewise, the electromagnetic charges that make up digital bits are mainly energy but also have very small masses.

naturally occurring. Finally, the stakeholder interacts with the library as place in what we term an experience. We postulate that physical and digital libraries differ most in what types of materials are selected for inclusion, and largely overlap in the ideas that are manifested by those materials. Whether the form of expression is physical or digital in turn strongly impacts selection, preservation, access, and the user experience. These overlaps and distinctions provide ways to think about physical and digital library places and in turn how people experience libraries.

Figure 1 presents a view of the library as a place, which encompasses both physical and digital libraries. The focus of this model is the space itself, whether a physical or a digital space. The space must exist prior to any of the other elements of this model coming to pass: prior to materials being collected and stored in it, and prior to people coming to it and experiencing it. Materials, whether physical or digital, are brought into the space through the process of collection development, and the space functions as storage for these materials. Additional value is added to the space through organizational structures that facilitate access. Materials must be brought into the space prior to users coming to the space, since, without these materials, there would be no reason for users to use the space except as a meeting place, which is not sufficient to distinguish a library from many other social spaces. Users then come to the space (physically or virtually) to use the materials stored in it. This use, situated in the space, causes the user to have an experience of the space, the materials, any other library stakeholders present, and the ideas embodied in the materials. Underlying the rest of this model is the fact that the space may be either physical or virtual – that is, the library may be either a physical or a digital library, which in turn dictates certain characteristics of the other elements of the model, such as the format of materials stored in the library, the media by which users may “come to” the library, and the experience that users are likely to have of the library. Presumably, the overall experience leads to new ideas that may themselves in turn become part of the library space.

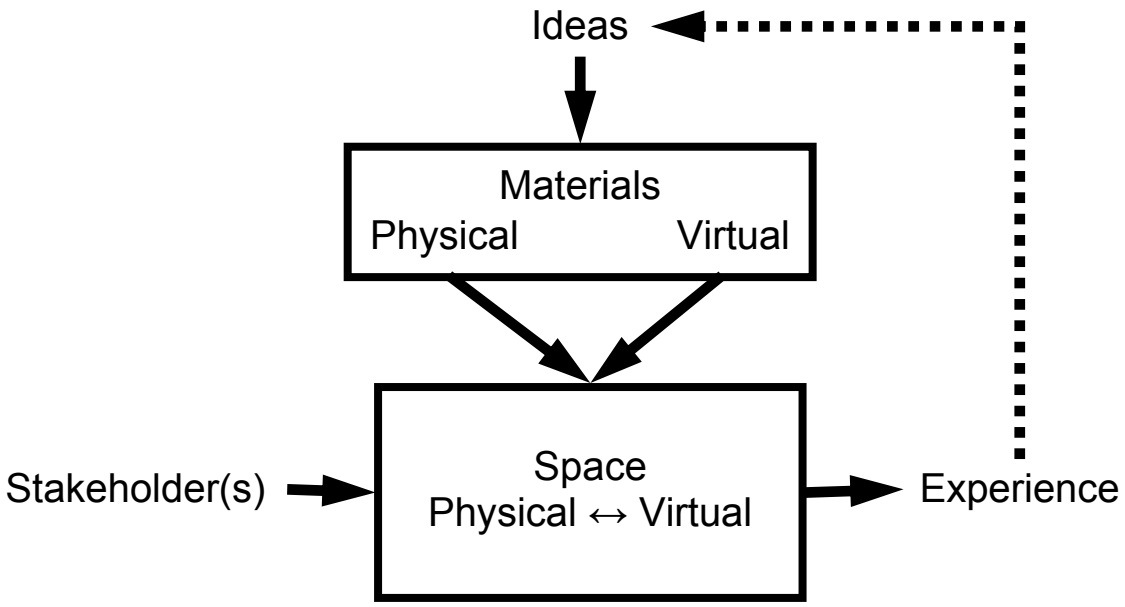

Figure 1: Model of the Library as Place

Lakoff and Johnson (1980) discuss the metaphors that we use and take for granted in our everyday use of language. They divide these metaphors into two types: structural metaphors, in which one concept is portrayed in language in terms of another concept (e.g., argument in terms of war); and orientational metaphors, in which a concept is portrayed in spatial terms (e.g., happiness in terms of up). Lakoff and Johnson argue that these metaphors are not merely figures of speech, but have their basis in our everyday experience, and in turn deeply influence our conceptualizations of the concepts to which they are applied. The idea of the digital library as place is, to a certain extent, an orientational metaphor: a library building is a physical place, but a digital library is not. There is nothing inherently spatial about a digital library, or more fundamentally about the information objects contained in a digital library's collection. Users of digital libraries may perceive their interaction with information in spatial terms, as users of physical libraries are forced to interact with information in spatial terms due to the layout of the library itself. This orientational metaphor of the digital library as a space – and further, of the "information space" – is one way to think about the physical-conceptual continuum for places and libraries, and the farther toward the conceptual side of the continuum we get, the more important metaphors become for guiding actions in the space.

Spaces for Materials

Space is an important characteristic of a physical library; for example, the amount of floor space and shelf space is critical. Too little space may, for example, prompt the library to install compact shelving to maximize the use of existing space, to build an addition onto the building to expand existing space, to move materials into an auxiliary space such as off-site storage, or to build a new building to create an entirely new space. The issue of space is important in the physical world because the amount of material that can exist in a physical space is constrained by the size of the space and the size of the materials. Thus, physical space strongly influences most physical library functions.

This is of course not the case for virtual "space" and electronic materials. Electronic materials occupy no physical space – or, if electronic materials can be said to occupy any physical space at all, they occupy the space required for the disk array on which they reside. The benefit of electronic materials, from the perspective of physical space, is thus that a quantity of physical materials that would occupy a large physical space may be stored in a much smaller physical space, if converted to an electronic form. For example, as of this writing, high-end desktop computers come standard with hard drives of up to 800 GB capacity, which is a quantity of data equivalent to over eight thousand meters of shelved printed textual materials (Lyman & Varian, 2000). Moore's law states, loosely, that the amount of processing power that can be contained on a microchip doubles every 18 months, and a corollary to Moore's law states that the capacity of computer memory systems increases at approximately the same rate. Thus, not only can a greater quantity of materials be stored electronically than physically in the same physical space, but this quantity of electronic materials is ever-increasing.

Over eight thousand meters of shelving is the physical space that would be occupied by these hypothetical physical materials if these materials were stored locally, and the space required for a disk array is the physical space that would be occupied by the corresponding electronic materials stored locally. The location of storage, then, raises an

additional issue regarding space: materials stored locally take up space locally, but materials stored remotely, from the user's point of view, occupy no space at all. For example, if one wants a specific book that is not held in one's local library's collection, all one needs to do is to place an interlibrary loan request: fill out a form, a librarian places a request with the interlibrary loan consortium of which one's local library is a member, and some remote library ships the book to the local library. The book requested on interlibrary loan exists in the world and occupies space somewhere, but it occupies no space in the local library. Thus, when the book arrives, one has gained access through the local library to material that occupies no space in the local library.

Interlibrary loan raises the issue of ownership versus access in physical libraries, and demonstrates that it is not necessary for a library to own materials in order to provide access to them. The role of place where materials are physically stored is one of the traditional roles of the physical library. To fulfill this role, the physical library had to own these materials, and this came with all of the responsibilities of ownership: the initial decision of what is worth owning, and the long-term care and curation of those materials. The American Library Association first published the Interlibrary Loan Code in 1917 (American Library Association, 2001), so for nearly a century libraries have accepted the role of providing access to materials rather than owning those materials. Physical libraries have in the past few decades been experiencing a shift towards increasing access rather than ownership. This shift has come as libraries have subscribed to publisher-provided and third-party databases to gain access to journals in electronic format that the library may not subscribe to in print, and as libraries have subscribed to services such as NetLibrary (www.netlibrary.com) which make the full text of books available electronically that libraries may not own in print. This trend will likely continue to accelerate due to efforts such as the Google Books Library Project (books.google.com/googleprint/library.html) and the Open Content Alliance (www.opencontentalliance.org). There has been considerable backlash in recent years in the library and academic communities against journal publishers in response to the "serials crisis" of increasing costs for consistent or even decreasing access (see, for example, Pew Higher Education Roundtable (1998), and the whitepapers produced for

the Convocation on Scholarly Communications in a Digital World at the authors' own institution (www.unc.edu/scholcomdig/)). Whatever the future of library-publisher relations holds, however, as increasing numbers of books and journals are published electronically, libraries will increasingly provide access to materials that they do not own. Digital libraries too own materials, as do physical libraries that digitize components of their collections. Though these materials are in electronic formats, the issues of collection development and maintenance remain consistent. Thus, while providing access to materials owned by another institution is not a new role for physical libraries, the trend in physical libraries is to move further from the traditional role of the library as owner and curator of materials. Digital libraries, and physical libraries that maintain digital collections, on the other hand, continue to fulfill this more traditional role for the library.

It may take from a few days to a few weeks to gain access to a book requested via interlibrary loan, because it is stored remotely from the local library. Electronic materials stored remotely, on the other hand, are accessible far more rapidly; even with the slowest dial-up connection, accessing electronic materials stored remotely takes on the order of minutes, not days or weeks. Thus, the location of the space in which physical materials are stored affects the time it takes to access those materials, but that effect is dramatically reduced for digital materials.

The physicality of electronic materials is complicated by the fact that a digital library may exist on one or more mirror sites – thus the digital library exists in several physical locations. Perhaps more importantly, the servers on which the digital library exists may be located anywhere on Earth (or even off Earth if the so-called "Interplanetary Internet" should come to pass (www.ipnsig.org)). Although increased physical distance means increased latency, the functionality offered by the digital library may be the same whether the server is in the room next door or on Mars. A more appropriate approach to the "space" occupied by electronic materials, therefore, is not to consider the physical space occupied by electronic materials, but the virtual "space" occupied by such materials.

Information Architectures for Physical and Digital Libraries

In physical libraries in the United States, there are two classification schemes that are commonly used to organize materials: the Library of Congress and the Dewey Decimal classification schemes. These classification schemes, and others that serve similar purposes, are overlays on the physical space of the library, as well as over the materials themselves. A different classification scheme may be overlain over the same physical space, without altering the physical space. Indeed, this happens whenever a library switches from one classification scheme to another, as many libraries have from Dewey Decimal to Library of Congress over the past several decades. This process is extraordinarily labor-intensive, particularly for a large collection, but it does not necessarily require any sort of renovation to the physical space of the library. (Though it may be a renovation or some other large-scale change to the physical space that motivates the change of classification scheme, as in the currently ongoing reclassification from Dewey to Library of Congress in Duke University's Perkins Library: www.lib.duke.edu/perkproj/) The physical space and the classification scheme utilized within that space are logically separate.

When a user comes into a physical library, one possible strategy that she could employ to find the materials that she is looking for is to search in a card or online catalog, determine the call numbers for these materials, and then find those materials on the shelves, which are organized according to call number. The call number is the point of connection between the physical space and the classification scheme that overlays it: the call number orients both the physical materials and the user of those materials within the physical space, and to a limited extent unites the ideas manifested in the materials to the space of ideas manifested in the classification system.

In a digital library, on the other hand, the "space" itself is defined by the classification scheme (though frequently this scheme is neither Library of Congress nor Dewey Decimal). When a user comes to a digital library, she is presented with an interface. Principles of information architecture suggest that this interface should reflect the

classification scheme according to which the digital library collection is organized. If the digital library's collection is reorganized according to a different classification scheme, then the interface itself should change to reflect that. While a physical space and a classification scheme are logically separate, a digital "space" and a classification scheme are of a piece: the classification scheme to a certain extent defines the digital space. When the classification scheme utilized in a digital space changes, the user's interaction with that space changes. A digital library may even employ multiple classification schemes and allow each user to select the scheme she prefers.

More importantly, whereas physical materials can only be placed in one location, digital materials can be 'placed' in multiple locations. Kwasnik (1999) writes that mutual exclusivity is a requirement of traditional classification schemes: a given entity can belong to one and only one class. The requirement of mutual exclusivity in classification schemes may be an upshot of the fact that physical artifacts (such as books) can only exist in one place (such as on one shelf in a library). Kwasnik admits, however, that the principle of mutual exclusivity makes realistic representation of knowledge difficult (p. 28): ideas do not lend themselves to being so narrowly pigeonholed. The flexibility of digital space to accommodate multiple classification schemes simultaneously allows a digital library to better accommodate the multiple ideas manifested in artifacts. Thus, a key difference between physical and digital libraries is that physical libraries typically provide only a few access points for materials that are then retrieved from specific physical locations, whereas digital libraries provide a multiplicity of indexes for access from potentially many locations.

Rosenfeld and Morville (2002) suggest that information architecture is fundamentally an exercise in classification: the task of the information architect is to create a sensible and intuitive classification scheme according to which information will be organized and made available to users. It is this classification scheme that dictates both the organization of a website, and users' interaction with it. Jakob Nielsen suggests that the structure of a website helps users to navigate within that site (www.useit.com/alertbox/20000109.html). This is one of the underlying principles of information architecture: that classification

schemes are important in presenting electronic data. The underlying metaphor of information architecture is obviously that of physical architecture: the orientational metaphor of “navigation” or “movement” through information is employed as analogous to moving through physical spaces.

On the other hand, instead of navigating through menus and links to find materials, the user could use the digital library’s search engine if one is provided. In this way, the user may retrieve a set of materials from the digital library’s collection matching certain criteria. This is of course also possible, but considerably more difficult in a physical library: retrieving a set of materials from a physical library’s collection requires the user to engage in the two-step process of first determining the call numbers of the materials to be retrieved, and then of moving through the physical space to collect those materials manually. A search of a digital library, on the other hand, may provide the user with a citation and a link directly to an information resource (as in a search engine), or with the actual resource itself (as in a full-text database).

Digital libraries allow the same two methods for accessing materials as are allowed in a physical library – browsing and searching – but the user’s experience in employing these methods are entirely different in the physical and digital realms. First, browsing is an efficient method of accessing materials in a digital library, due to the integration of the classification scheme and the “space” in a digital library. In a physical library, on the other hand, the efficiency of browsing is in large part dependent on the materials being browsed: it would be highly inefficient to attempt to find one specific book in a library by browsing, but browsing current serials is an extremely efficient means for scanning a large amount of information. Further, while searching may be the most efficient method of access in a physical library because it provides a point of connection between the classification scheme and the physical space, searching in a digital library bypasses both the classification scheme and the virtual space created by it.

Let us now return to architecture, both physical and virtual. A physical library is a prisoner of its physicality: it is difficult to alter the architecture of a physical library after

it is built: new construction must take place, or the existing construction must be retro-fitted with new objects, such as compact shelving. A digital library, on the other hand, may be reconfigured comparatively easily after it is built. New "spaces" may be added or removed or altered, and new pathways through the space may be added. Thus from the library's point of view, digital libraries offer more flexibility and lower costs architecturally. From the user's point of view, however, the persistence and stability of physical architecture helps frequent and casual users to navigate in a "known" space. Changes in physical or virtual spaces can be jarring and disruptive for people. This is a particular concern in today's digital environment where people use relatively small screens to represent the entire underlying architecture. In effect, the entire virtual space of a digital library implodes in order to be represented on a desktop or PDA/cell phone display.

In a physical library, special collections consist of subsets of the library's entire collection, and the materials in special collections are generally classified in such a way as to differentiate them from the main collection and are stored in a space separate from the main collection. In a digital library, on the other hand, there may not be any need to separate out items in a special collection from items in the main collection, either logically or architecturally. In a digital library, no item in the collection is any more or less accessible than any other. Whether the back-end of a digital library is a file structure or a database, all items contained therein may be referred to logically in the same way. This logical consistency allows for architectural flexibility: in effect, a digital library's entire collection may be part of one or more special collections.

Some digital libraries have, however, created special collections of sorts. At one extreme, ibiblio (www.ibiblio.org), a contributor-run digital library (Jones, 2001), provides access to more than 1,500 different collections that are fully independent. These are partitions of the full digital library space defined by the topical areas of the entire set of contributors. Other digital libraries provide specific partitions that are not mutually exclusive and may serve as exhibits. The Perseus Digital Library, for example, maintains an "exhibit" on Hercules (www.perseus.tufts.edu/Herakles/) and another on the ancient Olympics

(www.perseus.tufts.edu/Olympics/). At the time of this writing, the American Memory Project was featuring the Ansel Adams and African-American Sheet Music collections (memory.loc.gov/ammem/). It is possible for a digital library to create a special collection, simply by providing easy access to a select subset of the resources in the collection. Indeed, any number of such special collections may be created by "slicing" the entire collection in a variety of ways: ibiblio, Perseus, and American Memory have created special collections by creating architecturally, if not logically separate collections. It is also comparatively easy to change these special collections over time, in a way that it is not easy to do in a physical library. These exhibits or special collections may also be maintained indefinitely since the virtual materials can exist in multiple locations and thus are infinitely reusable, without the costs of physical space. Creating or changing a special collection in a physical library requires the physical movement of materials; creating or changing a special collection in a digital library requires the alteration or replication of the links on webpages.

A physical library is a prisoner of its physicality, but a digital library is prisoner of its technology. Physical space is clearly more important in physical than in digital libraries, but digital libraries are more dependent on energy than are physical libraries. Without electricity, a modern physical library would give up some services but could maintain basic operations. A digital library is useless without the energy needed to transfer and display information. This tradeoff in crucial requirements in the physical and digital libraries reflects the nature of the matter or energy manifestations of ideas contained in the respective materials. Thus, matter dominates physical libraries and energy dominates digital libraries and these differences sit along the physical-conceptual continuum of libraries as place.

In sum, we see that the requirements for and uses of physical space are dramatically different for physical and digital libraries. Physical libraries are bound by a more or less static physical architecture that dictates how physical materials may be accessed, whereas digital libraries can leverage the spatial-temporal characteristics of digital materials to provide a variety of architectures that provide more control over collections but require

energy to deliver this control. Physical libraries mainly depend on classification systems for locating materials in physical space, whereas digital libraries depend on classification systems for locating materials in conceptual space, allowing an item to have many classification ‘call numbers’ within a single classification system, and allowing items to be found through a variety of different classification systems. Digital libraries are dependent on electricity for representation and are thus better suited to materials at the conceptual end of the continuum of library as place. We now turn attention to the important functions of selecting and preserving these materials.

Collection Development and Preservation

Two of the most fundamental issues faced by a library are storage and maintenance over time. Thus, decisions must be made on what is the best use of available storage space and how the materials in the space can be preserved over time. These issues require two sets of decisions: what materials will be brought into the space, and what materials will be stored over the long term or removed from the space. In many respects, the issues involved in collection development are the same for physical and digital libraries, with respect to materials serving the library mission, the appraisal process, and costs associated with acquisition or licensing. One important distinction between collection development in physical and digital libraries, however, is that the physical library is constrained by physical space for the materials selected, whereas the digital library is more constrained by the materials available. The maintenance and preservation functions also differ significantly between physical and digital libraries.

Storage Space

The decision concerning what materials will be brought into the storage space is known as collection development. The collection development process is fundamentally the same for both physical and digital materials: identifying candidate materials pertinent to the library mission and budget, assessing the quality of the ideas represented in the materials, and storing what can be stored given the available space. The costs involved in

collection development are likewise the same for both physical and digital materials: there are costs involved in assessing and collecting materials, maintaining materials over time, and providing access to the materials to users.

The form of the materials is less critical than the quality of the ideas represented in those materials, and librarians and other stakeholders will continue to invest considerable effort in assessing the value of the materials they include in their libraries. In physical libraries, these efforts fall almost totally to librarians to select and acquire materials. In digital libraries, the nature of digital materials allows users and other stakeholders to participate in selection and acquisition directly. How user contributions may fit into the overall quality assurance models that libraries have developed over the years, however, is still evolving.

There are two ways in which electronic materials may come into existence: an object may be "digitized" – that is, an electronic representation may be made of a physical object, by scanning it, digitally photographing it, or some other representation method – or an object may be "born digital" – that is, created electronically and not in a physical format. Digitization, however, is expensive – so much so, in fact, that organizations such as the Institute of Museum and Library Services (www.imls.gov) and the National Endowment for the Humanities (www.neh.gov) currently award grants to support digitization efforts, as many institutions cannot afford to undertake such an effort without financial support. For materials that are unique, rare, or fragile, however, digitization may be the best way to insure that these materials (or at least alternative representations of the ideas manifested in these materials) are available to users, or even available at all in the long term. Born-digital materials, on the other hand, may be considerably less expensive to produce – it of course costs nothing to digitize these materials, and the cost to create certain types of materials digitally may be less than the cost to create comparable materials physically (for example, physical video editing requires expensive equipment that is unnecessary for editing digital video). Born-digital materials are, further, neither rare nor unique, since the cost of copying digital materials is so low as to be practically

nonexistent. Both the human labor of creating and cataloging, and the intellectual property costs, however, remain significant for both physical and digital materials.

Thus, physical libraries must consider storage space limits in collection development, which in turn affects the user experience in the physical library as place, whereas digital libraries are less constrained by storage space but are constrained instead by energy sources that likewise affect the user experience in the digital library as place. Most importantly, both physical and digital libraries must appraise the value of works they wish to add to the collection, regardless of its representation form. Likewise, they must consider the costs of acquisition and/or licensing in the collection, and the issue of maintaining and preserving the collection, to which issue we now turn.

Preservation

Once an object is in a digital format, the costs involved in maintaining it over time are the same, whether it is a digital representation of a physical object or born digital. There are several hidden costs involved in maintaining digital objects over time (Hedstrom and Ross, 2003; National Science Foundation and Library of Congress, 2003). First, computer hardware has a finite lifespan: the disk array on which a digital object is stored will eventually fail, or the server in which that hard disk is installed will eventually need to be upgraded. In these situations, the digital object will need to be migrated to another piece of hardware. Likewise, librarians or system administrators who manage the hardware must regularly attend to software upgrades. A second cost of the maintenance of digital objects is changes in formats. Over time, formats for files change – new applications come to be used, new versions are released and functionality changes, and eventually applications cease to be used. This change in applications and functionality requires that over time, digital objects be "ported" to new formats that are compatible with new applications. In response to this issue, Adobe Systems is currently attempting to position its Acrobat software as an archival standard for text documents, so that both the data within a document and the form of the document may be maintained in the long term (Adobe, 2002). This is an attractive solution in many ways, but limited to documents and

digital objects that emulate the format of paper, and perhaps not a viable solution for digital objects in other formats, such as video or music or data sets.

While physical objects of course also need to be maintained over time, the time spans on which they require maintenance are generally much longer than digital objects. The usable lifespan of digital media varies with the medium (perhaps as little as one to two years for magnetic tape, five to ten years for magnetic disks, and thirty or more for optical disks, though estimates vary (Rothenberg, 1995, Van Bogart, 1995)); the usable lifespan of physical objects tends to be far greater. Many libraries own books that are over one hundred years old and in perfectly readable condition (even if perhaps no longer in circulation); it is unlikely that any currently existing digital format will be so readily usable one hundred years from today. Other formats of physical objects have even greater life spans: sculpture, for example, properly maintained, may last for hundreds or even thousands of years (Michelangelo's David, for example, is approximately five hundred years old, while the Venus de Milo is over two thousand. (The Venus de Milo, of course, was not properly maintained for many hundreds of years, but since her discovery in 1820, that has been rectified for what remains of her.) Thus, the quality of the storage space also matters (e.g., temperature, humidity, etc.), and archivists are only beginning to have enough experience with digital storage media to determine environmental requirements. The current status of digital preservation is to plan for regular migrations with associated costs. One alternative to this approach is massive replication, in the hope that a subset of the copies will persist through local migrations; a project in this vein is LOCKSS (lockss.stanford.edu). With this approach of course comes all of the accompanying problems of version control seen in hand-copied manuscripts over the ages.

Whether an object is a physical object, a digital representation of a physical object, or born digital, one issue that is consistent is the decision whether to store the object over the long term or to remove it from storage: in archives this is the appraisal process, and in libraries this is the weeding process. This archival function is necessary in physical libraries to insure that only the most valuable materials are maintained in the collection over the long term. Value may be defined in any number of ways, such as those materials

that are worth the most in monetary terms, the rarest or most unique items, or those items that receive the most use. The process by which this appraisal takes place is summed up neatly by Eastwood et al. (2001), as "study[ing] the records themselves and determin[ing] the various elements of them that are likely to give them continuing value, for example, their usefulness for legal purposes, their value as evidence of the functioning and organization of their creator, or their potential for research" (p. 18).

The larger the physical space a library occupies, of course, the more material can be maintained in the physical library's collection. Similarly, the greater the volume of the disk arrays on which a digital library resides, the more material can be maintained in the digital library's collection. In physical and virtual spaces alike, however, the larger the space and the more material contained in it, the greater the need for the space to be well organized and maintained, and the greater the demand on librarian time to husband the materials and space.

Thus, both physical and digital libraries must consider how best to preserve materials and the costs of doing so when making collection development decisions. Librarians can learn from archivists about what is needed to preserve physical materials; librarians with digital assets are challenged to discover how to preserve digital materials as well as what the costs will be, as we have little experience upon which to make judgments. At present, the best solution is regular conversion and upgrades, the costs of which can be only estimated rather than accurately budgeted.

Spaces for Stakeholders

The Physical Library as Place

Libraries have long served as important places for people to work, think, and collaborate. Many academic libraries are literally cathedrals of learning with impressive architectural features. The new Seattle Public Library Central branch (www.spl.org) is a contemporary example of how libraries may work with architects and artists to craft spatial messages

for users. In essence, library spaces are used as much to inspire ideas and feelings as they are to serve utilitarian functions. However, some new library places are beginning to directly address new library space models where the library is really a hybrid physical and digital place. For example, in describing the new health sciences library building at the University of Maryland, Weise (2004) writes, "we have done our best to provide [users] with services so they won't have to come to the library" (p. 10). Likewise, projects are underway at the University of British Columbia and the California State University at Northridge to replace the existing academic library with a learning center where human-oriented workspaces are in one wing and the physical materials are stored in another wing, in temperature-controlled (cold) compact storage attended by Automated Storage and Retrieval Systems (www.library.ubc.ca/home/asrs/; Kirsch, 1999).

Two related social forces that have generated considerable thinking about libraries as places are the popularization of the Internet, and the appearance of large chain bookstores such as Barnes and Noble and Borders. Interestingly, these two forces emerged in close temporal proximity in the mid-1990s. As anyone who has been to a shopping mall in the past decade knows, these bookstores contain comfortable chairs in lounge-like seating areas, childrens' play spaces, and coffee bars. Essentially, these bookstores attempt to fulfill the role of what Oldenburg (1999) refers to as "third places." The first two places are the home and the workplace, while the third place is an exclusively social place: the town commons, the street corner, or the local pub, for example. Third places are "public places that host the regular, voluntary, informal, and happily anticipated gatherings of individuals" (p. 16). As Coffman (1998) points out, these bookstores deliberately attempt to create third place-style environments by offering inviting surroundings and a schedule of events.

The advent of such "third place" bookstores led Coffman (1998) to pose the question, "what if you ran your library like a bookstore?" The Multnomah County Library in Oregon was one of the first libraries to offer a coffee bar, partnering with Starbucks Coffee in 1997 (MacLeod, 1998). Since then, many other libraries – both public and academic – have added coffee bars. Coffee bars are, however, simply one instantiation of

a larger trend in libraries to create spaces that will be appealing to users and can serve as social spaces. There is a particular concern to appeal to undergraduates who, with the advent of the World Wide Web, some believe to be using the library less and less. Carlson's (2001) article entitled The Deserted Library portrayed a situation in which the increasing use of electronic materials by students meant a decreasing use of materials and services within the library building. This article caused a certain degree of panic in the academic library world, even, as Albanese (2003) reported, causing academic library directors to resign. This trend may also have influenced decisions in the late 1990s and early 2000s to spend money on academic libraries, both renovations to existing buildings and construction of new library buildings[2] (Fox, 2002).

This trend also influenced the development of the LibQUAL+ survey instrument (www.libqual.org) to evaluate library service quality. LibQUAL+ assesses quality along four dimensions, one of which is how the user feels about the library as a place (Heath, et al., 2003). Along this dimension, LibQUAL+ includes questions concerning the user's feelings about the library as:

- A space that facilitates quiet study
- A haven for quiet and solitude
- A place for reflection and creativity
- A comfortable and inviting location
- A contemplative environment

All of these questions are concerned with the ambience of the space, and the user's feelings about the space. Many reports by libraries that have conducted LibQUAL+ surveys then go on to discuss how the library can foster ambience, in order to make users feel that the library is comfortable and inviting, a place for quiet study, reflection, and creativity (www.libqual.org/Information/Related_Sites/; Cook and Heath, 2001).

[2] Of course, concerns about getting undergraduates to libraries are a long-standing issue. The rise of undergraduate libraries in the 1950s-70s aimed at creating spaces specifically designed for the academic and social requirements of undergraduates (Braden, 1970).

But what if the user finds coffee bars to be comfortable and inviting, or the park to be a place for reflection and creativity? What if the local coffee shop is more convenient for the user to get to? The physicality of libraries, however inviting, is by nature place-bound: the user has to physically travel to the library to partake of the environment. Given a choice between different physical places in which similar tasks may be accomplished – e.g., a library or a bookstore in which to get access to printed materials, or the local coffee shop as a place to sit and work – is it any wonder that users choose the more inviting physical environment? As the functionality of libraries increasingly comes to be available virtually, is it any wonder that users are not coming to the physical library, and are instead making use of this functionality in other, more inviting or more convenient physical environments?

The Electronic Environment as Place

Alongside this movement in libraries to create more inviting physical environments, was a movement to create more "physical-like" digital environments. This period of time in the mid- to late-1990s saw the rise of information architecture as a profession and a field of study. As discussed above, the field of information architecture is predicated on a metaphorical sense of digital space.

While of course there is no such thing as a coffee bar online, there certainly are more or less inviting virtual environments. Kalay & Marx (2001) suggest that the natural and logical way to design an inviting virtual environment is to base it on physical space, that "designing places in Cyberspace can, indeed must, be informed by the principles that have been guiding physical place-making for centuries" (p. 9). In an extreme case of virtual design being based in physical design, Frischer (2005) describes the CVRLab at the University of California at Los Angeles, which creates "scientifically authenticated, 3-D computer models of the world's cultural-heritage sites" such as the Roman Forum, the House of Augustus, and the Colosseum in Rome (pp. 47-48): physical places, though ones for which it may no longer be possible to know precisely the details of the physical design. Not all virtual design is so literally based in physical design, however; some is

more metaphorical. Basing the digital experience of place on the physical provides the user with a familiar environment, and thus creates fewer barriers for use. Information architecture and web design best practices are consistent with this approach. Vincent Flanders, on his entertainingly named website webpagesthatsuck.com and in his book of the same name (Flanders and Willis, 1998), lampoons websites with poor design, and points out what elements contribute to this poor design, as a tongue-in-cheek method of teaching good web design. Flanders has gripes with many elements of web design, but fundamentally his message is a simple one: the function of web design is to deliver information to the user as efficiently as possible, without unnecessary design elements to distract from the information itself. Jakob Nielsen delivers a similar message on his website (useit.com) and in his book (Nielsen, 2000): good design creates a positive experience for website users. Virtual environments may be more or less "comfortable" due to their design. As discussed above, people treat their experience of "moving through" virtual spaces as analogous to moving through physical spaces; a well designed virtual space therefore makes for a more inviting space for users.

In a digital library, this philosophy of design may lead to a focus on what, in a physical library, is referred to as "signage": the labeling of areas where materials or services are located so that the user may easily find them. Different digital libraries take different approaches to signage. As discussed above, in a digital space, the classification scheme is equivalent to the organization of the space. Further, the subset of the classification scheme that is available to the user is equivalent to signage. Two examples will illustrate this point. The Math Forum (mathforum.org), organizes its collection according to topic and grade level. The Digital Library for Earth System Education (DLESE, dlese.org) provides four simple classification schemes by which a user may access the collection: Grade level, Resource type, Collections, and Standards. These classification schemes are both how the materials in the digital library's collection are organized, and according to which the materials are accessed by users.

Another distinction between physical and electronic environments as spaces is that of the accessibility of the materials in those spaces. In a physical library, the user can gain

access to the collection only by physically coming to the library. In a digital library, the user can gain access to the collection electronically from anywhere without physically going to the library. An interesting situation exists for physical libraries that maintain electronic components, however: electronic materials are not accessible physically, and physical materials are not accessible electronically. Thus, the physical library has two mutually inaccessible collections, the physical and the digital. In many cases, physical libraries do have physical and digital versions of the same work (which usually means distinct costs); we suggest, however, that the very format of representation supports different types of value-added services that make users' experiences with the same intellectual work quite different. It is here where the issues raised by the environment of the library as place diverge most strongly: if the user is using digital materials, whether the user is in a physical library or at home or work, the experience will be more similar than if the user is using physical materials for the same work in the library or at home. In essence, the user's experience of the library as place is more dependent on the form of the material and what additional services the library provides than it is on whether the user's body is in a physical library or elsewhere using a digital library.

While physical and digital collections are mutually exclusive, the physical and digital spaces "inhabited" by users of these collections are not. Rather, these spaces overlap, or are superimposed upon one another. A user may be present in both a physical and a digital library simultaneously, or may be present in some third place and making use of both digital resources and physical services (e.g., interlibrary loan).

In sum, a continuum of environments exist, ranging from entirely physical to entirely digital, with a range of hybrids. Spaces at the physical end of this continuum have the capacity to strongly affect the user's experience: for example, as mentioned above, both cathedrals and the new Seattle Public Library main branch are masterful architectural works that craft spatial messages. Spaces at the digital end of this continuum, on the other hand, are impoverished by comparison. Many online "spaces" are impressive feats of technical expertise and data visualization (see, for example, the Atlas of Cyberspaces (www.cybergeography.org/atlas/) for some of the most cutting-edge of these spaces) but

many, if not most, are indistinguishable from places of work or play because the same physical devices and interaction styles are required by the constraints of the technology. Consequently, physical libraries may be awesome and inspiring, while current digital libraries are impoverished spaces. These awesome and inspiring spaces, however, may be highly constraining, requiring considerable human effort to access the ideas contained in the space, while the impoverished digital space may enable more direct access to those ideas. Thus, the classic architectural tension between form and function is quite vivid in libraries, both physical and digital.

Individual Spaces

These awesome and inspiring spaces are also by nature shared spaces: most libraries are designed to serve multiple user populations and multiple users. The physical library is a space where individuals come together. Though it is possible for an individual to use the library herself, there are always going to be others in the space: other users or librarians. The only libraries that are designed for only one user are personal libraries, libraries collected by a single individual for her own personal use. Such libraries are not shared spaces; instead they are individual spaces, often in one's office or home; that is, in one's personal space, the space that one customizes to suit oneself.

Such individual spaces are beginning to emerge in the digital arena. Systems to assist with collection development for such personalized spaces are nascent but developing, as some work has been done already on personalized agents for information retrieval and filtering (Foltz and Dumais, 1992; Rhodes and Starner, 1996). Despite the fact that the idea of personalized information spaces dates back at least to the Memex (Bush, 1945), there has to date been little work done on systems for personalized organization of the information collected by a single individual. Experimental systems to perform this function are only recently beginning to emerge, and take two distinct approaches: the first is to allow the user to search their own files using a search engine (for example: Google Desktop, desktop.google.com, and Beagle, beagle-project.org), and the second is to perform what Microsoft refers to as an "implicit query" (Kanellos, 2003): the user's files

are searched automatically, and data retrieved context-sensitively. The most extensive personal digital collection to date is Gordon Bell's LifeBits project (research.microsoft.com/research/barc/MediaPresence/MyLifeBits.aspx): Bell is attempting to collect digital representations of literally everything that he comes in contact with every day (Gemmell, et al., 2002). The LifeBits project is thus an individual collection in every possible way: it is a collection about, created by, and organized by a single individual. As the technology for wearable computing (Starner, 1996; DeVaul, Pentland, and Corey, 2004) and personal area networks (Zimmerman, 1996; Gutierrez, et al., 2001) improve and become more widespread, it will be possible for more such individual collections to be created that include traces of one's personal experiences as integral parts of the collection – with significant implications for future searches and collection use.

Borgman (2003) suggests that the next research front in the digital library arena is the personal digital library, and Beagrie (2005) discusses several research and development fronts related to personal information capture and management. It is unclear, however, whether such personal information spaces may reasonably be referred to as libraries. Certainly, like traditional libraries, a personal information space is intended for a specific user population: indeed, a very specific user population of one. And like traditional libraries, a personal information space provides architecture for the collection and organization of materials and functionality for the use and sharing of these materials. But this is not sufficient to distinguish a personal information space from many other spaces, both physical and digital. What personal information spaces to date lack, that traditional libraries possess, are human-intermediated services: that is, librarians. Of course early digital libraries also lacked human-intermediated services, and many still do, though such services have started to emerge in some large digital libraries, such as the National Science Digital Library (nsdl.org; Silverstein, 2003). So there is reason to hope that the functionality of human intermediation may yet be implemented in personal information spaces, though whether this will entail the specific user providing some form of mediation to herself displaced in space and/or time, or automating currently manual services, or development of software agents, or some other solution, remains to be seen.

What is clear, however, is that digital libraries have potentially much greater latitude in integrating and leveraging personal spaces than do physical libraries.

Spaces for Work

Electronic spaces (e.g., digital libraries) allow people to engage with a certain set of functionalities (e.g., library services) in their own preferred physical space. If an individual prefers coffee shops or the park as spaces to work or study or reflect, then the individual may be less likely to use a physical library. In such a case, it is necessary to bring that set of functionalities to the individual.

In a discussion of the future of digital libraries, Marchionini (2003) states that "as IT becomes more pervasive, the boundaries between physical and cyber spaces and between public and private spaces grow less distinct and more permeable." This blurring of boundaries is most obvious in advances in what is termed 'augmented reality' where the physical world is literally overlaid with digital added values. Blueprints on eyeglasses for maintenance workers and medical imaging displays projected on surgery patients are popularized examples, while Back et al. (2001) demonstrated children's books augmented with sound effects that take commercial learning systems such as LeapPad a step further. In a similar vein, Huang (2001) discusses what he calls "convergent architecture." Huang, an architect of physical buildings, is somewhat more conservative than Marchionini when he states that "there is little or no interaction or coordination between the activities performed virtually and those performed physically… What this comes down to is a failure to fulfill one of the central tenets of architecture: aligning the structure, or form, of a space with its use, or function" (p. 150).

A library is fundamentally a "pull" technology, where the user must go out of her way to deliberately retrieve materials. This is the case in both physical and digital libraries: a user must go to a physical library and must seek materials out and for certain types of materials must literally pull them off of shelves. Similarly, a user must go to a digital library and must use a technology more commonly thought of as a pull technology –

HTTP – to retrieve webpages. “Going” to the digital library, however, takes substantially less time and effort than going to the physical library since the going is virtual. Moreover, it is feasible that digital library materials may be ‘pushed’ to users either through subscription- or advertising-based alerting services such as RSS.

One important difference between the physical and digital library visit is the exclusivity of the physical visit. If one visits a physical place, one cannot simultaneously be in another place. This is not the case in digital places where individuals can simultaneously work in multiple spaces, either actively, for example through the use of multiple windows, or automatically, for example through automated processes and daemons. In fact, in the extreme case of identity theft, one could be ‘present’ in a number of places at one time unknowingly executing actions that have significant meaning and impact on one’s life. This sort of presence management is critical in the physical world, as one’s preferences for interacting with information – indeed, one’s very ability to interact with information – changes as one moves through space: one may, for example, prefer to communicate by telephone and to interact with information on the web in the office, but to communicate face-to-face and interact with paper at home. Of course, in one’s interactions with physical objects in the physical world this is not called presence management – it is simply presence.

An increasing number of physical libraries are maintaining digital collections alongside their print collections, and as this trend continues the experience of using a physical library will become more fully integrated functionally with digital materials, and in time hopefully architecturally as well. As digital libraries proliferate and both portable computing and wireless networking improve, the experience for a user of using a digital library will become more fully integrated with her daily activities in the physical world. As Brunk (2001) suggests, as technology advances and as physical and digital library functionalities merge, “it will become harder to distinguish between the physical world and the online world.”

A self-centered example will illustrate this point. The authors' offices are physical spaces in which we do work. Physically, these spaces are fairly small. For the purposes of our work, however, these spaces are almost unboundedly large, when viewed from the perspective of our ability to access electronic materials from within these spaces. Indeed, the sheer quantity of data that is available – on the free internet and in databases, available to us courtesy of the university's campus network – as we go about our work is greater than the physical contents of all of the physical libraries on campus, and perhaps greater than the physical contents of all of the physical libraries in the world. In fact, it is not our offices that are important in allowing us to access this information, but our computers. The approximately one cubic meter of physical space – the space bounded by eyes, hands, keyboard, and screen – is unboundedly large, in our ability to access information. Indeed, both authors own laptops, so this physical space is portable, which is of course the whole raison d'etre of laptops: this cubic meter of physical space may move throughout physical space, but thanks to the existence of a proxy server on the university's campus network, our ability to access electronic materials from this space is unchanged (at least when that physical space overlaps with a physical space containing an accessible wired or wireless network connection).

In his book City of Bits, William Mitchell (1996) claimed that this integration of technology and networking into individuals' daily lives and activities was increasingly converting people into "Cyborg Citizens." As ominous as this perhaps sounds, Mitchell views it as natural and desirable: in the way that eyeglasses improve vision, so other technologies improve other human senses and functions. Mitchell goes on to discuss the environments that are created, even necessitated, by these Cyborg Citizens, both in their personal and work lives: both entirely virtual "spaces" and integrated physical and virtual spaces, reminiscent in fact of Huang's (2001) "convergent architecture." Mitchell argues that these are spaces in which individuals and resources intersect: for example, employees intersect with their work as it is either pushed to or pulled by them. Functionality is brought to the individual. In this vein, libraries and other information services are beginning to offer push functionality to users through RSS feeds that continually broadcast information to subscribers (Hammond, Hannay, and Lund, 2004).

These capabilities both support individual use of the digital library and lead to new kinds of spaces for collaboration.

Spaces for Collaboration

Electronic spaces bring functionality not only to the individual, but to groups. As Mitchell (1996) points out, telecommuting enables both the virtual "cottage industry" and the virtual corporate office. The difference between these work environments is simply one of scale: how many individuals are collaborating, performing and sharing work. Marchionini (1999) gives this virtual space the name sharium: "a workspace with rich content and powerful tools where people can work independently or collaborate with others to learn and to solve their information problems" (p. 1). The sharium is an extension of the digital library, encompassing functionality that will enable users to utilize the sharium "as a problem solving space where individual or collaborative investigation and construction of new knowledge takes place" (p. 1). The sharium provides the tools and virtual spaces to which people may bring their own materials as well as use the library's materials. People working in this space may work alone, but may gain enormously by working with others to create new ideas and material manifestations of those ideas. Moreover, people may contribute those materials back to the library and the larger community. In the sharium, people also contribute time and expertise as members of communities of interest physically distributed around the globe. In the sharium, shared wikis, smartboards, and teleconferencing equipment; personal blogs; ephemeral chat rooms; and archival forums serve as analogs to the meeting rooms, bulletin boards, and public kiosks in physical libraries. The sharium is not bounded by physical space and allows extensive contributions by stakeholders. These contributions serve as a potentially valuable set of ideas and materials that may eventually be evaluated by the community either informally or formally. Open-source software communities are among the highest-profile examples of the contribution feature of the sharium, but other examples include the University of Pittsburgh's Supercourse (www.pitt.edu/~super1/) project, which as of this writing has over 2,600 contributed lectures on public health and prevention; Wikipedia (en.wikipedia.org), a contributor-constructed encyclopedia

containing millions of articles; and the Open Directory (www.dmos.org), a directory of the Web in which contributors classify websites by topic. These emerging contributor-created information resources represent important alternatives to the carefully curated collections produced by professional librarians in physical and digital libraries.

Kranich (2004) refers to shared information spaces as information commons: "a resource, or a facility, 'that is shared by a community of producers or consumers'" (p. 2). Information commons are "areas" in the public domain that are maintained as public – as, for example, parks and water resources are public – for their value in "promoting democracy and the free flow of ideas" (p. 12). The information commons is thus an alternative to the "enclosure" of intellectual property and information resources that exists under current copyright law in the United States. The sharium is a space for collaboration, but the information commons politicizes that collaboration; Kranich suggests that public spaces and the public interest go hand in hand in a democratic society. Information, like parks, Kranich suggests, is a resource that is best and most useful when owned in common by all potential users, and private ownership of such resources is detrimental to civil society. The information commons, as a resource that is not diminished by use, which is in fact enhanced by contributions from users, is thus an important alternative to the more common copyrighting and patenting of intellectual property.

The term "information commons" actually has two more or less distinct meanings: the first, as discussed above, being roughly equivalent to "sharium." The second meaning is roughly equivalent to "collaboratory." An information commons, according to this definition of the term, is a space designed to enable shared use of computing resources. The Symonds Labs at Rice University (www.symonds.rice.edu) and the Virtual Village at the Public Library of Charlotte & Mecklenburg County (plcmc.org/libLoc/mainVirtualVillage.htm) are outstanding examples of such spaces. Many other examples of such spaces were presented at the Information Commons Symposium, hosted by the Triangle Research Libraries Network (TRLN) in February 2005 (www.unc.edu/~pmpittma/InfoCommons/InfoCommons.htm). Information

commons of these types may take any number of forms: computer labs with seating arranged so that multiple users can share access to one computer, seating arranged in booths, group study rooms, wired classrooms, lounge-like spaces with wireless network access, and probably as many other configurations as teams of librarians and architects could envision.

Information commons are spaces deliberately designed to bring together the three components of which information science is composed: information, technology, and people. Information commons qua sharia are intellectual spaces to which people come to use shared information resources, made available through the use of technology. Information commons qua collaboratories are physical spaces to which people come to use shared technological resources, as a means of accessing and utilizing information resources. Both types of information commons are shared spaces, and both are efforts to foster social use and construction of technology and information.

Spaces for Education

The idea of social construction of information is not a new one. In the field of education, this idea is instantiated in the pedagogical style called cooperative or collaborative learning. These terms refer to pedagogical styles in which students work together in groups toward common educational goals (Johnson & Johnson, 1989; Bruffee, 1999). These approaches are rooted in the social learning theory of Vygotsky (1978) whose ideas about zones of proximal development emphasize how crucial physical interaction is to learning. Libraries have always to some extent been environments that supported this sort of collaborative learning, but in recent years new library building projects have been deliberately positioning the library in this role. In fact, physical libraries have created information commons to invite students and faculty to a physical space devoted to shared conceptual spaces of ideas and social interaction. The University of Southern California's academic library is often mentioned as a model (e.g., Oblinger & Oblinger, 2005). Academic libraries in particular have positioned themselves in this role, but increasingly public libraries are doing so as well. Academic libraries have always contained spaces for

collaboration: work tables, study carrels, small conference rooms, and the like. Nowadays, more and more such spaces are being designed into public libraries. One article about the new Seattle Public Library main branch, for example, states that it "is a building designed to be understood inside out" (Dietrich, 2004): in other words, it is a building designed with function foremost, and form following. The function of many of the spaces in the Seattle Public Library is to be meeting spaces, public reading areas, and spaces for collaboration between users, and between users and librarians.

There has been a burst of literature in recent years describing renovation and expansion projects in academic libraries (Lucier, 1995; Demas & Scherer, 2002; Bennett, 2003; Shill & Tonner, 2003, 2004; Freeman, 2005; Peterson, 2005). Freeman suggests that an academic library should address the "'psychosocial' aspects of an academic community": the library contributes to students' educational experience by providing a common space that "cut[s] across all disciplines and functions" (p. 6). In this way, the library is conceived as a place that by its very nature supports the academic mission of the institution. The nature of this type of library is as an information commons, in both the physical and intellectual senses of the term: a shared space containing information resources. Miller (2002) suggests that simply being an information commons is insufficient, however: the academic library must also be "staffed with professionals who can help people with their intellectual inquiries" (Partnership in the Learning Process section, ¶ 3).

On the one hand, this approach to library construction reifies the academic library's place as the intellectual center of the educational institution. On the other hand, this approach emphasizes how many of the library's traditional functions can be accomplished electronically. In order to maintain the library's centrality to the educational institution, when much of the library's resources can be used electronically, academic libraries must position themselves not as spaces for materials but as spaces for people. Indeed, the resources in the library may be as much for show, props to create an environment that users find inviting, as for actual use: Freeman (2005) suggests that "a significant majority of students still considers the traditional reading room their favorite area of the library –

the great, vaulted, light-filled space, whose walls are lined with books they may never pull off the shelf" (p. 6). In short, academic libraries are positioning themselves as community centers: as places for users to "hang out" individually or in groups, for work or social purposes. Essentially libraries are positioning themselves as third places with network access and resident librarians.

Collaborative Services

One of the most fundamentally collaborative functions of libraries is reference work. Reference work has traditionally also been place-bound, performed at the reference desk. The cornerstone of desk-based reference work is the interview – even if research indicates that a reference interview is conducted only approximately half the time (Lynch, 1978). The reference interview is stereotypically a one-to-one conversation between the librarian and the information seeker, in which the librarian attempts to elicit the seeker's information need, in the face of the seeker's quandary of asking a question on a topic about which she may know little or nothing (Belkin, Oddy, and Brooks, 1982). The interview is viewed as central to this interaction, as the collaboration between the librarian and the information seeker allows the librarian to assist the user to focus her question and allows the librarian to provide appropriate resources.

One aspect of physical place that digital reference currently cannot emulate is the quality of being face to face: transactions conducted via these forms of media lack the richness of a face-to-face conversation. The forms of non-verbal communication that a librarian relies on in the reference transaction – from the user's body language to the librarian's ability to size up a user based on appearance and manner – are lost. This is similarly true in other functions of the digital library; computer-mediated communication is less rich a communication medium than face-to-face communication (Daft and Lengel, 1986). Coffman (2001) states that for this reason "it is hoped that chat is an interim technology which will soon give way to something much more humane like voice." It is not clear that Voice Over IP (VoIP) is likely to take off as a medium for reference work, nor is VoIP as rich a medium as face-to-face, but communication via VoIP is functionally

similar to communication via telephone, and the telephone is a well-accepted technology for collaboration in a variety of settings. What is more, voice-based reference services appear to be staging a comeback in some more cutting-edge libraries (Bourne, 2004; Robinson and Fry, 2004). Videoconferencing technology has also improved and become affordable enough (Marriott, 2004) that future reference services may utilize it to return to the preferred model of face-to-face communication, though there is some evidence that the various forms of non-verbal communication may not be critical to collaboration (Walther, 1999). Videoconferencing technology may yet have a future in digital libraries to similarly support collaboration, though the appropriate uses of such technology is a topic in need of future research. Further on the horizon is the possibility of virtual reality services in which people project themselves into virtual spaces 'staffed' by avatars of real librarians or software agents (these might be called "cyberprofessionals").

Pomerantz (2003) discusses issues involved in integrating digital reference service into digital libraries. One of the unique aspects of reference work in this environment is that reference librarians become collection developers, as their answers to reference questions may be stored in the digital library, along with any materials these answers point to. Thus, over time, materials "accrete" in the digital library due to the fact that they are part of or pointed to by reference transactions. Ackerman & Malone (1990) refer to one such system as an Answer Garden. This form of collection development runs counter to the manner in which collection development has traditionally been performed: instead of a staff of collection development librarians collecting only those materials for the library that have been deliberately vetted, collection development becomes a collaborative process between reference librarians and users. In this form of collection development, librarians provide users with materials or links to materials in their effort to fulfill the users' information needs. Indeed, the environment in which the reference transaction occurs thus becomes a sharium: a collaborative environment in which participants solve an information problem, and in which the artifacts of that collaboration are stored.

Another unique aspect of reference work in the digital environment is that reference transactions become annotations to any materials that are provided to the user by the

librarian. A reference transaction may contain URLs or some other form of "pointer" to particular information resources. Over time, as reference transactions are archived, these pointers may be mined to create a "profile" for each information resource in the collection. This profile may serve to identify what types of questions, or what information needs particular information resources may be used to answer. It was mentioned above that one possibility for human intermediation in personal information spaces is for the user to provide some form of mediation to herself; this type of information resource profile development could fulfill this function. This profile development could also be useful, as Bollen and Luce (2002) suggest, in identifying the preferences of entire user communities, and in the creation of special collections on particular topics or for particular uses and user communities.

Conclusion

For many users of a physical library's resources and services, the library's digital component is what they interact with most, or even exclusively. As Carlson (2001) points out, library users' increasing use of electronic materials often means a decreasing use of materials within the physical building. This trend will likely be exacerbated by efforts such as the Google Books Library Project. Thus, as Taylor (1968) points out, physically going to the library is often the last resort for users. As the internet becomes more and more a part of people's everyday life, however, and people increasingly turn to online sources for their information seeking tasks, it is possible that digital libraries will be preferred by many to physical libraries. It is not, one suspects, that people do not go to the physical library because they object to the library per se, but rather simply that it is less convenient in certain cases than using online sources. Digital libraries are a possible solution to this problem. This creates the dual role for physical libraries of providing access to specialized materials not available online, and as social spaces.

As more digital libraries are built, and as more physical libraries offer electronic access to parts of their collection, two trends are likely to result:

1. The role of the library as a storage space for materials will become decreasingly important;
2. The role of the library as a space for users, for individual and collaborative work, and as a space for social activity, will become increasingly important.

Some non-digital materials may never have digital representations made of them, and some non-digital materials will always need to be accessed in their original forms for certain purposes. These materials must be stored and made accessible somewhere, so the authors suggest that the library and the archive will continue to be relevant for the foreseeable future. But the quantity of digital materials – whether digital representations of physical materials or "born digital" – continues to increase, and to far outstrip the increase in the quantity of print materials: according to Lyman & Varian (2003), digital materials saw an 87% increase and paper a 36% increase between 1999 and 2002. Storage, organization, and preservation of physical materials will continue to be important, but as the quantity of digital materials in the world continues to increase, storage, organization, and preservation of digital materials will be increasingly important.

As a result of the vast increase in the quantity of digital material, information spaces will increase in importance as spaces where users can make use of the digital materials available to them. The information commons will come to be increasingly important in libraries, as both a physical and an intellectual space. Both of these types of information commons support the other: as physical commons become more widespread there will be increasing opportunity and need for users to access material in intellectual commons, and as intellectual commons come to contain more material and possess more functionality there will be more incentive for users to make use of them both individually and collectively in physical commons.

As libraries, both digital and physical libraries fulfill the same functions: both are cognitive spaces that can be intellectually moved through and modified to suit cognitive needs. As spaces, digital and physical libraries differ in their capacity to fulfill the same functions. Digital libraries are unable to fulfill some of the functions of the physical

library as physical spaces, but are able to offer functions beyond what the physical library can offer as cognitive spaces. This is likely to be where much of the development of digital libraries will occur in the years ahead: enhancing the cognitive space by augmenting representations of the ideas in the materials with new kinds of extensions, hyperlinks, and annotations, while also adding capabilities for users to create profiles that support more personalized interactions among people and digital libraries.

Digital libraries are not physical spaces, and so are unable to fulfill those functions for which the physicality of the library is important, functions of the library that are by nature place-bound. One such function of the library is to be a place for people to congregate; in short, the digital library cannot fulfill the function of a library as a physical community center. Another such function is to be a space that can be physically moved through and modified to suit physical needs. Thus, the visceral advantages of holding, seeing, and smelling material objects and the sense of awe that well-designed physical spaces offer are missing in digital libraries. Just as face-to-face communication is often preferable to mediated communication, working with digital materials leaves something behind in exchange for convenience and new functionality. Working with digital materials and in virtual spaces, however, enables sharium-style functionality that may be used to expand the community of users far beyond what is possible in a physical space.

Physical space is an important constraint in physical libraries, but minimally important in digital libraries. The concept of place, however, is equally important in both physical and digital libraries because a sense of place is dependent on functionality, community, and personal experiences in the place. Digital libraries support new kinds of functionality, much broader communities, and emerging senses of place. Digital libraries project a ‘look and feel’ through interfaces that ‘brand’ the library and give patrons a vicarious sense of place. Although this vicarious sense of place cannot match the real place, we argue that digital libraries offer important new extensions to physical libraries and that these extensions are mainly toward the conceptual side of the space continuum, where more malleable representations and extensions are possible. We view this as an important move forward in making ideas more accessible to people and the new capabilities in these

digital places will cause people to seek them out and appreciate them just as they do physical libraries.

Kohl (2006) argues that “we have outgrown the metaphor” of the library as place. At best, Kohl suggests, “a place can continue to be part of the definition of a library, but it is reduced to only a part” (p. 118). We agree that the metaphor of place must in future be only part of the conception of the library. However, we believe that it will remain an important part, as the notion of what a place is continues to change. Indeed, throughout this paper, we have frequently used the word ‘space’ rather than ‘place’ as the dominant metaphor, as we believe that this word more reliably captures both the physical and the virtual. We believe that libraries are fundamentally spatial, but that the definition of space must be broadened: the most critical element of this space may not be that it is either physical or virtual, but that it is intellectual.

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