

Libraries and Imagination at the Dawn of the World Wide Web

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This article traces discussions from 1991 to 1994 about the impact of the World Wide Web on libraries. Librarians and other information professionals commented about the Web's potential as a tool for organizing and using materials on the Internet in print journals devoted to library science, in periodicals about computing trends, and in online media such as discussion lists. Evaluation of the Web took place in the context of interest in Internet Gopher, WAIS and similar applications, and the wish to simplify access to online information. Librarians reading about the Web at that time encountered

two schools of thought. Some visionaries hoped that the Internet would free researchers from relying on intermediaries, including librarians. Practical-minded librarians, on the other hand, emphasized organizing the Internet as a service to readers. Both camps saw potential value in the World Wide Web. By 1994, librarians were experimenting with specific Web-based projects to organize digital information, improve online searching, guide users, and publish texts online. Libraries were soon using Web-related software to fulfill traditional missions in the new online environment.

Introduction

As the twenty-first century begins, the World Wide Web has transformed the operation of American academic libraries. Acquisitions units are licensing Web-based texts from publishers. Public service areas have adopted HTML-based interfaces to serve users who are as likely to “visit” libraries through Web browsers as in person. Technical service operations are switching from telnet-based to Web-based applications. Libraries are adjusting to a new ability to offer images and sounds as well as text. As the line blurs between what is “in the library” and what is “on the Web,” librarians are challenging old assumptions about the limits on their responsibility to advise readers.

It is easy to forget that the World Wide Web is barely ten years old. Between 1991 and 1994, librarians and other information professionals conducted a lively public debate in library and information science journals and in new media such as discussion lists, as they grappled with the possibilities raised by the Web medium.

By the time the Web came to their attention, librarians were already aware of a variety of software used for particular tasks. These applications ranged from telnet for e-mail and OPAC access and ftp for file sharing, to more complicated systems such as Internet Gopher for organizing online files, WAIS (Wide Area Information Services), and archie and veronica for keyword searching on the Internet. Librarians generally regarded these programs as limited and frustrating. Anyone wishing to work with online information had to learn too many diverse and demanding sets of instructions. Despite all this effort, the Internet remained compartmentalized, disorganized, and difficult to visualize, so that it was hard to know whether information was available or how to find it.

Librarians' interest in the Web and their evaluation of its potential took place against this backdrop. They were quickly attracted by the Web's cross-platform capability, the relative simplicity of its point-and-click format, and the flexibility of hypertext for connecting, organizing and retriev-

ing files through the Web. At the same time, librarians assumed that innovations like the World Wide Web would not require radical changes in the basic mission, values and philosophy of librarianship. During a period of free-wheeling discussion, this stance lent a practical tone to librarians' approaches to Internet tools like the Web.

Dawn for the World Wide Web

In his recent memoir, *Weaving the Web*, Tim Berners-Lee reminisces about and discusses the origins of the World Wide Web. Berners-Lee wrote his World Wide Web software during 1990, adopting concepts of the personal workstation, cross-platform access, and hypertext from the writings of Vannevar Bush and Theodor Nelson (Berners-Lee 1999). [1] Beginning in December 1990, his creation was online at CERN (the Centre Européenne pour la Recherche Nucléaire, or the European Laboratory for Particle Physics) and under examination by a widening audience.

By the Spring of 1992, computer-savvy librarians were aware of the World Wide Web. In an article in *Electronic Networking*, Berners-Lee and three colleagues presented their plan to reach some of Vannevar Bush's goals: "extending ... intellect by making collective knowledge available to each individual" through networked computers and hypertext links that would "mimic human association of ideas" by means of a system of "text retrieval, which allows associations to be deduced from the context of text" so that the reader had only to "supply some words representing that which he desires" (Berners-Lee 1992, 52). In May 1992, an abstract of the article appeared in the library-oriented newsletter *Current Cites*. [2] On May 29, 1992, the prominent PACS-L discussion list distributed the abstract, which described the World Wide Web as "a hypertext document system designed to provide access to documents around the world, thus creating an organized world-wide web of data and relevant connections between databases" (PACS-L 1992b). [3]

News of the Web fell on receptive ears in libraries. Librarians were keenly interested in improving access to online information. The Internet hinted at vast potential, but was notoriously difficult to use for anyone without substantial experience and patience. Internet users had to master a long list of software applications, in-

cluding telnet, ftp, Gopher, WAIS, veronica andarchie. [4] Librarians disliked the need to employ different commands in each system. Mary Lukanuski wrote in 1992:

Imagine the capacity to search a variety of databases through one interface. Imagine searching in everyday language, without having to use Boolean operators. Imagine not logging in and out when changing databases. Imagine accessing text, sound, and images with the same interface (Lukanuski 1992, 742). [5]

Edward J. Valauskas had something similar in mind in 1993 when he wished that

some ancient predictions about computers will come true. Soon it may no longer matter what kind of box we are using or accessing, what kind of file or what version of software was used in making it available to use, or at what distance ... I won't have to remember commands, addresses or character strings that never quite made sense to me (Valauskas 1993b, 89). [6]

In the same 1992 issue of *Electronic Networking* that announced the World Wide Web, an article by Clifford B. Neuman identified four key barriers that made it hard to use and share Internet-based sources:

... it is difficult to identify the information of interest; it is difficult to keep track of this information once found; it is difficult to share information about what is available, or to collaboratively maintain such meta-information; and the information is often scattered across multiple file systems of different types, meaning that different mechanisms are needed to access it (Neuman 1992, 30). [7]

These functions – identifying or selecting resources, maintaining access to them, listing available materials, and presenting them to users – were familiar problems for librarians. Until they were solved, there could be no computer-based "virtual library."

The appearance in 1993 of the Mosaic Web browser (the precursor of Netscape) heightened interest among librarians. On July 20, 1993, PACS-L reprinted the *Current Cites* newsletter 4/7 of July 1993 (PACS-L 1993b), which noted an article in the *Chronicle of Higher Education* describing the new Web-compatible interface software being distributed for free by NCSA, the National Center for Supercomputing Applications (DeLoughry 1993). Mosaic and the Web seemed to meet the requirements for Internet access summarized by Edward Valauskas in *Online* in September 1993:

A first step for a new Internet resource 'collector' would be to pull these diverse tools (WAIS, Gopher,archie, and others) together under one umbrella. Ideally, it would simplify use and encourage you to take advantage of the best features of all of these tools. ... Unlike any analog catalog, with the click of a mouse, you could go right into an Internet resource and use it immediately. ... This sort of 'collector' would provide a kind of infrastructure for an Internet catalog. It would be a framework for organizing intellectual resources on a scale unknown in any library or computing center now (Valauskas 1993a, 99).

In the features of Mosaic, Valauskas recognized a solution, as well as a new problem:

Mosaic is a way to pull together documents, Internet search tools, scientific data, and other files under a single framework. What would be the easiest way to organize these resources online? Mosaic brings together resources under specific menus. Within these broad options, Mosaic works like World Wide Web, a hypertext way of looking at resources (Valuaskas 1993a, 100).

The notion of mastering a single application had obvious appeal. At the same time, organizing a whole new universe of materials was an obvious challenge.

Valauskas' remarks neatly illuminate the initial enthusiasm about the Web: excitement about its potential, combined with uncertainty about its characteristics. Like many early commentators, Valauskas was still wrestling with the difference between Mosaic and the Web: between the train and the track, as it were. [8] Neither was it yet clear the extent to which the latter placed limits on the performance of the former. In part, these unsettled details reflected the crucial role played by Mosaic in popularizing the Web: the ease of using the Web through Mosaic temporarily masked some unsolved problems.

Given their frustration with the eccentric tools needed to travel on the "information super-highway," [9] it was no surprise that the simple Mosaic interface entranced librarians and other information workers. In a short "history" of Mosaic published in October 1994, Richard W. Wiggins highlighted the same features that appealed to Valauskas: Mosaic's ability to replace awkward commands with a graphical interface, and to incorporate the orderly hierarchies and menus found in familiar Gopher systems, while transcending those structures at will with hypertext hot links, and multi-protocol capabilities that simplified access to the uncomfortable array of

information sharing systems on the Internet: ftp, Gopher, WAIS, and the rest (Wiggins 1994, 48-51). [10]

Willing librarians caught in the Web

Mosaic's convenience was of special interest to librarians, for whom computer-oriented public service had been an issue for some time. In an early explanation for librarians in *Computers in Libraries* of December 1992, Gord Nickerson praised CERN and the World Wide Web concept for unifying access to materials in unlike formats on the "same computing platform" and providing "a common document-naming scheme" (Nickerson 1992b, 75). [11] A convenient interface was the first priority, and ways to find and deliver text were also needed.

Librarians' interest in the Internet, the World Wide Web and Mosaic developed rapidly because the promise of these tools capitalized on a good deal of prior conversation, in which the future of libraries in a digitized world had been imaginatively explored. Planning the library of the future was difficult, because it was not clear what the contents of that library might look like. Librarians were not only trying to envision something new, but something that might very well have no visible or concrete manifestation. These circumstances led to wide-ranging exploration of useful metaphors and analogies. As Marian L. Dalton put it in Fall 1991, the ability to find information in the "electronic equivalent of a huge, but widely dispersed, 'virtual' library" was a critical issue:

... until maps are available describing where the treasures are, this goal is far from reachable. Appropriate tools to locate information in this amorphous library are sorely needed.

As Dalton pointed out, the virtual library of the future promised to extend and support library access to

information in formats to which librarians have traditionally provided access via catalogs or indexes: full texts of monographs and journal articles, photographs or other images, multimedia materials, and, of course, bibliographic information

but also found itself threatened by a lack of indexing or cataloging techniques that could keep

track of an overwhelming array of additional items never dealt with before. These included:

collections of software, various computer files of research data, bulletin boards or forums, scholarly research status reports, 'geodata' (data associated with electronic maps), and directories... (Dalton 1991, 31-32). [12]

As Dalton asked in the title to her article: "Does Anybody Have a Map?" Without one, it was hard for librarians to set a course.

In the absence of maps, mental or otherwise, librarians at first relied on straightforward description in an effort to grasp an unfamiliar approach to information seeking, one that was novel but nevertheless easily recognizable as important. In June 1992, in order to tell readers of *Wilson Library Bulletin* "how librarians and libraries can benefit from net connectivity," Jean Armour Polly painted a picture of her online experiences:

On my electronic adventure I browsed the online catalog at the University Library in Liverpool, England, leaving some "Hi there from Liverpool, New York" mail for the librarian.

I downloaded some new Macintosh anti-virus software from Stanford's SUMEX archive.

Then I checked a few databases for information needed for this article, and scanned today's news stories.

I looked at the weather forecast for here in the East and for the San Francisco Bay area, forwarding that information to a friend in San Jose who would read it when he woke up. The Internet never closes! (Polly 1992, 38) [13]

The sheer novelty of online activity retained its attractive power for a long time. When Steve Cisler remarked in *Library Journal* that "What is most evident to the browsing librarian is the diversity of the information served" and made his case in July 1994, his examples ranged from "serious" patent information to a "frivolous" collection of lawyer jokes (Cisler 1994, 32). [14] Reports on these kinds of disjoint resources, however intriguing, still suggested that the whole was less than the sum of its parts.

In the days before Mosaic, the diversity of the Internet was a curse as well as a blessing. In particular, the long list of necessary applications and information systems presented obstacles for librarians and library users alike: email, telnet, Usenet, ftp, and so on. Each effort to simplify the process seemed instead to spawn one more application that had to be learned, in dizzying succession. Thus in October 1992, Mary Lukanuski was

touting WAIS in *American Libraries* as "one method for 'navigating the network'" that would overcome the "overwhelming amount of information ... currently available to anyone with a PC and a modem" (Lukanuski 1992, 743). A year later, Karl Bridges was extolling the virtues of Gopher systems as

a new and potentially revolutionary method for managing information in libraries ... that makes it easy for users to navigate through the internet using a hierarchical menu system to locate information.

In Gopher, Bridges saw some prospects for information sharing among libraries: such an extension of traditional inter-library cooperative efforts might "create a seamless worldwide virtual library where the physical location of the information becomes irrelevant to the user" (Bridges 1993, 36-37). [15]

By making the delivery system more transparent, Gopher began to restore content to a position at the center of the online information experience. The World Wide Web had the same appeal: it demonstrably shortened the list of Internet-related tools to be mastered. In 1994, Dan Lester specifically identified the cross-platform capability of the Web and Mosaic as a breakthrough that allowed librarians to focus on searching for information instead of struggling with software:

Well, what does all this stuff mean to us in libraries? Just as many libraries have quickly learned the value of Gopher as a tool to find information on a multitude of topics, today we're starting to find the same information, plus much additional information, with a WWW browser (Lester 1994, 7). [16]

In a handout about the Mosaic browser for the North Carolina State University libraries in April 1994, John Ulmschneider made much the same point:

Mosaic is the first software tool that seamlessly integrates hypermedia technology - which links information files to related information files through their contents rather than by indexes or other formal means - for navigating networked resources along with transparent support for diverse data formats... (Ulmschneider 1994). [17]

So did Dongming Zhang, describing a Cornell University Libraries project to manage online information simply, through the use of Mosaic and

hypertext links inside and among documents. These can be used to conveniently link subject-related or consequence-related documents and provide information at a more comprehensive level. It can also handle multimedia information and has a good graphical user interface. Finally, it is compatible with other network protocols and applications, such as ftp, gopher, and WAIS (Zhang 1994, 68). [18]

That level of convenience had the potential to win new friends for the Internet. Steve Cisler said so in the pages of *Library Journal* in July 1994:

Mosaic presented an attractive graphic interface to text, sound, and images, and this enabled Internet junkies to spend even more time online. More importantly, it showed novices why the Internet could be useful to other than net nerds and mouse potatoes (Cisler 1994, 32).

As Cisler realized, Mosaic and the Web not only simplified life for current Internet users: they cleared the way for Internet use by a wider public.

Libraries without librarians?

Expansion of the world of Internet users was not without controversy. Many in the existing online community were skeptical about newcomers to the Internet. Cisler observed this clash of cultures in 1993:

With the arrival of new users, many of them from the commercial sector, a series of cultural and policy-based brushfires have been started. Stated in crude binary terms, they center on fee versus free, open and closed systems, anarchic versus governed, private and anonymous versus centralized secure systems with accountability, indexed information versus raw data, unimpeded rivers of data versus filtered, bottled, and marketed information, free speech versus censorship, access for some versus universal access, flat-rate pricing versus packets/mile charges, cultural preservation versus cultural disintegration, and centralized sources of information versus every user as publisher (Cisler 1993).

Librarians were among the newcomers viewed with suspicion. Librarians brought with them longstanding positions and outspoken beliefs on many information-related issues, a posture that did not sit well with some nonlibrarians. Many experienced Internet users wanted universal online access to promise an open system in which the simplicity of the World Wide Web would eliminate the need for authorities, including librarians. In the influential pages of *Wired*, Gary Wolf had this to say in 1994 about browsing the Web:

One thing it was not like: it was not like being in a library. The whole experience gave an intense illusion, not of information, but of *personality* (Wolf 1994b). [19]

And “not like being in a library” appealed to many people, for whom the concept of ‘the library’ stood for qualities associated with a by-gone era.

For those expecting or hoping to liberate information and its users from the strictures and intermediaries of old institutions – including libraries – the Web and Mosaic offered an alternative. Some features of the Mosaic browser suggested an online New World in which individuals might construct associations, connections and institutions on their own terms. Among these devices was the ‘Annotate’ feature of the Mosaic browser. Richard Wiggins had this to say about the implications of this option in October 1994:

One of the more ambitious features NCSA has tried to provide in Mosaic is annotation support. This enables a user to annotate a given Web page either in a set of personal notes – which are stored locally and are visible only to that individual – or in a set of group annotations – which are kept online by an annotation server.

The group annotation concept is particularly ambitious: Carried to a logical conclusion, group annotations take on the role of Usenet news. For now, NCSA says that group annotations are intended to support small workgroups, not Internet-wide discussion groups (Wiggins 1994, 50). [20]

To the extent that the online community viewed the Web as a place where individuals and small groups made their own rules, they were skeptical about any role for librarians.

At the same time, many librarians were just as skeptical about Mosaic and the Web: these applications were viewed as untested novelties, or novelties that had been tested and found wanting according to the standards of sound librarianship. Mary Lukanuski reported how an online library experiment at the Apple Computer company played to mixed reviews in 1992:

Nonlibrarians are enthusiastic. Database searching is no longer intimidating, and personalized information can easily be found without the intermediary of a reference librarian. The intermediaries, however, are less than enthusiastic. ‘Professional searchers have been suspicious,’ commented Apple’s [Janet] Watts on librarians’ reactions to the WAIS search capacities. ‘They have less control over the search and feel a need to understand how it works’ (Lukanuski 1992, 742).

In 1993, Steve Cisler reported the same reservations:

A few years ago, the head of a fee-based online service was asked when the Internet could be used to access his system. "Why should we hook our drinking water supply to a sewage system?" was the gist of his reply. Some time after that a special librarian for a large corporate library stated that she felt it was her duty to keep the engineers and other patrons in the company from using a dangerous and dirty system like the Internet. Of course, they were already using it; she just did not want to get involved at that time. Both of these people wanted to protect their enterprise and their users from what they saw as an uncontrollable, chaotic system, full of dirty data, unruly computer intruders, foul-fingered Usenet orators, corrupted programs, and unreliable connections. This view was indicative of the kind of stratification of the online world. There was not very much knowledge about or interest in learning about the different segments. Professional online database searchers did not frequent the world of Usenet. Internet users looked down at the bulletin board system operators, and commercial consumer service providers were in their own separate world with only a few links to these other worlds. CompuServe did not talk to Fidonet which was unaware of Usenet, and the Internet was a loosely guarded secret (Cisler 1993).

Librarians were dubious that such a grab-bag merited their attention as a collection of tools worth mastering.

It was the challenge of locating, retrieving and organizing access to Internet resources that eventually lured libraries into the online world. Growing experience with the Internet and the Web convinced many librarians that valuable resources were present, but also underscored the crying need for systematic organization. There was a challenge that few librarians could resist.

"Paths of whim and intuition"

Early descriptions of online activity, especially on the Web, tended to mistake the simplicity of point-and-click browser interfaces for simplicity in finding things. Too much of the infrastructure that supported effective searching was taken for granted. This 1992 comment by Tim Berners-Lee is representative:

A typical information hunt will start from a default hypertext page by following links to an index (Berners-Lee 1992, 57).

This casual remark assumes three things: that the hunter is already aware of an initial Web page,

that the start page includes pathways to appropriate indexes, and that appropriate indexes are in existence. All three in fact rely on prior work.

Careful reading of early reports by Web users reveals difficulties that are understated in the authors' analyses, despite being recorded in descriptive passages. For example, Edward Valauskas used a particular vocabulary to describe a Gopher search he conducted in 1993: "I scan a year's worth of tables of contents;" "curious about the ... folder, I open it ...;" "I imagine a few other folders that I need to explore." 'Exploration,' 'imagination,' 'curiosity' and 'scanning' imply intuitive or serendipitous searches, rather than operations that are intentional, planned, efficient and effective. Enthusiasm about the genuine contributions of the World Wide Web and Mosaic led many commentators to downplay these problems. Imprecision in searching was not so much forgiven as ignored, in favor of other aspects of the new online environment. When Valauskas remarked in March of 1993 that "I do not know where my searches and folder sifting takes me, nor does it matter ..." (Valauskas 1993b, 88), he was not expressing satisfaction with aimless searching, only relief that hypertext and the Web no longer forced him to know the location of online information in advance. But neither did he complain about the aimless and inefficient aspects of the process.

Writing two months later, Valauskas was more thoughtfully candid about these problems:

Virtual browsing: the act of invoking serendipity on a computer ...

Is virtual browsing reality? How do I get from here (my keyboard and modem) to there? ... Are there any guides? Maps?

Navigating is an entirely new problem in this new world of computer networks. We spend an inordinate amount of time and skill in learning our way along the electronic roads on the network, looking for files, depositories, and meeting fellow travellers. For some of us, learning the 'navigation data' for these electronic byways is more important than reaching a specific digital destination. The actual process of moving from one electronic address to another, is our sole reason for exploring. For others, the process is not as important as reaching a destination - of finding information as quickly as possible - to satisfy a need, not to participate in a network odyssey (Valauskas 1993c, 103).

This wish - to find a specific piece of information as directly as possible - expressed the librarian's hopes for the Web.

By 1994, librarians reading about online information encountered two perspectives. Some commentaries simply overlooked utility and efficiency as criteria for success, a mood captured by Gary Wolf in an article for *Wired* called “Why I Dig Mosaic:”

Last night Mosaic blew my mind ... With seamless grace it brought me in direct contact with information that I didn't know I wanted to know.

I launched Mosaic for a prosaic reason: to track down some details about the World Wide Web on the pages at CERN in Geneva. But I typed the address incorrectly – or had it copied down wrong – and I soon found myself wandering aimlessly along the interwoven strands of the Web, listlessly clicking on links, circling in the near vicinity of CERN (not geographically, of course, but along vectors of association), hoping in a rather lame way to hit on the document I was looking for. Finally, I found myself standing on the NCSA demo page, much as tourists wandering through the complex alleys of an old city will, when their energy runs out, eventually walk along with the flow of traffic and find themselves in one of the main intersections or town squares (Wolf 1994b).

In a companion article, Wolf added:

By following the links ... you can travel through the online world along paths of whim and intuition. ... Mosaic is not the most direct way to find online information. Nor is it the most powerful. It is merely the most *pleasurable* way. ... Mosaic is clumsy but extraordinarily fun. ... Long-frustrated dreams of computer liberation – of a universal library, of instantaneous self-publishing, of electronic documents smart enough to answer a reader's question – are taking advantage of Mosaic ... (Wolf 1994a).

Wolf perfectly represented one side of the argument, challenging traditional, library-like approaches to information seeking. His comments rejected mediation by experts in favor of “direct contact,” planning in favor of serendipity, analysis in favor of “intuition,” frustration in favor of “liberation,” and professionalism in favor of “fun.”

Ranged on the other side were critics of an uncharted Internet, who were more likely to describe the Web as a “horrendous multi-dimensional maze” (Moody 1994, 5). These users remained in need of someone who could get things organized.

Metaphors of knowledge

Wolf's article in *Wired* is noteworthy also for its evocative metaphors: “interwoven strands,” “complex alleys,” “town squares.” If discussions of on-

line library information were to move beyond tired formulations such as the ‘computer card catalogue,’ new images were called for. When Wolf presented his view of the Web in 1994, he was able to take advantage of recent artistic conventions that depicted the online world in symbolic terms.

William Gibson's ground-breaking science fiction substantially influenced this movement. The best known of the “cyberpunk” writers, Gibson contributed powerful imagery in passages like the following from “Burning Chrome,” a short story first published in *Omni* magazine in 1982:

The matrix is an abstract representation of the relationships between data systems. Legitimate programmers jack into their employers' sector of the matrix and find themselves surrounded by bright geometries representing the corporate data.

Towers and fields of it ranged in the colorless non-space of the simulation matrix, the electronic consensus-hallucination that facilitates the handling and exchange of massive quantities of data (Gibson 1982, 74). [21]

The depiction of computer-based worlds through geometry and color was further popularized by the Walt Disney Studios motion picture *Tron*, which also appeared in 1982. [22]

By the early 1990s, academic papers about information and information seeking employed concepts of visual or three-dimensional representations of data, which by implication made that data available for manipulation or exploration in new ways. In a 1991 conference presentation that cited Gibson among its sources, Patricia Ann Carlson painted this picture of a future online search environment:

Imagine, for example, the potential for a knowledge domain or ‘library land’ ... to be represented in 3-D space. As a learner, you walk through the information environment – or better yet, fly over the landscape – looking for a particular subject. Since your assignment is to write a research paper on some aspect of the French Revolution, you land in Paris, zoom in on the knowledge shop in the Rue de Calais, and walk in.

The friendly proprietor asks you a series of questions to determine your needs, and then decides that ... it would be best for you to visit the Sculpture Gallery. ... you are amazed to see life-size figures of the major names associated with the period, clustered in order of importance. (Were you to find this grouping unsuitable for your purpose, you could select another arrangement – alphabetical, let's say – enter your request, and watch the clusters dynamically reconfigure). ... you stop occasionally to

activate a button at the base of each figure. The statue dissolves into a collection of icons representing the major subsets of information.

... you return to the shopkeeper and ... she helps you to refine and focus your collection of topics, and gives advice on gathering further information. ... she directs you to the Hall of Records. This room reminds you of a well-stocked library, except that the items on the shelves are topic modules rather than titles ... organized alphabetically. ...[You] ask that only those items containing a set of keywords be visible. You've further requested that these items be rank-ordered based on a sophisticated algorithm that calculates the number of times the keywords appear and the size of the segment where the word appears.

In Carlson's formulation,

... though the 'knowledgescape' may have familiar features, neither the scene nor 'puppet' shares 100 per cent fidelity with reality. They are symbolic, and hence amenable to all sorts of purposeful manipulations ... (Carlson 1992, 72-74). [23]

Carlson's "library land" is not merely a library housing novel digital products, but a true virtual alternative to traditional library techniques.

Carlson's future also includes another element borrowed from cyberpunk conventions: a major role for software-based intelligent agents.

In a virtual environment, the human is just one of possibly many active (even intelligent) elements in the landscape. ... The human does not enter commands per se, but rather performs functions by interacting with other elements in the scene (Carlson 1992, 72).

The notion of a self-managing Internet, possibly inhabited and overseen by autonomous devices, was widely discussed. Marian L. Dalton cited Robert W. Kahn and Vinton G. Cerf about "knowledge-robots or knowbots, to do the leg-work of finding information ..." (Dalton 1991, 37). Gary Wolf speculated on several comparable developments in his *Wired* article. According to Wolf, David Raggett at Hewlett-Packard

... imagines the different computers on the Web sharing data in such a way that the most popular information is replicated onto many machines, while the least popular information lives on a single machine. Addresses, in the conventional sense, would disappear. No human being would know where any specific piece of information was stored. The Web would shift its data around automatically, while users could retrieve documents simply by knowing their names. The Web, in this scheme, becomes unlocatable and omnipresent (Wolf 1994a). [24]

Raggett's approach was not the only one that appealed to Wolf:

At MIT, a researcher named John Mallery points out how primitive the Web's links are today. They are fun, he agrees, but they are not smart. You can find information on the Web only by drifting through the links other users have created or by knowing the specific address of the document. But if documents and parts of documents were catalogued in more complicated ways, the system itself could build links. Browsing a magazine on the Web might automatically generate links to other magazines. Looking at an archive of photographs of flowers might automatically create links to a botanical database (Wolf 1994a). [25]

These conceptions aspired to solve the problems of organizing information and establishing paths to reach it without human labor, because the information was assumed to perform both kinds of tasks for itself. From a librarian's perspective, this marked a small advance, because the tasks were at least recognized as important. On another level, however, this 'answer' merely rephrased the question: the mechanics and techniques of the processes remained unstated and assumed.

Taming the Web through practical librarianship

However interesting, artificial intelligence remained a matter of speculation while the expanding body of online information made the need for organized access real and immediate. Even as some authors dismissed the library as a model, other writers argued in favor of librarians' skills and library principles. In a pair of articles in 1992, Gord Nickerson remarked that

Librarians are good at filtering and organizing information ... (Nickerson 1992a, 54).

And

Creating good hypertext documents is far more difficult than making them available - but then, isn't that why there are library schools? (Nickerson 1992b, 77)

A digital handout from the University of Illinois captured the mood among many librarians: "... the next obvious question is *how do I get started?*" (UIUCnet 1992). And start they did, in a myriad of places.

Practical efforts to organize access to the Internet began on a local scale, often through the efforts

of dedicated individuals. As Marian L. Dalton noted in 1991, "Currently, most of the resource directories available are simply lists maintained online by dedicated individuals ... " (Dalton 1991, 32). A well-regarded early example was "Special Internet Connections," better known as "Scott Yanoff's list" and publicized through PACS-L as early as February 1992 (PACS-L 1992a). [26] Much of the early enthusiasm for the Gopher approach reflected appreciation of its convenient starting point prepared by the University of Minnesota. Greg Notess gave advice that was widely followed by those trying to "get started": "If you don't have a local Gopher, a good place to start is Minnesota, the Gopher State..." (Notess 1993, 101). [27]

In the absence of formal instruction, many newcomers to the Internet had no choice but to rely on advice from digital old hands. [28] Michael F. Schwartz observed in 1992 that

Knowing who provided each service often required users to consult a local expert, an inefficient use of resources for all parties concerned (Schwartz 1992). [29]

In the same year, Gord Nickerson too noted the importance of special knowledge:

A persistent problem with the Internet is that it is hard for a user to find out what is available, where it is located, and how to get there to use the resource.

It reminds me of a private library I visited as a graduate student in history. The specialized collection was enormous but since it did not use standard classification and cataloging methods, my adviser (who had been there often) had to show me where the items I sought were located. In the same way, much useful information is hidden in the nooks and crannies of the Internet, but finding out what is available and how to access it is difficult.

When the net was small, veteran networkers knew exactly where to go for the information they needed (Nickerson 1992b, 75).

But Internet users who were not veterans were in dire need of guides, lists and directories.

These initial efforts were limited in scale, and limited in their success. The tools available for information-seeking disappointed Judith D. Ahrens and Gerardo A. Esquer when they tried the Internet in 1993. They located a hard copy list of libraries that were offering online resources, but found the list too inflexible: "it is organized by library name, and not by subject." Archie's keyword search capacity failed to cover much of the

online universe: "We were rewarded with the name of exactly one document, raising doubts about Archie's indexing capability." Gopher and Veronica fell short, too.

Gopher has several problems. First ... we had to ... repeat the process [of searching over and over] ... Second, each Gopher server menu reveals an ad hoc, idiosyncratic organization. Veronica ... could improve gopher by constructing a menu of items from Gopher clients worldwide that meet the user's search criteria ... Veronica, however, will only be as good as the non-standard topic descriptions used in Gopher menus (Ahrens and Esquer 1993, 19-20). [30]

In other words, in 1993 the haphazard construction of the Internet's tracks still made it hard for the trains to run on time.

Thanks to its simplicity, Internet users soon preferred the Web and Web browsers for unstructured "surfing" on the Internet. [31] The same simplicity led librarians to prefer the Web over other systems as a foundation for more methodical searching. They reached this conclusion on the basis of potential: the Web had not yet eclipsed Gopher as the prevalent system. However, the growth of Gopher sites weakened rather than strengthened that system's attractions.

Several writers pointed out the limitations on node and branch tree structures, the hierarchical foundation behind the Gopher approach to organizing Internet sites for access. In 1991, Marian L. Dalton could already list these defects in managing or using large arrays of Gopher menus:

... it is difficult to delete information within the heart of the tree. ... there is no built-in mechanism for warning that a particular subject search may be very long or inefficient. A search also returns everything found to the requestor, no matter how many items are located.

Dalton suggested another look at the strengths of a familiar tool: "the library catalog is a logical choice..." (Dalton 1991, 36).

Proposing a catalog of the Internet gave librarians some idea of what they wanted to do: it did not begin to accomplish it. The sheer number of potential Internet sites to be cataloged was one of the most daunting aspects of the task, especially if the work could not be automated, a concern raised by Dalton:

Will librarians be required to create and maintain catalog entries for each file a researcher would like to share, or

can the entries be produced [sic] the indexing terms, and will a controlled vocabulary be used? (Dalton 1991, 36)

Many observers were interested initially in the Internet's capacity to support individual efforts. In 1992, Clifford Neumann proposed personal, customized directories as a solution to organizing the Internet:

Users will build their own hierarchies of files. ... If individuals do not like the way information is organized, they can organize it themselves ... (Neuman 1992, 33) [32]

But the experience of relying on local, small-scale and idiosyncratic organizing schemes soon persuaded librarians that shared solutions would be more effective than those devised by individuals. Both Gopher and the Web promoted cooperation among would-be organizers of the Internet: local efforts based on either system produced online sites that were mutually compatible and readily fit together into a larger structure.

Many commentators saw no realistic alternative to librarians and library practices, for imposing control and organization on Internet materials. Michael Schwartz wrote in 1992:

In libraries, highly trained staff are responsible for organizing the available data. Library science has developed methods over hundreds of years to construct a model in which the user, with some experience, can navigate through, locate, retrieve and use the desired information. In contrast, in the Internet every user is also a potential "publisher" and "librarian". No one expects the average user to be able to organize his or her information with such skill (Schwartz 1992).

If organization was wanted, professional attention was needed.

Sizing up the problem of organizing the Internet in 1993, Edward Valauskas made explicit reference to library techniques as tools to promote systematic searching:

How would you catalog the Internet? Would you invent an online catalog, complete with a classification scheme, or perhaps a printed and electronic directory with frequent addenda? Would you rely on software to track down and keep up with the diversity of lists, files, and services on the Internet? Internet tools, like TurboGopher and WAIS, point to the need for Internet organization, but are not a systematic cataloging of files as we might imagine in a card catalog (Valauskas 1993a, 99).

As librarians tried WAIS, Gopher and the Web, not all systems proved equally effective for the job.

Upon its introduction, the relative simplicity of learning Gopher's menu system made it an attractive organizing tool, but its other defects soon exposed it to competition. In 1993 Ed Krol pointed to the shortcomings of Gopher and predicted its eventual eclipse by the World Wide Web:

Some believe the Web isn't going anywhere because its slow, steady growth has been eclipsed by the explosive growth of Gopher, which has experienced such growth because its simple structure makes it easy to establish servers and resources.

But that simple structure limits the high end of what Gopher can provide in the long run (Krol 1993, 34). [33]

In 1994 (as opinion was turning in favor of the Web) James Powell summarized the defects that capped the growth of Gopher space:

... the Gopher menu system is very restrictive in the way it presents information. Adding help or introductory information must be done by adding a menu item for that purpose, since each menu item must be only one line of 70 characters and must either be a branch or an end point. ... Creating meaningful menus is very challenging work and there is much debate on how to present information. Often, Gopher menus either spill over to multiple pages or are so short as to appear deceptively barren. And finally, Gopher currently lacks support for any standard network resource locator equivalent to the URL provided by WWW. It is for these reasons that I believe Gopher will eventually become merely another information resource accessible by the World Wide Web (Powell 1994, 66). [34]

Gopher had not proved to be scaleable: as the Internet grew larger, so did awareness of the limitations in the Gopher approach.

Later versions of Gopher used "bookmarking" to address shortcomings in the hierarchical approach:

The Gopher bookmark feature presents a local client user with the chance to create his/her own menu of commonly used choices from the total. Since some items are buried deep in the [predetermined Gopher] menu structure, bookmarks present a short cut (Notess 1993, 101-102).

"Bookmarking" was a significant idea. However, it was just as functional on the Web as it was in Gopher, and any comparison underscored the superiority of the Web. Bookmarking in Gopher reminded users of defects in the system's sup-

posed strength, its simple hierarchy of menus. Bookmarking on the Web was a natural extension of the system's hypertext foundations:

One of the convenient features in Mosaic is the ability to build Hot Lists of sources that you want to return to in the future. These work much like Bookmarks in Gopher clients ... (Lester 1994, 8).

Bookmarking features made more sense in a Web browser because they reflected the basic architecture of the hypertext Web. Bookmarking features in Gopher were exceptional, because they contradicted the system's underlying principles.

The hypertext structure of the Web also had a subtle appeal for librarians, thanks to its similarity to well-known library techniques. One potential library contribution was organizing the Internet along the lines used in card catalogs. For this task, the Web outperformed Gopher, because it was more consistent with some key concepts in modern librarianship. The hypertext foundation of the Web was a better match for the principles of modern relational cataloging, the underappreciated way in which modern library card catalogs, classification schemes, and OPAC databases organize, prioritize and interrelate diverse concepts. Like hypertext, relational cataloging systems allowed connections between any two items. Cross-references ("see also") performed that work in old-fashioned card catalogs and hot links could do the same on the Web, but Gopher hierarchies could not support it. Both Web surfers and librarians had more to gain from the cross-reference than from the hierarchical menu.

This was not to deny that a vast labor of organization would be required. The pleasures and successes of 'serendipitous' browsing on the Web already relied on much hidden, preexisting preparation. Michael F. Schwartz recognized this as early as 1992:

Browsing is closely related to organization, since the better organized the information, the easier it is to browse. Yet by itself, browsing is not sufficient. Because there are few barriers to "publishing" information on the Internet, the Internet contains a great deal of information that is useful to only very few users, and often for only a short period of time. To other users, this information clutters the "information highway", making browsing difficult. Even if all of the information were of interest and well organized, the sheer volume of information can be daunting. For example, in a deeply nested file system with millions

of files, browsing to locate a file would be infeasible. In this case, tools are needed that support searching. Searching is an automated process, where the user provides some information about the resources being sought, and the system locates some appropriate matches (Schwartz 1992).

Writing about WAIS in 1993, Edward Valauskas also acknowledged that unseen hands could make the difference between success and failure on the Internet. "Nothing is systematic about WAIS indexing," he wrote.

The real power of WAIS is its response to questions ... presented in everyday colloquy, not in arcane symbolism. There is danger to such ease in querying a computer, and not a few WAIS fans imagine that they are really talking to computers via artificial agents. But unlike asking a question of a reference librarian (using many conventional and electronic resources), the weakness of WAIS is apparent in the kinds of databases that are available. A too-specific question to WAIS will yield no answer.

Asking my computer, via WAIS, to uncover a pair of lines sung by a drunk in Stanley Kubrick's film of Anthony Burgess' *A Clockwork Orange*, is straining the limits of virtual serendipity at this point in the evolution of WAIS resources. Imagine the chain of events that would have to have taken place long before I have formulated my question. Someone who is a fan of Burgess or Kubrick or both would have to prepare and index electronic text of scripts and other documents, load them on an appropriate and reachable computer, make it known to the directory-of-servers that these files are available, and allow me free access over a network at any time. Alternatively, I can walk over to one of my bookshelves and pull out a copy of Anthony Burgess' autobiography, flip through the text (relying on the random access nature of my memory telling me that the relevant passage is 'somewhere' in the middle of the book), and find the lines in a few minutes.

There are certain tasks that computers cannot do ... Questions are born in special circumstances loaded with ambiguity. As any reference librarian will tell you, a patron's initial question at the reference desk seldom reflects the real information need. Repeated questions and answers back and forth eventually yield the right answer. Computers and their software - so far - cannot handle this dance for knowledge (Valauskas 1993c, 103-104).

Dan Lester pointed out the connections between established library techniques, organization, and finding online information. In April 1994, he had this to say about hyperlinks:

If this all sounds rather mystical or strange, think of a typical reference search. We start with an encyclopedia, perhaps, and find an article to give us some information. That article contains a cross reference to related information, so we jump to a different volume and page of that set of books. At that point we find a citation to a book...

so we go to the catalog to track down the book ... All of us are familiar with this type of running around, tracking things down, finding documents, and so forth. WWW servers do the same thing without requiring us to move from in front of our workstations because the links are made by the servers ... (Lester 1994, 7).

The same structure of carefully prepared cross-references was at work, whether the reader was using print tools or the flexible, non-linear hypertext capability of the World Wide Web.

The appeal of a self-organizing Internet, intelligent agents and similar futuristic devices did not dissipate easily. However, the failures and disappointments that came with an overemphasis on searching software, in the absence of attention to that which was being searched, argued for assigning a familiar role to librarians. In 1994, James Powell wrote:

This web of information would benefit enormously from the organizational and information management skills librarians could bring to it. Indeed, it is unlikely that any of these local collections of information will become reliable resources until librarians step in and sort out what resources are available where (Powell 1994, 66).

Dongming Zhang agreed:

With the tradition of archiving and preserving knowledge, academic libraries are the natural candidates for handling electronic information (Zhang 1994, 68).

His comment also pointed up growing awareness that other library functions remained valid and significant in an online world.

New worlds for librarians

As librarians recognized how compatible features of “the Web” were with “the library,” they began to experiment. Some of their ideas built on library functions of long standing. As early as 1991, Kathleen Burnett predicted that hypertext techniques could improve user assistance:

... in the nineties, BI will be handled through the aegis of end-user-directed multimedia presentations, such as Hypercard stacks – in other words, multimedia will perform the explanation function... it is absolutely essential that the presentations be well designed and extremely user-friendly. Who will design the presentations? (Burnett 1992, 135) [35]

HTML-based ‘self-guided library tours’ are now common. Burnett also predicted major advances in full text access:

Ten years from now ... It should be possible to ‘browse’ the stacks without leaving the terminal; to ‘open’ a book, and view its table of contents; perhaps even, to flip through the pages of two books ... and compare them. ‘Virtual browsing’ may allow libraries to prohibit patron access to the stacks ... many functions which have previously required a trip to the library might someday soon be carried out from the home, via the ‘virtual library’ (Burnett 1992, 138).

Today, users can achieve these effects by opening multiple browser windows.

Alastair G. Smith also saw that traditional library functions could be performed using HTML and Web browsers. In 1994, he proposed “a ‘home page’ of information resources that are significant to the library user group” for the purpose of “providing access to external resources[,] providing information about the library[, and] organising information about the organization ... campus-wide ...” (Smith 1994, 5 and 11). [36] It is hard to imagine a university library today without multiple Web pages to perform these functions.

Librarians at North Carolina State University also investigated applying the Web to sustaining and expanding library activity. Eric Lease Morgan wrote in 1994:

Keeping in mind libraries are about information and not about books and other printed materials, how can libraries use Web clients and servers to provide better library service? The Web can be used to distribute information about libraries. This information includes such things as hours of operation, reference guides, policies, descriptions of services, lists of subject specialists, and building maps. Like our earliest online catalogs, this particular use of the Web transfers old services to a new technology without truly taking advantage of the new technology’s strengths. The organization of Internet resources is another use of this new technology. We are all aware of the tremendous, ever growing amount of data and information available on the Internet. Organizing this information into a coherent whole is a daunting task being attempted by many, many people. Who can do this better than librarians who have special training and experience in organizing information? (Morgan 1994) [37]

Morgan could see that using the Web for traditional functions soon led to awareness of new functions.

Morgan was not the only writer to nominate librarians for new roles. Even before the Web dis-

placed Gopher, Karl Bridges foresaw how the Internet allowed libraries to publish as well as deliver information: "Most libraries ... have reams of word-processed documents that could be easily adapted for use by a Gopher" (Bridges 1993, 38).

To test similar convictions, James Powell decided in 1993 to build a model Web-page based library site:

... it occurred to me that a hypertext library system might be a viable alternative to the more common but less flexible Gopher menu system that libraries such as ours have put in place. ...

I decided that this basic library information system would include the following capabilities and resources:

- (1) the ability to access documents stored locally,
- (2) the ability to access documents and resources located on other computer systems provided in a variety of formats by a variety of information servers,
- (3) the ability to accept information from the patron for information requests such as ILL or renewal notices,
- (4) the ability to access the local library OPAC, other library OPACs, and other information services available via telnet on the Internet, and
- (5) a basic document classifying some diverse information resources by general subject classifications (Powell 1994, 62).

Powell's first four capabilities are characteristic of integrated library systems today. The fifth capability anticipated the creation of Web page-based pathfinders by subject bibliographers.

I found that the part of the system that demonstrates one of the areas where librarians could make the greatest contribution to the Internet was the document listing resources by subjects. Here I listed a few subjects with links to various resources... I was able to point links to specific parts of remote Gopher trees and to specific newsgroups within the Usenet hierarchy. In this way, seemingly unclassifiable collections of information, such as Usenet news and Gopher, could be presented in an organized manner (Powell 1994, 63).

While Powell's model Web site could not solve the problem of 'cataloging the Internet,' bringing together scattered Internet materials in a library setting was an important step, because it validated those materials as worth of library attention, and validated the library as an agency to manage access to them.

Powell also recognized that the multi-media capability of the Web opened the door for services that had previously been impractical or impossible:

... the possibilities for a hypertext electronic library are boundless. Special Collections could provide access to fragile material as scanned pages. Information terminals could be set up in the library lobby with floor maps and hypertext descriptions of the materials and resources located on each floor. Terminals in different parts of the library could present an introductory page appropriate for the type of materials located on that floor. Patrons using the library OPAC could view help information ... while accessing the OPAC in a separate window. Labs could be set up in the media center to provide access to audio resources, such as Internet talk radio, graphics and motion video segment, and custom hypertext applications for courses taught on campus (Powell 1994, 64).

Libraries now are providing or developing most of these service ideas.

Eric Lease Morgan suggested the use of software to mimic the reference interview in an on-line environment:

Imagine a scenario where you are asked a number of questions via an HTML form. Based on the answers to these questions, other questions are asked. At the end of this question/answer process, the CGI script generates either a "game plan" for locating the information you seek or it generates queries that can then be applied to various databases across the Internet (e.g., OPACs, Web servers, and Veronica servers) (Morgan 1994).

These kinds of interactive help screens are of intense interest to reference librarians today.

Librarians also became experts on the faults and virtues of Web sites, a new skill for a new format in which readers encountered information. It was deceptively simple to create "hotlists" of "bookmarked" URLs using Mosaic. It took a little longer to understand the difference between valuable and pointless Web sites. Too many early Web pages were collections of links to comparable Web pages, which might even point to each other in a circular fashion. Steve Cisler dismissed such Web pages in 1993, pointing out that utility and quality were more important than quantity:

Many sites, in their excitement, are using the kitchen sink approach to links and content. They might choose a name such as CyberDepot and throw a bunch of files together with pointers to other interesting ones, but users will have a hard time making sense of WWW sites such as that. People will tend to visit some places once but will only return to those that do things well ... (Cisler 1994, 34).

Librarians continue to analyze why some Web sites "do things well" and others fail. To share

what they knew, librarians at IUPUI drafted a comprehensive plan for serving the library's public by

not only educating our patrons about the [library's new Web-based] system, but by preparing them for the world of the Internet – a world where they are swimming at their own risk with no librarian on duty (Koopman and Hay 1994, 610).

Teaching Web surfers to evaluate their online discoveries has become a core mission for most reference and instruction units today.

Astute observers even realized that the Web would propel librarians into completely new roles, in spheres ranging from the legal to the technical. In 1993, Valauskas foresaw the legal implications of an online information environment:

the true restraints will really be not technology or our imaginations, but copyright, licenses, and the boundaries of human law over intellectual property (Valauskas 1993b, 89).

Valauskas returned to this theme a few months later:

For vehicles like Mosaic to be truly utilitarian, access to copyrighted data, now locked in paper books, journals, and newspapers, is essential, but nearly unattainable. ... Mosaic proves that there are no technological boundaries to reaching text, graphics, audio, and data. The real boundaries will be organizational. Is there a more systematic way to reach these resources ...? Is it legal? (Valauskas 1993a, 101)

Technical obstacles are being overcome much more rapidly than legal obstacles, in today's atmosphere of commodified information.

The potential for online publications pointed to new technological skills for librarians as well. In 1994, Alaister Smith foresaw that library staffs in the future would have to master server technology:

Development of a Web server provides librarians with an opportunity as integrators of Internet information, producing custom home pages for their organization, applying traditional skills of location, evaluation, and organization of information.

The development of Web resources puts librarians into a new role, that of creators of information (Smith 1994, 11).

Eric Lease Morgan made the same point:

I advocate the creation and maintenance of Web servers and other Internet resources by librarians. Although this

requires the development of new skills, librarians already possess the more critical skills necessary to make these Internet services truly useful, and, while there are some risks involved in this effort, these risks are well worth taking (Morgan 1994).

By the end of 1994, these savvy librarians had grasped the implications of the Web and foreseen fundamental future library operations.

Library commentators also saw the potential and implications of a commercialized World Wide Web, issues that went beyond narrow library interests. Steve Cisler remarked in 1994: "Commercial development is both a plus and a danger" (Cisler 1994, 34). Richard Wiggins noted the potential importance of

... a secure Mosaic version, which would provide encryption and authentication to foster Internet-based commerce (Wiggins 1994, 49).

As Dongming Zhang remarked:

We look forward to the day when standard formatting codes, such as HTML, will be utilized by the publishers of electronic journals ... (Zhang 1994, 68–69).

Such developments, in the context of e-commerce at large, have placed libraries squarely in the middle of novel problems, from licensing to printing.

Conclusion

By the end of 1994, there was explosive growth in the use of HTML and Mosaic for academic library business. The period of evaluation had passed: the Web had been judged superior to competing approaches to information on the Internet, and older applications were being absorbed or abandoned.

At the same time, discussion of library matters in the context of the Internet increasingly reflected practical problem solving and the presentation of specific projects. It was generally assumed that libraries would incorporate Internet materials, the World Wide Web, and Web browsers into their operations. Despite the revolutionary change in access methods implied (and subsequently demonstrated) by Web-based technology, there was no expectation of a revolutionary change in library philosophy. The role of the librarian was expected to evolve: traditional library concepts

were no longer treated with the same skepticism – or ignored – as they had been during early discussions of the “information superhighway” and the “virtual library.”

The absence of revolutionary change has not satisfied all commentators. In a recent two-part article in *College and Research Libraries*, Charles Martell was pessimistic about the future of librarians. In a wide-ranging discussion, he wrote that,

There is no indication that librarians have adapted a cyborg attitude as part of their accommodation to technology. Machines are viewed as convenient tools. We behave as if we are entirely free to choose and discard what we wish. This is untrue. We are not always free to choose. The Internet is only the latest example. The imagination of the public was stirred by a continuing string of media stories about the Internet and its success. Success bred success and the Net was thrust upon us (Martell 2000, 111).

Martell suggested that the recent, rapid assimilation of the Internet into library practices without large-scale disruption is a deceptive and short-lived success. In the initial contest between library tradition and technological innovation, tradition prevailed. However, given the inevitable continuation – perhaps even the acceleration – of technological change, this may not be the final outcome. If so – if some future round of innovation is so radical that compromise with past practices and principles becomes impossible – then Martell warned that libraries have merely postponed or even lost the opportunity for fundamental change. If some other social institution achieves the kind of “library land” described by Patricia Ann Carlson, libraries could be rendered obsolete.

Martell was not uniformly gloomy: he saw opportunity as well as risk in the future for librarians. The record established by librarians during the dawn years of the World Wide Web – and presented in this article – suggests grounds for optimism. The written record reveals librarians’ vitality as innovative thinkers. While fiscal and physical factors may have slowed the pace at which many of our libraries can adopt Web-based techniques, the librarians who work in those libraries have been active observers of a stunningly different new technology, and brave and imaginative thinkers about its implications. The library-oriented media performed well as active arenas for discussion, in which a wide range

of librarians took part as authors or readers. Librarians paid attention to the Web at an early date. They were resourceful but also pragmatic in considering whether the Web could help with library work. They rapidly translated long-standing library functions and principles into this new format. Librarians very soon were creating their own Web sites, either to incorporate Web techniques into existing functions or to extend the library mission. Certainly our experience of the information revolution of the late twentieth century suggests that more changes lie ahead. At the same time, the experience of librarians up to this point suggests that they will rise to the occasion.

Notes

1. Vannevar Bush (1880–1974) wrote a seminal article about personal workstations in 1945 (Bush 1945). Bush taught at MIT from 1919 to 1971; during World War II, he was Director of the Office of Scientific Research and Development. Theodor (Ted) Nelson was an early exponent of hypertext and envisioned a system he called “Xanadu.” For more about his work, see “The Curse of Xanadu” (Wolf 1995). Today, Nelson is a consultant and academic; on his Web site (Nelson 2000) he recommends “Ted Nelson, Hypertext Pioneer” as an online summary of his work (ZDTV n.d.). Berners-Lee trained as a physicist before working at CERN in 1988; today he works in the Laboratory for Computer Science at the Massachusetts Institute of Technology. His home page provides additional information (Berners-Lee n.d.).
2. A history of the *Current Cites* project, which began in 1990 and has been distributed electronically since 1991, is available online (Current Cites 1998). Berners-Lee’s co-authors in 1992 were Robert Cailliau, Jean-Francois Groff and Bernd Pollerman.
3. For more about PACS-L, see Walt Crawford’s “Talking About Public Access: PACS-L’s First Decade” (Crawford 2000). By June 1992, PACS-L had 4,000 subscribers and was still growing. The *Current Cites* Web site (Current Cites 1999) lacks issues before 1995, but earlier content is available from the “Archives of PACS-L@LISTSERV.UH.EDU Public-Access Computer Systems Forum” Web site (LISTSERV.UH.EDU n.d.) maintained by the University of Houston. The abstract of Berners-Lee’s article is item 3 for May 1992, week 5.
4. Readers may consult the *Free On-Line Dictionary of Computing* for convenient definitions of terms from the early history of the Internet, including thumbnail descriptions of obsolete systems (Howe 1993).

5. Lukanuski was a librarian at RAND in Santa Monica in 1992; in 1999, she was Managing Producer at Studio Verso, now part of Metrius, an e-commerce consulting firm.
6. In 1993, Valauskas was Head of Library Public Services at the Superconducting Super Collider Laboratory in Dallas, Texas; today he is a consultant on Internet issues and Chief Editor of the online serial *First Monday*. For further information see his home page (Valuaskas 1998).
7. The 1992 Neuman and Berners-Lee articles are mutually citing, although neither discusses the other in depth. In 1992, Neuman worked at the Information Sciences Institute of the University of Southern California. He remains today at the University of Southern California as Senior Research Scientist, Information Sciences Institute and Senior Project Leader, Global Operating Systems Technology Group. For further information see his home page (Neuman n.d.).
8. Berners-Lee comments on this initial tendency to mistake Mosaic for the Web, in his recent memoir (Berners-Lee 1999, 71).
9. References to information “superhighways” extend back into the mid-1980s. For example, Andrew Pollack wrote in the *New York Times* of 27 June 1986: “In ISDN, the phone system would become a superhighway, able to carry several types of traffic simultaneously” (Pollack 1986, D1). United States Vice President Al Gore helped popularize the phrase by using it in a speech at the National Press Club on December 21, 1993 (Gore 1993).
10. Wiggins is a long time coordinator of Internet activities for the Computer Laboratory of Michigan State University, where he continues to work in Special Projects and as manager of the Central Systems Services group in the Computer Laboratory.
11. Readers of *Current Cites* and PACS-L would have been aware of Nickerson’s endorsement by the end of January 1993, when *Current Cites* 4/1 (January 1993), became available on the PACS-L discussion list (PACS-L 1993a). Nickerson is a longtime employee of the University of Western Ontario in information systems support.
12. Dalton was a systems engineer for IBM in 1991, pursuing an MLS at Simmons College; today she manages systems for Central Maine Power.
13. After the text’s initial appearance in *Wilson Library Bulletin*, a longer version was posted online (Polly 1993). As a public librarian in 1992, Jean Armour Polly was one of the earliest Internet authorities to write for an audience of librarians. She went on to be active in the Internet Society and today is an author and consultant. For more information, see her Web page (Polly n.d.).
14. Cisler and Polly alternated as authors of this regular monthly column: Cisler’s name appears at the end of this particular piece. In 1994, Cisler was a Senior Scientist for Apple Computer Library. Today he is a consultant and commentator on information and networking issues; for more information, see his Web page (Cisler 2000).
15. In 1993, Bridges was a reference librarian at Eastern Illinois University; he is now a reference librarian at the University of Vermont.
16. In 1994, Lester was a network information coordinator for the Boise State University Library. Today he is webmaster for RiverofData.com, a library services consulting firm.
17. Ulmschneider was an Assistant Director in the North Carolina State Libraries in 1994. Today he is Executive Director of the Virginia Commonwealth University Libraries.
18. Zhang was an electronic resources cataloger for the Johns Hopkins Medical Library in 1994. Today he is a Senior Applications Developer in Systems Management for Homewood Academic Computing, part of Johns Hopkins University.
19. The italics appear in the original. In the online Wired Archive, the author’s name sometimes is misspelled as “Wolfe.”
20. Annotate’ did not survive as a feature in later browsers, but some old pages about it remain on the Web. These range from NCSA’s page for “Help On NCSA Mosaic Annotate Menu” (NCSA 1993) to advice from academic computing centers such as “How Annotations Work:”

... opening the Annotate Window provides a large space to append your comments. The annotation, which becomes a separate file, is added to the end of the original document as a hyperlink ... An infinite number of annotations can be made to a specific document. You can edit and delete annotations (University of Melbourne n.d).

Comments like the following suggested bright prospects for the future:

NCSA Mosaic currently supports only personal annotations, which cannot be viewed by anyone else. In the future, workgroup and public annotations may be options (Washington University 1994).

‘Annotate’ implied a level playing field on which individual annotations would benefit from the same status markers applied to the works being annotated: titles, statements of authorship, notices of the date of composition. The idea that annotations would promote equality on the Internet seems naïve today, but it is easy to understand the appeal of an online world in which the personal computer would be more than an improved television set.

21. Several science fiction writers, including the cyberpunk figure Bruce Sterling, prepared remarks in support of the 1992 President's Program of the Library and Information Technology Association (LITA) of the American Library Association (Sterling 1992).
22. An illustrated article about the movie *Tron* appears immediately following "Burning Chrome" in the July 1982 issue of *Omni* (Manna 1982).
23. Carlson's paper was published after a Spring 1991 conference on "The Social Construction of Knowledge" at MIT. In 1991, Carlson was a resident researcher for the United States Air Force; today she is a professor of American literature at Rose-Hulman Institute of Technology. Vickie L. Kline invoked some of the same elements – metaphors of motion and avatars as intelligent agents – in "Spirit Guides of Cyberspace," a Position Statement prepared for the First Annual Conference on the Theory and Practice of Digital Libraries, which took place in 1994 (Kline 1994, 214). The conference papers are available also on the Web (Hypermedia Research Lab 1994), but the Position Statements appear only in the printed proceedings.
24. Raggett worked on HTML projects for Hewlett-Packard in the early 1990s; today he is on assignment from HP at the World Wide Web Consortium; for more information see his Web page (Raggett n.d.).
25. John C. Mallery remains a research scientist at MIT, working in the Artificial Intelligence Laboratory; for more information, see his Web page (Mallery n.d.).
26. Early versions of Yanoff's list provide interesting snapshots of Internet resources before the Web became the dominant format (Yanoff 1993).
27. Notess continues to work as a librarian at the Montana State University library and as a regular columnist for *Online*; for more information see his Web page (Notess 2000).
28. A few 'old hands' made helpful advice available online. Beginning in August 1992, Rick Gates produced the Internet Hunts, a series of collaborative practical exercises in finding online information. For examples, see "First Internet Hunt !!!" (PACS-L 1992c) and "Results: First Internet Hunt, Pt. 2 of 2," (PACS-L 1992d).
29. In 1992, Schwartz was an associate professor of computer science at the University of Colorado. Today he is a consultant; for more information see his Web page (Schwartz n.d.).
30. In 1993, Esquer was a library science graduate student and Ahrens was an assistant professor in the College of Information Studies at Drexel University.
31. Jean Armour Polly used the term "surfing" in a 1992 article for *Wilson Library Bulletin*, "Surfing the Internet: an introduction" (Polly 1992). On her Web site, Polly notes, "I am credited with coining the phrase Surfing the Internet, back in 1992" (Polly n.d.). By the Spring of 1993, the term was appearing in conventional media: see for example Peter Hum's news report, "Cyberpunk: They're technorebels in a universe called cyberspace where experiences are shared via magical cybernetic links known to the rest of us as computers" (Hum 1993, B1).
32. The notion of a commercial cataloging solution was not considered: thus in April 1994, it was Yahoo! and not an established company like Wilson or Bowker that took the first steps toward that kind of Internet portal (Yahoo 1999).
33. In 1992, Krol was director for LAN deployment at the University of Illinois at Urbana-Champaign. Today he remains at Illinois as the assistant director for Network Information Services in the Computing and Communications Service Office, and is a columnist for *Network World*.
34. In 1994, Powell was a library automation librarian at Virginia Polytechnic Institute and State University. Today he is Director of Web Application Research and Development in for Information Systems and Computing at Virginia Tech; for more information see his Web page (Powell n.d.).
35. Burnett first presented her remarks at a 1991 conference. In 1992, she was an assistant professor in the School of Library and Information Studies, Rutgers University. Today she is an assistant professor in the School of Information Studies, Florida State University.
36. Smith is a longtime member of the School of Communications and Information Management at Victoria University of Wellington, New Zealand; for further information see his home page (Smith 2000).
37. Morgan has been a consistent advocate of user-oriented library automation during his career at North Carolina State University; for more information see his home page (Morgan 1999a). He is perhaps best known today for his work with MyLibrary, "a User-centered, Customizable Interface to a Library's Collection of Information Resources" (Morgan 1999b). His interest in such user services is already apparent in his 1994 article, which goes on to say:

... the organizational scheme must be comprehensible to your intended audience. Think about the people who will be using the Web server. What are their backgrounds? What do they want? What specialized terminology do they use? In general, how do they think? Incorporate the answers to these questions into the structure of your Web server. "Libraries are for use," and, in order for this to happen, your classification system must be understandable by most of your clientele (Morgan 1994).

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