# Reference Evolution under the Influence of New Technologies

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## *Abstract*

This article presents a historical view of library reference evolution under the influence of new information technologies. Two evolution directions were determined through a comprehensive literature review – the increase of the availability and accessibility of electronic resources and the expansion of the media through which reference services are provided. Placing reference progression in a historical context, this article will strengthen the understanding of library reference work, and hence, lead to a more coherent development of the reference profession.

## *I. Introduction*

The evolution of library reference work has been greatly influenced by the advent of new technologies, such as computing, electronic mass storage and networking technologies. From online commercial database searching entering the library world in mid-1970s, to synchronous Web-based chat reference appearing at the turn of this century, reference services have migrated from the solely print-resources-oriented services limited in a certain physical space, to a diversified service portfolio that could reach more people with more resources and less restriction of time and space.

In retrospect of the development of library reference work in the past half century, two primary changes resulting from the adoption of new technologies can be identified, as indicated in Figure 1. One is the increase of the availability and accessibility of electronic resources; another is the expansion of the media through which reference services are provided. In this article, the evolution of reference services in these two aspects will be examined to provide a historical view of how new technologies have reshaped library reference work. Understanding the way a particular field progresses can inform future advancement of this field, thus, this article hopes to enhance general and professional understanding of reference development by laying out the two important directions that library reference has been moving along, especially in a time when new technologies have transformed many aspects of our social life.

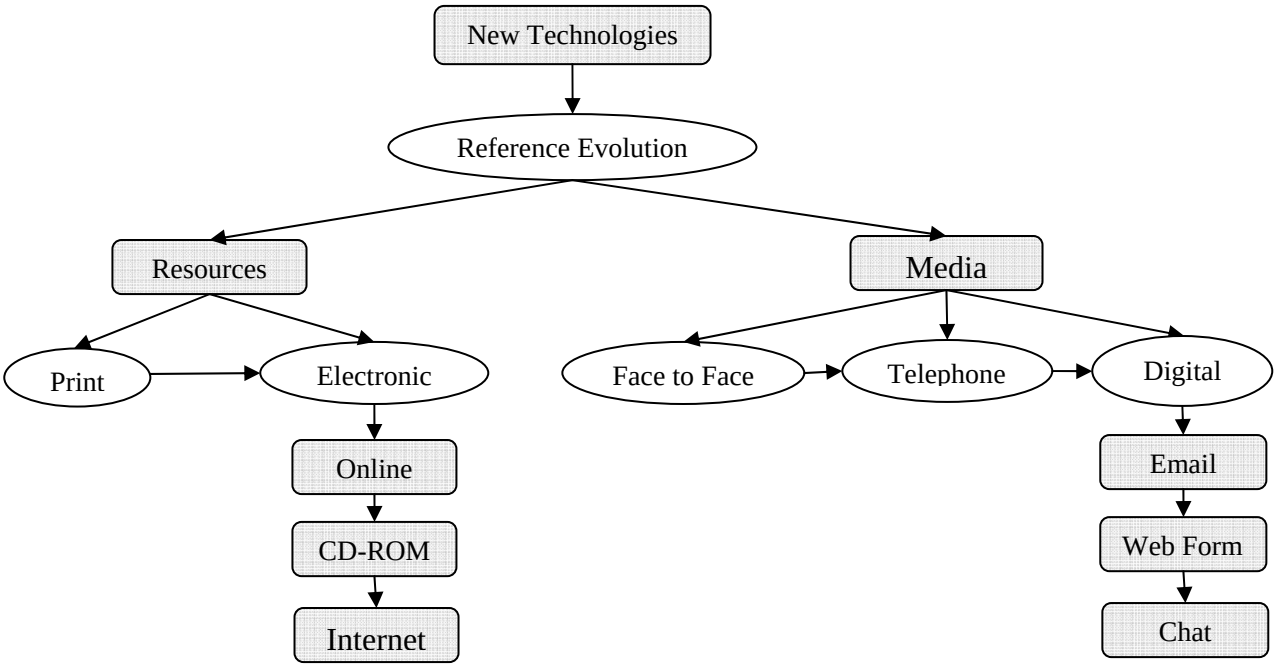


Figure 1. Graphic representation of reference evolution under the influence of new technologies

## *II. Increase of the Availability and Accessibility of Electronic Resources*

The development of electronic resources for libraries to use in reference services has gone through three stages: online commercial databases, CD-ROM, and the Internet.

### 2.1. Online

Online databases, including both bibliographic and ASCII full-text databases are the first generation of electronic resources. In early 1970s, the development of hard disc storage systems made it possible for computers to handle random access to data and multi-user sessions, which expanded the potential user pool of bibliographic databases and directly led to the subscription to online database services in libraries in the mid-70s (Straw, 2001; Neufield & Cornog, 1986). Online databases were provided by vendors such as DIALOG, ORBIT, BRS, and Lexis-Nexis, etc, where multiple databases were

mounted in “databanks” and accessed through dial-in from telecommunicated terminals (Hahn, 1996; Straw, 2001). However, online searching did not become popular until 1975 when the first packet-switching networks such as Tymnet were put into use, which ended the days of long-distance calls (Tenopir, 1993).

As the first tide of electronic resources widely accepted by libraries, online databases were not only hailed by library users (Straw, 2001; Arnold & Arnold, 1997), but also enhanced reference services in a variety of ways. Unruh (1983) listed three important advantages of online databases:

- Facilitating retrieval: the use of operators such as OR, AND, or NOT allows multiple concepts to be linked in a logical statement for retrieval.
- Expanding resources: the limit of the physical collections in a library is offset by the availability of more complete online indexes and periodicals.
- Enhancing the image of reference librarians: the sophisticated skills needed in navigating online databases increase the public’s perception of librarians and their appreciation of the profession.

However, while the advent of online databases freshened up library reference services, reference librarians had to deal with the problems that were inherent in the use of them. The effective searching of online databases demanded complex and special skills that could only be achieved through considerable training. Not all reference librarians would master the skills of online searching. The searching tasks were usually delegated to a separate department, bibliographers or subject specialists, or a particular

reference librarian. They formed a new profession of “online searcher” that was dedicated to handling electronic information seeking in libraries of the late 1970s and early 1980s. (Straw, 2001; Williams, 1978; Neufield & Cornog, 1986; Moore, 1998a; Stevens, 1983)

A statement from Straw (2001) vividly described the scenario of online database searching – “A patron hoping to find something online had to seek the services of a librarian with knowledge of a unique and powerful computer. The patron’s request needed to be translated into a special language that could be understood by the computer. When the language was put into the computer, a strange information alchemy produced something that hopefully would be of relevance and value to the patron” (p.5).

The domination of professional searchers in the filed of online databases was broken in early 1980s when IBM introduced microcomputers (PC). Online vendors started promoting end-user searching systems such as CompuServe, BRS/AftreDark, and DIALOG’S Knowledge Index (Tenopir, 1993), which demystified online databases to the general public and turned to a new page of the accessibility of electronic resources.

Sophisticated online searching skills were not the only problem faced by reference librarians. Another issue that had been hovering along the entire online age was fee. Online commercial services imposed expensive fee structures for searching the databases, which were so expensive that libraries could not single-handedly absorb all the cost but have to transfer some of them to users (Straw, 2001; Williams, 1978; Hauptman, 1983). The zealous debate of whether libraries should charge users for online database

searching was documented in numerous publications in late 1970s and early 1980s. (Waldhart & Bellardo, 1979; Weaver, 1983)

The complexity of searching and the concern of fees resulted in limited use of online databases. Terminals for online searching were usually placed in an isolated area for the delegated online searcher(s) to process users' requests (Tenopir, 1987). Brunelle and Cuyler thought this was "especially unfortunate because online databases contain a wealth of the kind of hard data that is appropriate to more traditional reference services" (p.93). They suggested that online database searching should be incorporated into regular desk reference work. This proposal was echoed by Havener (1990), whose study showed that online was more efficient and more effective than print in searching information to answer conceptual ready reference questions, whereas there were no major differences between the two in searching for factual questions.

Online databases prevailed as the only electronic resources in libraries until mid-1980s when the development of technology brought another choice to libraries: the CD-ROM.

## 2.2. CD-ROM

CD-ROM stands for Compact Disc Read Only Memory, which is a victory of mass storage technology. An enormous amount of data can be stored in a 4.72-inch CD-ROM (Straw, 2001). The huge capacity for digital information storage quickly gained popularity for CD-ROM among both users and librarians (Salomon, 1988), but this popularity could not be achieved without the introduction of IBM's microcomputer, or PC, which marked a new era of personal computing (Lenck, 1991). The combination of

PC and CD-ROM expanded libraries' options for electronic resources and added more diversity to library reference services.

Databases stored on CD-ROM were first introduced by Silver Platter in 1985 (Tenopir, 1989; Straw, 2001). Very quickly, non-bibliographic material like dictionaries, encyclopedias, directories, and other reference works were also taking advantage of this new mass storage technology. In the late 1980s, resources available on CD-ROM even expanded to full text and graphic images (Straw, 2001; Melin, 1986). People started having more and more options of electronic content after CD-ROM made its way to libraries.

Like online commercial databases, libraries' adoption of CD-ROM was also warmly greeted by the general public (Roose, 1988; Tenopir, 1988). However, unlike online databases, CD-ROM no longer fell under the privilege of certain librarians who used to assume the exclusive role of "online searcher". Every library user could access CD-ROM resources though a workstation, which unleashed an unprecedented wave of end-user searching. When discussing the first few CD-ROM versions of databases, Rietdyk (1988), the vice president of Silver Platter in the 1980s, pointed out that "from the beginning of the product design it was stressed that this product should be able to be used directly by the true end user of the library and not only by the experienced searcher."(p.58)

One primary reason for end-user searching to become popular was the fee structure imposed on CD-ROM resources had changed. Libraries only needed to pay a fixed amount of subscription fee for unlimited use of the CD-ROM resources. Without

the concern of keeping track of searching time to control cost, CD-ROM users could conduct as many searches as they want. (Tenopir, 1988; Roose, 1988; Rietdyk, 1988; Straw, 2001).

According to Straw (2001), freedom from monetary concerns was not the only change that motivated the growth of end-user searching in libraries, “the searching technology was often simpler and more intuitive than those offered by online services” (p.7). On one hand, the easier searching interface allowed users to search independently instead of completely relying on intermediaries; on the other hand, users did not have much knowledge and experience with CD-ROM resources and needed help from librarians on which database to choose and what search terms to use. With the advent of CD-ROM and growing number of end-users, the role of librarians, had changed form intermediary searchers to instructional teachers. They assumed more responsibility in providing one-on-one assistance to users and teach them how to operate workstations and use CD-ROM resources (Straw, 2001; Dyson & Kjestine, 1993; Tenopir, 1988; Boye, 1996; Rietdyk, 1988).

This new responsibility incurred a big change in reference work (Tenopir & Neufang, 1992). Expertise on CD-ROM resources was no longer the business of only a few, but all reference librarians. Everyone was expected to be able to assist users on CD-ROM searching whenever there was such a request. Rettig (1996) claimed that “the hallowed reference desk has diminished in importance as the demands of CD-ROM users for assistance have grown and have increasingly taken the reference librarian away from the desk”(p.80). However, being familiar with the electronic resources was only part of the increased knowledge requirement. Reference librarians also had to learn about

computer software and hardware, including operating systems, printing, and general computer troubleshooting techniques, in order to help users when they have difficulty using the computers (Straw, 2001; Dyson & Kjestine, 1993; Tenopir, 1988; Boye, 1996; Moore, 1998a).

In a study of CD-ROM's impact on reference services, Tenopir and Neufang (1992) found a change in users' attitude about the library and about the research process – "End-user options fit right into the new generation's expectations and experiences…. …  Users are making more demands on librarians, providing more challenges to reference work and often leading to enhanced services" (p.58).

While CD-ROM, touted as the "new papyrus", was becoming a promising electronic resource in libraries, it was not perfect. There was no standard retrieval software and both librarians and users had to learn a particular search interface for different products. Lack of data currency limited the use of CD-ROM to some extent, and investment in hardware and software became a big burden on library budget. (Rietdyk, 1988; Straw, 2001; Moore, 1998a; Tenopir, 1989)

The presence of CD-ROM did not make online commercial databases obsolete since both of them had their own advantages and disadvantages. But many libraries witnessed the diminished usage of online searching after the introduction of CD-ROM (Straw, 2001; Lancaster, Elszy, Zeter, Metzler & Low, 1994), especially when single-CD-ROM-loaded workstations were connected by Local Area Network for multi-user access, which, according to Tenopir (1997), made CD-ROM "a practical alternative for online searching even at large university or public libraries" (p.129).

## 2.3. Internet

In early 1990s, a new networking technology, which was originally developed in Defense Department to connect computers for defense-related research, became available in the public domain. This technology allowed isolated computers to be connected in an enormous network, known as the Internet. Basically, the Internet provided an infrastructure for electronic information stored in individual computers to flow around the entire network. Greatly enhancing the availability and accessibility of electronic resources, the Internet quickly gained popularity among libraries (Straw, 2001).

In a nation-wide survey conducted by Tenopir (1995) in 1994, 77% of surveyed university libraries and 84% of large public libraries reported offering Internet access to their users in the library. Not only could users have access to resources on the Internet, they could also use Internet applications such as email management software installed in libraries' computers (Tenopir, 1995; Straw, 2001).

However, the potential of Internet resources was not fully mined until after the advent of the graphical World Wide Web (WWW, or the Web) in 1994. The Web is a platform that runs on the Internet, presenting the resources through a multi-media and hyper-linked interface and locating them by Uniform Resource Locators (URLs). Based on the Web, Internet resources can be accessed and viewed through an application called the Web Browser. The arrival of the Web greatly facilitated the growth of Internet resources and Internet usage among the general public (Straw, 2001; Naughton, 2000). Libraries started embracing the Web as the standard framework to mount locally-created resources such as library websites, online catalogs, Internet reference resources and instructional materials for remote users. Database producers also veered to the Internet

and developed Web-based databases targeting end-users, which were less intimidating because the search interface took the form of Web pages and users were no strangers to Web pages (Tenopir & Ennis, 2001; Tenopir, 1995; Tenopir, 1996; Tenopir, 1997; Straw, 2001; Moore, 1998a). A statement from Tenopir (1994) precisely depicted the changes the Internet has brought to database resources – "The Internet is important as a conduit – a less expensive way to reach commercial systems through a telnet connection; as an alternative or first choice – a less expensive way to reach certain materials; and as a force for change – as commercial online services, database producers, and searchers react to the first two and change the way they do things because of it" (p.32).

The arrival of the Internet and its exponential growth, not only expanded the choices of electronic resources, revamped the old ways of database and catalog searching, but also reinforced the instructional role of reference librarians. Unlike well-structured database resources, the enormous amount of information available on the Internet is neither critically scrutinized nor carefully organized. Moore (1998a) described the Internet as "a library with all the books tossed on the floor" (p.117). Thus, in order to help users navigate the overwhelmingly intricate resources on the Internet without being misled by deceptive and biased information, reference librarians had to spend more time teaching them how to access the Internet, how to locate information on the Internet, and how to evaluate located information and then utilize them (Straw, 2001; Moore, 1998a; Hope, Kajiwara & Liu, 2001).

Apparently, the Internet has been a ground-breaking force in reshaping libraries' reference services. Straw (2001) believed that "the Internet is transforming the nature of reference work" (p.9). In this section, only part of the transformation brought by the

Internet has been discussed: the unprecedented increment on accessibility and availability of electronic resources. The influence of the Internet is more than that. In the next section, another aspect of the Internet's power will be examined to review how the way reference assistance is provided has been transformed by the Internet.

## *III. Expansion of Reference Service Media*

Ever since Samuel Green (1876) defined the relations between librarians and library users, human-intermediated assistance provided by reference librarians has been considered a pivotal function of reference departments for over a hundred years. The essential part of reference work is to help users find information to fulfill their information needs by every possible means.

The media of the provision of reference services have evolved in the past century. At first, reference service could be only delivered inside the library where librarians and users communicated in the face-to-face fashion. Then, remote reference came into the picture when the use of mail, telephone and Teletype were incorporated in designing reference services (Ryan, 1996; Janes, 2003). As computing and networking technologies (especially the Internet) were adopted by libraries in 1980s, remote reference was brought to a new level, where digital media started becoming a popular choice to deliver reference services to reach a far wider audience. Email and online real time interaction, are the two primary types of such reference services. Users can send their queries by email, or by filling out a Web form, and then receive answers by email; or engage in an online interactive session where they can communicate with librarians synchronously and receive immediate help from the librarians.

There has not been a consensus on the term used to describe digital-media-based reference services. Most of the time, they are referred to as either "digital reference services" or "virtual reference services". As the professional association of reference and user service librarians, RUSA (2004) chose to use "virtual reference" for the new service and defined it as the "reference service initiated electronically, often in real-time, where patrons employ computers or other Internet technology to communicate with reference staff, without being physically present. Communication channels used frequently in virtual reference include chat, videoconferencing, Voice over IP, co-browsing, e-mail, and instant messaging" (n. p.). Lipow (2003), while acknowledging the mixed use of these two terms in current literature, preferred to use "virtual reference" in the context of "live, interactive, and remote services" (p. xx), instead of in the broader sense conveyed in RUSA's definition. The use of "virtual reference" dedicated solely to online real-time chat reference services was also exemplified in the works of Meola and Stormont (2002), Coffman (2003), and Ronan (2003).

Another popular term used in naming the digital-media-based reference services, "digital reference", also has multiple definitions:

- "the use of digital technologies and resources to provide direct, professional assistance to people who are seeking information, wherever and whenever they need it" (Janes, 2003, p.29)
- "human-intermediated assistance provided to users via electronic media in fulfillment of users' information needs" (Pomerantz, 2003, p.36)

- "Internet-based question-and-answer services that connect users with experts and subject expertise" (VRD, 2003, n. p.)
- "the use of human intermediation to answer questions in a digital environment" (Lankes, 2005, p.321)

All the above definitions captured the crucial components of "digital reference": human-intermediated assistance and digital media. Although some researchers tend to incorporate digital/electronic resources in "digital reference" as well (Tenopir, Ennis, 1998, 2002), RUSA (2004) clarified this distinction by stating that "while online sources are often utilized in provision of virtual reference, use of electronic sources in seeking answers is not of itself virtual reference". Thus, resources created and distributed in digital means are not considered part of "digital reference".

Since "virtual reference" is still debatable in terms of scope, for the purpose of this article, "digital reference" will be used as the term to describe the digital-media-based delivery of human-intermediated assistance, either through email, online real-time interaction, or any other viable digital technology.

## 3.1. Email Reference Service

The application of email was adopted by libraries as an extension of reference desk as early as 1980s (Schardt, 1983; Kittle, 1985; Howard & Jankowski, 1986; Weise & Borgendale, 1986; Bonham, 1987; Roysdon & Elliott, 1988; Hodges, 1989). These early email reference services were mostly provided through email systems linked to OPACs or campus-wide information networks (Ford, 2002). A survey conducted by ARL in 1988 indicated that 20% of ARL libraries offered email reference services by then

(Still & Campbell, 1993). One decade later, this number rocketed up to 96%, due to the widespread availability of the Internet and personal computers (Ford, 2002; Goetch, Sowers & Todd, 1999; Coffman & McGlamery, 2000).

Email reference services are provided either through a link of email address to which users can send their questions, or through a Web form that users can fill out to submit their questions. In both ways users receive the answer to their questions by email (Lankes, 1998a; Lagace, 1999; Janes, Carter & Memmott, 1999; White, 2001). While libraries were making email reference services available for their users, some independent Internet-based services, usually called "AskA" services, also started offering email reference services to answer questions from the general public (Bushallow-Wilbur, DeVinney, and Whitcomb, 1996; Philip, 1997; Lankes, 1998a). These services are mostly subject-specialized (Pomerantz, 2003), for example, "Ask Dr. Math" focuses on mathematics, "Ask the Space Scientist" answers questions about astronomy and space science, and "Ask A Linguist" helps people seek information related to language and linguistics, etc.

Like other remote reference options, email reference service has freed users from the geographic limitations, making it possible for them to ask questions wherever they are as long as they have Internet connection. Not only so, users could ask questions whenever they have one (Bushallow-Wilbur et. al., 1996). However, the immediacy of being able to ask questions, does not guarantee an immediate response from the librarians since email is an asynchronous communication means. The lag of time is a prominent characteristic of email reference, which has both its advantage and disadvantage. While it gives librarians more time to compose the answer, it inevitably prevents them from conducting

in-depth reference interview with users (Still & Campell, 1993; Ryan, 1996; Hulshof, 1999; Janes & Hill, 2001; Philip, 1997; Hahn, 1997; Lankes, 2000; Moore, 1998b; Schwartz, 2003; Coffman, 2003). Although Abels (1996) proposed several approaches for email reference interview, the interview process could be very lengthy. As Straw (2000) pointed out, it might take weeks to conclude a reference negotiation conducted through email exchanges.

One remedy for the lack of interactivity inherent in email reference services is to use well-designed Web forms to elicit users' information needs (Lagace & McClennen, 1998; Janes & Hill, 2001; Stemper & Butler, 2001). Haines and Grodzinski (1999) suggested that a structured Web form might force users to submit pertinent information that may have otherwise been left out but useful for librarians to answer their questions. However, Carter and Janes (2000), in discussing the Web form used by Internet Public Library, stated that "users seem to have difficulty in assigning subject categories to their question, and to determine whether they are factual or require sources for assistance, and these decisions were often overridden by question administrators" (p. 251). The effectiveness of Web forms could be undermined by users' inappropriate understanding of the items on the Web form.

As technologies advance, the issue of reference interview is no longer an objection to digital reference services. The application of online real-time interactive technologies in libraries allows librarians and users to interact synchronously in a digital reference session. The following section will provide an overview of the other primary digital reference option: online real-time interactive reference service.

## 3.2. Online Real-time Interactive Reference Service

Reference services provided via the online real-time interactive mode were rarely presented in the literature until mid-1990s (Ford, 2002). Real-time technologies, such as videoconferencing, were only being experimented in libraries to provide synchronous reference services to users during 1990s. Using a videoconferencing system, librarians and users can see each other through Web cameras installed in both of their computers, have a conversation through microphones, and even communicate by exchanging typed messages. While several videoconferencing-based reference projects were implemented in mid- and late 1990s (Bilings, Carver, Racine & Tongate, 1994; Pagell, 1996; Dent, 2000; Folger, 1997; Lessik, Kjaer & Clancy, 1997; Morgan, 1996), the technological shortcomings such as poor video transmission quality, limited bandwidth, limited access to the supporting infrastructure made it difficult for "a critical mass of users" (Sloan, 1997) to develop for this service.

The rather cumbersome videoconferencing technology was not the only resort for online real-time interactive reference. Libraries also tapped other online real-time applications to provide chat-based reference services, or in short, chat reference services, where librarians and users can "chat" with each other by exchanging written messages. In this scenario, visual and audio information does not exist anymore and the communication is only achieved by typing messages back and forth.

Ronan (2003), in his book "Chat reference: a guide to live virtual reference services", provided a comprehensive summary of the systems supporting chat functionality that have been used in libraries for online real-time services. According to Ronan (2003), although some libraries developed in-house software for chat reference

services, most libraries chose to use software already available on the market. There are two major categories of such systems, one is simple text-based chat applications, and another is more advanced, full-fledged commercial software with features like page-pushing or white-boarding.

### Simple text-based chat applications

Internet Relay Chat (IRC), MOO (Multi-User Domain Object-Oriented), and Instant Messaging (IM) are the popular technologies for text-based chat reference services. They are appealing to libraries because the software is mostly free or inexpensive. But some of these technologies require users to have a client installed on their computers in order to benefit from the services, and most of the systems support no other features than simple text messaging for the purpose of chat reference.

### Commercial chat software

Commercial chat software allows librarians and users to do more than simply exchanging text messages, such as page pushing, file sharing, and co-browsing. Some libraries use online real-time interactive features of courseware to provide chat reference services, but it can only reach a small portion of users that have account names (Ronan, 2003). A more popular and widely-accepted option is call center software, or Web contact center software (Francouer, 2001).

Call center software was originally developed to facilitate customer services on business Web sites. It has been adapted to accommodate the needs of library services. For example, the two popular systems among libraries, LSSI's Virtual Referent Toolkit (now

purchased by Tutor.com), and Metropolitan Cooperative Library System's 24/7 Reference (now merged with OCLC's QuestionPoint) were both created based on eGain, a commercial call center software.

Since call center software is usually hosted on the vendor's server, what libraries need is only a log-in name, and users can access the service simply through a browser window. In a chat session activated by the call center software, librarians are able to push pages, send files, prescript messages to save time, and escort users in the information searching process by co-browsing Web pages with them. These features make it easier for librarians to transmit electronic information to users and guide them in the navigation, given the fact that digital reference services utilize electronic resources extensively in answering questions (Lankes, 1998b, Bry, 2000; Janes, Hill, and Rolfe, 2001; Tenopir & Ennis, 2001). At the end of each chat session, a transcript of the reference transaction will be emailed to users for future reference.

Chat reference services are currently the predominant mode of online real-time interactive reference services in libraries. One distinct advantage of this service mode is that it enables the synchronous interaction between librarians and users, and hence the capability to conduct reference interview (McGlamery & Coffman, 2000; Smith, 1999; Yue, 2000). However, since the medium has changed, chat reference cannot completely model the reference interview in the face-to-face reference setting. Concerns over the difficulty in question negotiation with users in a chat session have been frequently expressed in the literature.

- No verbal or visual cues are available in chat reference, which not only makes it hard for librarians to evaluate users' responses, but also requires them to have a thorough understanding of chat-based online communication to better interact with users (Janes, 2002; Stormont, 2001; Broughton, 2001; Smith, 1999; Francoeur, 2001; Koyama, 1998; Straw, 2000; Viles, 1999; Ronan, 2003)

- Time pressure is also a challenge faced by librarians during the transaction. Users might become impatient when librarians take time to search information for them because, unlike in the face-to-face reference setting, users do not understand what is happening at the other end of the communication and might get tired of waiting if there are no constant responses. Librarians have to reassure users by sending short messages like "I'm doing the search now" to keep them engaged in the interaction (Stormont, 2001; Francoeur, 2001; Boyer, 2001; Trump & Tuttle, 2001; Oder, 2001; Brandt, 2000; Peters, 2000; Schneider, 2000).

- Vanishing users are another problem that librarians have to deal with, where users disappear in the middle of a chat session without any notice. It could be an abrupt technical problem that disconnects the user, or he/she gets impatient and closes the window, or he/she happens to find the answer to his/hers question somewhere else and does not need the service any more (Francoeur, 2001; Janes, 2002).

Despite the above limitations, chat reference services make it possible for users to get reference help remotely, immediately and interactively, as long as they have a computer connected to the Internet. The elimination of the restriction of "mortar and brick" not only extends the service to remote users, but also enables longer service hours. Some of the chat reference services are even available around the clock. This convenience of service hours is brought by the new possibility that comes with chat reference services – collaboration in the form of consortium. For the first time reference responsibilities can be shared among various libraries to serve a larger number of users for a longer period of time (Stahl, 2001).

## 3.3. Digital Reference Consortia

Reference collaboration among libraries has been brought to a new level by digital reference. In desk or telephone reference settings, inter-library collaboration happened when users of one library were referred to the resources or services at another library, or reference librarians of one library contacted (by telephone) another library or service for information (Pomerantz, 2006). When digital reference made its way to libraries, forming consortia, the collaboration mode that used to exist only in areas like cataloging, database purchasing, and interlibrary loan, started becoming a viable option for libraries to share resources and expertise in reference work.

The advantages of digital reference consortium have been well discussed in the literature (Eichler & halperin, 2000; Smith, 1999; Stormont, 2000; McGlamery & Coffman, 2000; Yue, 2000; Stahl, 2001, Pomerantz, 2006). When digital reference services are provided in the asynchronous form, such as email, the purpose of the consortia is to create a mechanism for members to "swap out-of-scope and overflow

questions, so that if one service received a question that it could not or would not answer for some reason, it could be forwarded to another service in the consortium that could answer it" (Pomerantz, 2006, p. 48). Virtual Reference Desk (now discontinued due to lack of funding) for AskA services and QuestionPoint for library-affiliated email reference services are two well-known consortia of this kind.

The purpose of consortia formed among synchronous digital reference services, such as chat reference services, is to share resources and manpower between libraries by members taking turns in staffing the services and answering questions from users of all participating libraries. Some of these consortia are established among libraries using the same chat application; some are formed by libraries within a certain geographic region. A case study of NCknows, a consortium of libraries in North Carolina, indicated that "for a comparatively minimal investment in supporting users outside of their primary user communities, these chat services increased several times over the volume of transactions that they were able to handle during their hours of service, in addition to dramatically expanding the number of hours that chat-based reference service could be offered to their primary user community" (Pomerantz, 2006, p. 49).

The possibilities to participate in digital reference consortia not only allow libraries to make more efficient use of scarce resources such as materials, time and money, but also, as Pomerantz argued, provide them with the potential benefits from "network effects", where the value of a consortium increases as the number of members of that consortium increases.

According to Pomerantz (2006), “in order for digital reference services to be able to provide answers to their users, it is increasingly important that services collaborate, sharing knowledge as any other resource might be shared” (p. 53). Undoubtedly, the thriving digital reference consortia have proved this point.

## *IV. Summary*

In the past half century, information technologies have transformed library reference work in two instrumental ways – the manifold increase of the availability and accessibility of electronic resources, and the unprecedented expansion of the media through which reference services are provided. The transformation keeps library reference abreast with the rapidly changing information horizon and ensures the fulfillment of library’s mission in assisting users in their information seeking process. Placed in the historical context, library reference progression under the influence of new technologies reviewed in this article may serve as a foundation for reference professionals to conjure up ideas for future advancement. As library reference moves forward, on one hand, there is always room to further increase the accessibility of electronic resources – features like search alerts and federated search in databases are becoming more and more popular in improving search effectiveness and efficiency, and reference librarians’ role in helping users master new search features and augment their own search skills will be constantly reinforced; on the other hand, the media through which reference services can be provided keep expanding as new technologies emerge – the rapid growth of mobile device users brings forth the possibilities of delivering reference services to hand-held computers and cell phones, and librarians can offer their assistance to an even wider user community.

The advent of new technologies has had a significant impact on the evolution of library reference work, and will continue to do so in the ever changing information world. The historical overview of reference progress to date presented in this article will strengthen the understanding of the growth of reference resources and services, and hence, lead to a more coherent development of the reference profession.

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