FACTORS INFLUENCING DIGITAL REFERENCE TRIAGE: A THINK-ALOUD STUDY[1]

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This article describes a think-aloud study conducted to identify factors that influence the decisions made by digital reference "triagers" when performing triage on questions received by digital reference services. This study follows and expands on a Delphi study that identified factors that triagers agreed on after the fact of their performance of triage by identifying factors that triagers take into consideration during their performance of question triage. Thirty-eight factors that influence triage decisions were identified, in eight categories. Eight of these factors are intrinsic to the question itself; the remaining thirty factors are extrinsic to the question, situating it in a context for the user and the service. These factors must be taken into consideration by any future system for automated triage.

Introduction

Nearly forty years ago, Jesse Shera [1] not only foresaw the use of computing to take some of the menial labor out of library reference work but also proposed a method for achieving that goal. Shera wrote that "the really great promise of automation is to be sought in . . . the opportunity it affords to analyze the reference process and re-define reference service" [1, p. 203]. He saw this redefinition as removing the "fetch and carry" aspects and the potential to raise the intellectual level of reference work. To achieve this end, Shera proposed an agenda for action: first, analyze the processes involved in reference service and how questions are handled by humans in those processes, and second, create algorithms to represent

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these processes. Forty years later, Shera's agenda still provides a sound course of action.

One development that Shera [1] did not anticipate, however, was the invention and popularization of the Internet and the evolution of digital reference services in that environment. Despite the fact that Shera perhaps never imagined this new environment in which reference could be performed, his prediction about automation redefining reference service remains as true today as it did forty years ago.

The growth in the past decade of both the infrastructure and the number of users of the Internet has enabled a corresponding growth in the number of users of digital reference services on the Internet. This increase in the use of digital reference services has led to increases in the number of questions received by these services, thus putting a strain on the human intermediaries in these services. As Shera [1] foresaw, both the ability of a reference service to scale up to handle an increasingly large number of questions and the quality of the answers provided are directly affected by the extent of automation employed by that service: the more processes that are automated, the more time and effort can be dedicated by the human intermediaries to tasks that cannot yet be automated. There is, now more than ever, an increased and immediate need for automation in digital reference services.

In order to design algorithms to automate performance of any process, however, it is necessary to decompose, or break down, processes into rules for action. In order to decompose processes, of course, it is necessary to determine which processes will be analyzed. As the triage process is the first step performed by a digital reference service after the receipt of a question, this provides one logical place to start.

In a Delphi study of digital reference "triagers," published in this journal, Jeffrey Pomerantz, Scott Nicholson, and R. David Lankes [2] identified fifteen factors that triagers agree affect the process of triage. A factor is anything that affects the process of routing and assigning reference questions. Pomerantz, Nicholson, and Lankes found that factors fall into three categories: (1) factors specific to the question, such as the subject of the question; (2) factors specific to the answerer, such as the answerer's area of subject expertise; and (3) factors specific to the reference service, such as the scope of the service's collection. A limitation of this Delphi study is that it identified factors that triagers agreed on after the fact of their performance of triage. This retrospective identification of factors that affect triage is useful, and indeed the fifteen factors identified by Pomerantz, Nicholson, and Lankes served as a partial framework for the present study's analysis and discovery of factors that influence the triage process. The present study follows and expands on Pomerantz, Nicholson, and Lankes's

work, however, by identifying factors that triagers take into consideration during their performance of question triage.

This study was exploratory in that it sought to identify factors that influence the decisions made by digital reference triagers when performing triage on questions received by digital reference services. It was assumed at the outset of this study that the fifteen factors identified by Pomerantz, Nicholson, and Lankes [2] would be among those identified in this study. As will be discussed below, all but one of these fifteen factors were in fact among the factors identified in this study. A secondary assumption of this study was that if this study identified more factors beyond these original fifteen, then these fifteen factors would be the top fifteen, those that were the most important to triagers during their performance of triage. As will be discussed below, this did not, in fact, turn out to be the case.

The research questions for this study are essentially the same as Pomerantz, Nicholson, and Lankes's [2] research questions: (1) What factors are taken into consideration by digital reference triagers when performing triage? (2) Can these factors be ranked in order of importance? (3) Are there groups of factors that can be discovered? In order to answer these questions, triagers were observed performing the task of triage, utilizing the think-aloud methodology.

Literature Review

This study begins from the general process model of asynchronous digital reference presented in figure 1. This model is derived from Lankes [3] and the Virtual Reference Desk (VRD) Project's AskA Software specifications document [4] and was validated in a recent study by Pomerantz and colleagues [5]. This model consists of five steps:

1. "Question acquisition" is the means employed by the service to obtain a patron's questions via e-mail, Web forms, chat, or other means.
2. "Triage" is the assignment and routing of a question to a reference or subject expert "answerer." This assignment of a question can occur within a service (when a question is received by a service, the individual performing triage—the triager—assigns it to a specific reference or subject expert within that service) or between services (if a question is received by a service that, for whatever reason, it cannot or will not answer, the triager forwards that question to a different digital reference service).
3. "Answer formulation" is the process of the answerer creating an answer or other type of response to the question. Factors for creating "good" answers, such as the patron's age and cultural appropriate-

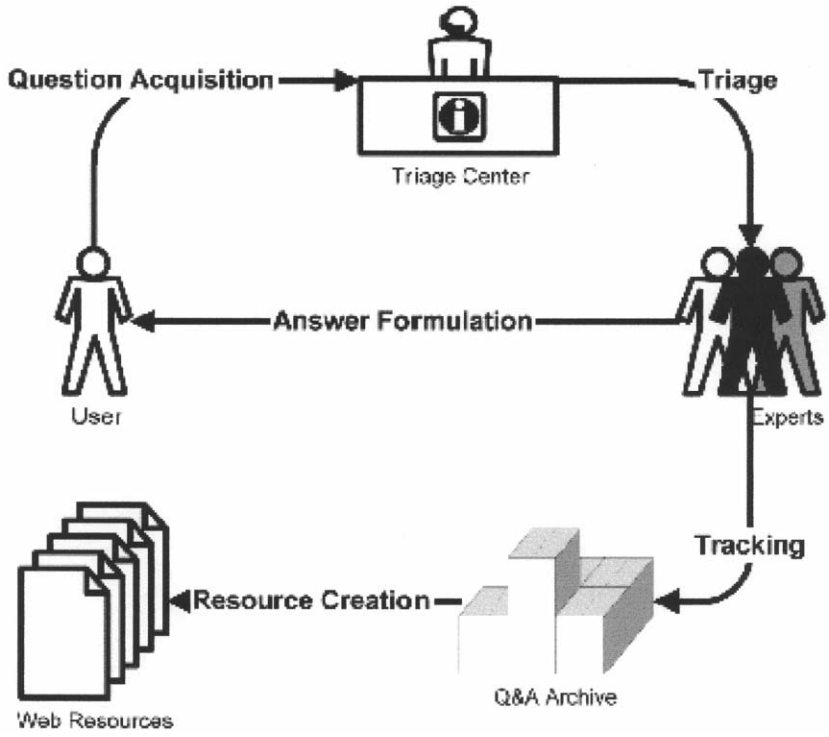

FIG. 1.—General digital reference model

ness, must be taken into consideration at this point. Answers are also sent to the patron in this step.

4. "Tracking" is the quantitative and qualitative monitoring of questions for trends. Tracking allows the identification of frequently asked questions, "hot topics," and it may indicate where gaps exist in the collection(s).
5. "Resource creation" concerns the use of tracking data to build or expand collections to meet patrons' information needs better.

This process model is presumed to be applicable to all asynchronous digital reference services, though different services employ variations of the processes at each step. Some services may even skip steps; for example, not all services may archive questions or answers to create resources. Additionally, some steps may be repeated, especially if this model is seen to span more than one service; for example, a triage center at one digital reference service may receive a question and route it to a different service, which may then route it to an expert.

In desk reference services, the librarian who happens to be at the desk when a patron approaches is generally the librarian who responds to that patron's question. This librarian may not, however, be the most appropriate person—in terms of subject expertise, reference experience, or other service criteria—to respond to that particular question. In some cases—for example, when the question is outside the service's scope—rather than simply turn a patron away without an answer, a reference librarian will refer a patron to another reference service or organization [6–8]. In such cases, the burden is generally on the patron to contact that other service and complete the referral. Digital reference services similarly forward questions to other services, but there is a critical difference in how this is performed. This difference lies in who has the responsibility for completing the referral: in digital reference, if triage is performed, it is not the patron who is sent from one service to another, but the patron's question. Thus, the burden is on the service that received the question from the patron, rather than on the patron him- or herself, to perform triage. While referrals are relatively common, but not necessary, in desk reference services, triage is a crucial step in the management of questions in digital reference services.

The necessity of triage in digital reference has been a contributing factor that has led to the creation of consortia of digital reference services. Some of these consortia are composed of libraries using the same software application, such as QuestionPoint (http://www.questionpoint.org), Virtual Reference Toolkit (http://www.tutor.com), and 24/7 Reference (http://www.247ref.org). Some of these consortia are composed of libraries within a single state or geographic region, such as QandA-NJ, a service of the New Jersey Library Network (http://www.qandanj.org); KnowItNow, the Cleveland, Ohio, public library's CLEVNET Consortium (http://www.knowitnow24x7.net); and the Western New York Library Resources Council (http://www.wnylrc.org). Some of these consortia are sets of otherwise unaffiliated libraries and AskA services that have agreed to swap out-of-scope and overflow questions, such as the VRD (http://www.vrd.org). Digital reference services that are members of these question-swapping consortia, therefore, receive not only questions submitted directly by patrons but also questions triaged from other services. No large-scale study of traffic in digital reference services has ever been conducted, but several studies of individual services indicate that services of all types are receiving an increasing volume of questions overall [9–11].

This study is concerned with the triage step in the process model presented above. Michael McClennen and Patricia Memmott [12], in their discussion of "the various roles played by participants in the digital reference process" [12, see "The Model," par. 2], point to the existence of a filtering stage in the processing of digital reference questions. The individual who performs this filtering—the "filterer"—decides which questions

the service should accept, which can be answered with stock answers, and which are "nonquestions"—including repeat questions and spam [12, see "Filterer," par. 1]. The triager performs a task similar to that performed by the filterer. For this study, however, two distinct tasks performed by the filterer or the triager are separated: the filtering out of nonquestions and the triaging of questions to the appropriate expert or service. While the filtering task is unquestionably important to digital reference services, this study is concerned only with the task of triage, and specifically the triage of questions to the appropriate expert answerer or other digital reference service.

Two variations on the triage process are employed by different digital reference services [4]. The first variation is concerned with the agent that makes decisions in the triage process: either a human triager or an automated process. In either case, criteria must exist for deciding how to assign and route questions. If a human performs triage, these criteria may be more heuristic, whereas if an automated process performs triage, these criteria must be rigorously codified in software. The second variation on the triage process involves how a question is triaged to an answerer: questions are either assigned to specific answerers by the triager (either human or automated) [2], or questions are stored in a "triage area" and self-selected by answerers [3, 13].

QuestionPoint (formerly the Collaborative Digital Reference Service) is a digital reference service consortium managed as a partnership between the Online Computer Library Center and the Library of Congress (http://www.questionpoint.org). QuestionPoint is an example of a service that utilizes an automated triage process: when a question is received by the service, a software algorithm assigns the question to one of the digital reference services participating in the consortium. This algorithm assigns questions "on the basis of such data elements as hours of service, including time zones, subject strengths, scope of collections, types of patrons served, etc." [14; see "How Does CDRS Work," par. 2].

The Internet Public Library (IPL), by contrast, is an example of a service that utilizes a human filterer and allows experts to self-select questions. McClennen and Memmott state that the IPL has "developed written policies and procedures, including guidelines for making the necessary decisions regarding which questions to accept, reject, or refer" [12, p. 146]. The existence of these policies and procedures demonstrates the necessity for digital reference services to establish criteria for the performance of triage, even when those performing triage are the service's "most experienced staff" [12, p. 146].

Finally, many digital reference services, particularly those that receive few questions per day, utilize a human triager who assigns questions to individual answerers [15]. This process is highly labor intensive. The triager

must read each question and decide to whom the question should be routed based on whatever factors are appropriate to the service, to the question, and to the answerer. This study is concerned only with human triagers and the factors that they take into consideration when making the decision to triage a question to a specific answerer. It is precisely these factors that this study elicits.

Methodology

The Think-Aloud Method

In order to determine what factors are taken into consideration by digital reference triagers when performing triage, triagers were observed performing the task of triage. Data on the factors that triagers take into consideration during the triage process were elicited utilizing the think-aloud methodology. Respondents were triagers in digital reference services affiliated with public, academic, and special libraries, as well as those in AskA services (unaffiliated with any physical library). Think-aloud cases were conducted until saturation was achieved, and no new factors that affect triage decisions were discovered.

K. Anders Ericsson and Herbert A. Simon [16] describe two possible relationships between cognitive processes and verbalization: concurrent verbalization, in which "information is verbalized at the time the subject is attending to it," and retrospective verbalization, in which "a subject is asked about cognitive processes that occurred at an earlier point in time" [16, p. 218]. The think-aloud is a methodology to elicit concurrent verbalization of an individual's internal cognitive processes and, further, to structure the verbalization process so that the verbalization can be utilized as data.

The premise of the think-aloud method is that individuals may not have conscious access to all of their internal cognitive processes involved in performing a particular task. The think-aloud method does not, therefore, attempt to gain access to individuals' internal cognitive processes but, rather, to elicit verbalizations that are representative of individuals' cognitive processes. The major assumption made by the think-aloud methodology is that elicited verbalizations are in fact representative of individuals' cognitive processes.

The think-aloud methodology elicits verbalizations from the contents of an individual's working memory by providing an individual with a specific task and instructing the individual to speak aloud while performing that task [17]. The individual is instructed to say anything and everything that crosses his or her mind, speaking constantly, without consciously filtering what is being said (insofar as that is possible). In this manner, the respondent will

articulate his or her cognitive processes involved in performing the given task.

Selecting an appropriate task is the most important factor in the reliability of the think-aloud method. Certain tasks are inappropriate for the think-aloud method because of the fact that they are either nonverbal or entirely verbal: nonverbal tasks such as dance are inappropriate because they do not require internal verbalization to perform and so may be difficult or impossible to externally verbalize. Conversely, a verbal task such as performing a reference interview is inappropriate because the task itself requires the subject to be speaking, thus allowing no "space" for the subject to verbalize about the task without interrupting the task itself. The ideal task for the think-aloud method is one that requires thought that can be expressed verbally, while not requiring much or any verbalization in the process of performing the task. The task of triage is therefore highly appropriate for the think-aloud method, as it is an inherently verbal task: questions, which are textual documents, are routed and assigned within and between services for reasons that can be articulated verbally.

Solicitation of Respondents

Digital reference services were selected for solicitation from two sources, the libraries listed in the LIBWEB database that offer digital reference services and the digital reference services listed in the VRD's AskA Locator.

The LIBWEB Web site (http://sunsite.berkeley.edu/Libweb) is a database of library Web sites maintained by the University of California at Berkeley's Digital Library SunSITE. The most complete database of library Web sites that exists online as of this writing, LIBWEB lists over 6,500 library Web sites in over one hundred countries. The LIBWEB database lists libraries by geographic regions roughly corresponding to the continents. Within these regions, the database is further subdivided by country.

The AskA Locator (http://www.vrd.org/locator) is a database of AskA services maintained by the VRD Project. The AskA Locator is perhaps the only database of AskA services that exists online. As of this writing, the Locator lists ninety-five AskA services, organized according to fourteen subject areas.

In 1999, Joseph Janes, James Carter, and Memmott [18] found that 44.7 percent of academic libraries offered digital reference services. Janes [9] found, in 2000, that 12.8 percent of public libraries offered digital reference services and, in 2002, that 35 percent of public libraries offered digital reference services [10]. I am not aware of any similar figures for other types of libraries. By definition, of course, 100 percent of AskA services offer digital reference services.

None of these studies, however, attempts to identify the raw number of libraries offering digital reference service—undoubtedly, in part, because

identifying a raw number of libraries is difficult enough. Janes, Carter, and Memmott's [18] figures are drawn from a sample of institutions classified as Baccalaureate I and higher, but that excludes associate's colleges, tribal colleges and universities, and specialized institutions such as medical, business, and law schools, seminaries, and the like, not to mention institutions outside the United States.[3] Janes's [9, 10] figures are drawn from a survey of public libraries conducted by the National Center for Education Statistics; the American Library Association (ALA) [19] has a different value for the number of public libraries in the United States.

According to ALA, no directory of all libraries in the United States or the world exists [20]; as a result, no directory of reference services exists. Similarly, Janes [21] states that "no definitive list of reference librarians exists" [21, p. 550]; more important for the purposes of this study, no definitive list of digital reference services exists. Thus, it is impossible to know what the "demographic" makeup of the population of digital reference services is, and it is therefore similarly impossible to know what percentage or segment of the total population of digital reference services is made up of the twenty-eight responding services.

As no definitive list of digital reference services exists, it is impossible to know the ratio of libraries that offer digital reference service to AskA services that exist in the world. However, if the LIBWEB database and the AskA Locator are any indication, far more libraries that offer digital reference service exist than AskA services. A proportional sample was collected from these two sources, though some estimation was required to determine the appropriate proportion of services from the LIBWEB database and the AskA Locator. This sample was, however, restricted to services in the fifty-three nations in which, according to the Central Intelligence Agency *World Factbook* (http://www.cia.gov/cia/publications/factbook), English is spoken (though not always as the only language spoken). Approximately 80 percent of the libraries listed in the LIBWEB database and approximately 90 percent of those in the AskA Locator are in nations in which English is spoken. Because the number of libraries listed in the LIBWEB database so vastly outweighed the services listed in the AskA Locator, it was decided that AskA services should be oversampled so as to ensure a sufficient sample size of AskA services, while not requiring that thousands of libraries be sampled. It was decided to oversample AskA services for another reason as well—because the same low response rate was anticipated as was reported by Janes, Chrystie Hill, and Alex Rolfe [22], who found that they received a response from only 46 percent of AskA services, half of which were drawn

3. The classification is according to the Carnegie Foundation for the Advancement of Teaching's Classification of Institutions of Higher Education, available at http://www.carnegiefoundation.org/Classification/ (last accessed August 10, 2004).

from the same AskA Locator as those for this study (the other half were commercial sites located by searching the Web). Thus, 2.5 times as many services were sampled from the LIBWEB database as from the AskA Locator; a total of 125 services were randomly selected from the LIBWEB database, and fifty AskA services from the AskA Locator, to be solicited for participation in this study.

This initial solicitation was made via the service's question submission Web form—if the service maintained one, or via e-mail if it did not. Initial contact was made in this way because it was a sure way to have the solicitation read by the triagers for the services since the solicitation was submitted as any question would be submitted to a service—the triager would see the solicitation in the course of triaging the submitted questions for the day.

This solicitation asked if the service triages questions to its librarians or experts and, if so, if it would be possible for the researcher to contact, by e-mail or telephone, an individual who performs the triage process. It was then up to the service to respond to the solicitation—which the vast majority did, if only to decline to participate. If a service did not perform triage, the reason why triage is not performed was noted, and there was no further contact with that service. If a service did perform triage, the researcher contacted a triager at the service. In order for a triager to participate in this study, four criteria had to be met: (1) the service performed triage, (2) the service performed triage manually, and not automatically, (3) the triager was willing to participate in a think-aloud case, and (4) the service was willing to share the questions that were triaged during the think-aloud case with the researcher.

In most cases, the triager who responded to the solicitation was willing to participate in a think-aloud case. In some cases, the triager who responded to the solicitation forwarded the researcher to another triager in the same library; the researcher then contacted that triager to solicit him or her for participation. Once a triager was contacted and willing to participate in a think-aloud case, an appointment was set up to conduct a think-aloud case in person or, in cases where travel to the site could not be arranged, over the telephone. In most cases, triagers had a specific time of day during which they performed triage on the questions received during the past business day; in these cases, the appointment or telephone call was set up for that time on a particular day. Some triagers performed triage irregularly, whenever it fit conveniently into their daily schedules; in these cases, a day and time for the appointment or telephone call was agreed on between the triager and the researcher. Twenty-eight think-aloud cases were conducted, with twenty-eight triagers from twenty-eight different digital reference services. This figure is 16 percent of the total sample of 175 services solicited for participation from the LIBWEB database and the

AskA Locator. Eight (29 percent) think-aloud cases were conducted in person, and twenty (71 percent) were conducted by telephone. These cases were performed between August 2002 and October 2002.

Data Collection

Respondents were instructed to perform their job as usual, triaging incoming questions to the appropriate (in their estimation) reference or subject expert, or other service. Respondents were instructed to think aloud while performing triage, with specific attention to factors that affect their triage decisions. The think-aloud cases continued for as many questions as were received by services on that day, up to a maximum of thirty questions, if the service received more than thirty on the day that the think-aloud study was performed. Think-aloud cases varied greatly in length; depending on the volume of questions received on that day, sessions ranged from fifteen minutes to over an hour. As it turned out, twenty-five out of the twenty-eight services studied (89.3 percent) received fewer than thirty questions on the day that the think-aloud study was performed. This distribution of services' volume of questions received, with few services receiving a large number of questions and many services receiving a small number, is typical: Lori Goetsch, Laura Sowers, and Cynthia Todd [23] report that the number of questions received per month by Association of Research Libraries member libraries ranged between two and 550, with a mean of sixty-seven—which translates to between one question every other week to twenty per day, with a mean of 2.4 (assuming a seven-day work week). Janes [21] found that three-quarters or more of librarians from a variety of different types of libraries—public and academic, small, medium, and large—reported that they had answered ten or fewer questions "using digital reference techniques" during the previous week [21, p. 553]. Thus, this study's finding of the distribution of services' volume of questions received is consistent with previous studies' findings. While there have been a few studies of the questions received by digital reference services [2, 24, 25], there have been none that attempt to correlate the volume of questions received by a service with the processes by which questions are handled. There is thus no evidence to support the supposition that the factors that affect triage decisions are different for services that receive different volumes of questions.

As mentioned above, some think-aloud cases were conducted in person, and some were conducted over the telephone. Before beginning a think-aloud case, the triager was instructed to try to speak aloud everything that goes through his or her mind and to verbalize his or her thoughts as they occur and not to interpret or filter them. In conducting think-aloud cases in person, the researcher sat with the triager while he or she was performing triage. In conducting think-aloud cases over the telephone, the re-

searcher and the triager were on the telephone while the triager was performing triage. Whether in person or on the telephone, occasionally the respondent would stop talking; the researcher would then prompt the respondent to continue to think aloud.

The think-aloud cases were recorded with the respondents' consent. During the in-person cases, a small handheld cassette recorder was placed before the triager; during the telephone cases, a phone tap–like adapter was attached to the telephone and the handheld cassette recorder. Once a think-aloud case was completed, the researcher transcribed the triager's verbalizations, word for word—including the researcher's own prompts to the triager—to create a written protocol for every respondent.

As the triager triaged questions, he or she also forwarded them to the researcher. It was necessary that the researcher have these questions so that he or she could refer to them during the transcription process in the frequent event that the triager referred to the question. Before a think-aloud case, the researcher provided the triager with an e-mail address for the purpose of forwarding questions. During the think-aloud cases, as the triager triaged questions, he or she forwarded them to the e-mail address provided. A total of 185 questions were triaged and collected during the think-aloud cases.

The written protocols of the think-aloud cases were imported into ATLAS.ti, a software application for performing content analysis (http://www.atlasti.de). In ATLAS.ti, these protocols were coded so that comments by respondents that indicated reasons for triage decisions were marked in the protocol. These codes were arrived at both deductively and inductively, utilizing the constant comparative method [26]. The constant comparative method is a method for the simultaneous coding and analysis of qualitative data. The first step in the constant comparative methodology is to code the data, classifying each piece of data into as many categories as is possible to fit it into. These categories emerge through the researcher's experience in collecting and analyzing data; categories emerge as the researcher makes generalizations about entities in the data and is able to state that a specific entity is an example of a specific category. As more and more data are collected, categories are created and refined, and it becomes clearer to which categories specific entities belong. The constant comparative methodology allows this data collection and analysis cycle to proceed for as long as necessary, which is until saturation is achieved; saturation is the point in the data analysis when the same or similar entities continue to be elicited from the methods of data collection being employed and no new categories are being developed.

The fifteen factors that Pomerantz, Nicholson, and Lankes [2] discovered that influence the triage process served as a "partial framework" [26, p. 45] for the present study's analysis and discovery of further factors that

influence the triage process. As data were collected from the think-aloud cases, more factors that influence the triage process emerged, and more categories of factors were developed. These codes were developed collaboratively by the researcher and two colleagues: early on in the data collection process, the three coders were provided with the written protocols of the think-aloud cases and Pomerantz, Nicholson, and Lankes's fifteen factors and instructed to develop additional factors as they felt necessary, given the content of the protocols. The coders then met to discuss these codes and to arrive at common ground in the operationalization of the factors developed. This was repeated three times—the final time being at the conclusion of the data collection process. At the conclusion of the third iteration, intercoder reliability was 92 percent; that is, 92 percent of the time all three coders would code a factor in the same way.

In analyzing the data from the think-aloud protocols, each factor was coded only once per question. The same factor was frequently mentioned multiple times by the triager in the course of triaging a single question. For example, in triaging the question, "How do you link an online form to a Microsoft access table?" part of the triager's verbalization was as follows: "That is not in our scope. That is going to [another service]. I don't know that they're going to do a better job with it than we would here, frankly, but . . . I mean, I could keep it here, and I could give them resources on Access, or something along those lines."

The quotes "I don't know that they're going to do a better job with it than we would here" and "I could give them resources on Access, or something along those lines" were both coded as "expected answer formulation," since they both address how the question would likely be answered by two different possible answerers. Thus, the same factor was mentioned twice in triaging this question as a way of verbalizing the pros and cons of triaging the question to another service or answering it locally. It does not make sense, however, for a single factor to affect a triage decision more than once. More than one factor may affect a triage decision, but a single factor may affect a triage decision only once. Further, the fact that a single factor was mentioned multiple times in the course of triaging a single question may be interpreted in a number of ways: as an indication of the importance of that factor to the triaging of the question or as an indication of uncertainty on the part of the triager about the importance of that factor to the triaging of the question. Both of these interpretations were appropriate for some questions and for some triagers. Additionally, some triagers were simply more verbose than others; whereas a laconic respondent might talk through triaging a question in only a few sentences, mentioning each factor only once or twice, a more talkative respondent might talk for many minutes per question, mentioning each factor several times. There was little consistency that could be discerned from different triagers' repetition

of certain factors in talking through their triage decisions. Each factor was therefore coded only once per question.

The think-aloud study sought to achieve "theoretical saturation" [26] of reasons for triage decisions. Barney G. Glaser and Anselm L. Strauss do not offer hard-and-fast guidelines for recognizing when saturation has occurred; rather, it is a heuristic process, involving a great deal of subjectivity on the part of the researcher. Glaser and Strauss state, "After an analyst has coded incidents for the same category a number of times, he learns to see quickly whether or not the next applicable incident points to a new aspect" [26, p. 111]. In other words, the researcher's familiarity with the categories into which entities are coded allows him or her to understand when no new categories are emerging from the data. As it turned out, saturation was achieved quickly in the present study before all of the think-aloud cases were performed. This "oversaturation" was itself useful because it allowed the researcher to conduct several more think-aloud cases than would have been necessary simply to achieve saturation and, thus, to be certain that saturation in the range of factors that affect triage had, in fact, been achieved.

After conducting a think-aloud case with a triager, a short, structured interview was conducted in order to collect data for the purpose of determining the "demographics" of the services studied in this phase of the research. In this interview, supplementary data about the service itself and the triage process as performed by the service were collected—if these data did not come up during the think-aloud case or the solicitation exchange.

Results

Participating and Nonparticipating Services

A pool of 175 potential services was solicited for participation in this study. Of these, twenty-eight triagers from twenty-eight different digital reference services participated in the think-aloud cases performed between August and October 2002. The breakdown of these twenty-eight services by type is as follows: academic libraries: sixteen (57.1 percent); AskA services: six (21.4 percent); public libraries: three (10.7 percent); special libraries: three (10.7 percent).

This distribution is quite unlike ALA's figures for the total number of libraries of different types in the United States [19]. The ALA's figures claim that 3 percent of the libraries in the United States are academic, 8 percent are public, and 7 percent are special; these figures do not include AskA services. The bulk of the remaining libraries in the United States, according to ALA's figures, are school libraries; school libraries are not

represented in this study, as very few of those listed in the LIBWEB database and none of those randomly selected from LIBWEB were found to offer digital reference service.

There is, however, no reason to believe that the distribution of digital reference services is necessarily similar to the distribution of libraries in the United States. First, ALA's figures would naturally have no category corresponding to AskA services, as AskA services are by definition unaffiliated with any physical library. Second, it is little surprise that academic libraries make up the greatest percentage of physical libraries that offer digital reference services since academic libraries were among the first to offer reference service via e-mail as outgrowths of existing reference desk services [27–32], and, according to Marilyn Domas White [33], adoption of the innovation of digital reference service continues at a fairly rapid pace among academic libraries (at least among Carnegie Foundation's Master's I and II universities and colleges).

Third and last, as stated above, the "demographic" makeup of the population of digital reference services is unknown. It is therefore impossible to know what the composition of a sample would have to be in order to be representative of the population of digital reference services. The best that can be accomplished is for a sample to achieve coverage by including digital reference services of all existing types. There are two methods for classifying digital reference services—by the type of library with which the service is affiliated and by the service's use of automation. The twenty-eight services that participated in this study include services affiliated with libraries of all types—academic, public, and special—and include AskA services as well. Pomerantz and colleagues [5] make a case for a more sophisticated analysis of digital reference services as well, based on functional, rather than organizational, characteristics: specifically, the services' use of automation in the process of providing asynchronous digital reference. Pomerantz and colleagues [5] present three different types of services: "high tech–low touch" services employ the most automation and the least human intermediation, "low tech–high touch" services employ the most human intermediation and the least automation, and "high tech–high touch" services employ a balance of both. These groups may be differentiated according to nine key characteristics; if data about these characteristics did not come up during the think-aloud case or the solicitation exchange with a respondent, these data were collected during the short structured interview conducted after the think-aloud case. Again, the twenty-eight services that participated in this study include services in all three functional groups. The breakdown of the participating services by use of automation is as follows: high tech–low touch: fifteen (53.6 percent); low tech–high touch: six (21.4 percent); high tech–high touch: seven (25 percent).

Little is known about those services that were solicited but did not participate in this study for the simple reason that they did not participate; thus, only minimal data could be collected about these services. The data that were collected included the country in which the service was located and the type of service (affiliated with a public, academic, or special library, or an AskA service). The samples of participating and nonparticipating services did not differ greatly in the countries in which they were located. These samples did differ, however, in the types of services they contained: the participating population contained a greater percentage of academic and public libraries and a smaller percentage of AskA services and special libraries than the population that did not participate. These findings point to a possible sampling bias in that AskA services and special libraries may be overrepresented in the population of services that participated in this study. It is worth pointing out, however, that the unit of analysis for this study is not the service but the triager's performance of triage on a single question; so, it is not clear that this possible sampling bias would have had any impact on the elicitation of factors affecting triage decisions for the questions collected in this study. By contrast, as mentioned above, no definitive list of digital reference services exists; it is therefore impossible to know whether the populations of participating and nonparticipating services differed according to other criteria.

Identified Factors That Affect Triage Decisions

Pomerantz, Nicholson, and Lankes [2] identified fifteen factors that triagers agree affect the process of triage. Grouped into three categories, they are as follows: factors that affect the triage process in general, factors that affect the triage process when routing or assigning questions to an answerer, and factors that affect the triage process when routing questions to another reference service. In the present study, a total of thirty-eight factors that influence triage decisions were discovered; grouped into eight categories, they are presented in table 1. Eight of these factors—the attributes of the question—are intrinsic to the question itself; the remaining thirty factors are extrinsic to the question, situating it in a context for the user and the service. Note that the sum of the percentages of the factors listed in table 1 is not 100 percent since more than one factor may affect the triage decision for a single question.

Approximately half of the factors identified in this study were dictated to the triagers by the service for which they were performing triage, and approximately half were unique to the triager him- or herself. The triage factors that were dictated by the service were those that were learned by the triager during his or her training—either from formal training documents prepared by the service or from informal training received by other triagers. Three factors that were dictated by most services were the subject

TABLE 1
CATEGORIES AND ATTRIBUTES THAT AFFECT TRIAGE DECISIONS

Category of Attributes and Attribute	No. of Questions	Percent of Questions
Attributes of the question:		
Subject of the question	144	77.8
Difficulty of the question	46	24.9
Generality or specificity of the question	37	20
Question type, according to one or more of the classes from the taxonomies of wh- words or functions of expected answers	6	3.2
The fact that one patron submitted multiple questions	4	2.2
Interestingness of the question, in the opinion of the triager	3	1.6
The fact that the question has a prior history with the service: it is a follow-up question or has been forwarded to another service, and the other service forwarded it back	2	1.1
Language in which the question is written	0	0
Attributes of the answer:		
Form in which the patron specifies that he or she would like the answer presented, e.g., short or long answer, or according to one or more of the classes from the taxonomy of forms of expected answers	1	.5
Attributes of the patron:		
Role, job description, or other capacity in which the question is being asked	21	11.4
School level	15	8.1
Organizational affiliation	6	3.2
Age	4	2.2
Country of residence	4	2.2
State of residence or other subdivision within the country of residence, e.g., province in Canada	1	.5
Attributes of the patron's current information need:		
Planned use of the answer	18	9.7
Date by which answer is needed	2	1.1
Information sources already searched	2	1.1
Attributes of the triaging service (the service or triager that received the question):		
No. of questions received on a given day	16	8.6
No. of questions on the same subject that are expected to be received by the service	3	1.6
Habits that the triager has developed over time in triaging questions	2	1.1
Attributes of the receiving service (the service to which a question is triaged):		
Scope of the service: does the service provide general or subject-specific reference?	47	25.4
Scope of the collection	12	6.5
Response rate: how many of the questions that the service receives get answered	4	2.2

TABLE 1 (*Continued*)

Category of Attributes and Attribute	No. of Questions	Percent of Questions
Depth of assistance provided—what is provided as or with an answer: citations only, answers, bibliographic instruction, etc.	2	1.1
Attributes of the receiving service or the answerer:		
Availability of appropriate information sources that can be consulted in answering the question	28	15.1
Quota for no. of questions that can be accepted per unit time	28	15.1
Subject expertise: areas in which the service or answerer has expertise in answering questions	25	13.5
Turnaround time for providing an answer	21	11.4
Audience served: patrons' affiliation, age, school level, and area of residence	7	3.8
Past performance in quality of answers provided	5	2.7
Country of residence	4	2.2
State of residence or other subdivision within the country of residence, e.g., province in Canada	2	1.1
Attributes of the answerer (the individual expert to whom a question is triaged):		
Expected answer formulation: how the triager anticipates that the answerer will formulate an answer	33	17.8
Reference experience	23	12.4
Customer service expertise	10	5.4
Subject interest beyond subject expertise	4	2.2

NOTE.—Wh- words are the set of words in English that can be used to form a question: who, what, where, why, which, and how.

of the question, the service's subject expertise, and the answerer's subject expertise; most services were limited in the scope of subject areas on which they would answer questions and so dictated to triagers the subject areas in which the service would and would not accept questions. Questions outside the service's scope were triaged to other services, and questions within the service's scope were triaged to the appropriate subject expert (or to one of the appropriate subject experts, if there were more than one expert in a particular area).

Another factor that was dictated by many services was the quota of questions that would be accepted by a service or an answerer per unit time: many services had agreements with other services or individual experts to triage only a certain number of questions to them per day, week, or month. These numbers were in many cases subject to change from month to month based on changing schedules and agreements, and so they were not included in formal training documents but were communicated formally from the service to the triagers. An informal factor related to quota was

the number of questions on the same subject that was expected to be received by the service. This factor was not formalized by any service that participated in this study and yet was elicited from several triagers. These triagers stated that the amount of experience they had in performing triage for their service allowed them to predict with a fair degree of accuracy how many questions on a subject would be received by the service per day or per week. The upshot was that these triagers would not send all of the questions on a particular subject to the appropriate service or expert near the beginning of that service or expert's quota cycle (when the cycle was a week or a month); instead, the triager would hold some of the quota in reserve for the end of the cycle.

Some of these thirty-eight factors are related, some quite closely. For example, the scope of a service—whether it is a general or subject-specific service—is closely related to the service's subject expertise and the scope of its collection. A reference service's scope, however, is determined prior to either its collection or experience in answering questions. The scope of a reference service is dictated by its mission or the mission of the institution with which it is affiliated, and the service's mission dictates its collection development policies and the type of subject experts that will be employed.

Two other related factors are the subject of the question and the geographic location of the answerer. One respondent's comment about a question concerning the proposed Twenty-Eighth Amendment to the Constitution was: "because it's asking about United States government I won't send it to her [a librarian] in Australia—I know she could find it, but someone in the U.S. would have better resources."

That this question was about the U.S. government indicated to this respondent that the question should be triaged to an answerer within the United States. Another respondent stated that his service will, whenever possible, forward questions about particular states to libraries in those states because those libraries often have access to state-specific information or access to databases that libraries outside of the state do not have and, thus, are able to provide more complete answers about state-specific issues than any out-of-state library would be able to do. Therefore, the subject of a question may dictate to the triager the preferred geographic location of an answerer.

Some of these thirty-eight factors are "on the edge" of two categories, being attributes of two elements of the life cycle of a question in a digital reference service. The factor quota for the number of questions that can be accepted per unit time, for example, is an attribute both of the receiving service and of the answerer. Some services only accept a certain number of questions from other services; the AskERIC service, for example, maintains a list of services to which they may triage questions, and of the number

of questions those services will accept from AskERIC per day or per week.[4] On the other hand, some experts will only answer a certain number of questions; the VRD service and many of the services affiliated with academic libraries maintain lists of individual experts to whom questions may be triaged, and of the number of questions those experts will accept per day or per week.

The factor of the availability of appropriate information sources that can be consulted in answering the question, in turn, may be an attribute of either the receiving service or the answerer, depending on the type of service for which the answerer is employed. If the answerer is employed by a digital reference service affiliated with a physical library, then the available information sources will include those in the library's collection and, therefore, is an attribute of the service. Alternatively, if the answerer is employed by an AskA service—that is, unaffiliated with a physical library—then the available information sources will include those to which the answerer has access: their personal collection, the free Web, and perhaps some fee databases. Thus, this factor falls under two categories of attributes.

An unexpected finding was that language did not come up even once as a factor that affects triage. The attribute "language" was one of the fifteen identified by Pomerantz, Nicholson, and Lankes [2]. Yet, counterintuitively, it was not elicited even once from the think-aloud cases as affecting the triage process. I believe that this is a case of sampling bias and not, in fact, indicative of the importance of the language of a question in affecting the triage process. As mentioned above, respondents were solicited from libraries in nations in which English is spoken. As it turned out, of the 185 questions triaged during the think-aloud cases, 184 of them were written in English and were triaged by and to individuals who were fluent in English—so, naturally, the language of the question did not affect the triage process. The one hundred and eighty-fifth question, received by the reference service at a university library in the Netherlands, was written in Dutch and was triaged by and to individuals who were fluent in Dutch—though the triager was also fluent in English. So, again, the language of the question did not affect the triage process. Several questions were triaged by libraries in Canada, but all of these were written in English and triaged by and to individuals who were fluent in English. Again, the language of the question did not affect triage. It is, therefore, my contention that the solicitation of respondents from libraries in nations in which English is spoken biased the sampling so that language was canceled out as an attribute affecting triage. An interesting study could be conducted

4. The AskERIC service was discontinued December 19, 2003, because of a reorganization of the ERIC system by the U.S. Department of Education. At the time that this study was conducted, however, AskERIC was still operational.

to test this hypothesis by studying triage in digital reference services for which issues of language are within scope—such as the Ask a Linguist service (http://www.linguistlist.org/ask−ling) and the Slavic Reference Service (http://www.library.uiuc.edu/spx/srs.htm)—or in ones that are affiliated with libraries located in strongly bilingual regions such as the southwest United States or the Canadian province of Quebec.

Discussion

Generalizability

There are two limitations on the generalizability of this study. The first is that, as discussed above, the makeup of the population of digital reference services from which this study sampled is not known; therefore, it cannot be known how representative of this sample population of twenty-eight responding services is. The second limitation on the generalizability of this study is that the respondents, while randomly sampled for solicitation, were ultimately self-selected in that the triager (or the triager's supervisor) chose to participate or not to participate in this study. While it cannot be known whether the pool of respondents for this study is representative of the population of digital reference services, it equally cannot be claimed that the findings of this study are generalizable to that population. Thus, all that is claimed is that this study presents the factors that affect triage in a subset of digital reference services that existed in mid- to late 2002.

That said, however, none of the thirty-eight factors identified in this study appear to be specific to any of the twenty-eight participating services. Some of these factors are intrinsic to the question itself, and some are intrinsic to the answer, the patron, and the answerer—situating the question in a context (see table 1). Other factors are intrinsic to the triaging and the receiving services, but these factors are generic and may apply to any digital reference service—they are not specific to any subset of services or type of services.

Comparison of the Delphi and Think-Aloud Studies

Figure 2 presents the distribution of all factors, with the fifteen factors identified in Pomerantz, Nicholson, and Lankes's [2] Delphi study highlighted. Note that "question subject" is the first factor both in this study's and in Pomerantz, Nicholson, and Lankes's findings. This indicates that question subject is the single most important factor that influences triage decisions: not only was it mentioned the most frequently by triagers during the think-aloud cases, indicating that it is the factor most attended to in triagers' internal cognitive processes, but it was also identified retrospec-

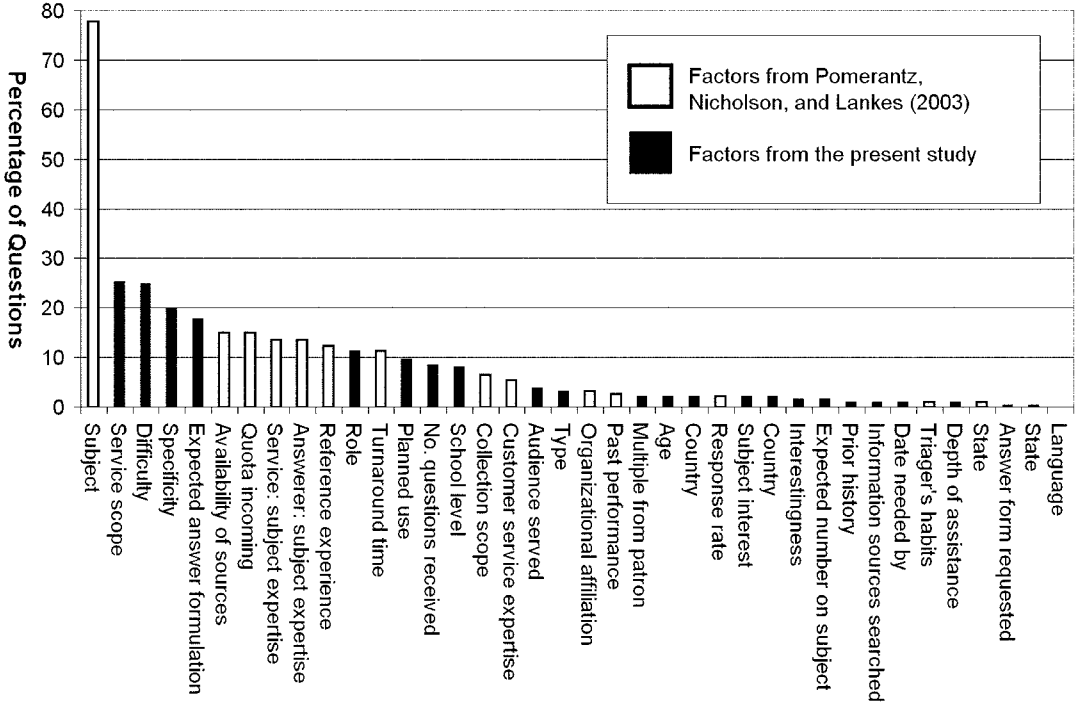

FIG. 2.—Distribution of all attributes that affect triage decisions, with the fifteen factors from Pomerantz, Nicholson, and Lankes [2] highlighted

tively by triagers in Pomerantz, Nicholson, and Lankes's study, indicating that triagers consciously recognize that it is a factor to which they attend.

It may be noted in figure 2 that, while question subject is the first factor in both studies' findings, the remaining fourteen of Pomerantz, Nicholson, and Lankes's [2] factors are scattered throughout the thirty-eight factors identified in the present study. Several of the fifteen factors are clustered near the top of the distribution, but the rest are distributed throughout. This indicates that the fifteen factors identified by Pomerantz, Nicholson, and Lankes are not necessarily the most important attributes that affect triage decisions but, rather, those of which triagers are consciously aware and able to verbalize retrospectively.

While Pomerantz, Nicholson, and Lankes [2] identified fifteen factors that triagers stated are the most important in influencing their triage decisions, they started out with a list of thirty-four factors. These thirty-four factors were compiled from the literature from both desk and digital reference concerning factors in making referrals. Pomerantz, Nicholson, and Lankes define "referral" as "the practice of a reference librarian redirecting a patron to another reference service or organization that the referring librarian believes can better address the patron's information need" [2, p. 107]. In addition to these original thirty-four factors from the literature, respondents suggested an additional eight factors during the course of Pomerantz, Nicholson, and Lankes's study. The fifteen most important factors were drawn from this set of forty-two.

The present study identified an additional fourteen factors, beyond the forty-two identified by Pomerantz, Nicholson, and Lankes [2]. These factors are as follows:

Attributes of the question:
- Generality or specificity of the question
- The fact that one patron submitted multiple questions
- Interestingness of the question, in the opinion of the triager
- The fact that the question has a prior history with the service: it is a follow-up question or has been forwarded to another service, and the other service forwarded it back

Attributes of the patron:
- Role, job description, or other capacity in which the question is being asked
- School level
- Age

Attributes of the triaging service:
- The number of questions on the same subject that is expected to be received by the service
- Habits that the triager has developed over time in triaging questions

Attributes of the receiving service:
  Response rate: how many of the questions that the service receives get answered
  Depth of assistance provided: what is provided as or with an answer: citations only, answers, bibliographic instruction, and so on
Attributes of the receiving service or the answerer:
  Quota for number of questions that can be accepted per unit time
Attributes of the answerer (the individual expert to whom a question is triaged):
  Expected answer formulation: how the triager anticipates that the answerer will formulate an answer
  Subject interest beyond subject expertise

Thus, between these two studies, a total of fifty-six factors have been identified that, to a greater or lesser extent, affect triage decisions. Some of these factors are highly important and affect triage decisions for many or most questions; for example, the question subject factor. Some of these factors are less important, and some were even idiosyncratic to individual triagers. The "habits that the triager has developed over time in triaging questions" factor, for example, is a catchall category for those personal habits in performing triage that the triager had developed over time and could not fully articulate.

Automating the Triage Process

Pomerantz and colleagues [5] state that there is a desire in the digital reference community for software applications designed to enable Web-based digital reference. This is borne out by the sheer number of software applications that exist to manage processes in handling digital reference questions. These include Virtual Reference Toolkit (http://www.tutor.com), 24/7 Reference (http://www.247ref.org), LivePeople (http://www.phplivesupport.com), the VRD's QABuilder (http://www.vrd.org/Incubator.shtml), and QRC, originally developed for the IPL [13] and now integrated into 24/7 Reference [34]. QuestionPoint was discussed above, as it is the one software application for Web-based digital reference that currently utilizes an automated triage process; this process, however, is based on only a few factors [14].

Perhaps the most important findings of the present study and of Pomerantz, Nicholson, and Lankes's [2] study is the set of triage factors, and the rankings of the importance of these factors. Identification of this set of triage factors and their ranking has implications for the development of applications for Web-based digital reference: the most important factors must be supported by these applications, while the least important factors may be dropped from software specifications when compromises need to be made.

In order to determine what the most and least important factors are for individual services, however, individual services must be studied in more depth than was done by this study. There are two components of the triage process that would have to be analyzed for each individual service: the set of answerers and other services to which questions are triaged, and the factors that affect those triage decisions.

Different digital reference services triage questions to different sets of recipients. The VRD service, for example, triages questions to its network of fifteen participating AskA services as well as to volunteer reference and subject experts, so the "triagee" may be a service or a specific individual. The AskERIC service, for another example, triaged questions to sixteen subject-specific clearinghouses, several adjunct clearinghouses and support components, and specific individuals employed by "AskERIC central" (the Clearinghouse on Information and Technology), where the triage process is performed, as well as occasionally to other AskA services. Many academic and public libraries triage questions predominantly to the library's employees, many of whom have subject specializations, and rarely to other services or other libraries. Thus, any rules for triage action and any algorithms based on these rules are not likely to be universal but, rather, are likely to be idiosyncratic to individual services. It would, therefore, be useful to conduct another study, similar to this one but in one service only, longitudinally over a span of weeks or months. The present study identified factors that influence triage in a cross-section of all types of digital reference services and did not address the issue of the recipient of the triaged question. From a study of the triage process in one single digital reference service it would be possible to identify factors that influence triage in that one service and to identify a set of service-specific triage recipients.

The second component of the triage process that would have to be analyzed for an individual service is the idiosyncratic set of factors that affect triage decisions in that specific service. Some of the factors identified in this study were common to many services, while some were unique to individual services or even individual triagers. The triage decision-making process is therefore slightly different from one digital reference service to the next, and even from one triager to the next. As discussed above, some of the factors identified in this study were dictated to the triagers by the service, and some were unique to the triager. Each service, therefore, has its own "standards" for triage, which are interpreted by each triager individually. No single algorithm for automating the triage process could therefore be utilized universally in all digital reference services; such an algorithm would have to be customized for individual services, and the most important factors for each service must be supported, while the least important factors may be dropped from software specifications for these customized applications.

It must be stated at this point that I do not believe that the triage process will be fully automated any time in the foreseeable future. Rather than "automated triage," I suggest the term "machine-assisted triage," echoing more familiar "machine-assisted" tasks in librarianship such as indexing, classification, and others. It is reasonable to assume that some processes in digital reference may be entirely automated in the near future—indeed, question submission is nearly there even now (except for the fact that it requires a human user to submit a question)—with the use of Web forms for question submission, auto-reply functionality, and storage of questions in databases. It is easily foreseeable that the tracking process may be automated through the use of "bibliomining" techniques [35]. It seems less likely, however, that the triage and answer formulation processes will be fully automated any time soon, as these processes require a great deal of human judgment. The goal that I advocate for machine-assisted triage is the development of an "auto-suggest" system that would automatically make triage suggestions for questions received by digital reference services. Such a system could suggest triage recipients based on patterns of behavior by human triagers—for example, if a specific type of question is routinely triaged to a specific answerer, then an automated system should replicate that behavior. To this end, the most useful scheme or schemes according to which to classify questions for this purpose is an important area for future work. The suggestions made by such an auto-suggest system could then be vetted by a human reference librarian and either approved or changed. While this would not entirely free human intermediaries from the task of performing triage, it may reduce the task considerably, thus allowing more of the human intermediaries' time and effort to be dedicated to tasks that cannot yet be even partially automated.

Conclusion

While ALA [19] and the National Center for Education Statistics (http://www.nces.ed.gov/surveys/libraries) both offer values for the number of libraries in the United States, a proper census of digital reference services has never been conducted. It is time for such a census to be conducted, both within the United States and globally; without this, it will remain impossible, as it was for this study, to determine whether any given sample of digital reference services is representative of the total population of digital reference services. At that time, studies similar to this one could be conducted on specific subsets of the population of digital reference services—academic libraries, AskA services, high tech–high touch services, and so on—to determine what factors affect triage in these specific types of services. Patterns between types of services and factors that affect triage

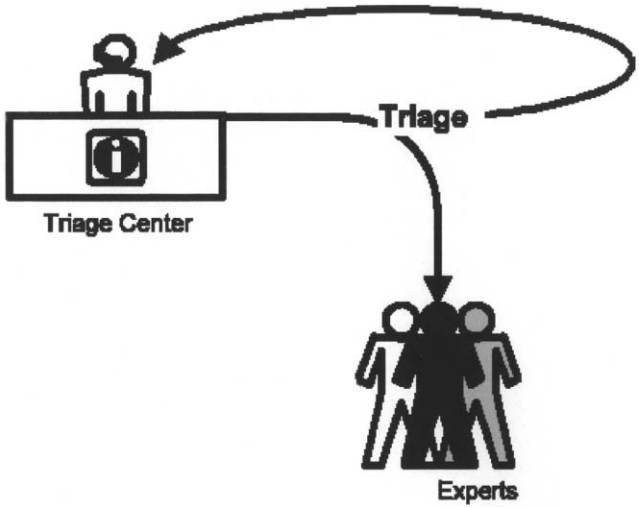

FIG. 3.—Proposed modification to the general digital reference model

in those types of services will enable customization of Web-based digital reference applications for services' specific needs and uses.

Within the past few years, a few models of digital reference have been proposed and studied [3, 5, 36, 37]. The current drawback of these models is that they offer a view from a very high altitude, as it were, encompassing a broad domain in little detail. Pomerantz, Nicholson, and Lankes [2] began the task of delving into one specific process described in these models, the triage process. The present study has further decomposed the triage process, validating the fifteen factors identified by Pomerantz, Nicholson, and Lankes and identifying an additional set of factors that influence triage decisions.

Based on the findings of this study, as well as those of Pomerantz, Nicholson, and Lankes's [2] Delphi study, a simple modification to the general process model of asynchronous digital reference presented in figure 1 is suggested. An arrow representing the triage process currently exists in figure 1, leading from the triage center to the experts. The proposed modification would have the arrow representing the triage process split, as shown in figure 3. One end of this split arrow leads to the experts, and the other end leads back to the triage center. The purpose behind this proposed modification to the general process model is to represent that triage occurs both within a service (from the triage center to the expert) and between services (from one triage center to another).

This goal of the research agenda, of which this study is a part, is to enable the design of algorithms to automate the triage process in digital

reference services. The decomposition of the triage process into the factors that affect that process was the first step toward making this possible. The next step must be to identify the rules according to which different digital reference services or types of services determine which factors are relevant, and how this weighting of factors influences the decision of which is the appropriate triage recipient. When these rules can be identified, then algorithms to automate the triage process may be designed and even customized to individual services' specific requirements.

This study is, therefore, merely a first step toward the automation of the triage process. The conclusion of this study is not a system for automating triage or even a design for algorithms. Rather, this study had more modest goals: to determine what factors triagers take into consideration during their performance of triage so that when algorithms are eventually designed, those factors that have been identified as important by human triagers may be utilized by automated triage systems.

This article described a think-aloud study conducted to identify factors that influence the decisions made by digital reference triagers when performing triage. This study follows and expands on a Delphi study, conducted by Pomerantz, Nicholson, and Lankes [2], that identified factors that triagers agreed on after the fact of their performance of triage, by identifying factors that triagers take into consideration during their performance of triage. Thirty-eight factors that influence triage decisions were identified within eight categories. Eight of these factors are intrinsic to the question itself; the remaining thirty factors are extrinsic to the question, situating it in a context for the user and the service. These factors must be taken into consideration by any future algorithm for automated—or machine-assisted—triage. Future work is required to determine weightings of factors specific to individual services so that algorithms for machine-assisted triage may be customized to individual services' specific requirements.

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