A Tale of Two Interfaces: How Facets Affect the Library Catalog Search Experience

Sarah Ramdeen and Bradley M. Hemminger
School of Information and Library Science, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-3360. E-mail: ramdeen@email.unc.edu, bmh@ils.unc.edu

In the summer of 2008 all University of North Carolina libraries switched from a traditional library catalog interface supporting text-based searching (TextOnly) to a text and facet-based interface (TextFacet) to improve users' search experiences. This study seeks to understand the differences between these two interfaces and how they affect the search experience of the novice user. In this study, 40 participants were asked to search for resources using both interfaces. Their search times and accuracy were measured across three types of search tasks (*known, partially known*, and *exploratory*). After completing the searches, they were asked a series of questions about their experiences. The data were analyzed in order to identify strengths and weaknesses in both search interfaces. Thirty-six out of 40 participants preferred the TextFacet interface to the TextOnly interface. Using three dependent variables—time, accuracy, and rating—the two interfaces were compared and interactions were tested with the three task types. Search times for the TextFacet were shorter and participants preferred the TextFacet search interface over the TextOnly search interface. Performances across the three task types were different in terms of search time. The *partially known* and *exploratory* task types showed similar distributions for rating and accuracy. These distributions were distinctly different from the *known* task type. The results of this study may assist libraries in developing improved library catalog search interfaces that utilize facets as well as text searching.

Introduction

Library catalogs are designed to allow the general user, whether novice or experienced, access to the library collection without having to first undergo training or ask for assistance from a librarian. Providing online access to library collections and resources gives patrons the ability to search or browse the collection at their own pace and convenience no matter what the motivation behind a search. Patrons are expected to be able to easily navigate the catalog and successfully determine if the library provides access to the material they are seeking. However, traditional library catalogs are not always easy to search, in part because the search interface and user interactions are not intuitive for searchers. While users who have training with a library catalog perform better than those without, Borgman found that "poor searching occurs at all levels of training and experience" (Borgman, 1986a, p. 394).

Novice users are defined as users with limited experience using online catalogs. Their results are limited by what they put in to the search box, their knowledge of how to use the options of the basic and advanced search boxes, and of how to modify their search when they do not obtain the expected results. While experience was found to be the "best predictor of self-expressed search success and satisfaction," Borgman states that "we also know that users are disinclined to seek training or even to read available documentation" (Borgman, 1986a, pp. 364 & 396). In order to address some of these issues, a number of libraries have been changing their online catalogs from a traditional text-based library catalog interface to search interfaces that incorporate facet-based search features into the traditional interface (Antelman, Lynema, & Pace, 2006).

A traditional interface allows users to search for materials in a collection by entering a combination of terms into a user interface. Once results are presented on the screen, users may only make major modifications by restarting or adapting the initial search query. An interface that incorporates facets allows users to conduct searches in a manner similar to a text interface; however, once presented with the results of a search, users may dynamically narrow or expand the result set by adding or removing facets. Facets are provided to users via the search interface and are generated from metadata relating the facets to the resulting records. In this paper, traditional text-based interfaces will be referred to as TextOnly and search interfaces that support dynamically modifying the search results through facet selections in combination with text searches will be referred to as TextFacet. The differences

Received August 3, 2011; revised September 23, 2011; accepted September 23, 2011

 DOI: 10.1002/asi.21689

between the two interfaces will be further described in the Background section, below.

Endeca[1] (Cambridge, MA) is a TextFacet-based commercial platform for search applications. It has been used by companies such as Borders[2] and Home Depot[3] to help customers search online through their inventory and narrow the search results list through a series of facets or qualifiers such as price range and category. Within the past 4 years TextFacet-based catalog interfaces have been implemented by all four libraries in the Triangle Research Library Network (TRLN, which consists of Duke, North Carolina Central University (NCCU), North Carolina State University (NCSU), and University of North Carolina at Chapel Hill (UNC) as well as many other academic and public libraries. This raises the question, is this new search interface effective in improving the searching experience of the typical library patron?

The research questions addressed in this study include:

1. Is there a difference in the time it takes a user to find a resource between the TextOnly and the TextFacet search interface?
2. Is there a difference in accuracy of search results between the two interfaces?
3. Is there a difference in search time depending on the type of search task?
4. Do users have an overall preference between the two search interfaces?
5. How do users feel about the use of facets in guiding their searches?

Background

In her 1986 article, *Why are Online Catalogs Hard to Use? Lessons Learned from Information-Retrieval Studies*, Borgman states that there are two types of knowledge needed to successfully use an online library catalog: knowledge of the mechanical aspects of searching, and knowledge of the conceptual aspects of searching (Borgman, 1986a). Knowledge of the mechanical aspects can be summarized as user knowledge of proper syntax and how to organize a search (Borgman, 1986a). Knowledge of the conceptual includes the tools and processes which are a part of the catalog that help a user refine the results (Borgman, 1986a). With traditional TextOnly catalog interfaces, experience and frequent use are required for novice users to become more successful in their search results (Borgman, 1986a). An important question is whether users will naturally and easily understand faceted search interfaces, and whether they will benefit from the inclusion of facets capabilities to their searches.

In order to fully test the boundaries of Borgman's second type of searching knowledge, the conceptual aspects of searching, one needs to incorporate different types of search tasks. *Exploratory* searches are searches that give little direction and rely on the patron to make decisions about the usefulness of results. This is in contrast to *known* searches, where the user has all of the information needed to find an item and requires identification only. Kules and Capra (2008) suggest that *exploratory* searches should address seven key qualities. This list includes elements such as subject matter that the searcher is unfamiliar with, a request the searcher can identify with, ensuring that the task is clear on which information is required and providing limited information about how to conduct the search or how to recognize a correct result (Kules & Capra, 2008, p. 1). The exploratory and partially known task types used in this study were designed to adhere to these guidelines.

Online catalogs are also difficult to use because they are not designed to help answer a question or to mimic user information-seeking behavior (Borgman, p. 493, 1996). According to Borgman, there is still a "gap between the way a question is asked and ways it might be answered" (Borgman, 1996, p. 496). TextFacet library catalog interfaces not only change the way searches are conducted, but also how they are refined. Because the user can more easily narrow (and broaden) their search via dynamic facet selection, they can more easily arrive at the desired results from a less well-specified initial text query. Thus, it may be possible that the changes introduced by TextFacet interfaces will help close the gap between the mental model users have of their search process and the interaction they have with the search interface to their library catalog.

La Barre (2007) provides an in-depth history of faceted classification in library catalogs through 1970. In 1991 Larson described many of the limitations of online catalogs (users not having mental models matching underlying structure of catalog and search interfaces, lack of expertise at Boolean searching) and recommended improved search interfaces supporting easier access to faceted metadata, support for clustering, and relevance ranked results lists, things that have recently become available. Novotny's "I don't think I click" 2004 article highlighted what has become accepted now—that users have been influenced by web search engines, and do not plan out elaborate search processes, but prefer to simply enter a few initial search terms, see an initial result set, and filter their search results through simple interactions.

One of the earliest interactive faceted search interfaces was the "a.k.a." interface implemented by the Getty Information Institute for their Art & Architecture Thesaurus (Bates, 2002). This early implementation was not successful, in part because the interface did not support selecting multiple facets in the same query (Bates, 2002). More recently, Hearst has extensively investigated using faceted metadata as the basis for dynamic search interfaces, supporting drilling down into results sets (English et al., 2002; Yee et al., 2003; Hearst, 2006). Most of their work examined interfaces for image libraries, but has application to library catalog interfaces. In their work they generally found that participants found it easier to refine and expand their searches using the various features provided by the faceted-based search tools. In Salaba and Zhang's 2009 study, 98 participants reviewed next-generation search features, and faceted navigation was ranked as the most desirable of the features (also including

[1] http://www.endeca.com/en/home.html
[2] http://www.borders.com/online/store/Home
[3] http://www.homedepot.com/

DOI: 10.1002/asi

user contributed content, sorting of results, and word clouds). These successes, as well as the success in applying faceted search to online commercial sites, has led to exploring the application of dynamic faceted search interfaces to library catalogs in products like Endeca, Aquabrowser,[4] WorldCat,[5] and Primo[6] (Sadeh, 2007).

There have been a number of recent studies looking directly at how searchers are using dynamic faceted search interfaces in library catalogs. These studies focus on transaction logs and other quantitative data. One previous user study was conducted at NCSU and compared an Endeca TextFacet-based library catalog interface to a traditional TextOnly interface (Antelman et al., 2006). Antelman et al. (2006) conducted transaction log analysis of their TextFacet library catalog interface and found that 30% of users were "selecting post-search refinements from the dimensions on the results page" (Antelman et al., p. 133).

Lown (2008, 2009) collected and analyzed 130,482 transaction logs from user searches of the NCSU Endeca TextFacet library catalog interface and reviewed them for search patterns. This exploratory study found that "34% (44,278) include at least one facet search" and that subject-topic and LCC subject headings were the most frequently used facet groups (Lown, 2008, p. 38). Niu and Hemminger reported similar results, finding 29% of sessions involved a faceted search in the UNC academic library catalog (Niu et al., 2009; Niu & Hemminger, 2010a), and 46% of sessions involved a faceted search operation in the Phoenix public library catalog (Niu & Hemminger, 2010b,c). The higher percentage of facet operations in the Phoenix catalog was likely due to specific one click facet-based searches available on the home page (recent titles, most popular, etc.).

An important aspect of faceted search is how it affects the user's mental model of the search process, and provides a framework for exploration and affordances for drilling down to find results. Mental models can affect search behavior, as found by Zhang (2008) in a study of undergraduates mental models for searching on the web. In addition to the filtering capability provided by a dynamic faceted interface, the simple display of faceted results may improve searching. In a user study, Kules, Capra, Banta, and Sierra (2009) found that participants used facets to organize their view of the topic in search results and suggested that facets were almost as important if not possibly more important than the search results. Using eye tracking they found that participants spent 25 seconds looking at facets and 50 seconds looking at results. They hypothesize that users may benefit from looking at the organizational information provided by the facets, even when they are not selected.

While facets have clearly improved dynamic searching in several environments such as online stores, their utility in library catalogs has not been as clear. In particular, this may be because the primary metadata assumed to help searchers, Library of Congress Subject Headings (LCSH), have several disadvantages when used for faceted searching (McGrath, 2007). While there has been work done aimed at improving this, primarily in adapting LCSH for a facet-based search (Dean, 2003; McGrath, 2007), the lack of coordination between LCSH and users' expectations for being able to logically narrow their search results with facets remains an issue. McGrath, Kules, and Fitzpatrick (2011) and others continue work on this, believing a faceted display will benefit libraries and their patrons; they are currently evaluating using a modification of Functional Requirements for Bibliographic Records integrated with facets to pose these questions to the searcher and allow them to search without having prior knowledge of the collection.

Methods

This study examines user performance and preference differences between a TextOnly and a TextFacet interface to the same library catalog using three common task types. Previous studies have used transaction logs to determine user search process and success. This study will expand on this knowledge by conducting direct user observations along with interviews of users. Direct observation allows for users' searches to be guided by defined task types and for more accurately determining search time and success along with user satisfaction with the search.

Search Interfaces

UNC recently switched to a TextFacet library catalog interface but also kept their original TextOnly interface available to patrons. This allowed for a comparison of the two interfaces while still accessing the same library catalog database. UNC's new TextFacet search interface is built using Endeca and is branded on the website as the "Beta" interface (Figure 2). The previous interface is TextOnly and was branded as "Classic"[7] (Figure 1).

While the two interfaces use the exact same underlying data records, the two interfaces have distinct differences in their appearance and how people interact with them. The TextOnly search interface supports both a basic and advanced search interface. Once a user has entered information, they are led to a results page. This page lists the library records that meet the user's search criterion. The user can select a record to view a more detailed description of the item (Figure 1). The record contains all of the information available about the item and the user's search terms are highlighted in red where they appear in the record. The subject headings (LCSH) contained in the record are listed for the item. Users can follow links for the listed subject headings to expand or modify their search. By selecting a subject heading, search criteria revert to perform a new search for all holdings that

[4]http://www.serialssolutions.com/discovery/aquabrowser/
[5]http://www.worldcat.org/
[6]http://www.exlibrisgroup.com/category/PrimoOverview

[7]As it was incorporated into the interface designs, it was not possible to exclude these titles. While noted by a small number of participants, it is not believed to have influenced their search behavior.

DOI: 10.1002/asi

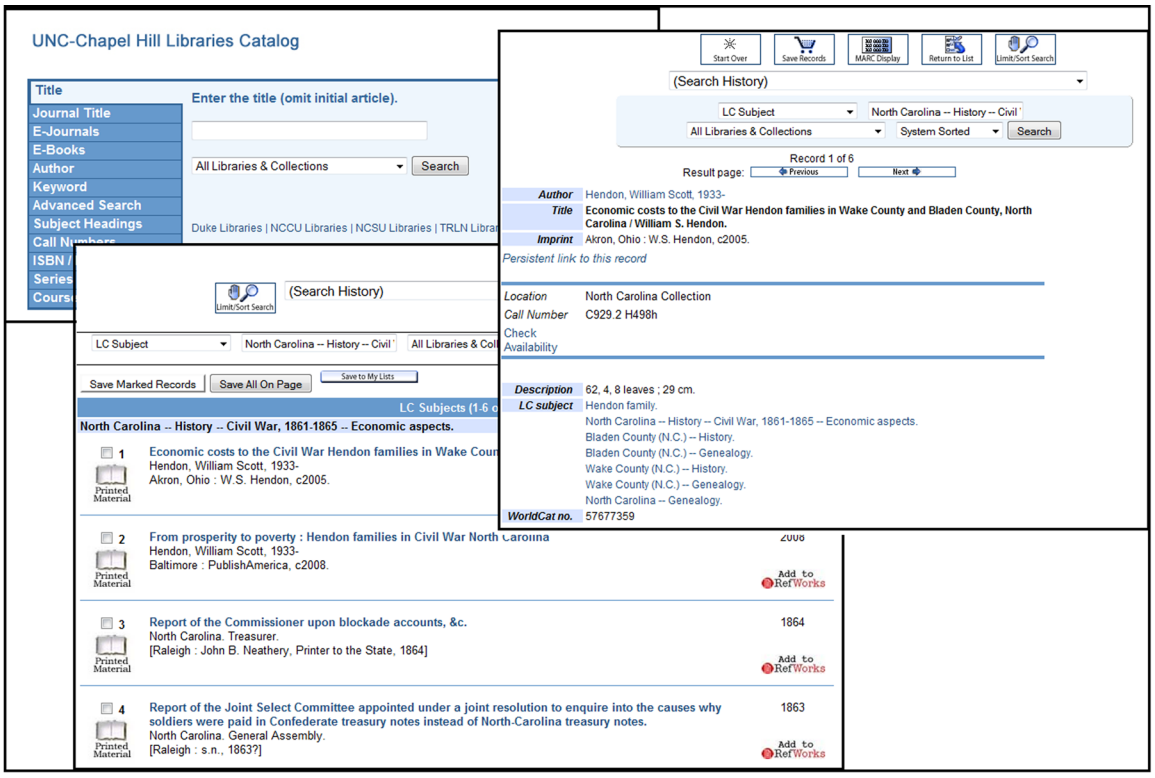

FIG. 1. UNC Classic Catalog (http://www.lib.unc.edu/webcat/). Top left is the basic search interface. The center image shows the results page. Top right is a sample record. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

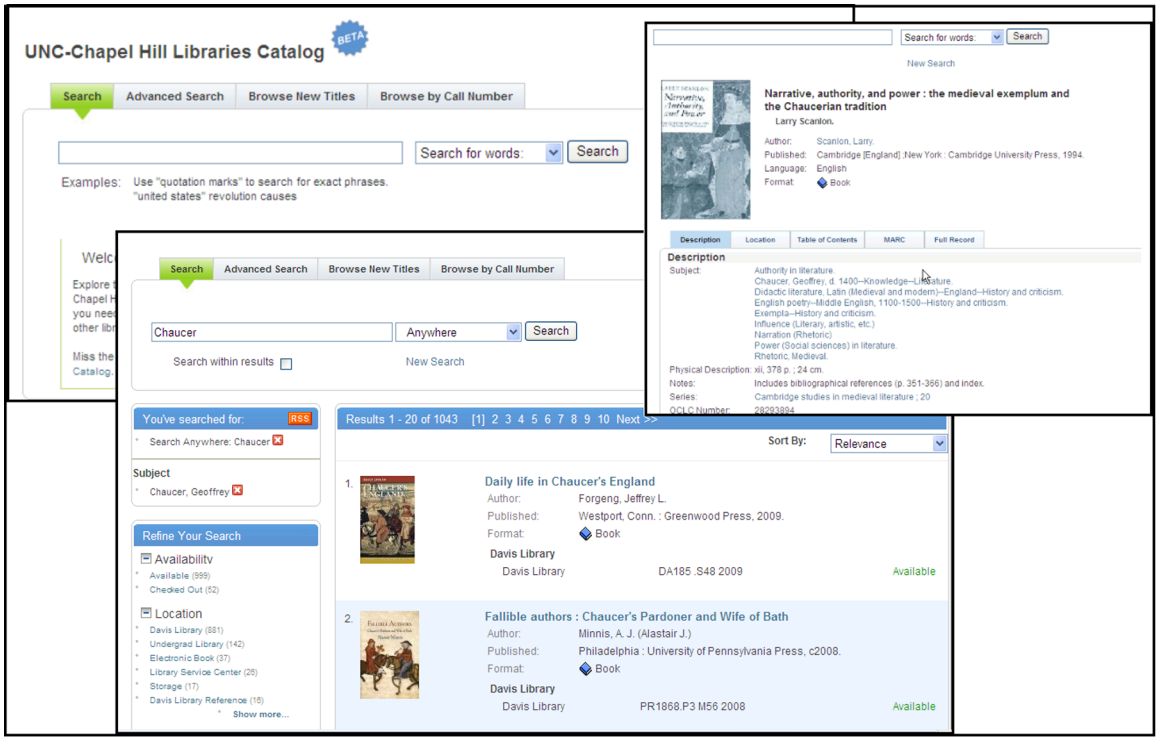

FIG. 2. UNC TextFacet Catalog (http://search.lib.unc.edu/). The top left is the basic search interface. The center image is the results page with facets along the left. Top right is a sample record. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

DOI: 10.1002/asi

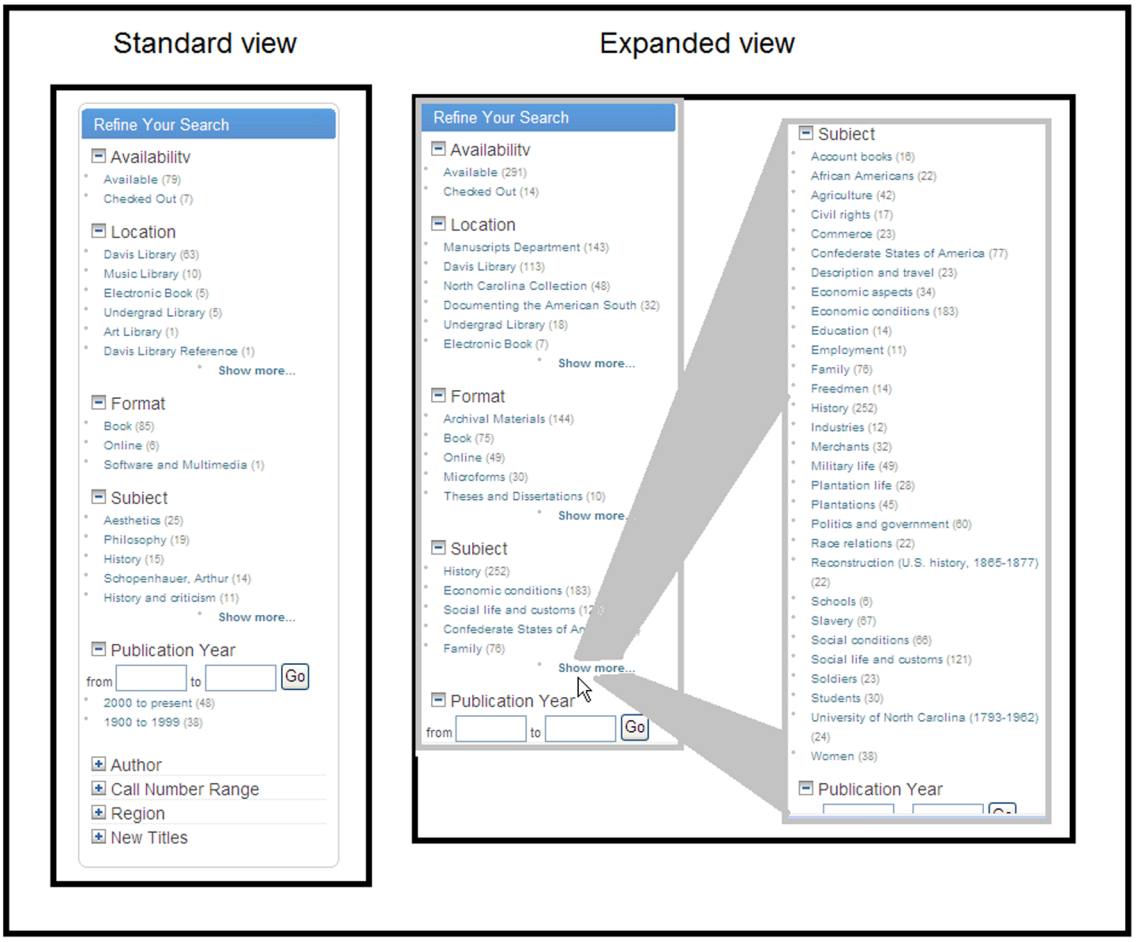

FIG. 3. Example showing initial facet selection presentation, and expanded view showing what will be displayed when the user selects "show more" for subject facets. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

have the same subject heading within the collection. This search interface has a limited number of options to narrow down a set of search results, and often users will encounter an intermediate page to refine their search before reaching the results page.

The TextFacet interface also starts with a standard search term page and offers users the option to perform a basic or advanced search. After entering their term(s) users are led to a results page. The results page is divided into a main section on the right, which lists the library records that meet the user's qualifications, and a smaller column along the left-hand side, which displays a series of nine different facet categories with which the user can refine their search. These nine commonly used facet categories initially start as either "open" or "closed." If closed they do not show any facet values until they are "opened." If open, they initially show the top five facet values (ones that that match the most content items), and can be expanded to show the top 30 (Figure 3, left column). On the results page, a user can add or remove any combination of facets by dynamically selecting or deselecting them one at a time, to revise the search results displayed. The search interface will only display facets that represent information about the user's current search results. This ability for dynamic modification and feedback of search results is a critical difference between the TextFacet and TextOnly interfaces. From either interface users can select a record and view all of the available information about the item. When navigating to a specific item, if the user selects a subject heading from the item's results page, this produces a new search result based on their original text search along with the new subject heading as a facet. All previously selected facets are removed. Information about a content item is divided into categories that can be selected using tabs at the top of the content item record information display (Figure 2). The Endeca TextFacet search interface record level view offers additional resources such as book covers and a table of contents not available in the original TextOnly interface. Users can also follow the subject heading links from the record to expand their search. Similar to the TextOnly interface, any link followed will reset the search criteria and only display records with the selected subject heading.

The major difference between the TextOnly and the TextFacet interfaces are these faceted categories. Both interfaces support narrowing a set of search results by adding additional text search terms, and broadening the results list by removing terms. In the TextOnly search interface, this

DOI: 10.1002/asi

TABLE 1. Task types found in the literature.

Task type	Definitions	Attribution
Simple	*"common conditions, required few answers, and were relatively well-defined"*	Sharit, Hernandez, Czaja, & Pirolli, p. 13, 2008
	"required only the use of one or two commands and followed explicitly from a single-step example of system operation"	Borgman, p.53, 1986b
Complex	*"generally dealt with uncommon conditions, required many answers, and were more ill-defined"*	Sharit, Hernandez, Czaja, & Pirolli, p.13, 2008
	"one that required the user to extrapolate from the examples given and to apply some problem-solving skills"	Borgman, p.53, 1986b
Known	*"find a piece of information known to exist. The search scope is so narrowly focused and specific that every searcher should have the same criteria in evaluating the relevance of the retrieved information"*	Kim, p.238, 2001
	"simply looking up information"	Qu & Furnas, p. 535, 2008
Exploratory	*"retrieve information that is related to the given subject or topic regarded as useful to the searcher"*	Kim, p. 239, 2001
	"the searcher lacks knowledge about the topic of interest", "she needs to explore more broadly through a complex process consisting of multiple searches and other information activities"	Qu & Furnas, p.535, 2008
Open	*"There is no one exact answer and searchers must develop acceptable responses. There may be many relevant sources, and searchers may have to study them and perhaps combine information"*	White & Iivone, p.723, 2001
	"ill-structured problems, where the information required for accomplishment cannot be determined in advance"	Bilal, p.1171, 2002
Closed	"exact answers are wanted", "Searchers have little discretion in judging correct answers or choosing alternatives"	White & Iivone, p.723, 2001
	"simple, well defined, and have structured problems. They can be routine information processing tasks with elements that are predetermined (the user knows them)"	Bilal, p.1171, 2002

requires the users to switch to an advanced search or to start their search over again, in contrast to TextFacet, which allows changes from the results page.

Sometimes there are more facet categories to display than there is available screen space. In this case the interface displays "Show more" at the end of the currently displayed set. By clicking on this the user can open up and see all available facet category options (Figure 3).

Task Types

Library catalogs can be used for a wide variety of search tasks. Commonly used terms for search tasks include *simple, complex, known, exploratory, open* and *closed*. Search tasks are multidimensional and the literature has not yet formed a standard set of tasks that ensure all skill areas of searching are engaged. However, work is being done to try to identify and classify search task types used in the literature ("Systematic Review of Imposed Search Tasks"[8]). Table 1 contains definitions of the major task types and lists relevant literature that examined search tasks defined in these ways.

Study Design

The study was a within-subjects design where participants performed similar search tasks using both interfaces. There were two independent variables: search interface and task type. Search interface refers to the type of library catalog interface and has two classes: TextOnly and TextFacet. The three task types selected for this study were (1) *known*, (2) *partially known*, and (3) *exploratory*. Table 3 describes these tasks and maps the selected tasks to the common task types cited in the literature. The *partially known* task types are considered blended searches for the *simple/complex* and *known/exploratory* categories. There are three dependent variables: time, accuracy, and rating. Time is the length of time in seconds it took the participant to complete their search. Accuracy was determined by grading participant responses on a four-point scale of 0–3 (0, completely incorrect; 1, partially correct; 2, mostly correct; and 3, completely correct). A grading rubric was developed for each of the task types. Search results were graded by two independent judges; the interrater agreement between the two judges was excellent (kappa of 0.95).[9] In cases of disagreement the judges discussed and determined a best grading. Participant rating of the interfaces was generated by the participant after each question. The participant was asked to evaluate the effectiveness of the interface on a five-point Likert scale of 1–5, with 1 being "not very useful for finding results," and 5 being "extremely useful in finding results." Additionally, observations were made by the investigator of the participants' search methods and participants' actions were recorded using screen capture and audio capture for postanalysis. The study was conducted during the 2008–2009 academic year.

[8]http://ils.unc.edu/searchtasks/

[9]Calculated using an online Kappa calculator, http://justusrandolph.net/kappa/

TABLE 2. Task types and common terminology for search tasks.

	Task type	Description	Example	Task types from the literature
1	Known	A complete description of the item is given. There is only one item that fits the criteria given.	A friend was recently talking about a book she read about language and you'd like to read it for yourself. Find out whether the library has a copy of Steven Pinker's "The Stuff of Thought."	Simple Closed Known
2	Partially Known	A partially complete description of an item is given. There is only one item that fits the criteria given.	This summer you are taking a trip to Europe and to get ready for your trip you want to read some travel books. You have read other books by travel author Bill Bryson and you think he wrote one about Europe. See if the library has it in their collection.	Simple Complex Closed Known Unknown
3	Exploratory	A search topic is given along with suggested search terms. There can be many items that fit the criteria.	You need to write a paper about the philosopher Arthur Schopenhauer. Find 3 resources relating Schopenhauer to aesthetics you would use to begin your research. Be sure the resources you find are in English.	Complex Open Exploratory

Participants were 40 freshman undergraduate students at UNC. Freshmen were used as subjects because they have limited experience conducting searches using the university library catalog (with either interface). Students were recruited by use of a mass email message sent to all UNC students with freshman status who opt in to receive mass emails. They were also recruited with fliers placed outside of freshman level English classes and by word of mouth. This study was approved by the UNC Institutional Review Board.

After the participants completed the search tasks, they were interviewed and asked specific questions to elicit information about their search experience and their search results using each interface. Questions included (1) examining the participant's opinion of each interface; (2) identifying problems encountered while searching; (3) selecting which features they liked or disliked; and (4) evaluating the strength and weaknesses of the answers they found during their searches. This two-part design supported quantitative analysis of the differences between the two search interfaces and also allowed for the collection of qualitative data about the user experience and opinions on use of the two search interfaces. This provided further insight into how the participants perceived differences between the two search interfaces.

Protocol

Participants performed three searches for each of the three task types for both interfaces, for a total of 18 searches (Table 3). Prior to each interface they conducted four training searches (one general practice, plus one practice with each of the three task types). Participants were trained and tested on one interface before training and testing with the second interface. Each participant saw the same number of search questions from each task type (9 of the 18 questions on TextOnly and the other 9 questions on TextFacet). The order of question presentation was counterbalanced across participants. This was done by creating test sets with blocks of three randomly assigned test questions, with each block containing one test question from each task type. Additionally, the order of presentation of the interface was counterbalanced across observers, half beginning with TextOnly and half with TextFacet. Prior to running the study, the test instrument (all questions) was tested and refined with seven pilot subjects on both interfaces. During the study, subjects were given as much time as needed to answer each question and all questions had answers within the library catalog that could be found using either interface. Timing began when they were shown the query, and ended when they selected their answer. Their timed work included formulating, specifying, and modifying their query terms and reviewing result sets.

TABLE 3. Study question distribution.

	Task type		
Search interface	Known	Partially known	Exploratory
TextFacet	3	3	3
TextOnly	3	3	3

The study included a total of 40 observers, with each observer reviewing 18 cases for a total of 720 searches for the entire study. In sum, 360 cases per interface, 240 cases per task type.

The study questions were designed to be similar to questions a student might normally encounter, either as a casual search for library items based on a recommendation from a friend, for one's own interest, or a search for resources needed for a class assignment. Questions were separately developed and piloted for each search task type. Examples and descriptions of these task types are shown in Table 2. A complete list of the questions is included in the Appendix.

Results

Table 4 contains the mean data for the three dependent variables (time, accuracy, and rating) and is subdivided into groups based on the two independent variables, search interface and task type. Distinct differences can be seen between

DOI: 10.1002/asi

TABLE 4. Means (with standard deviation) for the three dependent variables.

		Mean (SD)			
		Task type			
	Search interface	Known	Partially known	Exploratory	Overall
Time	TextFacet	38.5 (30.6)	96.7 (87.1)	136.2 (83.7)	90.5 (82.2)
(In seconds)	TextOnly	49.3 (29.8)	103.9 (90.0)	163.6 (115.0)	105.6 (97.7)
Accuracy	TextFacet	2.98 (0.13)	2.54 (0.88)	2.78 (0.46)	2.77 (0.60)
(Scale of 0-3)	TextOnly	2.97 (0.18)	2.73 (0.73)	2.60 (0.61)	2.76 (0.58)
Rating	TextFacet	4.88 (0.37)	4.14 (1.01)	4.28 (0.71)	4.44 (0.81)
(Scale of 1-5)	TextOnly	4.33 (0.94)	3.79 (1.01)	3.82 (1.03)	3.98 (1.02)

the TextOnly and TextFacet search interfaces as well as between the three task types. In order to understand these differences, each of the three dependent variables (time, accuracy, and rating) was examined for differences when comparing both search interface and task type. Regression analysis was used to examine differences between the two search interfaces. Analysis of variance (ANOVA) and Tukey's HSD (honestly significant difference, post-hoc test) (Howell, 2002) were used to examine differences between the three task types. All statistical analyses were performed using the statistical packages SAS (v. 9.2, Cary, NC) and R (v. 2.12.0).

Search Interface Comparison

Search time. A major research question in this study was to examine whether searches could be performed more efficiently (quickly) using an interface that supported dynamic faceted searching compared with one that did not.

Looking at the means in Table 4, searches performed with the TextFacet interface took less time than those performed with the TextOnly interface. Using a general linear model (GLM) in SAS, regression analysis of these times showed a significant difference in the time it took to perform all tasks for these two search interfaces, ($DF = 1, F = 6.58, p = 0.011$). As seen in Table 4, the overall mean time for TextFacet was 90.5 seconds and the mean time for TextOnly was 105.6 seconds.

Search accuracy. Since subjects were given as much time as needed to answer each question, differences were expected in search times (as seen above), but not in correctness of answers. Participants were expected to get mostly correct answers to all questions, independent of interface.

Differences in search answer accuracy due to the search interface were examined using a regression analysis (GLM). As expected, participants' accuracy did not differ between the two search interfaces. There was no significant difference ($DF = 1$, $F = 0.03$, $p = 0.8693$). As seen in Table 4, overall accuracy of responses for the two interfaces differed by only 0.01.

Search ratings. After finishing each search question, participants were asked to rate the effectiveness of the search interface used in answering that particular question. This evaluation may have been affected by search time and ease of conducting the search within each search interface. Difficulty of the question may have also affected the participant rating.

The data were analyzed using regression analysis (GLM). There was a significant difference between the two interfaces, ($DF = 1$, $F = 48.49$, $p < 0.0001$). Participants preferred the TextFacet interface over the TextOnly interface, with a mean rating for the TextFacet of 4.44 versus a mean rating for TextOnly of 3.98 (on a scale of 1–5). A proportional odds model, an ordinal logistic regression, preformed in R, was used in order to more closely examine the differences between the two interfaces. While the two interfaces showed a similar distribution in predicted probabilities of getting a rating 1–5, the TextFacet search interface was consistently predicted to be rated higher by participants than the TextOnly search interface for all task types. This can be seen in Figure 4. Even with their similar distributions, the TextFacet is more positively skewed, particularly for the *known* task type.

Task Type Differences

In this section the differences between task types are considered for the three dependent variables. Based on the results above, each of the two interfaces was analyzed separately, as they may have had different influences on the results. While presented separately for each interface type, the same statistically significant differences between task types were found when analyzed with the results of the two search interfaces combined for all three dependent variables. Analysis was conducted with SAS using ANOVA and Tukey's HSD for each variable.

Search time. Task types were also found to differ in their search times. There was a statistically significant difference based on task type for both the TextOnly ($F = 52.97$, $p < 0.0001$), and the TextFacet interfaces ($F = 57.45$, $p < 0.0001$); performing a Tukey's HSD analysis showed that search times were different across all task types for each search interface. In addition, every task type search time was significantly different from the other two task types. This underscores the differences between the tasks. The *known* task type had the shortest search times and the times increased, in a scalar fashion, as the task type changed to *partially known* and then *exploratory*. As seen in Figure 5,

DOI: 10.1002/asi

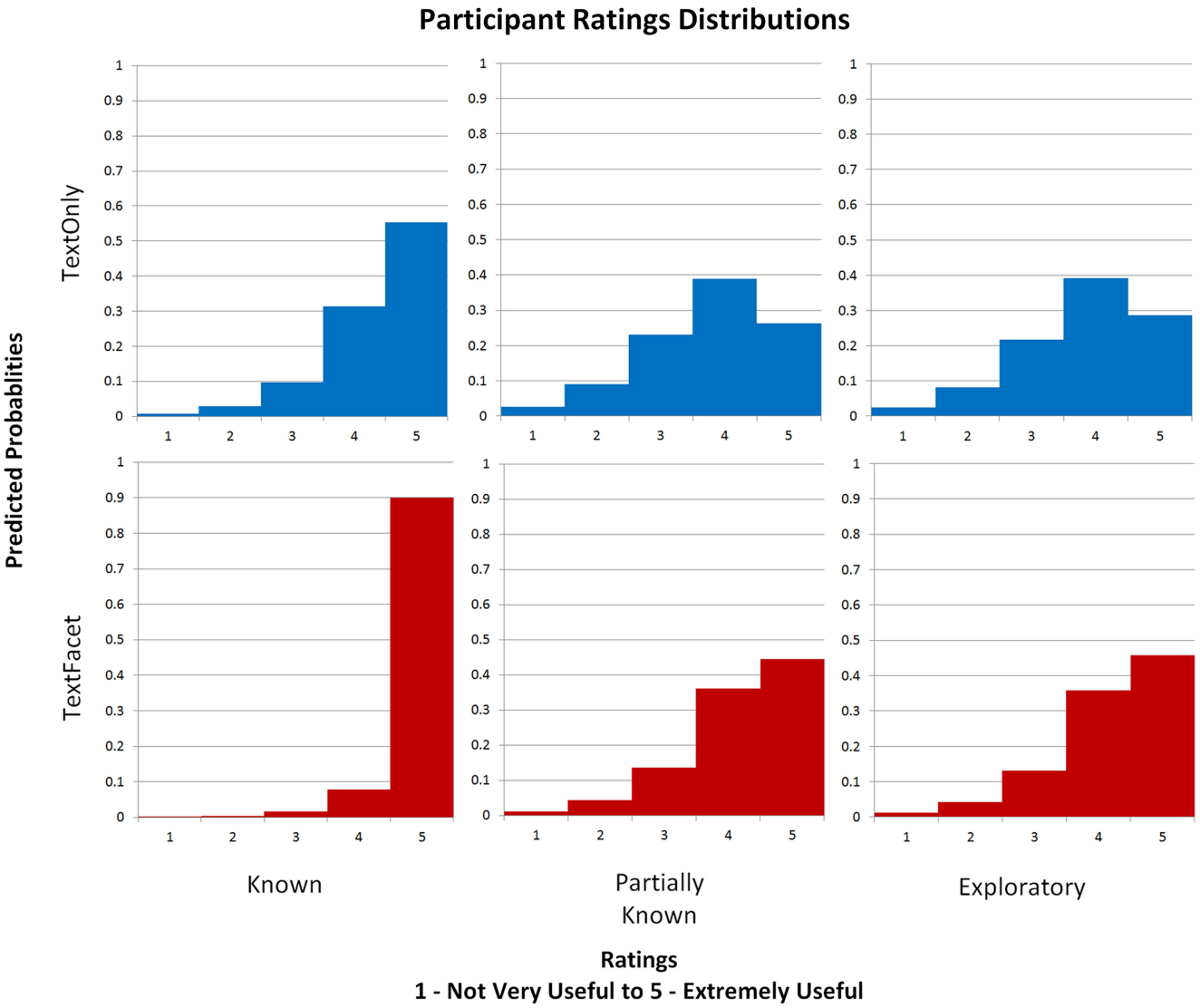

FIG. 4. Participant ratings distributions by task type and interface. Ordinal logistic regression was used to generate predicted probabilities for the ratings data. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

there is also difference between interfaces for each task type, which is particularly pronounced with exploratory task.

Search accuracy. The correctness of the search answer depended on the task type. There was a statistically significant difference based on task type for the TextOnly search interface ($F = 12.74$, $p < 0.0001$), as well as for TextFacet ($F = 11.96$, $p < 0.0001$). An interesting result was that the correctness for all three task types was significantly different from each other for the TextOnly searches, while only the *known* task types were found to be distinctly different from the *partially known* and *exploratory* for the TextFacet searches. These two task types, *partially known* and *exploratory,* were not found to be significantly different for TextFacet searches. This suggests an additional influence on accuracy for the TextFacet or that the two task types had similar challenges to accuracy on this interface. Otherwise the results paralleled those of search time, with performance increasing from exploratory to partially known to the best performance on known tasks.

Search ratings. User ratings of the search process also depended on task type (Figure 4). A regression analysis showed that there was a statistically significant difference by task type for the TextOnly search interface ($F = 11.37$, $p < 0.0001$), as well as for the TextFacet interface ($F = 33.37$, $p < 0.0001$). However, a Tukey's HSD analysis showed that only the *known* task type was significantly different from the *partially known* and *exploratory* task types. For both interfaces, the two task types, *partially known* and *exploratory*, were not found to be significantly different.

Interactions between interface and task type. Because these results may be affected by the task type in combination with the interface, a regression analysis (GLM) was used to look for an interaction between interface and task type.

DOI: 10.1002/asi

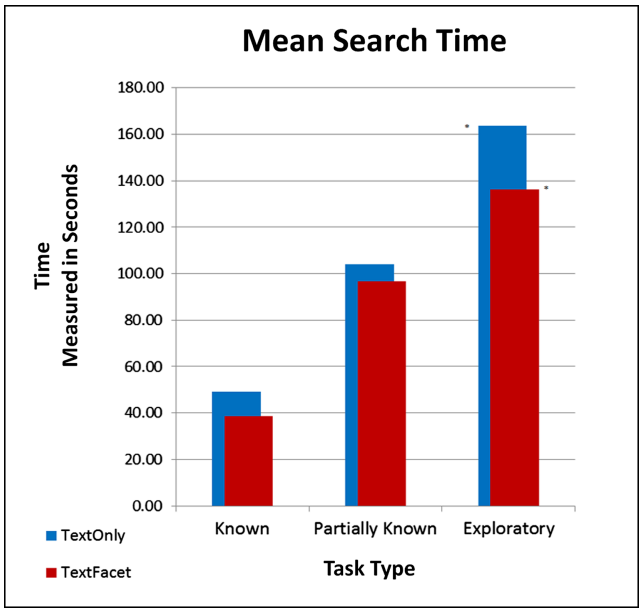

FIG. 5. Search times by task type and search interface. Plotting the means for search time illustrates the significant differences for search time. *Statistically significant difference between interfaces on this task type. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

No statistically significant interaction was found for either time ($DF = 2$, $F = 0.89$, $p = 0.4119$) or rating ($DF = 2$, $F = 0.72$, $p = 0.4892$). However, there was a statistically significant interaction for correctness ($DF = 2$, $F = 4.31$, $p = 0.0137$), which is likely connected to the TextFacet partially known score being lower than would be expected.

Observations Based on Users' Searches

There are nine different facet categories: availability, location, format, subject, publication year, author, call number range, region, and new titles. The most used facets were subject, format, and author. While this seems typical, it is worth noting that the artificial search scenarios may have affected which facets were used—availability and call number range did not factor in to the search criteria for any of the study questions. Availability is actually commonly used—it is now prominently displayed on the record listing itself, which has reduced the need for filtering by this facet.

The application of facets during a TextFacet search was dependent on the participant's task type. For *known* searches, participants rarely used the facets to assist in their search process. Often, with enough information entered in to the initial search, participants found the correct item right away. Occasionally the facets would be used to narrow down a number of similar results by selecting a facet which represented additional information from the question. For example, in Question 5 participants were asked to locate a book. Several participants were observed conducting the initial search including only keywords. With too many results to choose from, which included audio versions of the desired item, some of these participants selected "Book" from the "format" facets to narrow the search results. This differed from those participants who restarted the search or those participants who scrolled through all of the results.

In many of the *exploratory* searches, participants used the facets of the TextFacet interface to narrow or change their search. Once on the results page, most participants would scroll through the results to find items that fit the search criteria, but some of the participants needed more help in narrowing a long list of results. These participants used the "subject" facets to help adjust their search, narrowing the results. Often participants appeared to browse the subject facets looking for variations of the terms in the search criteria, occasionally restarting the search using the new terms gleaned from the facet list. Some participants appeared to use the facets as confirmation that they were searching in the right topical area, and then selected items from the results page without looking further into the record details. This was substantially different from the TextOnly interface, where participants would have to adjust on their own the search terms used or follow subject headings—which would lose the initial search criteria and show all results from that subject heading.

One more important advantage of the faceted-based interface is the ability to more gracefully handle less precise initial text search terms. Because of the ranked relevance results, and the feedback provided through the facets, users were generally able to quickly arrive at successful results with the TextFacet interface. The TextOnly interface, on the other hand, often caused participants problems with incorrectly entered text, or from not specific enough search terms. This observation helped in identifying an additional advantage for the TextFacet interface, which is to autosuggest search terms during text entry, based on the underlying faceted metadata. This helps bridge the problem of differences between the user's mental model and the underlying metadata representation for the content items. By providing suggestions that direct users to use terms that match metadata fields like author and subject, the searcher can be directed more effectively toward proper results. This has been implemented in the current UNC library catalog[10] and has been very successful (used in over 20% of searches, Niu & Hemminger, 2011).

Searchers did not always use the facet-based search interface effectively. For one search question (#7), some participants relied too heavily on the facets to guide them to the desired results. They only examined the facets generated by the initial text search, but not the actual result set, and would get caught up in a cycle of continually changing and rechanging facet selections without making significant progress toward the desired results. While narrowing one's search results by adding facet constraints is generally an effective strategy, it can lead to problems if the initial text search terms have limited the user to an unproductive subset of search results. In these instances, it would be necessary to change the original search terms.

[10] http://www.lib.unc.edu/

DOI: 10.1002/asi

In another search question (#8) some users did not know what the term in the query meant (OED = Oxford English Dictionary), and similarly spent time adding and deleting facets without effectively changing the search results, in this case because of not understanding the query intent. TextOnly query interactions, where users are forced to select new text terms for each query modification, were less likely to have this problem. However, most participants did not have this problem, and those that did quickly learned to consider changing text search terms as well as filtering by facets to modify the search. These two issues (Queries 7 and 8 for faceted search) were the primary reason for the anomalous (relatively poorer) performance in accuracy for the TextFacet partially known searches (Table 4).

Poststudy Interview

Participants' overall qualitative impressions. After completing the 18 study questions, participants were asked about their experiences with both search interfaces. They were asked which interface they preferred overall, what they liked and disliked about each interface, what they found confusing, and they were asked to grade the accuracy of their results for each interface. They were also asked to explain their responses and were probed for details and often asked to demonstrate their responses using the interfaces themselves.

In order to analyze the qualitative data collected at the conclusion of the search tasks, participant responses were coded and organized by similarity and then by theme. Participant comments fell into one of four major categories: (1) Aesthetics/Layout/Presentation; (2) Usability; (3) Search interface (facets, organization, and interface); and (4) Interactions/Results. Comments were also divided into those that were positive/helpful and critical—things that participants felt hindered their search process. During the interview portion of the study, 36 of the 40 participants preferred the TextFacet search interface. On average, the participants believed the answers found using the TextFacet search interface were more accurate than the answers found using the TextOnly search interface.

There were over three times as many favorable comments about the TextFacet search interface as the TextOnly. The majority of the favorable comments for the TextFacet search interface concerned either the ability to modify/refine search results or the ease of use and guidance provided by seeing available facets for narrowing the search. For example: "[You] didn't have to know like exactly what you're looking for . . . it would show up on the side." The favorable comments about the TextOnly search interface were mostly about the initial search interface (basic and advanced) or the results page especially the highlighting of search terms within the resulting record, "I also liked that this one highlighted in red the words that I had searched for. So like if I was looking for a documentary, I knew it was not something like Leatherheads."

There were 2.5 times as many unfavorable comments about the TextOnly search interface than the TextFacet search

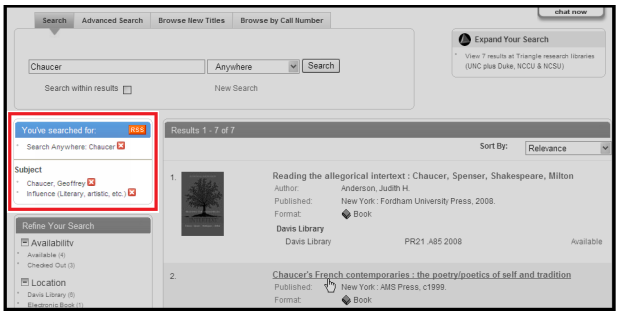

FIG. 6. UNC TextFacet catalog facets. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

interface. The most frequent negative comments about the TextFacet search interface concerned the initial search interface (basic and advance search) and the results page (it being tab-based instead of single page). "Once [I] started narrowing it down, [it was] hard to tell what to take off." Figure 6 shows how the selected facets are presented to the user. The most frequent negative comments about the TextOnly search interface concerned the lack of ability to modify or refine search results easily and the overall organization of the search interface, "[It] felt more difficult to filter out results that were not relevant."

When discussing the TextFacet search interface, seven participants stated that they would not have used the facets or understood how they worked if they had not been pointed out to them by the researcher during the training session. This agrees with Borgman, who suggests that searches are more effective when users have had training (Borgman, 1996, p. 501). While users may have explored or used the facets without the training, they were better able to implement them as part of their search process after being shown how they worked. Among those who did not actually apply the facets during the study, many stated that they liked that they could see the facets on the screen with the search results to confirm they were searching in the right area even if they did not actually select any of the facets. This is supported by Kules et al. (2009) and the results of their eye-tracking study.

Participant confidence in search process. After completing the study questions, participants were asked to grade the correctness of their own answers on a scale from 0–100%. Overall participants graded the TextFacet interface higher than the TextOnly. When asked why there was a difference between the two systems, participants felt the facets of the TextFacet search interface reinforced the notion that the results found fit their search criteria. In addition to this, they also felt that being able to easily modify the search from within the results without starting the search over also provoked confidence in their search results. In the TextOnly search interface, participants placed a lower value on their answers because they were not always sure they were on the right track. Reasons for this included the lack of outside confirmation of the search results. It was not always clear from the initial search page why the records displayed were part

DOI: 10.1002/asi

of the result set. Thus, in order to judge the value of the result set, they often had to open numerous records to determine why they were included. It was not always easily determined from the record details why it had been included in the search results and, as a consequence, participants felt less confident of the correctness of the results.

Limitations of the Study

While the two search interfaces are typical of real-life library catalog interfaces before and after the addition of faceted-based querying, there are other, smaller differences between the catalogs. For instance, the visual presentation of the results looks quite different, with book covers included in the TextFacet search listings, while the TextOnly interface lists more records per screen. Thus, some study measures, like user ratings, may have been influenced by these differences in addition to the presence or absence of faceted querying. One aspect of the interface design of the faceted search was the ability to search within results, which was effectively used for some TextFacet searches, while an equivalent feature was not readily available on the TextOnly interface.

Despite extensive piloting, some questions did affect outcomes. Certain questions trapped inexperienced facet searchers into unproductive search result sets (described in Results). In other cases, participants had problems answering a few questions, apparently due to limited knowledge of the subject matter of the question. This may or may not have caused slower times and poorer accuracy. Another unexpected problem with one of the study questions occurred when the library removed one of the expected response items from the catalog. During peak library usage, the library catalog encountered performance issues, returning results with a slight delay that affected both interfaces. This may have influenced users' frustration with both search interfaces—affecting user ratings, and affecting their search times.

Conclusions

Participants preferred the Endeca-based (TextFacet) search interface compared to the traditional library catalog (TextOnly) search interface. They found the Endeca search interface to be faster and they felt more confident in their answers. They also found the search interface to be more effective in helping them to answer the questions. While they did not always use the facets to adjust their searches, they visually referred to them when evaluating the search results. Participants found positive and negative aspects to both search interfaces, but found that there were more stumbling points for novice searchers in the TextOnly search interface.

There was a statistically significant difference in search times, and participant ratings of their searches due to the search interface. There was no difference in search accuracy, as expected, since searchers had unlimited time. Participants exhibited shorter search times and higher ratings on the TextFacet search interface than the TextOnly search interface.

An important contribution of this work is an examination of the effect of task type on search time, search accuracy, and participant search rating. The results showed a quantitative difference in search time performance across all three tasks, with *known* the fastest, followed by *partially known* and *exploratory,* which took the longest. In accuracy and ratings, there was a clear difference found between *known* and *partially known/exploratory* tasks. It was less clear whether there was a difference between partially known and exploratory tasks. It may be that a difference exists as evidenced by search time differences, but it was not detectable in this study perhaps because of interaction problems with the faceted search interaction as described in the results section. On the other hand, while the two tasks may be different for some purposes, it might be that they are similar enough that they should be considered part of the same search task class. This merits further investigation.

Overall, participants preferred the TextFacet search interface, both for ease of use and because the facets reinforced confidence in selecting a correct answer. Using the facets, participants could narrow and broaden their searches while still maintaining context for their search. This suggests that a primary tactical use of facets in the search process is to narrow a large result set down to a more manageable size for browsing. And it facilitates users providing less specific or less accurate textual queries to begin the search process because of the ease of narrowing the resulting search set with facets. While many participants did not actually select facets when conducting their searches, their statements of utilizing them for feedback and verification, suggest that usage numbers may be higher than those reported from log analysis (30–46% from Antelman et al., 2006; Lown, 2008; Niu et al., 2009). Based on our participant's comments and Kules's (2009) findings, it is clear that facets facilitate the broadening or narrowing of search results and provide a mental framework for navigation and a means to analyze results. Further, it is anticipated that autosuggestion of text entry terms based on the underlying metadata will further improve TextFacet search results.

It is important to remember that, despite their ease of use, some participants indicated they would not have used the facets or used them as well without training. Thus, while today's users may increasingly come in contact with faceted search experiences, it may still be desirable to educate them about dynamic faceted search interfaces as a basic component of information literacy.

The advantages of a TextFacet-based interface are a step toward making library catalogs more user-friendly for the novice user and overcoming some of the challenges identified by Borgman (1986a, 1996). The users taking part in this study adapted to the Endeca-based TextFacet search interface with little difficulty. Overall, the participants using the TextFacet search interface as compared to the TextOnly search interface performed better, rated it better on a per question and overall basis, and had more positive comments about it. This strongly suggests that libraries consider adding facet-based search interface capabilities to their library catalogs.

DOI: 10.1002/asi

Future Work

There are still many unanswered questions when it comes to facets. It is expected that there are user factors like individual search habits and experience level as well as contextual factors like differences between academic and public libraries which could affect these results. A more detailed examination of individual steps in the search process as well as the higher level tactics employed may provide better information about how facets are used. Continuations of this work are under way at UNC to attempt to gain a more complete understanding of the search process by combining detailed transaction log data, where search motivation is usually not known, with observational studies of subjects performing specific search tasks.

Acknowledgments

We thank Lisa Norberg, Jill Sexton, and Ben Pennell of the UNC Library for their assistance in making available the library catalog interfaces, and space in the library to conduct the experiment, Julia TerMaat for being the second scorer for evaluating correctness of answers, and Julia Kampov for all her help and support. This study was funded in part by a grant from the Ochiltree Foundation (Information Seeking Behavior of Scientists, P.I. Bradley Hemminger).

References

Antelman, K., Lynema, E., & Pace, A. (2006). Toward a 21st century library catalog. Information Technology and Libraries, 25(3), 128–139.

Bates, M.J. (2002). The cascade of interactions in the digital library interface. Information Processing & Management, 38(3), 381–400.

Bilal, D. (2002). Children's use of the Yahooligans! Web search engine. III. Cognitive and physical behaviors on fully self-generated search tasks. Journal of the American Society for Information Science and Technology, 53(13), 1170–1183.

Borgman, C.L. (1986a). Why are online catalogs hard to use? Lessons learned from information-retrieval studies. Journal of the American Society for Information Science, 37(6), 387–400.

Borgman, C.L. (1986b). The user's mental model of an information retrieval system: An experiment on a prototype online catalog. International Journal of Man-Machine Studies, 24(1), 47–64.

Borgman, C.L. (1996). Why are online catalogs still hard to use? Journal of the American Society for Information Science, 47(7), 493–503.

Dean, R.J. (2003). FAST: Development of simplified headings for metadata. Authority Control: Definition and International Experiences Conference, Florence, Italy. Retrieved from: http://www.sba.unifi.it/ac/relazioni/dean_eng.pdf

Emanuel, J. (2011). Usability of the VuFind next-generation online catalog. Information Technology & Libraries, 13(1), 44–52.

English, J., Hearst, M., Sinha, R., Swearingen, K., & Lee, K. (2002). Flexible search and navigation using faceted metadata. Technical Report. University of California at Berkeley.

Hearst, M.A. (2006). Design recommendations for hierarchical faceted search interfaces. In A. Broder, Y. Maarek (Ed.), SIGIR 2006 Workshop on Faceted Search (pp. 26–30). New York: ACM Press.

Howell, D. C. (2002). Statistical methods for psychology (5th ed.). Pacific Grove, CA: Duxbury/Thomson Learning.

Maarek (Ed.), SIGIR 2006 Workshop on Faceted Search (pp. 26–30). Seattle, WA, August 10, 2006.

Kim, K. (2001). Information-seeking on the Web: Effects of user and task variables. Library & Information Science Research, 23(3), 233–255.

Kules, B., & Capra, R. (2008). Creating exploratory tasks for a faceted search interface. Paper presented at the Second Workshop on Human-Computer Interaction (HCIR 2008).

Kules, B., Capra, R., Banta, M., & Sierra, T. (2009). What do exploratory searchers look at in a faceted search interface? In Proceedings of the 9th ACM/IEEE-CS Joint Conference on Digital Libraries, JCDL '09 (pp. 313–322). New York: ACM.

La Barre, K. (2007). The heritage of early FC in document reference retrieval systems, 1920-1969. Library History, 23(2), 129–149.

Larson, R.R. (1991). Classification clustering, probabilistic information retrieval, and the online catalog. The Library Quarterly, 133–173.

Lown, C. (2008). A transaction log analysis of NCSU's faceted navigation OPAC. School of Information and Library Science. Retrieved from: http://hdl.handle.net/1901/488

Lown C., & Hemminger, B.M. (2009). Extracting user interaction information from the transaction logs of a faceted navigation OPAC. Code4Lib Journal, Issue 7, 2009-06-26.

McGrath, K. (2007). Facet-based search and navigation with LCSH: Problems and opportunities. Code4Lib Journal, 1.

McGrath, K., Kules, B., & Fitzpatrick, C. (2011). FRBR and facets provide flexible, work-centric access to items in library collections. In Proceeding of the 11th Annual International ACM/IEEE Joint Conference on Digital Libraries (pp. 49–52).

Niu, X., Lown, C., & Hemminger, B.M. (2009). Log based analysis of how faceted and text based search interact in a library catalog interface. In Proceedings of the 3rd Workshop on Human-Computer Interaction and Information Retrieval (HCIR '09) (pp. 62–65). Washington, DC, October 23, 2009.

Niu, X., & Hemminger, B.M. (2010a). A method for visualizing transaction logs of a faceted OPAC. Code4Lib Journal, Issue 12, ISSN 1940-5758.

Niu, X., & Hemminger, B.M. (2010b). Tactics for information search in a public and an academic library catalog with faceted interfaces. In Proceedings of the 4th Workshop on Human-Computer Interaction and Information Retrieval (HCIR '10) (pp. 83–86). New Brunswick, NJ, August 22, 2010

Niu, X., & Hemminger, B.M. (2010c). Beyond text querying and ranking lists: How people are searching through faceted catalogs in two library environments. In Proceedings of the 73rd ASIS&T Annual Meeting, Vol. 47. Pittsburgh, PA, October 22–27, 2010.

Niu, X., & Hemminger, B.M. (2011). Beyond text querying and ranked lists: Faceted search in library catalogs. In Proceedings of the 74th ASIS&T Annual Meeting, Vol. 48. New Orleans, LA, 2011.

Novotny, E. (2004). I don't think I click: A protocol analysis study of use of a library online catalog in the Internet age. College & Research Libraries, 65(6), 525.

Olson, T.A. (2007). Utility of a faceted catalog for scholarly research. Library Hi Tech, 25(4), 550–561.

Qu, Y., & Furnas, G.W. (2008). Model-driven formative evaluation of exploratory search: A study under a sensemaking framework. Information Processing & Management, 44(2), 534–555.

Randolph, J.J. (2008). Online kappa calculator. Retrieved from: http://justus.randolph.name/kappa

R Data Analysis Examples: Ordinal Logistic Regression. UCLA: Academic Technology Services, Statistical Consulting Group. Retrieved from: http://www.ats.ucla.edu/stat/r/dae/ologit.htm

Salaba, A., & Zhang, Y. (2009). User perspectives on NextGen catalog features. Proceedings of the American Society for Information Science and Technology, 46(1).

Sharit, J., Hernández, M.A., Czaja, S.J., & Pirolli, P. (2008). Investigating the roles of knowledge and cognitive abilities in older adult information seeking on the web. ACM Transactions on Computer-Human Interaction (TOCHI), 15, 3:1–3:25.

White, M.D., & Iivonen, M. (2001). Questions as a factor in web search strategy. Information Processing & Management, 37(5), 721–740.

Yee, K.P., Swearingen, K., Li, K., & Hearst, M. (2003). Faceted metadata for image search and browsing. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 401–408). April 5–10, 2003, Ft. Lauderdale, FL.

DOI: 10.1002/asi

Appendix I. Study Questions

Task Type 1

1. You are researching German films and need to locate and view the DVD version of Rainer Werner Fassbinder's "Berlin Alexanderplatz."
2. A friend was recently talking about a book she read about language, and you'd like to read it for yourself. Find out whether the library has a copy of Steven Pinker's "The Stuff of Thought."
3. From the class syllabus, locate a copy of the required text for your Telecommunications class. The ISBN is 0792325688. Locate a copy of the book in the library so that you do not have to buy it.
4. You are working on a project about Bach for your introductory music appreciation class. Locate a copy of "The New Bach Reader" published by Norton.
5. You are taking a creative writing class next semester taught by Sarah Dessen. She is a local author and you want to check out her writing style. Look for a copy of her recent book, "Lock and Key."
6. For your Spanish literature class you are asked to translate a passage from a modern work of fiction. The instructor has given you a list of choices. Find a copy, in Spanish, of "El Alquimista" by Paulo Coelho.

Task Type 2

7. You remember using a book for a class a few semesters ago that was really useful, and you'd like to see whether the library has a copy. It was about using PHP for Web Development. You think one the author's names rhymed with "spelling."
8. Your professor suggested you use something called the "OED" for finding the historical usage of particular words. Find this resource in electronic form.
9. A friend was raving about a book she just finished. You want to read it, but you can't remember the title, but you're sure it's Pynchon's latest novel.
10. You heard a book mentioned on the radio that you'd like to read. All you remember is that it has the word "Germs" in the title and that it's about the advancement of human civilizations throughout history. Locate the book.
11. This summer you are taking a trip to Europe and to get ready for your trip you want to read some travel books. You have read other books by travel author Bill Bryson and you think he wrote one about Europe. See if the library has it in their collection.
12. You are having a party for a friend and you want to include some Big Band style music. They are a big fan of Frank Sinatra. Search the library catalog to see if they have a musical recording of Frank Sinatra singing Big Band music.

Task Type 3

13. You need to write a paper about the philosopher Arthur Schopenhauer. Find 3 resources relating Schopenhauer to aesthetics you would use to begin your research. Be sure the resources you find are in English.
14. This semester you are taking an American History class. For an assignment you are asked to find three documents that deal with the economic aspects of the Civil War in North Carolina.
15. You are interested in learning more about the concept of free-will to help you write a paper on the topic for your philosophy class. Choose 3 sources that would provide a good introduction to the topic.
16. Find 3 sources that would help get you started researching microfinance as a means to provide economic development in poor regions.
17. You are writing a paper for an art class. You want to write about Graffiti as art. You have heard it is also called street art. Find 3 sources about the history of Graffiti.
18. You are in the Math and Physics Library working on a project. You need to find three resources about the relationship between physics and musical sound. See if you can find them in this library.

DOI: 10.1002/asi